PART 1 – GENERAL

1.1 RELATED DOCUMENTS

Applicable portions of the Project Manual including but not limited to the Drawings and Specifications.

1.2 SUMMARY

This Section includes administrative and procedural requirements governing allowances.

Definition:

Allowances. "'Allowance' is defined as "a not-to-be-exceeded amount", either individually or in the aggregate, which is established between the Owner and the CONTRACTOR as part of the bid documents when the precise scope of a particular line item(s) has not been defined to a level which is adequate for the CONTRACTOR to provide a definitive line item pricing for that particular scope of Work.

1.3 COORDINATION

At the earliest practical date after award of the Contract, the Contractor shall advise Owner of the date when final selection and purchase of each product or Work described by an Allowance must be completed to avoid delaying the Work.

Coordinate Allowance items with other portions of the Work. Furnish templates as required to coordinate installation.

1.4 PROCEDURES

Submit cost proposals for purchase of products or work included in Allowances in the form specified for Change Orders.

Coordinate and process submittals for Allowance items in accordance with Section 01300 as for other portions of the Work.

The use of any Allowances by the CONTRACTOR will be subject to the Owner's sole approval and it is the Owner's intent to minimize the use of Allowances to the fullest extent possible.

For any Allowances which the Owner allows the CONTRACTOR to use, the following rules shall apply: (i) the Allowance shall cover the cost to the CONTRACTOR of the cost of Work, as defined in the Agreement and the CONTRACTOR's portion of overhead and profit associated with the stated Allowance; and (iii) upon completion of the portion of the Work subject to an Allowance, the Contract Amount for that portion of the Work will be adjusted based upon the approved actual Cost of the Work, including the proportionate overhead and profit, provided however that the total amount of payments under the Allowances will not exceed the approved aggregate amount of the Allowances.

PART 2 – PRODUCTS

NOT USED

PART 3 – EXECUTION

3.1 SCHEDULE OF ALLOWANCES

Allowance No. 1 – Security System $200,000
Allowance for security system required for this project as identified by the Owner to the Contractor after the Contractor's bid award. The security system shall be furnished and installed by a security system contractor that shall be designated by the Owner.

3.2 PAYMENT

Once the cost proposal for the Allowance has been incorporated into the Contract by Change Order, Payment for the Allowance will be based upon either the unit prices or a schedule of values provided with the proposal and incorporated in the Change Order.

END

MEASUREMENT AND PAYMENT LUMP SUM CONTRACTS
Section 01025

For this Project, all measurement and payment sections, including standard technical specifications and special specifications, are modified by this Section.

All work items installed, provided, constructed, etc. with the exception of the unit price items listed in the 300L, shall not be paid for separately but shall be considered subsidiary to the lump sum bid price for the Project. The cost of all work materials, labor, overhead, insurance, equipment, etc. necessary to finish the work complete in place shall be included in the lump sum bid price for the project.

End

ALTERNATES
Section 01030

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

Applicable portions of the Project Manual, including but not limited to relevant Drawings and Specifications.

1.2 SUMMARY

This Section includes administrative and procedural requirements for alternates.

1.3 DEFINITIONS

A. Alternate: A Bid Item for a scope of work described in the Section 00300 Bid Requirements and Contract Documents that, if accepted by Owner, may result in additions to or deductions from the Base Bid.

1.4 PROCEDURES

A. Coordination: The Contractor must modify or adjust any affected adjacent Work as necessary to completely integrate work of the Alternate into the Project.

B. The Contractor must include as part of each Alternate, any miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of the Alternate.

C. Notification: The awarded contract will include all accepted Alternates.

D. Schedule: A Schedule of Alternates is included at the end of this Section. Specification Sections referenced in such schedule contain requirements for materials necessary to achieve the Work described under each Alternate.

E. Bidders must respond to all Alternates listed on the 00300 Bid Form, even if acceptance or rejection of an alternate will not change the Bid amount. Bid amounts must be entered in the spaces for each Alternate in the Bid Form.

The Owner has established a priority order (Alternate No. 1 has the highest priority) for the acceptance of Bid Alternates based on the Project needs and budget. Alternates will be accepted in the order listed on the Bid Form, but such acceptance will not exceed the Project budget.

PART 2 - PRODUCTS

NOT USED

PART 3 – EXECUTION

3.1 SCHEDULE OF ALTERNATES

Alternate No. 1 – Alternate Water Quality Controls: The construction of drainage improvements and rain gardens along Forest View Dr. between Redbud Tr. and the Bee Creek substation.

The trapezoidal ditches have (3H:1V) side slopes with an average depth of 1.25 feet and varying bottom with (Bw) and length (1175 LF with 2.5-foot Bw, 275 LF with 1-foot Bw, and 1000 LF with 3-foot Bw), including 750 CY (plan) of excavation, including 3575 SY of Soil Retention Blanket Class 1 Type A, Topsoil and Seedbed Preparation, and Native Seeding for Erosion Control.

The cross drainage structures include 3 EA Four-Sided Area Inlets, 300 LF of 24" RCP Class IV Pipe, 75 LF of which will include CLSM bedding and embedment, 3 EA Headwalls with Energy Dissipators, 170 CY of Dry Rock Riprap including bedding layer and filter fabric, 150 LF of level spreader wall approximately 2-feet tall with 150 LF of laydown curb removal and replacement and pavement restoration (3" HMAC Type C, 10" compacted flex base, and 8" moisture conditioned subgrade) and 300 LF of video of installed storm drain pipe.

The infiltration rain gardens include 140 CY of biofiltration medium, 24 CY of concrete retaining walls, cast-in-place including reinforcement, 155 CY (plan) of unclassified Structural Excavation & Backfill, 12 CY of Embankment, 150 LF of laydown curb removal and replacement with rain garden inlet, 85 CY of Dry Rock Riprap including bedding layer and filter fabric, 150 LF of level spreader wall approximately 2-feet tall, 263 EA 3-Gallon and 1-Gal Plants, with 30 lbs. each of Black-eyed Susan and Gregg's Mistflower seed.

Adjustments to existing utilities include 75 LF of 16" Class 250 Ductile Iron waterline with restrained joints, 6 EA 16"x16" Wet Connections, 6 EA concrete retards around the existing 16" waterline, and pavement restoration (3" HMAC Type C, 10" compacted flex base, and 8" moisture conditioned subgrade), 300 LF of two 1" telecommunication lines.

Erosion and Sedimentation Controls include 300 LF of silt fence, 35 LF of rock berm, 1 stabilized construction entrance, and 2720 LF of Mulch Sock. Tree protection includes 3,088 LF of Protective Fencing Type A Chain Link Fence (Typical Application).

Also included is 0.77 Ac of preparing Right of Way, Clearing and Grubbing, and Management Practices, 156,000 Gallons of Watering, 15 EA 3-Inch Caliper Tree Mitigation, and 10 EA 6-Inch Caliper Tree Mitigation.

END

1. CONTRACTOR shall perform all layout work to transfer all controls for grades, lines, levels and measurements from a minimum of two reference points provided by OWNER. All survey work will be performed under the direct supervision of a Texas Registered Professional Land Surveyor (RPLS).

2. Within 5 work days of the Notice To Proceed date, or within 10 Working Days of initiating work based on the approved Schedule in a new area of the Project, the CONTRACTOR shall survey and stake the locations of all proposed improvements behind the curb and within the ROW (examples: manholes, storm inlets, fire hydrants, etc.), or any other improvements identified by the OWNER'S REPRESENTATIVE, for the purpose of identifying the nature and location of these improvements to the adjacent property owner(s). The OWNER'S REPRESENTATIVE will identify to the CONTRACTOR the improvements to be staked.

3. OWNER will not stake for construction and will not be on site for survey layout activities, except to perform quality control checks.

4. CONTRACTOR shall be required to set elevation hubs (blue tops) for subgrade and base course on centerline, at quarter points and curb lines or edge of pavement at intervals not exceeding 50 feet.

5. The construction plans will include horizontal and vertical control points. References to approved COA benchmarks used in establishing controls on the drawings will be provided by the Owner's E/A. In addition, on building projects and/or projects not built within an existing public ROW, a boundary survey will be supplied together with a legal description of the property and all easements where Work will take place.

6. CONTRACTOR shall submit construction staking layout sheets sealed by a Professional Engineer or Registered Professional Land Surveyor registered in the State of Texas. CONTRACTOR shall use a qualification based selection process consistent with the Professional Services Procurement Act, Chapter 2254.004 of the Texas Government Code, when securing the services of a Professional Engineer or Registered Professional Land Surveyor. It is a violation of State Law to solicit bids for the services of a Professional Engineer of Registered Professional Land Surveyor.

    6.1 Any discrepancies found with the construction documents' dimensional layout will be corrected. CONTRACTOR shall assure that the Owner's Representative and E/A are notified so that the appropriate actions are taken to correct the Contract drawings.

    6.2 All Work shall be done to the lines, grades and elevations indicated on the drawings. Information concerning basic horizontal and vertical control points will be provided by the E/A, **HDR Engineering Inc**. These points shall be used as the datum basis under this Contract.

    6.3 All work to transfer all controls for grades, lines, levels, layout and measurements shall be performed under the supervision of a Texas Registered Professional Land Surveyor, provided by the CONTRACTOR. Such work shall conform to the standards for construction staking in the most recent edition of the Texas Society of Professional Surveyors Manual of Practice for Land Surveying, Category 5, Sections 1-12 inclusive.

6.4 The offset centerline stakes will be set at no greater than fifty (50) foot intervals and at points of alignment or grade changes. References to lines and grades as established by the CONTRACTOR's surveyor shall be in reference to these stake lines. The CONTRACTOR is required to provide a sealed statement from his RPLS that the controls are correct and the site layout has been done by their professional staff.

6.5 The CONTRACTOR shall place grade stakes and submit construction staking layout sheets. The CONTRACTOR shall allow a minimum of ten (10) days after submission to the Owner's Representative for review of construction staking layout sheets. Construction staking layout sheets shall include, at a minimum, the information contained in the form included at the end of this section. No Work shall be performed without Owner's Representative review and return to CONTRACTOR of construction staking layout sheets. The Owner's Representative, E/A and the CONTRACTOR shall review the survey controls on the ground.

6.6 Prior to any excavation, the CONTRACTOR shall establish the elevation to top of ground at offset stakes at the distance deemed appropriate by the CONTRACTOR to preclude disturbance of offset stakes during construction. **The CONTRACTOR shall set all blue tops for subgrade and base courses on centerline at quarter points, at curb lines or edge of pavement, and other points that may be indicated on the Drawings, all at intervals not to exceed 50 feet.**

6.7 The CONTRACTOR shall furnish, without charge, experienced personnel and such calibrated survey equipment, tools, stakes, and other materials that the Owner's Representative may require in establishing or checking control points, or in checking survey, layout, and measurement work performed by the CONTRACTOR.

6.8 The CONTRACTOR shall keep the Owner's Representative informed in a reasonable time in advance of the times and places at which he wishes to do work, so that any checking deemed necessary by the OWNER may be done with minimum inconvenience to the E/A and minimum delay to the CONTRACTOR. Surveying will be coordinated between the Owner's Representative and CONTRACTOR in a manner convenient to both.

6.9 During layout, CONTRACTOR shall field verify the elevation and alignment of all tie-in points to existing infrastructure. This work shall be performed sufficiently in advance of construction so that any conflicts may be resolved without delay. Any work done without being properly located may be ordered removed and replaced at the CONTRACTOR's expense.

6.10 The CONTRACTOR shall carefully preserve all monuments, benchmarks, reference points, and stakes. In case of the destruction thereof, the CONTRACTOR shall bear the cost of replacement and shall be responsible for any mistake or loss of time that may be caused. Permanent monuments or benchmarks, which must be removed or disturbed, shall be protected until properly referenced for relocation. The CONTRACTOR shall furnish materials and assistance for the proper replacement of such monuments or benchmarks.

6.11 The CONTRACTOR shall satisfy himself before commencing work as to the meaning and correctness of all survey control stakes, marks, etc., and no claim will be entertained by the OWNER for or on account of any alleged inaccuracies, unless the CONTRACTOR notifies the OWNER in writing before commencing the affected Work.

7. As needed for necessary documentation of the work progress, the CONTRACTOR shall maintain and/or protect offset or survey staking for the duration of the project. Any re-staking required to meet this requirement shall be done at the CONTRACTOR'S expense.

8. This item is subsidiary to the work as a whole.

End See attached "Construction Staking Layout Sheet"

CONSTRUCTION STAKING LAYOUT SHEET

Project Name: _____ **Date:** _____
C.I.P. ID#: _____ **Instrument No.:** _____
Person Recording: _____ **Weather Conditions:** _____
Crew Members: _____
General Purpose & Scope of Survey: _____

STATION	B.S.	H.I.	F.S.	LEVEL LOOP ELEVATION	ROD READING	HUB ELEVATION AT STATION	(TARGET) (eg., pipe invert) ELEVATION	C - CUT OR F - FILL	% GRADE	NOTES: INDICATE WHETHER CENTERLINE HUB OR _____ FT. OFFSET HUB

PART I - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Administrative and procedural requirements for:

a. Indication of applicable building codes and related codes.

b. Project signs.

c. Contractor's field office.

d. Engineer's field office.

e. Project photographic documentation.

f. Adjacent properties and facilities.

1.02 QUALITY ASSURANCE

A. Regulatory Requirements:

1. References in the Contract Documents to local code(s) means the following:

a. National Electric Code in effect at the location of the Project.

b. NFPA 101 – Life Safety Code.

1.03 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:

a. Engineer’s Field Office: Proposed location, type of construction, size, and layout of Engineer’s field office.

2. Project Data:

a. Manufacturer’s published literature and product data for Engineer’s field offices:

1) Furniture and furnishings.

2) Office equipment.

3) Safety items and first-aid kit.

4) Proposed communications service(s).

1.04 CONTRACTOR'S FIELD OFFICE

A. Establish at the Site the Contractor's field office, structurally sound and in accordance with Laws and Regulations, sufficient for Contractor's needs at the Site. [Contractor's field office shall have a US postal service mailing address.]

B. Equipment: Telephone, copier/scanner, and (as deemed necessary by Contractor) appropriate computer equipment.

C. Contractor's personnel will be reasonably present at Contractor's office during working days.

D. At Contractor's field office, maintain complete file of the Contract Documents, Submittals approved or accepted (as applicable) by Engineer, interpretations and clarifications issued by Engineer, copies of Contractor's daily field reports in accordance with Section 01 71 23 - Field Engineering, all necessary and required safety data sheets, copies of documents comprising Contractor's safety program, record documents required by the Contract Documents including the General Conditions and Section 01 78 39 - Project Record Documents), and other files of field operations deemed appropriate by Contractor and as required by the Contract Documents.

E. Remove field office from Site following Substantial Completion of all the Work and prior to final inspection of the completed Work.

1.05 ENGINEER'S FIELD OFFICE Separate from Contractor's field office.

A. General Construction:

1. New or reconditioned mobile office trailer as manufactured by Other.

2. Baked enamel aluminum siding.

3. 3-1/2 IN foil-backed fiberglass insulation throughout.

4. Interior paneling.

5. Vinyl tile flooring.

6. 8 FT high acoustic tile ceiling.

7. Two private office areas, one at each end of trailer, one reception-conference room area, and private washroom.

8. Windows:

   a. Minimum two per room, excepting washroom, with one each on opposing walls.

   b. Combination screen-storm windows.

   c. Provide horizontal louver blinds on each window.

9. Nominal 16 FT long and 8 FT wide.

10. Two exterior doors (with cylinder deadbolt locks) with outer screens, exterior lights and exterior stairs and railings.

11. A sketch of interior configuration with up to four doors will be provided by the Engineer.

12. Trailers, once sited, must be securely tied down and grounded.

B. Electrical System:

1. All fixtures, outlets, and wiring of Underwriters Laboratories, Inc. (UL) approved devices.

2. All circuits protected by circuit breakers; fuses are not acceptable.

3. Electrical system shall meet requirements of the latest National Electric Code (NEC).

4. System suitable for 220 V, 3 PH service.

5. Any transformers or other devices required to match this supply to the mobile office shall be provided and connected.

6. Provide a circuit breaker for the incoming service.

7. Each interior room except the washroom shall have at least four, 110 V duplex electrical convenience outlets.

C. Central Combination Electric Heating, Air-Conditioning System:

1. Fan-forced air.

2. Thermostatically controlled.

3. Individual room units are not acceptable.

4. Freeze protect and insulate all piping.

5. System sized to maintain 75 DEGF constant temperature in each room.

D. Lighting System:

1. Fluorescent type producing 100 foot-candles at desk top height.

2. Ample ceiling fixtures provided to ensure adequate lighting throughout.

E. Standard Washroom:

1. Flush toilet, sink, hot and cold running water.

2. Electric water heater.

3. Mirror.

4. Electric ceiling or wall vent.

5. Sound insulated partitions.

F. Furnishings:

1. Full width built-in desk at ends of both end offices, with a nominal depth of 30 IN and overhead book shelves 12 IN deep.

2. Two desks 36 x 72 IN long with locking lap drawer.

3. One plan table 39 x 84 IN x 36 FT wide, with one locking equipment drawer.

4. One L-shaped secretary desk with main desk 36 x 72 x 36 IN high with locking lap drawer, side drawer, and hanging file drawer.

   a. The desk shall have a typewriter leaf with a typing paper filing cabinet.

5. Two 30 x 72 IN folding tables.

6. 6 folding chairs.

7. One Emerson Model OR300A, 2.7 CUFT refrigerator.

G. Safety Equipment:

1. One 10 LB ABC dry powder fire extinguisher, upright and fully charged, in an easily accessible location.

2. One OSHA, "Employee Right to Know" Poster, prominently displayed.

3. One first aid kit.

4. One weather radio.

H. Maintenance:

1. Provide all maintenance and upkeep of trailer and equipment.

   a. Equipment breakdowns shall be repaired promptly by Contractor.

2. Janitorial service.

   a. Weekly:

      1) Floor sweeping using dust suppressing compound.

      2) Wet mopping with floor detergent.

   b. Inclement weather: Conduct weekly requirements on daily basis.

c. Monthly: Wash windows and clean window blinds.

3. Pay all utilities costs.

4. Maintain at least until acceptance of the entire work by the Owner or until otherwise suspended by the Engineer.

I. Removal of Engineer's Field Office:

1. Remove field office from the Site following Substantial Completion and prior to final completion.

2. Jointly agree with Engineer and Resident Project Representative (RPR) on the date for closure of Engineer's field office, disconnection of utilities, removal of field office equipment, and physical removal of the field office and restoration of the field office area.

3. Completely remove Engineer's field office, all appurtenances, and associated site work such as walkways or sidewalks to the field office, temporary parking areas, temporary utilities serving the field office, and field office structure.

4. Restore area of the field office to conditions required by the Contract Documents. If not expressly required by the Contract Documents, restore area of field office to condition equal to or better than that at the time the Contract Times started to run.

PART II - PRODUCTS (NOT USED)

PART III - EXECUTION

END

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DEFINITIONS

General: Basic Contract definitions are included in the General Conditions, Section 00700 included herein.

Approved: The term approved, when used in conjunction with the Owner's Representative's action on the CONTRACTOR'S submittals, applications, and requests, is limited to the Owner's Representative's duties and responsibilities as stated in the Conditions of the Contract. A stamp reading "No Exceptions Taken" shall have the same intent as "Approved".

Furnish: The term furnish means supply and deliver to the Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

Indicated: The term indicated refers to graphic representations, notes, or schedules on the Drawings, or other paragraphs or schedules in the Specifications, and similar requirements in the Contract Documents. Terms such as shown, noted, scheduled, and specified are used to help the reader locate the reference. There is no limitation on location.

Install: The term install describes operations at the Project site including the actual unloading, unpacking, assembly, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

Installer: An Installer is the CONTRACTOR or another entity engaged by the CONTRACTOR, either as an employee, subcontractor, or contractor of lower tier, to perform a particular construction activity, including installation, erection, application, and similar operations. Installers are required to be experienced in operations they are engaged to perform.

Project Site: The space available to the CONTRACTOR for performing construction activities either exclusively or in conjunction with others performing other work as part of the Project. The extent of the Project site is shown on the Drawings and may or may not be identical with the description of the land on which the Project is to be built.

Provide: The term provide means to furnish and install, complete and ready for the intended use.

Regulations: The term regulations includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.

Trades: Using terms such as carpentry is not intended to imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as carpenter. It also does not imply that requirements specified apply exclusively to trades persons of the corresponding generic name.

INDUSTRY STANDARDS

Applicability of Standards: Except where the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

Publication Dates: Comply with the standards in effect as of the date of the Contract Documents.

Conflicting Requirements: Where compliance with two or more standards is specified and where the standards may establish different or conflicting requirements for minimum quantities or quality levels, refer to the Owner's Representative for a decision before proceeding.

Copies of Standards: Each entity engaged in construction on the Project is required to be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

Abbreviations and Names: Trade association names, titles of general standards, and names and titles of government agencies are frequently abbreviated. Where such acronyms or abbreviations are used in the Specifications or other Contract Documents, they mean the recognized name of the trade association, standards-generating organization, authority having jurisdiction, or other entity applicable to the context of the text provision. Refer to the "Encyclopedia of Associations," published by Gale Research Co., available in most libraries.

AA	Aluminum Association
AABC	Associated Air Balance Council
AAMA	American Architectural Manufacturer's Association
AAN	American Association of Nurserymen.
AASHTO	American Association of State Highway and Transportation Officials.
AATCC	American Association of Textile Chemists and Colorists
ACI	American Concrete Institute
ACIL	American Council of Independent Laboratories
ACPA	American Concrete Pipe Association
ADC	Air Diffusion Council
AFBMA	Anti-Friction Bearing Manufacturers Association
AGA	American Gas Association
AGC	Associated General Contractors of America
AGMA	American Gear Manufacturers Association
AHA	American Hardboard Association
AHAM	Association of Home Appliance Manufacturers
AI	Asphalt Institute
AIA	American Institute of Architects
AIHA	American Industrial Hygiene Association
AISC	American Institute of Steel Construction

AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction.
ALCA	Associated Landscape Contractors of America
ALI	Associated Laboratories, Inc.
ALSC	American Lumber Standards Committee
AMCA	Air Movement and Control Association
ANSI	American National Standards Institute.
AOAC	Association of Official Analytical Chemists
AOSA	Association of Official Seed Analysts
APA	American Plywood Association
API	American Petroleum Institute.
AREA	American Railroad Engineers Association
ARI	Air Conditioning and Refrigeration Institute
ARMA	Asphalt Roofing Manufacturers Association
ASA	Acoustical Society of America
ASA	American Standards Association.
ASC	Adhesive and Sealant Council
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating & Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASPE	American Society of Plumbing Engineers
ASSE	American Society of Sanitary Engineering
ASTM	American Society for Testing and Materials.
AWCMA	American Window Covering Manufacturers Association
AWG	American Wire Gage
AWI	Architectural Woodwork Institute
AWPA	American Wood Preservers Association

AWPB	American Wood Preservers Bureau
AWPI	American Wood Preservers Institute
AWS	American Welding Society
AWWA	American Water Works Association
BHMA	Builders Hardware Manufacturers Association
BIA	Brick Institute of America
BIFMA	Business and Institutional Furniture Manufacturers Association
CAGI	Compressed Air and Gas Institute
CAUS	Color Association of the United States
CBM	Certified Ballast Manufacturers
CCC	Carpet Cushion Council
CDA	Copper Development Association
CE	Corps of Engineers
CFR	Code of Federal Regulations
CGA	Compressed Gas Association
CISCA	Ceiling and Interior Systems Construction Association
CISPI	Cast Iron Soil Pipe Institute
CPSC	Consumer Product Safety Commission
CRI	Carpet and Rug Institute
CRSI	Concrete Reinforcing Steel Institute
CS	Commercial Standard of NBS (U.S. Dept. of Commerce)
CTI	Ceramic Tile Institute
DFPA	Douglas Fir Plywood Association
DHI	Door and Hardware Institute
DLPA	Decorative Laminate Products Association
DOC	U.S. Department of Commerce
DOT	Department of Transportation

ECSA	Exchange Carriers Standards Association
EIA	Electronic Industries Association
EIMA	Exterior Insulation Manufacturers Association
EJMA	Expansion Joint Manufacturers Association
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FCC	Federal Communications Commission
FGMA	Flat Glass Marketing Association
FHA	Federal Housing Administration
FM	Factory Mutual Research Organization
FS	Federal Specifications
FSC	Forest Stewardship Council
FTI	Facing Tile Institute
GA	Gypsum Association
GSA	General Services Administration
HEI	Heat Exchange Institute
HI	Hydronics Institute
H.I.	Hydraulic Institute
HMA	Hardwood Manufacturers Association
HPMA	Hardwood Plywood Manufacturers Association
IBD	Institute of Business Designers
ICEA	Insulated Cable Engineers Association, Inc.
IEEE	Institute of Electrical and Electronic Engineers, Inc.
IESNA	Illuminating Engineering Society of North American
IGCC	Insulating Glass Certification Council
ILI	Indiana Limestone Institute of America
IMSA	International Municipal Signal Association
IRI	Industrial Risk Insurers

ISA	Instrument Society of America
ITE	Institute of Transportation Engineers
LEED™	Leadership in Energy and Environmental Design
LIA	Lead Industries Association, Inc.
LPI	Lightning Protection Institute
MBMA	Metal Building Manufacturer's Association
MCAA	Mechanical Contractors Association of America
MFMA	Maple Flooring Manufacturers' Association
MIA	Marble Institute of America
ML/SFA	Metal Lath/Steel Framing Association
MSS	Manufacturers Standardization Society of the Valve and Fittings Industry
MUTCD	Texas Department of Transportation Manual on Uniform Traffic Control Devices
NAAMM	National Association of Architectural Metal Manufacturers
NAIMA	North American Insulation Manufacturers Association
NAPA	National Asphalt Pavement Association
NBFU	National Board of Fire Underwriters
NBGQA	National Building Granite Quarries Association
NBS	National Bureau of Standards (U.S. Dept. of Commerce)
NCMA	National Concrete Masonry Association
NCRPM	National Council on Radiation Protection and Measurements
NCSPA	National Corrugated Steel Pipe Association
NEC	National Electrical Code (Published by NFPA)
NECA	National Electrical Contractors Association
NEII	National Elevator Industry, Inc.
NEMA	National Electrical Manufacturers Association
NETA	International Electrical Testing Association

N.F.P.A.	National Forest Products Association
NFPA	National Fire Protection Association
NHLA	National Hardwood Lumber Association
NIST	National Institute of Standards and Technology
NLGA	National Lumber Grades Authority
NOFMA	National Oak Flooring Manufacturers Association
NPA	National Particleboard Association
NPCA	National Paint and Coatings Association
NRCA	National Roofing Contractors Association
NWMA	National Woodwork Manufacturers Association
OSHA	Occupational Safety and Health Administration
PCA	Portland Cement Association
PCI	Precast/Prestressed Concrete Institute
PDI	Plumbing and Drainage Institute
PE	Professional Engineer
REA	Rural Electrification Administration
RFCI	Resilient Floor Covering Institute
RMA	Rubber Manufacturing Association
RPLS	Registered Professional Land Surveyor
SDI	Steel Deck Institute
S.D.I.	Steel Door Institute
SFPA	Southern Forest Products Association
SGCC	Safety Glazing Certification Council
SIGMA	Sealed Insulating Glass Manufacturers Association
SJI	Steel Joist Institute
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SPIB	Southern Pine Inspection Bureau

SPRI	Single Ply Roofing Institute
SSPC	Steel Structures Painting Council
SSPMA	Sump and Sewage Pump Manufacturers Association
SWI	Steel Window Institute
SWPA	Submersible Wastewater Pump Association
TCA	Tile Council of America
TEX TEST	TxDOT Laboratory Test
TIMA	Thermal Insulation Manufacturers Association
TPI	Truss Plate Institute
TxDOT	Texas Department of Transportation
UL	Underwriters Laboratory, Inc.
USDA	U. S. Department of Agriculture
USGBC	U. S. Green Building Council
USPS	U. S. Postal Service
WCLIB	West Coast Lumber Inspection Bureau
WCMA	Wallcovering Manufacturers Association
WIC	Woodwork Institute of California
WLPDIA	Western Lath, Plaster, Drywall Industries Association
WRI	Wire Reinforcement Institute
WSC	Water Systems Council
WSFI	Wood and Synthetic Flooring Institute
WWPA	Western Wood Products Association
W.W.P.A.	Woven Wire Products Association

END

The Storm Water Pollution Prevention Plan for this project is attached.

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STORM WATER POLLUTION PREVENTION PLAN
FOR CONSTRUCTION ACTIVITIES

PROJECT LOCATION
COA GRID F-24
MAPSCO #583-H

PROJECT NAME
ULLRICH LOW SERVICE PUMP STATION
ELECTRICAL FEED RENEWAL

SITE PLAN/DEVELOPMENT PERMIT NO.
SPC-03-0005C (R2) – PHASE 2

CAS Consulting and
Services, Inc.
7908 Cameron Rd
Austin, TX 78754
TBPE Firm No. 3752

PLAN DATE AUGUST 21, 2020

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SECTION 8: PERMANENT STABILIZATION

SECTION 9: CERTIFICATION AND NOTIFICATION

SECTION 1: SITE EVALUATION, ASSESSMENT, AND PLANNING

1.1 Project/Site Information

Project/Site Name: ULLRICH LOW SERVICE PUMP STATION ELECTRICAL FEED RENEWAL

Project Street/Location: 1000 Forest View Drive, Austin, Texas.
City: Austin State: Texas ZIP Code: 78746
County: Travis
City of Austin Permit Number (complete when assigned):
SPC-03-0005C(R2) – Phase 2
City of Austin Case Manager (complete when assigned):
Jeremy Siltala

TPDES project or permit tracking number*: N/A

Latitude: Longitude:
30º 17' 23" N, 97 º 47'46" W

Method for determining latitude/longitude:
____USGS topographic map (specify scale:_____) ____EPA Web site ____GPS
Other (please specify): Google Earth

Is the project located in Indian country? _____Yes __X__No
If yes, name of Reservation, or if not part of a Reservation, indicate "not applicable."

Is this project considered a federal facility? _____Yes ___X_No

TPDES project or permit tracking number*: N/A
**(This is the unique identifying number assigned to your project by your permitting authority after you have applied for coverage under the appropriate Texas Pollutant Discharge Elimination System (TPDES) construction general permit.)*

1.2 Contact Information/Responsible Parties

Owner(s):
Austin Water Utility
City of Austin, Texas
P.O. Box 1088
Austin, Texas 78767

Operator(s)*: *Not applicable for City of Austin permit
N/A

Project Manager(s) or Site Supervisor(s):
Robyn Haasch
City of Austin Public Works Department
505 Barton Springs Rd. Suite 900
Austin, Texas 78704
Phone: (512) 974-2624

SWPPP Contact(s):
CAS Consulting and Services, Inc.
7908 Cameron Road
Austin, Texas 78754
Phone: (512) 836-2388
Fax: (512) 836-4515

This SWPPP was prepared by:
CAS Consulting and Services, Inc.
7908 Cameron Road
Austin, Texas 78754
Phone: (512) 836-2388
Fax: (512) 836-4515

Subcontractor(s)*: *Not applicable for City of Austin permit
N/A

Emergency 24-Hour Contact:
Kevin Fetterman – (512) 972-1800

1.3 Soils, Slopes, Vegetation, and Current Drainage Patterns

Soil type(s): Tarrant soils and Urban land (TeA and TeE).

Slopes (describe current slopes and note any changes due to grading or fill activities):

Slopes range from 0% to 10+%. The proposed building will be built on drilled piers due to the steep slopes in the area. 1,750 cubic yards of fill will be required for the proposed concrete pads, road, and duct bank.

Drainage Patterns (describe current drainage patterns and note any changes due to grading or fill activities):

Drainage in the treatment area is generally sheet flow and gutter flow with small drainage areas (<1 acre) feeding to curb cuts and then to storm sewer system. In the low service pump station area drainage flows directly into Lady Bird Lake and is primarily shallow concentrated due to the steep terrain. Drainage Patterns will be modified by grading and construction activities. Any additional runoff will be diverted to a retention pond.

Vegetation: No vegetation in roadways, mowed grassland with minor landscape plantings and large trees.

Other: N/A

1.4 Receiving Waters

Description of receiving waters:

Runoff from the site flows to Lady Bird Lake Colorado River Segment 1429 or to Little Bee Creek and then to Lake Austin Colorado River Segment 1403. There are no wetland areas on the site, none classified as US Army Corps of Engineers jurisdictional wetland and none classified as City of Austin jurisdictional wetlands.

Description of storm sewer systems:

Roadways in the treatment area have curb and gutter or bar ditches to collect surface runoff and funnel it via curb inlets and bar ditches to underground storm sewers constructed of reinforced concrete pipe (RCP) that terminate in concrete headwalls at nearby open channels. Roadways in the low service pump station area have mountable curbs to direct runoff.

Description of impaired waters or waters subject to TMDLs: N/A

Other: N/A

1.5 Site Features and Sensitive Areas to be Protected

Describe unique features that are to be preserved: N/A

Describe critical environmental features that are to be preserved: N/A
Describe measures to protect these features: N/A

1.6 Endangered Species Certification

Are endangered or threatened species and critical habitats on or near the project area?
__x__Yes ____No

Describe how this determination was made:

A permit with the Balcones Canyonlands Preserve (BCCP) is also being submitted for this project. The initial review for the BCCP permit noted a Golden Cheeked Warbler habitat.

If yes, describe the species and/or critical habitat: The project is located near a Golden Cheeked Warbler habitat (zone 1).

If yes, describe or refer to documentation that determines the likelihood of an impact on Identified species and/or habitat and the steps taken to address that impact. (Note, if species are on or near your project site, EPA strongly recommends that the site operator work closely with the appropriate field office of the U.S. Fish and Wildlife Service or National Marine Fisheries Service. For concerns related to state or tribal listing of species, please contact a state or tribal official.)

Refer to the 2007 Tier III Balcones Canyonlands Preserve Land Management Plan.

1.7 Maps and Photographs

See construction plan sheets.

SECTION 2: CONSTRUCTION ACTIVITIES AND SITE MANAGEMENT PRACTICES

2.1 Nature and Sequence of Construction Activity

Describe the general scope of the work for the project, major phases of construction, etc:

The project intends to replace the existing 15 kV Switchgear at the Ullrich Water Treatment Plant Low Service Pump Station (LSPS). The project also includes replacing the 15 kV:5kV transformers, the 5 kV distribution switchgear, the 480V distribution equipment and generator, and the 15 kV feeder cables from the Austin Energy Bee Creek Substation. The project will include construction of a new electrical building, retaining walls, electrical equipment, parking areas, access road, and duct bank routing.

Sequence of Construction:

1. Install temporary erosion/sedimentation controls.
2. Install stabilized construction entrances.
3. Construct project improvements.
4. Restore and revegetate disturbed areas.
5. Remove temporary erosion/controls after revegetation is established.

What is the function of the construction activity?
___ Residential ___ Commercial _X_ Industrial ___ Road Construction ___ Linear Utility
____ Other (please specify):
Estimated Project Start Date: July 2020 – to be verified
Estimated Project Completion Date: July 2021 – to be verified

2.2 Construction Site Estimates

The following are estimates of the construction site.

Total project area:	141.29	acres
Construction site area to be disturbed:	0.76	acres
Limits of construction:	2	acres
Percentage impervious area before construction:	6.24	%
Runoff coefficient before construction:	0.54	
Percentage impervious area after construction:	6.77	%
Runoff coefficient after construction:	0.58	
Cut/Fill Volumes per Phase:	1750 CY (Fill) 60 CY (Cut)	

Demonstration of how spoils will be handled during construction:

Spoils will be stored in a designated temporary spoils area within the site. Silt fences will be installed down-gradient from the spoils area. Spoils will be hauled to a COA-approved landfill for permanent disposal.

2.3 Phasing and Construction Sequence Plan

Refer to Specification 01143 – Checkout and Start-Up Procedures.

2.4 Potential Sources of Pollution

Potential sources of sediment to stormwater runoff:

Potential sources of pollution which may affect the quality of storm water discharges from the construction site include silt and sediments from staging area, oil leaking from construction equipment and litter from materials packaging opened on-site. To prevent pollution of the storm water discharges from the construction site, erosion/sedimentation controls have been specified in compliance with the City of Austin's Environmental Criteria Manual. Stabilized construction entrances will be installed to prevent trucks from tracking dirt onto the city streets. Silt fences will be installed down gradient of all outdoor construction staging areas to filter sheet flow runoff. Contractor will promptly remove any sediment that collects in the project area and repair any erosion controls that get damaged. Oil leaks will be immediately contained with absorbent materials. All disturbed areas will be revegetated upon completion of the project.

Potential pollutants and sources, other than sediment, to stormwater runoff: N/A

Trade Name Material	Stormwater Pollutants	Location

SECTION 3: GRADING AND EROSION/SEDIMENT CONTROL BMPs

3.1 Minimize Disturbed Area and Protect Natural Features and Soil

To prevent pollution of the storm water discharges from the construction site, erosion/sedimentation controls have been specified in compliance with the City of Austin's Environmental Criteria Manual. Stabilized construction entrances will be installed to prevent trucks from tracking dirt onto the city streets. Silt fences will be installed down gradient of all surface construction areas to filter sheet flow runoff. Contractor will promptly remove any sediment that collects in the project area and repair any erosion controls that get damaged.

All disturbed areas will be revegetated upon completion of the project improvements. Contractor shall water all seeded or sodded areas twice per week a minimum of 5 gallons of water per square yard to insure growth of vegetation. Watering shall continue until grass has reached a height of 1 ½" with 95% coverage and no bare patches greater than 16 square feet.

3.2 Control Stormwater Flowing onto and through the Project

Silt fence will be installed near the perimeter of all disturbed areas to intercept sediment and will remain in place until the disturbed area is permanently stabilized.

BMP Description:	***Silt Fence***
Installation Schedule:	***Prior to any site disturbance***
Maintenance and Inspection:	***Contractor***
Responsible Staff:	***Contractor***

3.3 Stabilize Soils:

All areas disturbed during construction will be re-vegetated with native seed.

3.4 Protect Slopes:

Gabions will be used in areas with steep slopes as temporary slope protection. Permanent retaining walls are also included in this design as additional slope protection.

3.5 Protect Storm Drain Inlets:

Inlet filter dikes will be installed, if needed, prior to any site disturbance to protect inlets from receiving stormwater from the sites.

BMP Description:	***Inlet Filter Dikes***
Installation Schedule:	***Prior to any site disturbance***
Maintenance and Inspection:	***Contractor***
Responsible Staff:	***Contractor***

3.6 Establish Perimeter Controls and Sediment Barriers

Silt fence will be installed near the perimeter of all disturbed areas to intercept sediment and will remain in place until the disturbed area is permanently stabilized.

BMP Description:	***Silt Fence***
Installation Schedule:	***Prior to any site disturbance***
Maintenance and Inspection:	***Contractor***
Responsible Staff:	***Contractor***

3.7 Retain Sediment On-Site: N/A

3.8 Establish Stabilized Construction Exits

A stabilized pad of crushed stone will be installed at all points of construction ingress and egress.

BMP Description:	***10'x50' (min) Stabilized Construction Exits***
Installation Schedule:	***Prior to any site disturbance***
Maintenance and Inspection:	***Contractor***
Responsible Staff:	***Contractor***

3.9 Additional BMPs: N/A

SECTION 4: GOOD HOUSEKEEPING BMPs

An effort will be made to store only enough products required to do the job. All materials stored on-site will be stored in a neat, orderly manner in their appropriate containers and, if possible, in an enclosure. Products will be kept in their original containers with the original manufacturer's labels. Substances will not be mixed with one another unless recommended by the manufacturer. Whenever possible, all of a product will be used before disposing of the container. Manufacturers' recommendations for proper use and disposal will be followed. The contractor will inspect daily to assure proper use and disposal of materials on-site. Contractor shall advise Owner immediately, verbally and in writing, of any fuel or toxic material spill and the actions taken to remedy the problem. Contractor is responsible for disposing fuels, materials and contaminated excavated materials in a legally approved manner. Contractor is responsible for complying with all applicable environmental laws. All waste materials will be collected and stored in a securely lidded metal dumpster. The dumpster will meet all local and state solid waste management regulations. All trash and construction debris from the site will be deposited in the dumpster and hauled to an approved landfill. No construction waste material will be buried on-site. All personnel will be instructed regarding the correct procedure for waste disposal. The contractor who manages the day-to-day site operations will be responsible for seeing that these procedures are followed. No hazardous waste is expected to be generated or encountered in this project. In the event that hazardous waste is encountered, the contractor will advise the Owner immediately. All hazardous waste materials will be disposed of in a manner specified by local or state regulation or by the manufacturer. The contractor who manages day-to-day site operations will be responsible for assuring that these practices are followed for any hazardous waste that is generated. Contractor will not aggravate any hazardous waste that is encountered. All sanitary waste will be regularly collected from the portable units by a licensed sanitary waste management contractor. The stabilized construction entrances are to be used by vehicles leaving the site to capture mud before it is tracked onto the existing streets. The paved streets adjacent to the site entrances will be cleaned (not flushed) as needed to remove any excess mud, dirt or rock tracked from the site. It shall be the contractor's continuous responsibility at all times, including nights, holidays and weekends until acceptance of

the project by the City, to maintain the specified areas relatively free of dust by sprinkling in a manner what will cause the least inconvenience to the public.

4.1 Material Handling and Waste Management

Waste Materials – All trash and debris will be collected and stored in dumpsters meeting all local and state solid waste management regulations prior to removal from site. The trash and debris will be hauled to an approved landfill site and no construction debris will be buried on site.

Sanitary Waste – Contractor is responsible for providing adequately maintained sanitary facilities.

Description

Building materials and other construction site wastes must be properly managed and disposed of to reduce the risk of pollution from materials such as surplus or refuse building materials or hazardous wastes. Practices such as trash disposal, recycling, proper material handling, and spill prevention and cleanup measures can reduce the potential for stormwater runoff to mobilize construction site wastes and contaminate surface or groundwater.

Applicability

The proper management and disposal of wastes should be practiced at every construction site to reduce stormwater runoff. Use waste management practices to properly locate refuse piles, to cover materials that might be displaced by rainfall or stormwater runoff, and to prevent spills and leaks from hazardous materials that were improperly stored.

Siting and Design Considerations

Solid Wastes:

- Designate a waste collection area on the site that does not receive a substantial amount of runoff from upland areas and does not drain directly to a water body.
- Ensure that containers have lids so they can be covered before periods of rain, and keep containers in a covered area whenever possible.
- Schedule waste collection to prevent the containers from overfilling.
- Clean up spills immediately. For hazardous materials, follow cleanup instructions on the package. Use an absorbent material such as sawdust or kitty litter to contain the spill.
    - During the demolition phase of construction, provide extra containers and schedule more frequent pickups.
    - Collect, remove, and dispose of all construction site wastes at authorized disposal areas. Contact a local environmental agency to identify these disposal sites.

Hazardous Materials and Wastes:

- Consult with local waste management authorities about the requirements for disposing of hazardous materials.
- To prevent leaks, empty and clean hazardous waste containers before disposing of them.
- Never remove the original product label from the container because it contains important safety information. Follow the manufacturer's recommended method of disposal, which should be printed on the label.
- Never mix excess products when disposing of them, unless specifically recommended by the manufacturer.

To ensure the proper disposal of contaminated soils that have been exposed to and still contain hazardous substances, consult with state or local solid waste regulatory agencies or private firms. Some landfills might accept contaminated soils, but they require laboratory tests first.

Paint and dirt are often removed from surfaces by sandblasting. Sandblasting grits are the byproducts of this procedure and consist of the sand used and the paint and dirt particles that are removed from the surface. These materials are considered hazardous if they are removed from older structures because they are more likely to contain lead-, cadmium-, or chrome-based paints. To ensure proper disposal of sandblasting grits, contract with a licensed waste management or transport and disposal firm.

Pesticides and fertilizers:

- Follow all federal, state, and local regulations that apply to the use, handling, or disposal of pesticides and fertilizers.
- Do not handle the materials any more than necessary.

- Store pesticides and fertilizers in a dry, covered area.
- Construct berms or dikes to contain stored pesticides and fertilizers in case of spillage.
- Follow the recommended application rates and methods.
- Have equipment and absorbent materials available in storage and application areas to contain and clean up any spills that occur.

Petroleum Products:

- Store new and used petroleum products for vehicles in covered areas with berms or dikes in place to contain any spills.
- Immediately contain and clean up any spills with absorbent materials.
- Have equipment available in fuel storage areas and in vehicles to contain and clean up any spills that occur.

Detergents:

Phosphorous- and nitrogen-containing detergents are used in wash water for cleaning vehicles. Excesses of these nutrients can be a major source of water pollution. Use detergents only as recommended, and limit their use on the site. Do not dump wash water containing detergents into the storm drain system; direct it to a sanitary sewer or contain it so that it can be treated at a wastewater treatment plant.

Limitations

An effective waste management system requires training and signage to promote awareness of the hazards of improper storage, handling, and disposal of wastes. The only way to be sure that waste management practices are being followed is to be aware of worker habits and to inspect storage areas regularly. Extra management time may be required to ensure that all workers are following the proper procedures.

Maintenance Considerations

Inspect storage and use areas and identify containers or equipment that could malfunction and cause leaks or spills. Check equipment and containers for leaks, corrosion, support or foundation failure, or other signs of deterioration, and test them for soundness. Immediately repair or replace any that are found to be defective.

Effectiveness

Waste management practices are effective only when they are regularly practiced at a construction site. In storage and use areas, post the guidelines for proper handling, storage, and disposal of construction site wastes; train workers in these practices to ensure that everyone is knowledgeable enough to participate.

Cost Considerations

The costs associated with construction site waste management are mainly attributed to purchasing and posting signs, increased management time for oversight, additional labor required for special handling of wastes, transportation costs for waste hauling, and fees charged by disposal facilities to take the wastes.

4.2 Establish Proper Building Material Staging Areas

The following materials are expected to be stored on-site: Electrical cables and equipment to be installed in the building.

4.3 Designate Washout Areas:

A concrete washout will be established near the stabilized construction entrance.

4.4 Establish Proper Equipment/Vehicle Fueling and Maintenance Practices:

Fuel will not be stored on-site. Fuel will be delivered to the site as needed for the purpose of refueling.

4.5 Control Equipment/Vehicle Washing

Description

Ideally, vehicle maintenance and washing occurs in garages and wash facilities, not on active construction sites. However, if these activities must occur onsite, operators should follow appropriate BMPs to prevent untreated nutrient-enriched wastewater or hazardous wastes from being discharged to surface or ground waters.

Applicability

Vehicle maintenance and washing BMPs prevent construction site spills of wash water, fuel, or coolant from contaminating surface or ground water. They apply to all construction sites. Appropriate BMPs include the following:

- Using a covered, paved area dedicated to vehicle maintenance and washing.
- Ensuring that the areas are properly connected to a storm drain system.
- Developing a spill prevention and cleanup plan.
- Preventing hazardous chemical leaks by properly maintaining vehicles and equipment.
- Properly covering and providing secondary containment for fuel drums and toxic materials.
- Properly handling and disposing of vehicle wastes and wash water.

Implementation

Inspect construction vehicles daily, and repair any leaks immediately. Dispose of all used oil, antifreeze, solvents and other automotive-related chemicals according to manufacturer instructions. These wastes require special handling and disposal. Used oil, antifreeze, and some solvents can be recycled at designated facilities, but other chemicals must be disposed of at a hazardous waste disposal site. Local government agencies can help identify such facilities.

Designate special paved areas for vehicle repair. To direct wash water to sanitary sewer systems or other treatment facilities, ensure that vehicle-washing areas are impervious and are bermed. Use blowers or vacuums instead of water to remove dry materials from vehicles if possible. Because water alone can remove most dirt adequately, use high-pressure water spray without detergents at vehicle washing areas. If you must use detergents, avoid phosphate- or organic-based cleansers to reduce nutrient enrichment and biological oxygen demand in wastewater. Use only biodegradable products that are free of halogenated solvents. Clearly mark all washing areas, and inform workers that all washing must occur in this area. Do not perform other activities, such as vehicle repairs, in the wash area.

Limitations

Vehicle maintenance area limitations include connection costs to sanitary sewers; disposal costs for wash water (fees charged by hazardous waste disposal facilities); construction costs for an enclosed maintenance area; and labor costs for hazardous waste storage, handling, and disposal. Depending on the volume of wastewater created and the type of detergents used, vehicle wash areas may also require permits.

Maintenance Considerations

Vehicle maintenance operations produce substantial amounts of hazardous and other wastes that require regular disposal. Clean up spills and dispose of cleanup materials immediately. Inspect equipment and storage containers regularly to identify leaks or signs of deterioration. Maintenance of vehicle wash areas is minimal, usually involving repairs to berms and drainage to the sanitary sewer system.

Effectiveness

These techniques effectively reduce discharges of untreated automotive wastes and wash water to receiving waters. Their effectiveness highly depends on personnel's training and level of commitment to follow procedures.

Cost Considerations

Costs associated with vehicle maintenance and wash areas include building enclosed structures, establishing connections to the sanitary sewer system, grading wash areas to

drain only to sanitary sewers, and increased labor associated with special handling of hazardous wastes.

4.6 Spill Prevention and Control Plan

The following good housekeeping practices will be followed onsite during the construction project.

1. An effort will be made to store only enough products required to do the job.
2. All materials stored onsite will be stored in a neat, orderly manner in their appropriate containers and, if possible, under a roof or other enclosure.
3. Product will be kept in their original containers with the original manufacturer's label.
4. Substances will not be mixed with one another unless recommended by the manufacturer.
5. Whenever possible, product will be used up completely before disposing of the container.
6. Manufacturers' recommendations for proper use and disposal will be followed.
7. The site superintendent will inspect daily to ensure proper use and disposal of materials onsite.

Hazardous Products Practices

These practices will be used to reduce the risks associated with hazardous materials, if hazardous materials are used.

1. Products will be kept in original containers unless they are not reseal able.
2. Original labels and material safety data will be retained.
3. If surplus product must be disposed of, manufacturers' or local and state recommended methods for proper disposal will be followed.

Product Specific Practices

The product specific practices to be followed are listed in Table 1.

TABLE 1
Product Specific Practices
The following product specific practices will be followed onsite: <u>Petroleum Products:</u> All onsite vehicles will be monitored for leaks and receive regular preventive maintenance to reduce the chance of leakage. Petroleum products will be stored in tightly sealed containers, which are clearly labeled. Any asphalt substances used onsite will be applied according to the manufacturer's recommendations.
<u>Fertilizers:</u> Fertilizers used will be applied only in the minimum amounts recommended by the manufacturer. Once applied, fertilizer will be worked in the soil to limit exposure to storm water. Storage will be in a covered shed. The contents of any partially used bags of fertilizer will be transferred to a sealable plastic bin to avoid spills.
<u>Paints:</u> All containers will be tightly sealed and stored when not required for use. Excess paint will not be discharged to the storm water system but will be properly disposed of according to manufacturers' instructions or State and local regulations.
<u>Concrete Trucks:</u> Concrete trucks will not be allowed to wash out or discharge surplus concrete or drum wash water on the site.

Spill Prevention Practices

The spill prevention practices to be followed are listed in Table 2.

TABLE 2

Spill Prevention Practices

In addition to the good housekeeping and material management practices discussed in the previous sections of this plan, the following practices will be followed for spill prevention and cleanup:

- Manufacturers' recommended methods for spill cleanup will be clearly posted and site personnel will be made aware of the procedures and the location of the information and cleanup supplies.
- Materials and equipment necessary for spill cleanup will be kept in the material storage area onsite. Equipment and materials will include but not be limited to brooms, dustpans, mops, rags, gloves, goggles, kitty litter, sand, sawdust, and plastic and metal trash containers specifically for this purpose.
- All spills will be cleaned up immediately after discovery.
- The spill area will be kept well ventilated and personnel will wear appropriate protective clothing to prevent injury from contact with a hazardous substance.
- Spills of toxic or hazardous material will be reported to the appropriate State or local government agency, regardless of the size.
- The spill prevention plan will be adjusted to include measures to prevent this type of spill from reoccurring and how to clean up the spill if there is another one. A description of the spill, what caused it, and the cleanup measures will also be included.
- The site superintendent responsible for the day-to-day site operations will be the spill prevention and cleanup coordinator. He will designate at least three other site personnel who will receive spill prevention and cleanup training. These individuals will each become responsible for a particular phase of prevention and cleanup. The names of responsible spill will be posted in the material storage area and in the office trailer onsite.

4.7 Any Additional BMPs: N/A

4.8 Allowable Non-Stormwater Discharge Management

1. Water used to wash vehicles where detergents are not used.
2. Water used to control dust.
3. Potable water sources including line flushing.
4. Uncontaminated ground or spring water.

SECTION 5: SELECTING POST-CONSTRUCTION BMPs

N/A

SECTION 6: INSPECTIONS

6.1 Inspections

1. Inspection Personnel: The Contractor shall provide qualified personnel to inspect disturbed areas of the construction site that have not been finally stabilized, areas used for storage of materials that are exposed to precipitation, structural control measures, and locations where vehicles enter and exit the site.

2. Inspection Schedule and Procedures:

The contractor shall inspect the disturbed areas at least once every fourteen (14) calendar days and within 24 hours of the end of a storm event of 0.5 inches or greater, or the contractor may establish a specific day each week for inspections to occur. Erosion and sedimentation control measures identified in the SWP3 shall be observed to ensure that they are operating correctly. Based on the results of the inspection, the SWP3 shall be modified as necessary (e.g. show additional controls on the erosion/sedimentation controls plan sheet and revise description of controls) to include additional or modified controls, or best management practices (BMPs), designed to correct problems identified. Revisions to the SWP3 shall be completed within 7 calendar days following the inspection. If existing controls need to be modified or if additional controls are necessary, implementation shall be completed before the next anticipated storm event, or as soon as practicable.

Contractor shall attach a copy of the inspection report to be used for the site.

6.2 Delegation of Authority

Contractor shall identify the individual(s) who have authority to sign inspection reports, certification and other information.

6.3 Corrective Action Log

Contractor shall maintain a log of corrective actions.

SECTION 7: RECORDKEEPING AND TRAINING

7.1 Recordkeeping

Records will be retained for a minimum period of at least 3 years after the permit is terminated.

Contractor shall maintain a log of date(s) when major grading activities occur.

Contractor shall maintain a log of date(s) when construction activities temporarily or permanently cease on a portion of the site.

Contractor shall maintain a log of date(s) when an area is either temporarily or permanently stabilized.

7.2 Log of Changes to the SWPPP

SWP3 LOG OF CHANGES AND UPDATES

DATE	CHANGE/UPDATE

7.3 Training

Individual(s) Responsible for Training:

Name: _____ Title:_____

Name: _____ Title:_____

Describe Training Conducted:
• General stormwater and BMP awareness training for staff and subcontractors:

• Detailed training for staff and subcontractors with specific stormwater responsibilities:

SECTION 8: PERMANENT STABILIZATION

All disturbed areas will be revegetated as shown on the construction plans. Seed mix is shown in the Project Manual in Standard Specification 604S pages 3 and 4. Topsoil requirements are shown in the Project Manual in Standard Specification 601S page 1.

SECTION 9: CERTIFICATION AND NOTIFICATION

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Name: _____ Title:_____

Signature:_____Date:_____

Repeat as needed for multiple construction operators at the site

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PART I - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Requirements for coordinating with Owner's operations during the Project.

2. Requirements for tie-ins and shutdowns necessary to complete the Work without impact on Owner's operations except as allowed in this Specifications section.

B. Scope:

1. Contractor shall provide all labor, materials, equipment, tools, and incidentals shown, specified, and required to coordinate with Owner's operations during the Work in accordance with this Specifications section.

2. Except for shutdowns specified in this Specifications section, perform the Work such that Owner's facilities remain in continuous, satisfactory operation during the Project. Schedule and perform the Work such that the Work does not: impede Owner's production or processes, create potential hazards to operating equipment and personnel, reduce the quality of the facility's products or effluent, cause odors or other nuisances, does not affect the public health, safety, welfare, and convenience, and does not adversely affect the environment resulting in violation of Laws or Regulations.

3. Work not specifically addressed in this Specifications section or in referenced sections may, in general, be performed, to be completed within the Contract Times, at any time during regular working hours in accordance with the Contract Documents, subject to the requirements in this section.

C. Related Requirements: Include but are not necessarily limited to:

1. Section 01010 - Summary of Work.

2. Section 02072 - Cutting and Patching.

1.02 REFERENCES

A. Terminology:

1. Terminology indicated below are not defined terms and are not indicated with initial capital letters, but when used in this Specifications section have the meaning indicated below:

a. The term "Owner" is used throughout this section. When the facility is operated or managed by an entity other than Owner, references in this section to "Owner" as the operator or manager of the facility will be interpreted as referring to the facility manager.

b. A "shutdown" is when a portion of the normal operation of Owner's facility, whether equipment, systems, conduit (including piping and ducting), has to be temporarily suspended or taken out of service to perform the Work.

c. A "tie-in" is a connection of new Work to existing facilities, including connecting to existing conduits (including piping and ducting), electrical systems, structural elements, process/mechanical elements, and other physical connections. Some tie-ins may require that the tie-in be made without an associated shutdown.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Review construction procedures under other Specifications sections and coordinate Work that will be performed with or before the Work indicated in this Section.

B. Sequencing and Scheduling:

1. Refer to this Specifications sections articles on sequencing, tie-ins, and shutdowns.

1.04 SUBMITTALS

A. Informational Submittals: Submit the following:

1. Shutdown Planning Submittal:

a. For each shutdown, submit an inventory of labor, materials, and equipment required to perform the shutdown and tie-in tasks, an estimate of time required to accomplish the complete shutdown including time for Owner to take down and start up existing equipment, systems, or conduits, and written description of steps required to complete the Work associated with the shutdown.

b. Furnish submittal to Engineer not less than 60 days prior to proposed shutdown start date. Do not start shutdown until obtaining Engineer's acceptance of shutdown planning Submittal.

2. Shutdown Notification:

a. After Engineer's acceptance of shutdown planning Submittal and prior to starting the shutdown, submit written notification to Owner and Engineer of date and time each shutdown is to start. Submit notification not less than 4 weeks in advance of each shutdown.

1.05 GENERAL CONSTRAINTS

A. Indicated in the Contract Documents are the sequence and shutdown durations, where applicable, for Owner's equipment, systems, and conduits (including piping and ducting) that are to be taken out of service temporarily for the Work. New materials and equipment may be used by Owner after the specified field quality control activities are successfully completed and the materials or equipment are substantially complete in accordance with the Contract Documents.

B. The following constraints apply to coordination with Owner's operations:

1. Operational Access: Owner's personnel shall have access to equipment and areas of the facility that remain in operation.

2. Temporary Partitions and Enclosures: Provide temporary partitions and enclosures necessary to maintain dust-free, heated, and ventilated spaces in areas of the facility that are adjacent to the Work and that must be kept operational. Comply with Section 01500 -Temporary Facilities.

3. Dead End Valves or Conduits:

   a. Provide blind flanges, watertight bulkheads, or valve at temporary and permanent terminuses of conduits, including piping and ducting.

   b. Blind flanges and bulkheads shall be suitable for the service and braced and blocked, as required, or otherwise restrained as necessary or as required by Engineer.

   c. Temporary valves shall be suitable for their associated service. Where valve is provided at permanent terminus of conduit, including piping or ducting, also provide on downstream side of valve a blind flange with drain/flushing connection.

4. Owner will assist Contractor in dewatering process tanks, basins, conduits, and other work areas to be dewatered for shutdowns. Maintain clean, dry work area by pumping and properly disposing of fluid and other material that accumulates in work areas.

5. Draining and Cleaning of Conduits, Tanks, and Basins:

   a. Unless otherwise shown or indicated in the Contract Documents, Contractor shall dewater process tanks, basins, conduits (including piping) at beginning of each shutdown. Flush, wash down, and clean tanks, basins, conduits (including piping), and other work areas.

   b. Contractor shall remove liquids and solids and dispose of them at appropriate location at the Site as directed by Engineer. Unless otherwise specified or indicated, contents of tanks, basins, and conduits (including piping) undergoing modifications shall be transferred to existing process tanks or conduits at the Site with capacity sufficient to accept such discharges, using hoses, temporary piping, temporary pumps, and other means provided by Contractor. Discharge of fluids across floors is not allowed.

   c. If drainage point is not available on the conduit (including piping) to be drained, provide a wet tap using tapping saddle and valve or other method approved by Engineer. Uncontrolled spillage of contents of conduits (including piping) is not allowed.

   d. Spillage shall be brought to Engineer's attention immediately, both orally and in writing, and reported in accordance with Laws and Regulations. Contractor shall wash down spillage to floor drains or sumps or other appropriate location and flush the system to prevent clogging and odors. If spillage is not suitable

for discharge to the drainage system, such as chemical spills, as determined by Engineer, Contractor shall remove spillage by other means, such as vactor truck, sorbents, or other method acceptable to Engineer.

6. Depending on seasonal demand, or other service outages, the Owner may request a delay of proposed shutdown dates.

1.06 WORK COVERED BY CONTRACT

A. The Work of this Contract under the Base Bid generally includes the following Project Classified Systems (PCS's):

1. PCS #1: Electrical Substation No. 4 (SUB4)

   a. Construct building with all associated structural and geotechnical work

   b. Installation of electrical, instrumentation and control, security, telecommunication, fire alarm and HVAC systems at SUB4.

   c. Connection to Austin Energy service

2. PCS #2: Existing Low Service Pump Station (LSPS)

   a. Sequenced demolition of existing electrical distribution equipment and support structure

   b. Sequenced installation of new electrical distribution equipment and support structure

3. PCS #3: Ductbank Installation from SUB4 to the LSPS

   a. Construct new ductbank and manhole system from SUB4 to LSPS

   b. Installation of medium voltage and fiber optic cables

4. PCS #4: Powder Activated Carbon (PAC) Building Electrical Feed

   a. Construct new ductbank and manhole system from SUB4 to PAC

   b. Installation of medium voltage cables

   c. Installation of new service transformer

   d. Demolition of existing service transformer

1.07 SEQUENCE OF WORK

A. General Notes:

1. Perform the Work in the indicated sequence. Certain phases or stages of the Work may require working 24 HR days or work during hours outside of regular working hours. Work may be accelerated from a later stage to an earlier stage if Owner's

operations are not adversely affected by proposed substitute sequence, with Engineer's approval. Stages specified in this article are sequence-dependent.

2. The intent of these construction sequence documents is to outline the proposed sequence of construction required to complete the demolition/modification/installation of existing and proposed medium voltage feeders, proposed Substation No. 4 and existing and proposed electrical equipment throughout the Ullrich Water Treatment Plant as set forth by this set of contract documents. Not all work items depicted in the contract documents are described in this construction sequence documents. This in no way relieves the contractor of the responsibility of completing all work depicted in this set of contract documents. The full scope of work required is contained within the complete set of contract documents.

3. When a power outage to a facility is required, the contractor shall request such an outage in writing no less than one month in advance of the required outage. The contractor's written request shall identify the desired date, time duration, and purpose of the requested outage. The contractor shall not proceed with the outage unless he/she obtains a written approval from the owner authorizing the outage. The owner reserves the right to modify or reject any request for such an outage. Modification or rejection of the contractor's request by the owner shall not be considered reason for delays in the construction schedule. Unless otherwise noted, the duration of any outage shall be limited to four (4) hours or less. The owner reserves the right to limit the duration of the outage to less than four (4) hours. Modifications of the outage duration by the owner shall not be considered reason for delays in the construction schedule.

4. The contractor shall take care to avoid damage to existing facilities. If any existing facilities are damaged in the course of construction of any part of this contract, the contractor shall repair the damaged facilities to their original operating condition immediately, with repair crews working twenty-four (24) hours per day until the damage is repaired, at no additional cost to the owner.

5. The contractor shall be aware that the age and condition of some of the plant's existing electrical distribution equipment may impact operation of circuit breakers and/or switches within the equipment as well as the sequence of operation proposed within the construction sequence documents. Therefore, prior to operating any circuit breakers and/or switches in existing electrical distribution equipment, the contractor shall coordinate proposed switching strategies and procedures with the plant and with Austin Water's electrical services division.

B. Stage I -Proposed Switchgear Building:

1. Equipment to be demolished:

   a. Existing 16 INCH Water Line inside of the building footprint

2. Equipment to be installed:

   a. 16 INCH Water Line relocation

   b. Switchgear Building

c. Furnish and install all electrical, controls, and instrumentation equipment within and surrounding the proposed Switchgear Building

3. Raceway and cables to be installed:

a. Interconnection to Austin Energy.

C. Stage II – Powder Activated Carbon Building Renovations

1. Equipment to be demolished:

a. Transformer "Transformer No. 11"

2. Equipment to be installed:

a. Transformer "PAC-XFMR-01"

3. Raceway and cables to be installed:

a. Between the proposed Switchgear Building and the existing PAC building.

D. Stage III - Service to LSPS 4160V Motor Control Centers:

1. Equipment to be demolished:

a. None

2. Equipment to be installed:

a. None

3. Raceway and cables to be installed:

a. Between the proposed Switchgear Building and Manholes "MH-4A" and "MH-4B"

b. Duct bank and exposed conduit extending from Manholes "MH-4A" and "MH-4B" and 4160V motor control centers "LSPS-MCC-002" and "LSPS-MCC-003".

E. Stage IV – LSPS 480V Distribution Equipment Part 1

1. Equipment to be demolished:

a. 12.47kV:4.16kV Transformer "SUB3-XFMR-02"

b. 4.16kV Switchgear "BUS-B"

c. 480V Automatic Transfer Switch "LSPS-XSW-ATS1"

d. 480V Panelboard "LSPS-PP-001A"

2. Equipment to be installed:

a. 12.47kV:480V Transformer "LSPS-XFMR-01"

b. 480V Switchboard "LSPS-SWBD-01"

c. 480V Panelboard "LSPS-PANEL-03"

3. Raceway and cables to be installed:

a. Duct bank between "MH-4A" and Transformer "LSPS-XFMR-01"

b. Duct bank between "LSPS-SWBD-01" and panelboard "LSPS-PANEL-03".

4. Notes:

a. Panelboard "LSPS-PANEL-03" to be temporarily served from Breaker "BKR-SWBD4" in switchboard "LSPS-SWBD-01".

b. Transfer loads from existing panelboard "LSPS-PP-001A" to proposed panelboard "LSPS-PANEL-03".

F. Stage V - LSPS 480V Distribution Equipment Part 2

1. Equipment to be demolished:

a. 4.16kV:480V Transformer "LSPS-XFMR-002"

2. Equipment to be installed:

a. 480V Switchboard "LSPS-SWBD-03"

3. Raceway and cables to be installed:

a. Duct bank between "LSPS-SWBD-01" and switchboard "LSPS-SWBD-03".

4. Notes:

a. Transfer loads from existing switchboard "LSPS-PWRC-001" to proposed switchboard "LSPS-SWBD-03".

G. Stage VI - LSPS 480V Distribution Equipment Part 3

1. Equipment to be demolished:

a. 12.47kV Switchgear "BUS 1" and "BUS 2"

b. 12.47kV:4.16kV Transformer "SUB-XFMR-01"

c. 4.16kV Switchgear "BUS-A"

d. 4.16kV:480V Transformer "LSPS-XFMR-001"

e. 480V Switchboard "LSPS-PWRC-001"

2. Equipment to be installed:

    a. 12.47kV:480V Transformer "LSPS-XFMR-02"

    b. 480V Switchboard "LSPS-SWBD-02"

    c. 480V Switchboard "LSPS-ATS-01" and "LSPS-ATS-02"

    d. 480V Switchboard "LSPS-SWBD-04"

    e. 480V Switchboard "LSPS-SWBD-05"

    f. 480V Switchboard "LSPS-SWBD-06"

    g. Remote I/O Cabinet "LSPS-COMMPANEL-03"

3. Raceway and cables to be installed:

    a. Remainder of duct bank shown on Drawing No. E10-116.

4. Notes:

    a. Furnish and install permanent feeders to panelboard "LSPS-PANEL-03".

    b. Re-fed loads previously served from existing switchboard "LSPS-PWRC-001" to proposed switchboards "LSPS-SWBD-04", "LSPS-SWBD-05", and "LSPS-SWBD-06".

H. Stage VII – Completion of Work

1. Complete all other work events, in their entirety and as set forth in this set of contract documents, which have not been outlined within these construction sequencing documents.

1.08 TIE-INS

A. Table 01143-A in this Specifications section lists connections by Contractor to existing facilities. Table 01143-A may not indicate all tie-ins required for the Work; Contractor shall perform tie-ins necessary and required to complete the Work as shown or indicated in the Contract Documents, regardless of whether tie-in is indicated in Table 01143-A. For tie-ins not indicated in Table 01143-A, obtain requirements for tie-ins from Engineer by requesting an interpretation or clarification.

PART II - PRODUCTS – (NOT USED)

PART III - EXECUTION

3.01 SUBSTITUTE PROCEDURES

A. Proposal of Substitute Sequencing, Shutdowns, and Tie-Ins:

1. As a substitute to the procedures indicated in this Specifications section, Contractor may propose providing additional temporary facilities that can eliminate or mitigate

a constraint without additional cost to Owner, provided such additional temporary facilities: do not present hazards to the public, personnel, structures, and equipment; that such additional temporary facilities do not adversely affect Owner's ability to comply with Laws and Regulations, permits, and operating requirements; that such temporary facilities do not generate or foster the generation of odors and other nuisances; and that requirements of the Contract Documents are fulfilled.

2. Engineer will consider proposals for substitute procedures after the Effective Date of the Contract. All Bids shall be based on the requirements of the Contract Documents, including this section.

3. Substitution Requests:

   a. When proposing a substitute procedure for a tie-in or shutdown or other requirements of this section, comply with the requirements of the General Conditions and Supplementary Conditions (regarding substitutes) and Section 01640 - Substitution Procedures.

   b. When deviation from specified sequence or procedures is proposed, Contractor's proposal shall explain in detail the proposed sequence and procedures and associated effects, including evidence that Owner's operations will not be adversely affected, to an extent greater than originally contemplated in the Contract Documents, by proposed substitution. List benefits of proposed substitution, including benefits to Progress Schedule.

3.02 GENERAL PROVISIONS FOR COORDINATING WITH OWNER"S OPERATIONS

A. When possible, combine multiple tie-ins into a single shutdown to reduce impacts on Owner's operations and processes.

B. Operation of Existing Systems and Equipment during the Work:

   1. Do not shut off or disconnect existing operating systems or equipment, unless accepted by Engineer in writing.

   2. Operation of existing systems and equipment will be by Owner unless otherwise specified or indicated.

   3. Where necessary for the Work, Contractor shall seal or bulkhead Owner-operated gates and valves to prevent leakage that may affect the Work, Owner's operations, or both.

   4. Provide temporary watertight plugs, bulkheads, and line stops as necessary and as required. After completing the Work, remove seals, plugs, bulkhead, and line stops to satisfaction of Engineer.

C. Bypassing:

   1. Diversion of flows around treatment processes is not allowed.

D. Performing the Work of this section constitutes Contractor's approval of underlying work and field conditions prevailing at the time of the Work.

3.03 PREPARATION

A. Coordinate preparations for removals with requirements of Section 02072 - Cutting and Patching, applicable.

B. Shutdowns - General Preparation:

1. Coordinate shutdowns with Owner and Engineer.

2. Submit shutdown planning Submittals and shutdown notification Submittals in accordance with this Specifications section's "Submittals" Article.

3. Furnish at the Site, in close proximity to the shutdown and tie-in work areas, tools, materials, equipment, spare parts, both temporary and permanent, necessary to successfully perform the shutdown. Complete to the extent possible, prefabrication of piping and other assemblies prior to commencing the associated shutdown. Demonstrate to Engineer's satisfaction that Contractor has complied with such requirements before commencing the shutdown.

4. Engineer shall have no duty to Contractor to advise Contractor of inadequate preparations by Contractor; Contractor is solely responsible for the means, methods, procedures, techniques, and sequences of construction.

C. Shutdowns of Electrical Systems:

1. Comply with Laws and Regulations, including the National Electric Code.

2. Contractor shall lock out and tag circuit breakers and switches operated by Owner and shall verify that affected cables and wires are de-energized to ground potential before starting other Work associated with the shutdown.

3. Upon completion of shutdown Work, remove the locks and tags and advise Engineer or Resident Project Representative (RPR) that facilities are available for use.

3.04 ATTACHMENTS

A. The following, bound after this Specifications Section's "End of Section" designation, are part of this Specifications Section:

1. Tables:

a. Table 01143-A, Schedule of Tie-ins (1 pages).

END

Table 01143-A
Schedule of Tie-Ins

Tie-In No.	New Line Size and Service	Existing (Connecting) Line Size & Service	Tie-In Building/Location	Construction Stage	Remarks
1	16 INCH Water Line	16 INCH Water Line	Low Service Pumpstation Switch Gear Building (Substation No. 4)	Stage 1	None
2					
3					
4					
5					
6					

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

Documents related to this section will include the construction drawings and general provisions of the Contract, including the General Conditions, Section 00700, Supplemental General Conditions, Section 00810, and other Division 1 requirements.

1.2 SUMMARY

A. This section describes the preconstruction conference and other Project related meetings which may be held on a routine schedule throughout the duration of the Project.

B. The CONTRACTOR, or his authorized representative(s), shall attend all Project related meetings as indicated herein. The CONTRACTOR's representatives, as a minimum, shall include his Project Manager and Superintendent. Other CONTRACTOR's representatives may attend Project related meetings; however, there shall be a maximum of four (4) CONTRACTOR's representatives at any one meeting unless the ENGINEER/ARCHITECT approves a larger number.

C. The CONTRACTOR shall provide all pertinent reports, copies of reports, etc., for each meeting as may be required by this or other sections of the Contract.

1.3 PARTNERING WORKSHOP

A. To complete this work most beneficially for all parties, the Owner desires to form a Partnering Team among the Owner, Engineer/Architect, Contractor, and Subcontractor(s). This relationship will draw on the strength of all parties to identify and achieve mutual goals. The objectives are effective and efficient contract performance, intended to achieve completion within budget, on schedule, and in accordance with the drawings and specifications.

B. The Owner will schedule a Partnering Workshop independent of or in conjunction with the Preconstruction Conference, to facilitate the project objectives. The partnering relationship will be multilateral in makeup and participation will be totally voluntary.

1.4 PRECONSTRUCTION CONFERENCE

A. Attendees

A preconstruction conference shall be held as soon after the award and execution of the Contract as possible and before any Work at the site is started. The conference will be held at a location selected by the Owner's Project Manager. The Owner's Project Manager shall prepare and distribute the meeting agenda, preside over the conference, and may distribute meeting minutes. The conference shall be attended by:

1. CONTRACTOR's Project Manager.
2. CONTRACTOR's Superintendent.
3. Any Subcontractors' and/or Suppliers' representatives whom the CONTRACTOR may desire to invite or whom the ENGINEER/ARCHITECT or OWNER may request to attend.
4. ENGINEER/ARCHITECT's representative.
5. OWNER's Project Manager.
6. OWNER's REPRESENTATIVE
7. OWNER's Sponsor Department Representative.

8. Representative from the City of Austin, Transportation Department if a traffic management plan is required.
9. Representative from the City of Austin, Watershed Protection and Development Review Department, Environmental Inspection Division, if site erosion / sedimentation controls are required.
10. Representative from the City of Austin, Transportation Department if utility coordination has occurred through the Austin Utility Location and Coordination Committee.
11. Representative from the City of Austin, Contract Management Department, Contract Administration Division, to discuss wage.
12. Representative from the City of Austin, Small and Minority Business Resources Department to discuss M/WBE compliance.

B. Meeting topics

The topics to be discussed may include, but will not be limited to, the following items:

1. Introduction of persons attending the meeting.
2. General project description, including length of contract and liquidated damages.
3. Key personnel associated with the construction (may include, but is not limited to the following):
   - CONTRACTOR's Project Manager
   - CONTRACTOR's Superintendent
   - OWNER's Project Manager
   - ENGINEER/ARCHITECT's representative
   - OWNER's Sponsor Department Representative.
   - Representatives of the various utilities.
4. Lines of communication and chains of command.
5. Wage and personnel records and reporting requirements.
6. Subcontractors and suppliers.
7. Submittal review and approval procedure. Submittals may include, but are not limited to the following:
   - Letter stating the name and qualifications of the CONTRACTOR's Superintendent
   - Letter(s) from the Subcontractor(s) listing their salaried specialists
   - If applicable, a letter designating the Registered Professional Land Surveyor
   - If applicable, a letter designating the Safety Representative (for general project safety) and the "Competent Person" for excavation safety
   - Excavation Safety Systems Plan
   - Schedule of Values
   - Schedule for submittals
   - Shop drawings
   - Construction schedule (The schedule shall indicate the phases of work in which subcontractors will be participating. Subcontractors shall be indicated by name.)
   - Payroll reports
   - Substitution of subcontractors
   - Non-use of asbestos materials affidavit
   - Appropriate safety training certificates for workers that will initially be on site

- Documentation for all workers initially on site who are governed by a prevailing wage classification as described in Section 00830.
- Construction Equipment Emissions Reduction Plan

8. Job and traffic safety.
9. Permits.
10. Utility coordination report.
11. Notification of property owners and other affected by the project
12. Job meetings.
13. Use of the site for construction, storage, staging, etc., and interrelationship with other contracts.
14. Equal opportunity requirements.
15. Laboratory testing of material requirements.
16. Inventory of materials stored on site provisions.
17. Progress estimate and payment procedure.
18. Posting of signs.
19. Project safety.
20. Prompt payment procedure.
21. Review of contract - addenda, supplementary general conditions, special provisions, special specifications, and other unique project items.
22. Other

1.5 JOB MEETINGS

A. General

Job meetings shall be held as deemed necessary by the ENGINEER/ARCHITECT or OWNER or as requested by the CONTRACTOR throughout the duration of the Project. The meetings shall be held at a location selected by or approved by the Owner's Representative. The OWNER's REPRESENTATIVE or CONTRACTOR, as agreed to, shall preside over the meeting and issue meeting minutes.

B. Attendees

Job meetings will be attended by the following:

1. CONTRACTOR's Project Manager, when requested to attend.
2. CONTRACTOR's Construction Superintendent.
3. Any subcontractors' and/or suppliers' representatives whom the CONTRACTOR may desire to invite or whom the ENGINEER/ARCHITECT or OWNER requests to attend.
4. OWNER's REPRESENTATIVE
5. ENGINEER/ARCHITECT's representative(s), if needed or required.
6. OWNER's PROJECT MANAGER, if needed or required
7. OWNER's Sponsor Department representative(s), if needed or required.

C. Meeting topics

The topics will include, but not necessarily be limited to, the following subjects:

1. Review of previous meetings' notes and update of pertinent information and Project status.
2. Identification and discussion of new job related construction problems. Such discussion will be toward resolving identified problems.
3. Review work accomplished to date and establish proposed construction activities for the upcoming week(s).
4. Discuss the status of or need for change orders.
5. Check of required bonds and insurance certificates (including Workers' Compensation Insurance verification for CONTRACTOR's, Subcontractor's, and Sub-Subcontractor's employees as stated in Section 00700, General Conditions, 5.2 Workers' Compensation).
6. Status of pay requests.
7. Work in progress.
8. Review and update construction schedule.
9. Review of submittals schedule and status of submittals.
10. Status of SMBR Compliance Plan.
11. Status of Safety Training certificates for all new workers on project.
12. Other.

1.6 OTHER MEETINGS

Other meetings shall be held from time to time as may be requested by the CONTRACTOR, the ENGINEER/ARCHITECT, or the OWNER. The time and place of the meetings shall be as mutually agreed upon. The attendance at the meetings shall be as requested by the party requesting the meeting.

END

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

The Contractor prepares submittals. Drawings and general provisions of Contract, including Section 00700, "General Conditions"; Section 00810, "Supplemental General Conditions"; Division 1 requirements and City of Austin Technical Specifications and Special Provisions thereto, should be used as the related documents for this requirement.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for submittals required for performance of the Work, including the following:

1. Security plan.
2. Contractor's construction schedule.
3. Submittal schedule.
4. Shop drawings.
5. Product data.
6. Samples.
7. Quality assurance and quality control submittals, including calculations, mix designs and substantiating test results.

B. Administrative Submittals: Refer to other Division 1 Sections and other Contract Documents for requirements for administrative submittals. Such submittals include, but are not limited to, the following:

1. Permits.
2. Applications for Payment.
3. Performance and Payment bonds.
4. Insurance certificates.
5. Monthly Subcontractors expense report.
6. Non-use of asbestos affidavits
7. Schedule of Values

C. Related Sections: The following Sections contain requirements that relate to this Section:

1. Section 00700, "General Conditions"; Section 00810, "Supplemental General Conditions"; and/or Division 1, Section 01025, "Measurement and Payment" specifies requirements for submittal of the Schedule of Values.
2. Division 1, Section 01200, "Project Meetings" specifies requirements for submittal and distribution of meeting and conference minutes.
3. Section 00700, "General Conditions"; Section 00810, "Supplemental General Conditions"; and/or Division 1, Section 01700, "Contract Close-out" specifies requirements for submittal of Project Record Documents and warranties at project close-out.
4. Section 00700, "General Conditions" Article 6.2.4 specifies requirements for Substitutes and "Approved Equal" Items.

D. Technical Submittals: Technical information required to be submitted by the Standard Specifications, Special Provisions or Special Specifications. A Technical Submittal list

PART 2 - PRODUCTS - not used

PART 3 - EXECUTION

3.1 SUBMITTAL PROCEDURES

Contractor shall be responsible for the following:

A. Coordination: Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.

2. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals or resubmittals concurrently.

   a. The E/A reserves the right to withhold action on a submittal requiring coordination with other submittals until all related submittals are received.

3. Processing: To avoid the need to delay installation as a result of the time required to process submittals, allow sufficient time for submittal review, including time for resubmittals.

   a. Allow fourteen (14) calendar days for initial review. Allow additional time if the Engineer must delay processing to permit coordination with subsequent submittals.

   b. If an intermediate submittal is necessary, process the same as the initial submittal.

   c. Allow fourteen (14) calendar days for processing each resubmittal.

   d. No extension of Contract Time will be authorized because of failure to transmit submittals to the E/A sufficiently in advance of the Work to permit processing.

4. The CONTRACTOR is to review shop drawings, product data and samples prior to submission to determine and verify the following.

   a. Field measurements

   b. Field construction criteria

   c. Conformance with the Specifications

   5. Each shop drawing, working drawing sample and catalog data submitted by the CONTRACTOR to have affixed to it the following Certification Statement, signed by the CONTRACTOR:

   "By this submittal, I hereby represent that I have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data and I have checked and coordinated each item with other applicable approved shop drawings and all Contract requirements."

   All Submittals without the Certification Statement will not be reviewed and will be returned to the CONTRACTOR for proper submission.

   6. No portion of the Work requiring a shop drawing, sample or catalog data is to be started nor any materials be fabricated or installed prior to the approval or qualified approval of such item. Fabrication performed, materials purchased or

on-site construction accomplished which does not conform to the approved shop drawings and data to be at CONTRACTOR's risk. The OWNER shall not be liable for any expense or delay due to corrections or remedies required to accomplish conformity.

7. Notify the E/A in writing, at the time of submittal, of any deviations in the submittal(s) from the requirements as specified with in the Contract Documents. If deviations are not noted, CONTRACTOR assumes responsibility for corrective action.

8. The review and approval of submittals by the E/A does not relieve the CONTRACTOR from his responsibility with regard to the fulfillment of the terms of the Contract. All risks of error and omission in submittals prepared by CONTRACTOR are assumed by the CONTRACTOR and the E/A shall have no responsibility therefore.

9. All submittals including schedules, shop drawings, logs, sequence plans, product data, samples, QA/QC, technical, record drawings, diaries etc. shall be uploaded to the project File Transfer Protocol (FTP) site in specified folders site by the CONTRACTOR as part of the submittal process

B. Submittal Preparation: Place a permanent label or title block on each submittal for identification. Indicate the name of the entity that prepared each submittal on the label or title block.

1. Provide a space approximately 4 inches by 5 inches (100 by 125 mm) on the label or beside the title block on Shop Drawings to record the Contractor's review and approval markings and the action taken.

2. Include the following information on the label for processing and recording action taken.

   a. Project name.
   b. Date.
   c. Name and address of the Contractor's Engineer.
   d. Name and address of the Contractor.
   e. Name and address of the subcontractor.
   f. Name and address of the supplier.
   g. Name of the manufacturer.
   h. Number and title of appropriate Specification Section.
   i. Drawing number and detail references, as appropriate.

C. Number of Copies:

1. Four (4) hard copies and one electronic of the proposed Construction Schedule and subsequent revisions are required in Microsoft Project and PDF format specified by OWNER. CONTRACTOR must upload to the Owner provided FTP site in specified folders.

2. Four (4) hard copies and one electronic of the proposed Submittal schedule and subsequent revisions are required in searchable format specified by OWNER. CONTRACTOR must upload to the Owner provided FTP site in specified folders.

3. Nine (9) hard copies and one electronic of Shop Drawings, Product, Product Samples, Quality Assurance and Quality Control submittals are are required in searchable format specified by OWNER. CONTRACTOR must upload to the Owner provided FTP site in specified folders.

4. One (1) one electronic of Shop Drawings, Product, Product Samples, Quality Assurance and Quality Control submittals are required in searchable format specified

by OWNER. CONTRACTOR must upload to the Owner provided FTP site in specified folders.

D. Submittal Transmittal: Package each submittal appropriately for transmittal and handling. Transmit each submittal from the CONTRACTOR to the E/A through the Owner's Representative using a transmittal form (An example Transmittal Form is provided at the end of this section) and upload to the project FTP site. The E/A will not accept submittals received from sources other than the CONTRACTOR.

1. On the transmittal, record relevant information and requests for data. On the form, or separate sheet, record deviations from Contract Document requirements, including variations and limitations. Include CONTRACTOR's certification that information complies with Contract Document requirements."

3.2 CONTRACTOR'S CONSTRUCTION SCHEDULE

A. Construction Schedule: As described in Section 2.4.2 of Section 00700 "General Conditions", prepare a fully developed CONTRACTOR's construction schedule ("Baseline Schedule") using Microsoft Project© software unless otherwise approved by Owner's Representative. Submit Baseline Schedule including MS Project source file prior to or at the preconstruction conference, and submit updated schedules and MS project source file as specified by the E/A, usually at each regularly scheduled Project Meeting and with each pay application.

1. Detail each significant construction activity and use a weekly timeframe for the schedule. Use the same breakdown of units of the Work as indicated in the "Schedule of Values."
2. With each update, revise task completion percentage and mark completed tasks.
3. Prepare the schedule on a sheet, or series of sheets, of stable transparency, or other reproducible media, of sufficient width to show data for the entire construction period.
4. Secure time commitments for performing critical elements of the Work from parties involved. Coordinate each element on the schedule with other construction activities; include minor elements involved in the sequence of the Work. Show each activity in proper sequence. Indicate graphically the critical path items and the sequences necessary for completion of related portions of the Work.
5. Indicate the phases of work in which subcontractors will be participating. Subcontractors shall be indicated by name.
6. Coordinate the Contractor's Construction Schedule with the Schedule of Values, list of subcontracts, Submittal Schedule, progress reports, payment requests, and other schedules.
7. Indicate substantial completion in advance of the date established for Final Completion to allow time for the E/A's procedures necessary for certification of Substantial and Final Completion.
8. Separate 3-week look ahead will not be permitted in-lieu of a fully revised project schedule.
9. Schedule must include the following columns of information: % complete, Baseline Start, Baseline End, Baseline Duration, Actual Start, Actual Finish, and Actual Duration.
10. The schedule shall be sequential and have the critical path highlighted with dependencies shown.

B. Work Stages: Indicate important stages of construction for each major portion of the Work, including submittal review, testing, and installation.

C. Cost Correlation: Within the Baseline Schedule, provide cost information indicating planned and actual costs. On the appropriate task line(s), show dollar volume of Work performed as of the dates used for preparation of applications for payment. Refer to Section 00700, "General Conditions", Article 14 Payment to Contractor and Completion for cost reporting and payment procedures.

D. Distribution: Following response to the Baseline Schedule submittal, distribute electronic copies to the E/A, subcontractors, suppliers, and other parties required to comply with scheduled dates. Keep a copy at the Project Site at all times.

1. When revisions are made, distribute to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in construction activities.

E. Schedule Updating: Revise the schedule after each meeting, event, or activity where revisions have been recognized or made and as requested by the E/A. Issue the updated schedule concurrently with the report of each meeting, or as requested by the E/A.

3.3 SUBMITTAL SCHEDULE

A. Concurrently with the development of the CONTRACTOR's Construction Schedule, prepare a complete schedule of submittals in Excel format. Submit the initial Submittal Schedule in Excel spreadsheet format along with the Construction Schedule, at, or prior to, the Pre-construction Conference.

1. Coordinate Submittal Schedule with the list of subCONTRACTORs, Schedule of Values, and the list of products as well as the CONTRACTOR's Construction Schedule.

2. Prepare the schedule in order by specification division. Provide the following information not limited to:

a. Submittal number.
b. CONTRACTOR reference number.
c. Related Section number or Specification number.
d. Submittal category (Shop Drawings, Product Data, Calculations, Test Results, or Samples).
e. Description of the work covered.
f. Name of the subCONTRACTOR.
g. Target due date.
h. Target date for completion of the E/A's review.
i. List the following information to be filled in later:
- Actual Submittal Date.
- Date Rec'd by ENGINEER.
- Scheduled return date for completion of the E/A's review.
- Number of days under review.
- Reviewer.
- Date sent to reviewer.
- Date received from reviewer.
- Verified against SPL (yes/no/NA)?
- Accepted (A) or Rejected (R).
- Action / Note.
- Date returned to CONTRACTOR.
- Days past original target submittal date
- Comments

B. Distribution: Following Owner's response to the initial submittal, print, upload the Excel spreadsheet to FTP site and distribute copies to the Owner's Representative, E/A, Owner, subCONTRACTORs, suppliers, and other parties required to comply with submittal dates indicated. Keep copies at the Project Site at all times.

1. When revisions or resubmittals are made, add the new resubmittal to the submittal schedule as a separate item using the nomenclature described in section 3.1 of this specification. Distribute to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in construction activities.

C. Distribution: Upon Owner's agreement with the schedule of submittals, print and distribute copies to the Owner's Representative, E/A, Owner, subcontractors, suppliers, and other parties required to comply with submittal dates indicated. Keep copies at the Project Site at all times.

1. When revisions are made, distribute to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in construction activities.

D. Schedule Updating: Revise the schedule after each meeting or activity where revisions have been recognized or made. Issue the updated schedule concurrently with the report of each meeting, or as requested by the E/A.

3.4 CONSTRUCTION SEQUENCE PLANS

The Contractor is required to submit construction sequence plans to the City at, or prior to, the pre-construction conference for approval. The Project shall be divided into phases according to the sequence of construction given in the Drawings and traffic control plans. The Contractor shall arrange his/her work schedule to complete all Work on each phase, including street repair, any valve casting or manhole adjustments, and street overlay before moving on to the next work area.

3.5 SHOP DRAWINGS

A. Submit newly prepared information drawn accurately to scale. Highlight, circle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not a Shop Drawing.

B. Shop Drawings include fabrication and installation Drawings, setting diagrams, schedules, patterns, templates and similar Drawings. Include the following information:

1. Dimensions;
2. Identification of products and materials included by sheet and detail number;
3. Compliance with specified standards;
4. Notation of coordination requirements; and
5. Notation of dimensions established by field measurement.
6. Sheet Size: Except for templates, patterns and similar full-size Drawings, submit Shop Drawings on sheets at least 8-1/2 inches by 11 inches but no larger than 24 inches by 36 inches.
7. Do not use Shop Drawings without an appropriate stamp indicating action taken.

3.6 PRODUCT DATA

A. Collect Product Data into a single submittal for each element of construction or system. Product Data includes printed information, such as manufacturer's installation instructions, catalog cuts, standard color charts, roughing-in diagrams and templates, standard wiring diagrams, applicable certifications and performance curves.

1. Mark each copy to show applicable choices and options. Where printed Product Data includes information on several products that are not required, mark copies to indicate the applicable information. Include the following information:

a. Manufacturer's printed recommendations;
b. Compliance with trade association standards;
c. Compliance with recognized testing agency standards;

d. Application of testing agency labels and seals;
e. Notation of dimensions verified by field measurement; and
f. Notation of coordination requirements.

2. Do not submit Product Data until compliance with requirements of the Contract Documents has been confirmed.

3. Distribution: Furnish copies of final submittal to installers, subcontractors, suppliers, manufacturers, fabricators, and others required for performance of construction activities. Show distribution on transmittal forms.

   a. Do not proceed with installation until a copy of the final submission of Product Data is in the Installer's possession.

   b. Do not permit use of unmarked copies of Product Data in connection with construction.

4. Potable Water, Reclaimed Water, and Wastewater Items or Projects: The Contractor shall submit descriptive information and evidence that the materials and equipment the Contractor proposes for incorporation into the Work is of the kind and quality that satisfies the specified functions and quality. **Austin Water Utility Standard Products Lists (SPL)** are a part of the Specifications. Contractors shall use products specified in the Contract Documents, listed on the SPLs, or approved by AWU through the process in Section 2.4.0 of the Utilities Criteria Manual. Products contained in the SPL cannot be substituted for items shown on the Drawings, or called for in the specifications, unless approved by the E/A in conjunction with the Austin Water Utility Standards Committee. **Unless otherwise specified,** products current at the time of solicitation shall be installed except where an updated List has been issued to remove a product because of quality or performance issues.

3.7 SAMPLES

A. Submit full-size, fully fabricated Samples cured and finished when specified and physically identical with the material or product proposed. Samples include partial sections of manufactured or fabricated components, cuts or containers of materials, color range sets, and swatches showing color, texture, and pattern.

   1. Mount or display Samples in the manner to facilitate review of qualities indicated. Include the following:

      a. Specification Section number and reference;
      b. Generic description of the Sample;
      c. Sample source;
      d. Product name or name of the manufacturer;
      e. Compliance with recognized standards; and
      f. Availability and delivery time.

   2. Submit Samples for review of size, kind, color, pattern, and texture. Submit Samples for a final check of these characteristics with other elements and a comparison of these characteristics between the final submittal and the actual component as delivered and installed.

      a. Where variation in color, pattern, texture, or other characteristic is inherent in the material or product represented, submit at least 3 multiple units that show approximate limits of the variations.

      b. Refer to other Specification Sections for requirements of Samples that illustrate workmanship, fabrication techniques, details of assembly, connections, operation, and similar construction characteristics.

      c. Refer to other Sections for Samples to be returned to the Contractor for incorporation in the Work. Such Samples must be undamaged at time of use.

On the transmittal, indicate special requests regarding disposition of Sample submittals.

d. Samples not incorporated into the Work, or otherwise designated as the Owner's property, are the property of the Contractor and shall be removed from the site prior to Substantial Completion.

3. Maintain sets of Samples, as returned, at the Project Site, for quality comparisons throughout the course of construction.

a. Unless noncompliance with Contract Document provisions is observed, the submittal may serve as the final submittal.

b. Sample sets may be used by Owner for final acceptance of the construction associated with each set.

B. Distribution of Samples: Prepare and distribute additional sets to subcontractors, manufacturers, fabricators, suppliers, installers, and others as required for performance of the Work. Show distribution on transmittal forms.

3.8 QUALITY ASSURANCE AND QUALITY CONTROL SUBMITTALS

A. Submit quality assurance and quality control submittals, including design data, certifications, manufacturer's instructions, manufacturer's field reports, materials test results, field testing and inspection reports, and other quality-control submittals as required under other Sections of the Specifications.

B. Certifications: Where other Sections of the Specifications require certification that a product, material, or installation complies with specified requirements, submit a certification from the manufacturer or responsible Engineer certifying compliance with specified requirements.

1. Signature: Certification shall be signed by an officer of the corporation or other individual authorized to sign documents on behalf of the company.

C. Calculations: When required in the technical specification, calculations shall be prepared and stamped by a Professional Engineer registered in the State of Texas.

D. Concrete, Controlled Low Strength Material, Asphalt Stabilized Base and Hot Mix Asphaltic Concrete Mix Designs and Substantiating Test Data: Requirements for submittal of mix designs and substantiating test data are specified in the applicable Technical Specification Section. Each separate batch plant supplying ASB, HMAC and/or concrete shall submit mix designs to the Owner's Representative for review.

3.9 ENGINEER/ARCHITECT'S ACTION

A. Except for submittals, for the record, or for information where action and return is not required, the E/A will review each submittal, mark to indicate action taken, and return within the time frame specified in Paragraph 3.1.A.3.

1. Compliance with specified characteristics is the Contractor's responsibility.

B. Action Stamp: The E/A will stamp each submittal with a uniform, action stamp. The E/A will mark the stamp appropriately to indicate the action taken, as follows:

1. "Reviewed": the Work covered by the submittal may proceed provided it complies with requirements of the Contract Documents. Final payment depends on that compliance.

2. "Reviewed with Comments": the Work covered by the submittal may proceed provided it complies with notations or corrections on the submittal and requirements of the Contract Documents. Final payment depends on that compliance.

3. "Revise and Resubmit" or "Rejected": do not proceed with Work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Revise or prepare a new submittal according to the notations and resubmit without delay. Repeat if necessary to obtain different action mark.

    a. Do not use, or allow others to use, submittals marked "Revise and Resubmit" or "Rejected" at the Project Site or elsewhere where Work is in progress.

4. Other Action: Where a submittal is for information, or for record purposes, or for special processing, or for other activity, the E/A will return the submittal marked "Record Copy", "Action Not Required" or "No Action Taken."

C. Unsolicited Submittals: The E/A will return unsolicited submittals to the sender without action.

3.10 PREPARATION AND SUBMITTAL OF CONSTRUCTION RECORD DRAWINGS

The Owner's Representative and the Contractor's Superintendent will each maintain a set of bluelines noting any changes in ink during construction of the Project. The Owner's Representative and the Contractor's Superintendent will compare bluelines at least weekly (at a time mutually acceptable to both) to exchange information and compare notes to ensure all items installed and changes are documented. The following is a recommended minimum of items to be noted:

GENERAL

1. Notes should be sufficiently clear to allow a draftsperson to easily make the necessary changes without the need for field checks and interpretation.
2. One complete set of Construction Record bluelines will be submitted prior to the final pay request and forwarded to the Owner.
3. CONTRACTOR will submit to the OWNER and upload an electronic copy to the FTP site of the redline drawings before final submittal to the E/A"

STREET RECONSTRUCTION AND OVERLAY PROJECTS

1. Location, type, and quantity of all work added or deleted from the Project including repair areas, milled areas, sidewalk, ramps, curb and gutter, etc.
2. Deviations in street, sidewalk, curb and gutter location and grades from Drawings.

WATER/WASTEWATER PROJECTS

1. Type, name and model numbers of all valves (with # of turns to open/close), air release valves, drain and fire hydrants noted at locations installed.
2. Installed locations of all assignments, appurtenances and elevations which differ from those indicated on the Drawings.
3. Pipe manufacturer type and classification noted in sufficient detail to determine location and extent of each type or classification installed.
4. Modification to any standard or special details noted.
5. Location and description of pipe closures.
6. Thrust blocking locations and restrained pipe lengths, approximate dimensions and quantities noted.
7. Location, type and quantity of all addition and deletions.
8. Changes in grade.

The above list is not intended to be complete. Any information noted which could be used for future maintenance, location and construction projects is encouraged to be noted on the bluelines.

3.11 CONSTRUCTION DIARIES

The Contractor shall prepare a daily construction diary recording as a minimum the following information concerning events at the site and submit duplicate copies to the Owner's Representative

at weekly intervals. The copies are to be signed by the project Superintendent as defined in Section 00700, Article 6.1.2.

1. Work performed;
2. Approximate count of Contractor's personnel, by classification, on the site;
3. List by classification, of all Subcontractors, personnel and any professionals on the site that day;
4. List of all equipment on the site by make and model;
5. High and low temperatures together with general weather conditions;
6. Start time and finish time of day's work;
7. Accidents and / or unusual events;
8. Meetings and significant decisions made;
9. Stoppages, delays, shortages and / or losses;
10. Meter readings and / or similar recordings;
11. Emergencies procedures that may have been needed;
12. Orders and requests of governing authorities;
13. Change Orders received and implemented;
14. Services connected and / or disconnected;
15. Installed equipment and / or system tests and / or startups and results;
16. Partial completions and / or occupancies; and
17. Date of substantial completion certified.
18. Date of notice to proceed, duration, date of substantial completion, percent of time used.
19. At a minimum, 6 digital photos with date stamped inside camera taken before start of work and after completion at appropriate times showing representative work, incorporated into the PDF diary (not provided separately)"

3.12 Request For Information (RFI) Log

A. The CONTRACTOR will be responsible for providing and updating an Request For Information (RFI) log throughout the project. This will be

   1. Prepare the log in chronological order. Provide the following information not limited to:

      a. RFI number.
      b. Subject / Description.
      c. SubCONTRACTOR involved.
      d. Specification / Drawing referenced.
      e. Date received from CONTRACTOR.
      f. Date returned to CONTRACTOR.
      g. Response / Resolution.
      g. Number of days under review.

B. Distribution: Following Owner's response to the initial submittal, print, upload the excel spreadsheet to FTP site and distribute copies to the Owner's Representative, E/A, Owner, subCONTRACTORs, suppliers, and other parties. Keep copies at the Project Site at all times.

   1. When revisions are made, distribute to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in construction activities."

C. RFI Log Updating: Revise the log after each meeting or activity where revisions have been recognized or made. Issue the updated log concurrently with the report of each meeting, or as requested by the E/A.

3.13 Change Order Log

A. The CONTRACTOR will be responsible for providing and updating a Change Order Log throughout the project. This will be

1. Prepare the log in chronological order. Provide the following information not limited to:

a. Reference number.
b. RFP number.
c. Description.
d. SubCONTRACTOR involved.
e. Current status.
f. Date requested by OWNER.
g. Response from CONTRACTOR info: date, amount, and additional/deletion days.
h. Response to CONTRACTOR info: date, amount, and additional/deletion days.
i. Change Order number to be used for item.
j. Change Order information: date, amount, additional/deletion of days.

B. Distribution: Following Owner's response to the initial submittal, print, upload the Excel spreadsheet to FTP site and distribute copies to the Owner's Representative, E/A, Owner, subCONTRACTORs, suppliers, and other parties. Keep copies at the Project Site at all times.

1. When revisions are made, distribute to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in construction activities."

C. Change Order Log Updating: Revise the log after each meeting or activity where revisions have been recognized or made. Issue the updated log concurrently with the report of each meeting, or as requested by the E/A.

3.14 Asset Management Tracking Form

"The Owner will provide asset tags for equipment and the CONTRACTOR will be responsible for affixing the tags on the equipment. The CONTRACTOR shall not affix asset management tags until Owner has accepted the installation.

The CONTRACTOR shall work with the ENGINEER and owner to complete and submit the Asset Management Tracking Form included in the project manual. This warranty/equipment list must be broken down in sufficient detail and approved by owner. Asset management tag numbers along with warranty information shall be tracked using the form provided and submitted with the required affidavits at the completion of the project. The Excel file of the form included will be provided to the CONTRACTOR upon request. The electronic file as well as hard copies shall be provided to the Owner as required by the Specifications."

Shop Drawing Transmittal

Month XX, 2008

Transmittal No. _____
Previous Transmittal No. _____
Previous Submittal Date _____

City of Austin
Construction Inspection Division
Public Works Department
P.O. Box 1088
Austin, Texas 78767

Project Name: Austin Lakeside Drive

Attention: Owner's Representative

Enclosed are nine (9) copies of the following items for your review:

Item No.	Description	Submittal Type	Specification Section	Subcontractor/Supplier
1.	6" DI Pipe	Produce Data	510	ABC Company
2.	8" Resilient Seat Gate Valve	Product Data	511	DEF Company

NOTE: Item 1 above contains a deviation from the Specifications as indicated on the item

Submitted by: _____

XYZ Company
101 Ranch Road 2974
Austin, Texas 78759

END

PART I - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Specific requirements for the preparation, submittal, updating, and status reporting of the construction Progress Schedule.

B. Related Specification Sections include, but are not necessarily limited to:

1. Division 0 - Procurement and Contracting Requirements.

2. Division 1 - General Requirements.

C. Review of the CPM Schedule:

1. In so far as the Contractor is solely responsible for its means and methods and the CPM schedule represents in part its means and methods, the review of the CPM schedules (preliminary, baseline, updates, revisions, etc.) is for compliance with the requirements as defined in the contract documents.

2. The review of the CPM schedule is not intended to be complete or exhaustive or check every activity and its relation to the work.

3. The A/E and Owner will provide comments on the CPM schedule compliance with those contract requirements and anomalies that might appear to the A/E and Owner.

4. If the Contractor fails to include contract requirements (e.g. specified cure times, commissioning periods) in the CPM schedule, or the A/E and Owner fails to notify the Contractor of anomalies the Contractor is not relieved of the contract requirements.

5. Acceptance of the CPM schedule does not imply that the Owner has approved or accepted the Contractor's means and methods or sequence for performing the work to construct the project.

6. If the Contractor has questions or concerns about comments, the Contractor, A/E, and Owner shall meet to resolve those issues prior to issuance of future updates or revisions.

1.02 QUALITY ASSURANCE

A. The person preparing, updating and revising the construction Progress Schedule shall be experienced in the preparation of schedules of similar complexity.

B. Project Scheduler Qualifications:

1. Minimum of five years experience working in some capacity as a scheduler and with the use of Microsoft Project Professional 2016 or later software for the purpose of developing, monitoring, updating and maintaining the Contractor's detailed schedule.

2. Minimum five years of relevant experience in construction, planning, scheduling, expediting and tracking the progress of the work for projects of a similar nature, size, and complexity.

3. Adhere to all requirements of this schedule specification, participate in all job progress review/update meetings, and other requested meetings regarding the project schedules.

4. If the A/E or Owner notifies the Contractor that the scheduler does not meets the minimum requirements, provide the qualifications of another scheduler that meets the requirements.

5. If the Contractor changes schedulers after the A/E or Owner determines the scheduler meets these requirements, follow this same process outlined above to substitute schedulers.

6. Qualifications necessary:

    a. Produced, updated, and maintained for at least five years complex construction schedules for projects of similar type, size and complexity.

    b. Proficient in the use of the scheduling program selected for this project.

    c. If the Contractor changes the person responsible for developing and maintaining the schedule, the Contractor will provide documentation verifying the new person meets the minimum qualifications.

1.03 DEFINITIONS

A. The following definitions shall apply to this Specification Section:

1. Preliminary Schedule: Establishes the Contractor’s plans to execute the first actions associated with the project and to establish a tool by which the progress of the project can be monitored during the period when the baseline project schedule is being developed. The Preliminary Schedule shall include a detailed plan for the first 90 days of the project and summary activities of the work to achieve the Substantial Completion Date, Final Acceptance Date, and any project Milestones defined in the Contract Documents.

2. Baseline Schedule: Establishes the Contractor’s plans to execute the project. The Baseline Schedule shall include preconstruction activities, submittals, A/E and Owner’s reviews, fabrication, and delivery; construction activities with durations not to exceed 20 days and whose progress can be reasonably measured; Milestones, and constraints defined in the Contract Documents; post construction activities, O&M Manual production, testing, commissioning, and project closeout.

3. Schedule Update: The initially accepted Baseline Schedule, or subsequently approved Revised Baseline Schedules, updated each month to reflect actual start and finish dates of each schedule activity and the remaining duration of activities that began during the period.

4. Current Schedule: The current schedule is either the Baseline Schedule or Revised Baseline Schedule including and incorporating Schedule Updates.

5. Revised Schedule: Updated schedule that include changes agreed on by the A/E, Owner, and the Contractor. The Revised Schedule shall be developed after the Schedule Update is completed. The Revised Schedule will become the Current Schedule that will subsequently be utilized for Schedule Updates.

6. Recovery Schedule: A Recovery Schedule shall be prepared when the Current Schedule forecasts the Work completing at least 10 working days or more in meeting a contract milestone or the contract completion date. The Recovery Schedule shall show how the Contractor intends to complete the Work within the Contract Time. Do not incorporate unapproved changes in the Recovery Schedule.

7. Short Interval Schedule: A schedule prepared by the Contractor reflecting the work planned for the current and subsequent two weeks and the work completed in the week prior to the current week. This is also known as a Look-Ahead Schedule.

8. Resources: Hours for each worker on the project, materials, and permanent equipment incorporated into the work, construction equipment, or budgeted dollars.

9. Time Impact Analysis (TIA): A schedule used to quantify the effects of an unplanned event which can have an impact on the work scope and Contract Time.

1.04 SUBMITTALS

A. Project Schedule Preparation:

1. Within five days from Execution of the Contract, Submit a statement of qualifications for the person responsible for the preparation, maintenance, updating and revision of all schedules. The statement of qualifications shall demonstrate that the scheduler meets the minimum qualifications for a scheduler outlined herein.

B. Preliminary Schedule:

1. Submittal and review:

a. Submit within 10 calendar days after the Effective Date of the Contract.

b. The A/E and Owner will review and provide comments to the Contractor within 10 working days after receipt of the schedule.

c. The Contractor will review and modify the Preliminary Schedule and return the schedule within five working days. If there are concerns about the comments

provided, the A/E, Owner, and Contractor will meet to review and resolve those concerns.

2. Submittal package:

   a. CPM time-scaled network diagram in PDF.

   b. Tabular Report.

   c. Preliminary Schedule Report.

   d. Electronic Data Files: The Contractor will provide the A/E and Owner with the source or "raw" data/electronic files in ".XER" format that can be viewed with the software used to develop the CPM schedule.

C. Baseline Schedule and Narrative Report:

1. Submittal and review:

   a. Submit within 30 days after Effective Date of the Contract or Notice to Proceed, whichever is earlier.

   b. The A/E and Owner shall review the Baseline Schedule and provide comments to the Contractor within 10 working days after receipt of the schedule.

   c. After receiving comments, the Contractor, A/E, and Owner shall meet to review the comments within five working days.

   d. After the meeting, the Contractor will modify the schedule as agreed and resubmit the Baseline Schedule within five working days.

   e. After the A/E and Owner confirms that the Contractor has made the changes as agreed, the schedule will become the Baseline Schedule.

2. Submittal package:

   a. CPM time-scaled network diagram in PDF.

   b. Tabular Report.

   c. Baseline Schedule Report: Provide a written Narrative Report as defined in this specification.

   d. Electronic Data Files: The Contractor will provide the A/E and Owner with the source or "raw" data/electronic files in ".XER" format that can be viewed with the software used to develop the CPM schedule.

D. Schedule Updates:

1. Submittal and Review:

a. Provide Schedule Updates five days after the last working day of the month as agreed to with the A/E and Owner.

b. If the A/E or Owner identifies anomalies the A/E and Owner shall provide comments to the Contractor on the Schedule Update.

c. Unless directed by the A/E or Owner to resubmit the schedule update within five working days, incorporate the A/E and Owner's comments into the next Schedule Update.

d. Do not include any changes to the existing logic, activity durations, add new activities, or delete activities within the Monthly update during the monthly updating process. Should the Contractor wish to make any changes to the existing logic, activity durations, add new activities, or delete activities, the proposed changes to the schedule will be submitted to the A/E and Owner for review. If the A/E or Owner determines the change(s) are not consistent with the contract document, the A/E or Owner shall notify the Contractor of its determination and maintain the current schedule. If the A/E or Owner determines the changes are consistent with the contract document, the changes can be put into the current update following the procedures described below under Sections F below.

2. Submittal Package:

a. CPM time-scaled network diagram in PDF.

b. Tabular Report.

c. Schedule Update Progress Report: Provide a written progress report with each schedule update.

d. Electronic Data Files: The Contractor will provide the A/E and Owner with the source or "raw" data/electronic files in ".XER" format that can be viewed with the software used to develop the CPM schedule.

E. Revised Schedule:

1. Submittal and Review:

a. Provide a Revised Baseline Schedule to reflect approved Change Orders as requested by the A/E and Owner.

b. Submit 10 working days after the Updated Schedule.

c. Activities will be added or the durations modified to reflect the work approved in change orders.

d. The A/E and Owner will review and provide comments to the Contractor on the Revised Baseline Schedule within five working days.

e. Incorporate the A/E and Owner comments into the Revised Baseline Schedule.

f. After acceptance by the A/E and Owner, the Revised Baseline Schedule, use for future Schedule Updates.

2. Submittal Package:

a. CPM time-scaled network diagram in PDF.

b. Tabular Report.

c. Revised Schedule Report: Provide a Narrative Report with its CPM schedule.

d. Electronic Data Files: The Contractor will provide the A/E and Owner with the source or "raw" data/electronic files in ".XER" format that can be viewed with the software used to develop the CPM schedule.

F. Recovery Schedule:

1. Unless otherwise directed in writing by the A/E or Owner, when the activities on the critical path or the completion milestones appear to be beyond the contract time, provide a Recovery Schedule demonstrating how the Contractor will recover the lost time so that the Work will be completed within the Contract Time.

a. Do not incorporate unapproved changes in the Recovery Schedule.

b. The Contractor's refusal, failure or neglect to take appropriate recovery action or to submit a written recovery statement shall constitute reasonable evidence that the Contractor is not prosecuting the Work, or separable part, with the diligence that will insure its completion within the applicable Contract Time and shall constitute sufficient basis for the A/E and Owner to recommend to withhold any payment or portion thereof otherwise due, or identify and order alternate recovery actions on the basis of the information in the Contract Schedule.

2. Submittal and Review.

a. Provide the Recovery schedule within 10 working days after requested by the A/E or Owner.

b. Activities will be added or the durations modified to reflect the changes to the work.

c. The A/E and Owner will review and provide comments to the Contractor on the Recovery Schedule within five working days.

d. The Contractor will incorporate the A/E and Owner comments into the Recovery Schedule.

e. The Recovery Schedule shall be used for subsequent Schedule Updates.

3. Submittal Package:

a. CPM time-scaled network diagram in PDF.

b. Tabular Report.

c. Recovery Schedule Report: Provide a Recovery Schedule Report with its CPM schedule.

d. Electronic Data Files: The Contractor will provide the A/E and Owner with the source or "raw" data/electronic files in ".XER" format that can be viewed with the software used to develop the CPM schedule.

G. Short Interval Schedule:

1. Submittal and Review:

a. Provide a three week rolling look-ahead Short Interval Schedule each week during the Contract Time by Friday noon prior to the first working day of the schedule.

b. If the A/E or Owner provides comments, the Contractor will revise and resubmit the schedule.

1.05 SCHEDULE REQUIREMENTS

A. General:

1. The above listed project schedules shall be used for evaluating all issues related to time for this Contract. The Project Schedules shall be updated in accordance with the requirements of this Specification to reflect the actual progress of the Work and the Contractor's current plan for the timely completion of the Work. The Project Schedules shall be used by the A/E, Owner, and Contractor for the following purposes as well as any other purpose where the issue of time is relevant:

a. To communicate to the A/E and Owner the Contractor's current plan for carrying out the Work.

b. To identify work paths that are critical to the timely completion of the Work.

c. To identify upcoming activities on the critical path(s).

d. To evaluate the best course of action for mitigating the impact of unforeseen events.

e. As the basis of progress payments to the Contractor.

f. As the basis for analyzing the time impact of changes in the Work.

g. As a reference in determining the cost associated with increases or decreases in the Work.

h. To prioritize the A/E and Owner's review of submittals.

i. To document the actual progress of the Work.

j. To evaluate resource requirements of the Contractor, the A/E, and Owner.

k. To integrate the Work with the operational requirements of the A/E and Owner's facilities.

l. To facilitate efforts to complete the Work in a timely manner.

2. The Project Schedules provide a basis for A/E and Owner decisions that may impact the Work under this Contract, as well as other concurrent or future Work. As such, the Contractor understands that time is of the essence in the performance of all Work under this Contract including but not limited to providing the necessary schedule information required by this Specification.

   a. The project schedules shall at all times accurately reflect the Contractor's current plan for the Work and shall be updated as required by this Specification.

   b. This Specification requires the Contractor to submit the Project Schedules in a specific format. Failure to meet the full requirements of this Specification will adversely affect the A/E and Owner's ability to administer this and other Contracts.

   c. Be responsible for all impacts to the Work on this Contract as well as the Work on other Contracts and any cost incurred resulting from the Contractor's failure to meet the requirements of this Specification.

   d. The monthly accepted Schedule Update, showing updated activities and status in accordance with the requirements of this Section shall be a condition precedent to the start of the progress payment cycle.

B. Schedule Detail:

1. The CPM Schedule shall contain sufficient prior to construction, construction, and testing & commissioning and closeout activities to represent the Work, with a means to monitor and follow progress of all phases of Work; comply with limits imposed by the scope of Work, with contractually specified interim milestones and completion dates; and with constraints, restraints, or sequences included in the Contract. The CPM Schedules shall include, but are not limited to the following:

   a. Include a well-defined activity coding structure that allows Project activities to be sorted by type of Work, location of Work, work breakdown structure (WBS), or as mutually agreed to by the Contractor, the A/E, and Owner. Activity coding shall be assigned consistently and uniformly among all similar activity types.

   b. Activities will be sorted by milestones, area, trades, and subcontractors as agreed on with the A/E and Owner.

   c. Construction start dates (Award date, Notice(s) to Proceed date).

   d. Preparation of submittals, submittal reviews and approvals, manufacture, tests, delivery, installation activities, critical materials and equipment shall be represented in the CPM Schedule. Description of the activity shall include sufficient detail to identify the unique scope of that activity.

e. Materials and Equipment Procurement: Include the following activity sequence for critical and long lead materials and equipment procurement or any activity that may be requested by the A/E or Owner:

   1) Submittal Preparation.

   2) Review and Approval.

   3) Fabricate and Deliver.

f. If the contract permits and the Contractor plans to request payment for materials and/or equipment prior to installation, a separate activity shall be included in the CPM schedule for each item for which the Contractor plans to request payment. This section does not supersede or take precedence over any other contract provision regarding such payment.

g. The CPM schedule shall include required review times for any Submittals and Approvals by regulatory agencies or other Parties as defined in the contract.

h. Milestones or access restraints for completion of certain portions of the Work or access and availability to Work areas.

i. Identification of interfaces and dependencies with preceding, concurrent, and follow-on Contractors, other agencies and utilities, typically shown as milestone type of activities.

j. Other activities can include shutdowns, utility tie-ins, plant tie-ins, traffic changes and closings, inspections and hold points, receipt of operations and maintenance (O&M) manuals, start-up of equipment, testing of equipment and systems, and commissioning.

k. Water curing of concrete after placement for all structures.

l. Planning for phased or total handover to the Owner.

m. Cost Loading: Allocation of the monetary value for each activity in the CPM Schedule. The sum of all values shall match the total Contract value. The A/E and Owner reserve the right to accept or reject any value and allocation to the activity.

n. Identification of manpower by trade, material, or equipment restrictions, as well as any activity requiring unusual shift work, such as two shifts, six day weeks, specified overtime, or work at times other than regular days or hours.

o. Resource Loading: Resource allocation for each activity in the CPM Schedule identifying the hours by trade, the physical quantity of material to be installed (Cubic yards of concrete, linear feet of pipe, etc.). The A/E and Owner reserve the right to accept or reject any value and allocation of the man-hours and/or the materials. The unit of measure shall be reviewed and approved by the A/E and Owner.

2. Calendars:

a. Develop activity calendars commensurate with the Contractor's workweek plan. Calendars shall include all non-working days, such as weekends, holidays, or other periods when the Contractor plans not to work. Calendar(s) shall be reviewed and accepted by the A/E and Owner as part of the CPM schedule submittal and will be monitored using the most updated schedule.

b. The planning unit for the Contract shall be days;

c. Calendars shall contain all Owner holidays;

d. Every activity shall be assigned a calendar that takes into account when the activity is planned to occur and/or when it is contractually permitted to occur.

e. Contract times are expressed in calendar days, the CPM Schedule shall be calculated in working days.

3. Logic and Durations:

a. Logic and activity durations shall be established by the Contractor consistent with the Contract requirements and shall reflect coordination between trades, definitive resource planning and on-site work conditions.

b. Logic shall show how the start of a given activity is dependent on the completion of preceding activities, and its completion restricts the start of following activities. Except for fabrication activities shall not have duration greater than 20 working days.

c. Except the first activity and completion milestone(s), each activity on the CPM schedule shall have a predecessor and successor activity.

d. Preferential Logic sequencing shall not be allowed in the schedule.

4. Restraints, Constraints and Milestones:

a. The start date of the CPM Schedule shall be the Contract Notice to Proceed.

b. The completion date of the CPM Schedule shall be the Contract Final Completion date.

c. All intermediate restraints and milestones required in the Contract shall be shown in proper logical sequence and properly constrained.

d. The CPM Schedule shall include all Work constraints indicated in the Contract or as added with a Contract modification. Other activity Constraints shall not be used unless approved by the A/E and Owner.

5. Schedule Dates: Whenever the term "schedule" or "scheduled date" is used, it shall mean the "early start" and "early finish" dates in the CPM Schedule. The "late" dates are for purposes of calculating float and do not represent the schedule dates.

6. Activity Descriptions:

a. Activities shall be described such that the Work is readily identifiable for assessment of start and completion, as well as intermediate status.

b. Descriptions shall utilize identifiers for physical locations such as column lines, stations, and elevations where possible to define the Work.

c. The activity description shall identify the scope of the activity.

d. There shall not be any two activities with the same activity description. If the Contractor wants to change the description of an activity, it will delete the activity and then add a new one with the new activity description.

C. Float:

1. The total float of an activity is the maximum time that its actual completion date can extend beyond its early finish date and not affect the Contract Time.

2. Float is not for exclusive use or benefit of either the Owner, Engineer, or the Contractor but is an expiring resource available to both parties. Float is used by any party, as needed, to meet the contract milestones and the contract completion dates, or to cover changes to the Contract. However the Contractor is expected to execute the work according to the Early Dates of the schedule.

3. Float Suppression: Pursuant to float sharing requirements of this Section, use of float suppression techniques such as preferential sequencing or logic, special lead/lag logic restraints, and extended activity durations are prohibited. Approval of any Schedule Submission by the A/E or Owner shall not preclude later correction of float suppression techniques or of any other deficiency by the A/E and Owner.

4. Early Completion Schedule: Recognizing that the Owner developed the project duration based on its needs and resources, if the Contractor proposes an early completion schedule, such schedule shall be subject to the acceptance of the A/E and Owner. Any time between the early completion of a contract milestone, including substantial completion, schedule proposed by the Contractor and that contract milestone will be considered float.

D. CPM Time-Scaled Network Diagram:

1. A printed logic diagram and PDF that include the following information:

a. Unique activity number/identifier; numeric, alpha or combination of numeric/alpha.

b. Activity description.

c. Activity duration.

d. Early start and early finish for each activity.

e. Late start and late finish for each activity.

f. Total float (TF) for each activity.

g. Bar showing the early start and completion dates of each activity.

h. The activities will be sorted by area, trades, and subcontractors as agreed on with the A/E and Owner.

i. Print the CPM time-scaled network diagram on minimum sheet size of 11 IN x 17 IN.

j. Provide electronic data in accordance with the Early Completion paragraph in the GENERAL REQUIREMENTS Article.

E. Tabular Reports:

1. Provide a Tabular Report with each schedule submittal that includes the following information;

a. Activity number/identifier.

b. Activity description.

c. Activity duration.

d. Early start and early finish for each activity.

e. Late start and late finish for each activity.

f. Total float (TF) for each activity.

g. Predecessor activities.

h. Successor activities.

i. Cost/budget to perform the work in the activity.

j. Resources needed to perform the activity.

F. Schedule Reports: Provide reports with each of the schedule submittals. As a minimum, the reports shall contain the following information:

1. Preliminary Schedule Report.

a. Executive Summary explaining how the Contractor plans to execute its plan to construct the project.

b. Critical activities needed to start construction.

c. Description of what the Contractor sees as the critical activities.

d. Constraints that will be included the schedule.

2. Baseline Schedule Report.

a. Executive Summary explaining how the Contractor plans to execute its plan to construct the project.

b. Assumptions used to develop the schedule.

c. Constraints included in the schedule as defined by the Contract Documents.

d. The critical path and near critical path activities with an explanation of why those activities are included on those paths.

e. Number of planned working days per week including shifts per day.

f. Manpower plan including craft on site per day.

g. Production rates assumptions.

h. Major equipment planned for the project and durations for their use.

i. Resource constraints.

j. Identification of unusual conditions or restrictions regarding labor, equipment or material.

k. Calendar(s) used in the contract and how the multiple calendars are used.

l. Holidays observed during construction.

3. Schedule Updates Progress Reports:

   a. Provide a report with each Schedule Update detailing the work completed during the month, any changes to the schedule logic, any changes to activity durations, any changes to the critical path, and any changes to its assumptions for constructing the Work, including assumed constraints included in the schedule as defined by the Contract Documents, permits, or the Contractor.

   b. Identify the current critical path activities.

   c. Indicate reasons the Contractor made the changes to logic, durations, activities, and/or the critical path.

4. Revised Schedule Report:

   a. Provide a report with each Revised Schedule detailing the work completed during the month, any changes to the schedule logic, any changes to activity durations, any changes to the critical path, and any changes to its assumptions for constructing the Work, including assumed constraints included in the schedule as defined by the Contract Documents, permits, or the Contractor.

   b. Identify the current critical path activities.

   c. Indicate reasons the Contractor made the changes to logic, durations, activities, and/or the critical path.

5. Recovery Schedule Report:

    a. Provide a report with an explanation of the changes in logic and/or activity durations.

    b. Identify the current critical path activities.

    c. Indicate reasons the Contractor made the changes to logic, durations, activities, and/or the critical path.

G. Electronic Data Files:

1. The Contractor will provide the A/E and Owner with the source or "raw" data/electronic files in ".XER" format that can be viewed with the software used to develop the CPM schedule.

H. Weather delays:

1. Include an activity on the critical path of the schedule with a duration of five working days per year for delays due to adverse weather on the project. When the A/E, Owner, and Contractor agree that a weather day affects the work, it will reduce the remaining duration of the weather day activity by the agreed on weather days.

    a. Adverse weather is considered when the temperature and/or precipitation exceeds the average temperature, precipitation and/or other weather event by 15 PCT as measured by the National Oceanic and Atmospheric Administration (NOAA) at the closest weather station to the project site and the adverse weather impacts the Contractor's delivery of material, availability of labor, or production of work. If the adverse weather does not affect delivery of material, availability of labor, or production of work, then it will not be considered adverse weather.

    b. The adverse weather must effect the work on the critical path at the time the adverse weather occurs.

    c. Any time not used in a calendar year may be carried over to the next year or considered float.

I. CPM Scheduling Software:

1. Unless otherwise agreed to with the A/E and Owner, use Microsoft Project Professional 2016 or later to develop and maintain the schedules listed above for this project.

    1) Provide data files that can be read using the Microsoft Project Professional 2016 or later. Do not employ any methods for locking data or preventing the A/E and Owner from reading the data using Microsoft Project Professional 2016 or later.

2. If the Contractor proposes to use a different scheduling software package for this project, provide up to three licenses for the software to the Owner and A/E and provide on-going training on the use of that software.

1.06 START-UP, DEMONSTRATION, TRAINING, AND FINAL COMPLETION

A. The Baseline Schedule must include broad-based activities for start-up, operator training, and final completion.

1.

a. Identify task for the substantial completion notification.

b. Pre-demonstration period:

1) Identify equipment start-up for all major equipment.

c. Identify all operator trainings required by individual Specification Sections.

d. Complete submission of all required submittals.

e. Demonstration period: Identify for each project classified system.

1.07 CONSTRUCTION SCHEDULING MEETINGS

A. Scheduling Conference Prior to Construction:

1. The A/E, Owner, and Contractor shall conduct a scheduling conference within 15 calendar days of Notice of Award. At a minimum, the Contractor's Project Manager and qualified Scheduler shall attend this meeting. The A/E and Owner will review the schedule requirements defined in the contract documents with the Contractor. Submit and provide an overview of the Preliminary Baseline Schedule.

B. Baseline Schedule Conference:

1. After the A/E and Owner reviews the Baseline Schedule submittal, the A/E, Owner, and Contractor meet to review the Baseline Schedule. Any comments or concerns will be addressed and re-submit the schedule with any agreed on changes.

C. Schedule Review Conferences:

1. Within five days after the A/E and Owner review the Schedule Updates, Revised Schedule, and Recovery schedule submittals, the A/E, Owner and Contractor meet to review the schedule submittal. Any comments or concerns will be addressed and modify the schedule with any agreed on changes.

1.08 TIME IMPACT ANALYSIS (TIA)

A. Provide a TIA to support all requests for increases to the Contract Time.

B. Use the Current Schedule to develop the TIA.

1. The TIA must be attached to any change order proposal prior to approval of any change to time or cost when requesting additional time.

2. Submit a written narrative report to the A/E and Owner with each request for adjustment to the Contract Time, or when the Contractor, A/E, or Owner consider that an approved or anticipated change may impact the critical path or progress of the work.

    a. Include a description of delaying factors and their impact with an explanation of corrective actions taken or proposed.

    b. The TIA shall illustrate the impacts of each change or delay on the current scheduled completion date or internal milestone, as appropriate.

    c. The analysis shall start by using the schedule that has a data date closest to and prior to the event or change.

    d. The analysis shall identify the activities on the critical path prior to the event or change, the activities added or extended as a result of the event or change, and the impact of those changes on the critical path activities.

    e. The analysis shall identify the impacts that the Contractor attributed to the change or Owner, those impacts that are the result of the Contractor's actions and those impacts that are considered concurrent.

    f. If the impact schedule shows that incorporating the event modifies the critical path and scheduled completion date of the accepted CPM Schedule, the difference between scheduled completion dates of the two schedules shall be equal to the adjustment of Contract Time.

C. Submit a TIA within 15 working days of receiving a written request for a TIA from the A/E or Owner, or after the event.

    1. Allow the A/E and Owner 30 days after receipt to approve or reject the submitted TIA.

    2. All approved TIA schedule changes shall be shown on the next Schedule Update.

D. Rejections of a TIA:

    1. If a TIA submitted by the Contractor is rejected by the A/E and Owner, meet with the A/E and Owner to discuss and resolve issues related to the TIA.

    2. If agreement is not reached, the Contractor will be allowed 10 working days from the meeting with the A/E and Owner to give notice.

    3. The A/E and Owner will withhold a portion of the progress payment if a TIA is requested by the A/E or Owner and not submitted by Contractor within 15 working days.

    4. The payment will resume on the next estimate after the requested TIA is submitted and accepted by the A/E and Owner.

E. Any delay by the Contractor that is in parallel with another delay not caused by the Contractor shall be considered a concurrent delay for which the Contractor will not be entitled to impactable/compensable time regardless if on the critical path or not.

PART II - PRODUCTS (NOT USED)

PART III - EXECUTION (NOT USED)

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Division 1 General Requirements

SUSTAINABLE CONSTRUCTION REQUIREMENTS

Section 01352

SECTION 01352.2

Building Project – LEED® Certification not Being Pursued

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section. The requirements may or may not include reference to sustainability/LEED.

Language in each section provides detailed guidelines to inform the Contractor of appropriate performance requirements for specific materials and products. All LEED/sustainable design materials, products, and methods must meet the specifications as written unless otherwise approved by the Architect.

Related Sections include the following Division 1 Sections:

1. Section 01300 Submittals.
2. Section 01505 Construction and Demolition Waste Management and Disposal.
3. Section 01730 Operation and Maintenance Data.

1.2 SUMMARY

A. This Section includes general requirements and procedures for compliance with certain Sustainable Construction requirements.

1. Some Sustainability requirements are dependent on material selections and may not be specifically identified as sustainability requirements. Compliance with requirements may be used as one criterion to evaluate substitution requests.

2. Additional Sustainability Construction requirements are dependent on Architect's design and other aspects of the Project that are not part of the Work of the Contract.

B. Related Sections: The contents of this Section are related to all Sections of these Specifications. Language in each section provides detailed guidelines to inform the Contractor of appropriate performance requirements for specific materials and products. All sustainable design materials, products, and methods must meet the specifications as written unless otherwise approved by the Architect.

C. Green Seal: standards for commercial adhesives and cleaning products; www.greenseal.org

1.3 DEFINITIONS

A. Certificates of Chain-of-Custody: 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 1.2, "Principles and Criteria." Certificates shall include evidence that mill is certified for chain-of-custody by an FSC-accredited certification body.

B. LEED™: Leadership in Energy & Environmental Design. This is not a requirement of this project. Included for information only.

C. Rapidly Renewable Materials: Materials made from agricultural products that are typically harvested within a ten-year or shorter cycle. Rapidly renewable materials include products made from bamboo, cotton, flax, jute, straw, sunflower seed hulls, vegetable oils, or wool.

D. Regionally Manufactured Materials: Materials that are manufactured within a radius of 500 miles (800 km) from the Project location. Manufacturing refers to the final assembly of components into the building product that is installed at the Project site.

E. Regionally Extracted, Harvested, or Recovered Materials: Materials that are extracted, harvested or recovered and manufactured within a radius of 500 miles (800 km) from the Project site.

F. Recycled Content: The percentage by weight of constituents that have been recovered or otherwise diverted from the solid waste stream, either during the manufacturing process (pre-consumer), or after consumer use (post-consumer).

1. Spills and scraps from the original manufacturing process that are combined with other constituents after a minimal amount of reprocessing for use in further production of the same product are not recycled materials.

2. Discarded materials from one manufacturing process that are used as constituents in another manufacturing process are pre-consumer recycled materials.

G. Albedo: The ratio of the amount of light reflected from a material to the amount of light shone on the material ranging from 0 (black) to 1 (white). As defined by the USGBC, a high albedo material has a reflectance of at least .3. Albedo is also known as solar reflectance or reflectivity.

H. Composite agrifiber product: A board or sheet product that uses an agricultural waste product (such as straw from wheat, oats, rice, and rye) as its fiber source instead of wood.

I. Embodied energy: The total energy that a product may be said to "contain," including all energy used in growing, extracting, and manufacturing it and the energy used to transport it to the point of use. The embodied energy of a structure or system includes the embodied energy of its components plus the energy used in construction. In some cases, a material designed for energy conservation may have more energy invested in making it than it can save throughout most of its lifetime.

J. Formaldehyde: A colorless, pungent smelling gas used as an adhesive component in many glues (especially those used to make composite and laminated wood products), and as an additive in paint and other products. As a monomer, formaldehyde can cause respiratory problems, cancer, or chemical sensitivity even at very low exposure levels (National Institute for Occupational Safety and Health (NIOSH) exposure threshold level is one part per million (ppm). See urea formaldehyde below.

K. Heat island effect: When warmer temperatures (from 6 - 10°F) are experienced in urban landscapes as a result of solar energy retention on constructed surfaces. Principle surfaces that contribute to heat island effect include streets, sidewalks, parking lots, and buildings. Also called "Urban Heat Island Effect."

L. Impervious surfaces: Surfaces that promote runoff of precipitation volumes instead of infiltration into the subsurface. The imperviousness or degree of runoff potential can be estimated for different surface materials.

M. In-factory VOC Flushout: Curing and ventilating materials after manufacture in order to reduce overall VOC levels before shipping to project site.

N. Indoor Air Quality: The character of air inside a building that affects the health and well being of building occupants. According to the U.S. Environmental Protection Agency and National lnstitute of Occupational Safety and Health, the definition of good indoor air quality includes (1) introduction and distribution of adequate ventilation air; (2) control of airborne contaminants; and (3) maintenance of acceptable temperature and relative humidity. According to ASHRAE Standard 62-1999, acceptable indoor air quality is defined as "air in which there are no known contaminants at harmful concentrations as determined by cognizant authorities and with which a substantial majority (80 percent or more) of the people exposed do not express dissatisfaction."

O. Indoor Environmental Quality: The overall character of the indoor environment that affects the health and well being of building occupants and is achieved through prevention, planning, and control of systems.

P. Life cycle: The consecutive, interlinked stages of a product, beginning with raw materials acquisition and manufacture and continuing with its fabrication, manufacture, construction, and use, and concluding with any of a variety of recovery, recycling, or waste management options.

Q. Life cycle cost (LCC) of material: The costs accruing throughout the service life of a material. Life-cycle costs address the capital costs involved in production, maintenance, and disposal, and can also include other environmentally related capital costs and societal costs.

R. Local/regional materials: Materials that are extracted, harvested or recovered, as well as manufactured within a 500-mile radius of the project site. See definition for manufactured below.

S. Manufactured: Refers to the final assembly of components into the building product before it is furnished and installed by tradesman (Reference: LEEDTM Materials & Resources)

T. Material Safety Data Sheets (MSDS): Occupational Safety and Health Administration (OSHA) required documents supplied by manufacturers of potentially hazardous products. MSDS contain information regarding potentially significant air-borne contaminants, precautions, steps for inspection, health effects, odor description, volatility, expected contaminants from combustion, reactivity, and procedures for cleanup.

U. MERV: The Minimum Efficiency Reporting Value for filtration media as determined by the ANSI/ASHRAE 52.2-1999.

V. Off-gas/out-gas: A process of evaporation or chemical decomposition through which vapors are released from materials. Carpeting, furniture, building materials, and wet-applied products (like paints, adhesives, and caulks) typically off-gas chemical compounds that are unpleasant to breathe and may be hazardous to installer and occupant health.

W. Post-consumer recycled content: The percentage (by weight) of a reclaimed waste material contained in a product. A reclaimed waste material (e.g., newspaper, magazines, beverage containers, etc.) has already served a purpose to a consumer and has been diverted or separated from waste stream for recycling.

X. Pre-Consumer Recycled Content: Previously referred to as Post-industrial recycled content. The percentage (by weight) of a waste material obtained from industrial processes which are contained in a product.

Y. Recycled material: A material that would otherwise be destined for landfill disposal but is diverted or separated from the waste stream, reintroduced as material feedstock, and processed into marketed end products.

Z. Reused Material: Any item that is salvaged or reused without significant reprocessing as in a recycling process.

AA. Source reduction: Minimization of waste at the start of a process or activity so that there is a reduced amount of waste to recycle or dispose. Also called precycling.

BB. Sustainable: The condition of being able to "meet the needs of present generations without compromising those needs for future generations". Achieving a balance among extraction and renewal and environmental inputs and outputs, so as to cause no overall net environmental burden or deficit. To be truly sustainable, a human community must not decrease biodiversity, must not consume resources faster than they are renewed, must recycle and reuse virtually all materials, and must rely primarily on resources of its own region.

CC. Urea formaldehyde: An adhesive resin polymer produced by reacting urea with formaldehyde (a VOC and a potential carcinogen). It is the least stable formaldehyde resin, emitting formaldehyde monomers for months or even years after manufacture. Generally used as a binder for interior composite wood products. See also formaldehyde and VOC.

DD. Visible Transmittance (Tvis): The ratio of total transmitted light to total incident light. In other words, the amount of light passing through a glazing surface divided by the amount of light striking the glazing surface. A higher Tvis value indicates that a greater percentage of incident light is passing through the glazing.

EE. Volatile Organic Compound (VOC): A large family of chemicals based on carbon and hydrogen structures that vaporize at room temperature. VOCs are one type of indoor air contaminant. They are found in many indoor sources including common building products and materials. Although thousands have been identified in indoor air, only a few are well understood and regulated. VOCs are considered unhealthful to humans - some individual VOCs are known or suspected human carcinogens or irritants to the eyes, nose, and mucous membranes. When released, VOCs can contribute to the formation of ground level ozone and smog. Formaldehyde and toluene are two examples of VOCs commonly found in building materials.

FF. Xeriscape: Quality landscaping that conserves water and protects the environment through its employment of seven principles: planning and design; soil analysis; appropriate plant selection; practical turf areas; efficient irrigation; use of mulches; and appropriate maintenance.

1.4 SUSTAINABILITY OBJECTIVES/GOALS

The City of Austin is committed to sustainability and expects the Project to reflect this commitment. The specific Sustainable (Design & Construction) goals for this project include:

1. Protection of the environment.
2. Limiting construction site area and disturbance of natural habitat and protection of trees and vegetation.
3. Reduction of waste created by construction activity.
4. Increasing the use of materials and products with recycled content.
5. Reliable systems.
6. Energy-efficient systems.
7. Chemically safe building materials and pest management.
8. Building materials that use less energy and create less pollution in manufacture, delivery, installation, renovation, and demolition.
9. Occupant health through good indoor air quality, thermal comfort, day-lighting, views, access to the outdoors, and ergonomic work areas.

1.5 SUBMITTALS

A. General: Submit additional Sustainability submittal requirements included in other sections of the Specifications. Provide completed Sustainable Construction Submittal Form with all submittals. Appendix A.

B. Sustainability submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated requirements.

C. Project Materials Cost Data: Provide statement indicating total cost for building materials used for Project. Include statement indicating total cost of mechanical and electrical components. Include breakout of costs for Divisions 2 -10 including overhead transport and taxes and for the following categories of items:

1. Wood-based construction materials

D. Sustainable Construction Action Plans: Provide preliminary submittals within 14 calendar days of date established for the Notice to Proceed indicating how the following requirements will be met.

1. Construction & Demolition Waste Management Plan complying with Division 1 Section 01505 "Construction Waste Management."

E. Sustainable Construction Progress Reports: Concurrent with each Application for Payment, submit reports comparing actual construction and purchasing activities with Action Plans for the following:

1. Waste reduction progress reports complying with Division 1 Section 01505 "Construction & Demolition Waste Management and Disposal."

2. Salvaged and refurbished materials.

F. Sustainability Documentation Submittals:

1. Product Data for roofing materials indicating Energy Star compliance.

2. Data for interior and exterior lighting fixtures that stop direct beam illumination from leaving the building site.

3. Product Data for plumbing fixtures indicating water consumption.

4. Product Data for new HVAC equipment indicating absence of CFC refrigerants. Phase-out plan to replace CFC refrigerants in HVAC/R systems with CFC free refrigerants within the Construction Period.

5. Product Data for new HVAC equipment indicating absence of HCFC refrigerants, and for clean-agent fire-extinguishing systems indicating absence of HCFC and Halon.

6. Comply with Division 1 Section 01505 "Construction Waste Management."

7. Receipts for salvaged and refurbished materials used for Project, indicating sources and costs for salvaged and refurbished materials.

8. Product Data and certification letter indicating percentages by weight of post-consumer and pre-consumer recycled content for products having recycled content. Include statement indicating costs for each product having recycled content.

9. Product Data indicating location of material manufacturer for regionally manufactured materials.

a. Include statement indicating cost and distance from manufacturer to Project for each regionally manufactured material.

b. Include statement indicating cost and distance from point of extraction, harvest, or recovery to Project for each raw material used in regionally manufactured materials.

10. Product Data for rapidly renewable materials.

a. Include statement indicating costs for each rapidly renewable material.

11. Construction indoor air quality management plan.

a. Product Data for temporary filtration media.

b. Product Data for filtration media used during occupancy.

12. Product Data and material safety data sheets (MSDSs) for adhesives and sealants used on the interior of the building indicating all adhesives and sealants used and stating that they meet the noted requirements and indicating maximum volatile organic compound (VOC). Indicate VOC content in g/L calculated according to 40 CFR 59, Subpart D (EPA method 24). The VOC content of adhesives and sealants used must be less than the current VOC content limits of South Coast Air Quality Management District (SCAQMD) Rule #1168, and all sealants used as fillers must meet or exceed the requirements of the Bay Area Air Quality Management District Regulation 8, Rule 51.

13. Product Data and material safety data sheets (MSDSs) for paints and coatings used on the interior of the building indicating chemical composition and VOC content of each product used. Indicate VOC content in g/L calculated according to 40 CFR 59, Subpart D (EPA method 24). VOC emissions from paints and coatings must not exceed the VOC and chemical component limits of Green Seal's Standard GS-11 requirements. List all interior paints and coatings used in the building that are addressed by Green Seal Standard GS-11, GS 03 or South Coast Air Quality Management District (SCAQMD) Rule 1113 and document that they comply with the current VOC and chemical component limits of the standard. Include a summary table comparing credit requirements and actual VOC levels for each product.

14. Product Data for composite wood and agrifiber products indicating that products contain no urea-formaldehyde resin.

a. Provide cut sheets of bonding agents for each composite wood and agrifiber, bonding agent and laminating adhesive product used in the project and documentation that no added urea formaldehyde resins are used in these products.

1.6 QUALITY ASSURANCE

A. Sustainability Coordinator: Engage a responsible person on the construction team who is familiar with Sustainable practices and procedures. The Coordinator may also serve as the Waste Management coordinator.

PART 2 – PRODUCTS

2.1 SALVAGED AND REFURBISHED MATERIALS

Provide salvaged and refurbished materials for a minimum of 5 percent of building materials by cost

.2.2 RECYCLED CONTENT OF MATERIALS

A. Provide building materials with recycled content for a minimum of 10% of the total value of the project, such that the sum of post-consumer recycled content plus one-half of the post-industrial is 10% of content of the materials in the project.

1. The cost of post-consumer recycled content of an item shall be determined by dividing the weight of post-consumer recycled content in the item by the total weight of the item and multiplying by the cost of the item.

2. The cost of post consumer recycled content plus one-half of pre-consumer recycled content of an item shall be determined by dividing the weight of post-consumer recycled content plus one-half of pre-consumer recycled content in the item by the total weight of the item and multiplying by the cost of the item.

3. Do not include furniture, plumbing, mechanical and electrical components in the calculation.

4. Recycled content of materials shall be defined according to the Federal Trade Commission's "Guide for the Use of Environmental Marketing Claims," 16 CFR 260.7(e).

2.3 REGIONAL MATERIALS

A. Provide regionally manufactured materials with a goal of achieving 10 percent of building materials (by cost).

2.4 CERTIFIED WOOD

A. Provide a minimum of 50 percent by cost of wood-based materials that are produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "Principles and Criteria for Forest Stewardship."

1. Wood-based materials include but are not limited to the following materials when made from made wood, engineered wood products, or wood-based panel products:

a. Rough carpentry.
b. Miscellaneous carpentry.
c. Heavy timber construction.
d. Wood decking.
e. Metal-plate-connected wood trusses.
f. Structural glued-laminated timber.
g. Finish carpentry.
h. Architectural woodwork.
i. Wood paneling.
j. Wood veneer wall covering.
k. Wood flooring.
l. Wood lockers.
m. Wood cabinets.
n. Furniture.
o. Non-rented temporary construction, including bracing, concrete formwork, pedestrian barriers, and temporary protection.

2.5 LOW-EMITTING MATERIALS

A. For interior applications use adhesives and sealants that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA method 24):

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. Sub-floor 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. Vinyl Composition Tile (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. Structural Glazing Adhesives: 100 g/L.
16. Wood Flooring Adhesive: 100 g/L.
17. Contact Adhesive: 80 g/L.
18. Plastic Cement Welding Compounds: 250 g/L.
19. ABS Welding Compounds: 325 g/L.
20. CPVC Welding Compounds: 490 g/L.
21. PVC Welding Compounds: 510 g/L.
22. Adhesive Primer for Plastic: 550 g/L.
23. Sheet applied Rubber Lining Adhesive: 850g/L
24. Aerosol Adhesive, General Purpose Mist spray: 65% by weight
25. Aerosol Adhesive, General Purpose Web spray: 55% by weight
26. Special Purpose Aerosol Adhesive, (All types): 70% by weight
27. Structural Wood Member Adhesive: 140 g/L.
28. Special Purpose Contact Adhesive (contact adhesive that is used to bond melamine covered board, metal, rubber or wood veneer 1/16 inch or less in thickness to any surface): 250g/L.
29. Top and Trim Adhesive: 250g/L.
30. Architectural Sealants: 250g/L.
31. Non-membrane Roof Sealants: 450g/L.
32. Single Ply Roof Membrane Sealants: 450g/L
33. Sealant Primers for Nonporous Substrates: 250 g/L.
34. Sealant Primers for Porous Substrates: 775 g/L.
35. Modified Bituminous Sealant Primers: 500g/L
36. Other Sealant Primers: 750g/L

B. For interior (inside the weatherproofing system) applications use paints and coatings that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA method 24) and the following chemical restrictions:

1. Flat Paints and Coatings: VOC not more than 50 g/L.
2. Non-Flat Paints and Coatings: VOC not more than 150 g/L.
3. Anti-Corrosive/Anti-rust Coatings: VOC not more than 250 g/L.
4. Floor Coatings: VOC not more than 100 g/L.
5. Clear Wood Finishes: Do not exceed the VOC content limits established in the South Coast Air Quality Management District (SCAQMD) Rule 1113 January 1, 2004 including:
a. Clear Wood Finishes: Varnishes VOC not more than 350 g/L, Lacquers 550g/L.

b. Sanding Sealers: VOC not more than 275 g/L.
c. Waterproofing Sealers: VOC not more than 250 g/L.
d. Varnishes and Sanding Sealers: VOC not more than 350 g/L.
e. Shellac: clear VOC 730g/L, pigmented 550g/L
f. Stains: VOC not more than 250 g/L.

6. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).

7. Restricted Components: Paints and coatings shall not contain any of the following:
a. Acrolein.
b. Acrylonitrile.
c. Antimony.
d. Benzene.
e. Butyl benzyl phthalate.
f. Cadmium.
g. Di (2-ethylhexyl) phthalate.
h. Di-n-butyl phthalate.
i. Di-n-octyl phthalate.
j. 1,2-dichlorobenzene.
k. Diethyl phthalate.
l. Dimethyl phthalate.
m. Ethylbenzene.
n. Formaldehyde.
o. Hexavalent chromium.
p. Isophorone.
q. Lead.
r. Mercury.
s. Methyl ethyl ketone.
t. Methyl isobutyl ketone.
u. Methylene chloride.
v. Naphthalene.
w. Toluene (methylbenzene).
x. 1,1,1-trichloroethane.
y. Vinyl chloride.

C. Composite wood and agrifiber products used on the interior of the building (defined as inside of the weatherproofing system) shall contain no added urea-formaldehyde resins. Laminating adhesives and bonding agents used to fabricate on-site and shop-applied composite wood and agrifiber assemblies bonding agent shall contain no added urea formaldehyde resin.

PART 3 – EXECUTION

3.1 SITE DISTURBANCE

A. Special Site Practices:

1. Construction Activity Pollution Prevention: Comply with City of Austin standard requirements.

2. Protect and restore natural vegetation per division 1 Sections and plans, and restrict construction activity only to defined site limits per plans.

3.2 CONSTRUCTION WASTE MANAGEMENT

A. Comply with Division 1 Section 01505 "Construction Waste Management."

3.3 CONSTRUCTION INDOOR AIR QUALITY MANAGEMENT

A. Comply with Division 1 Section 01510 "Construction Indoor Air Quality Management."
B. Comply with SMACNA IAQ Guideline for Occupied Buildings under Construction.

3.4 COMMISSIONING

A. Comply with Division 1 Section "Facility Start-up/Commissioning."

APPENDIX A: Sustainable Construction Submittal Form

SECTION 01352.2 APPENDIX A

PROJECT NAME: REQUIRED FOR ALL SUBMITTALS

Sustainable Construction Submittal Information SUBMITTALS CAN NOT BE APPROVED UNTIL RECEIPT OF THIS COMPLETED FORM.

1. General Information: PROVIDE FOR ALL MATERIALS

This information is used exclusively for sustainability records. All answers must be provided and supporting documentation must accompany this form.

Product/Material: _____ CSI Code(s): _____

Vendor/Sub: _____ Submittal #: _____

Contact name: _____ Phone: _____

Manufacturer: _____ Does the product/material meet the Project Specification requirements?

YES OR NO ?

Cost Information: PROVIDE FOR ALL MATERIALS IN DIVS. 2 - 10 ONLY

Each material/product must have a separate spreadsheet.

Provide the "materials cost" for each product/material. The material cost is the cost paid to guarantee the material in final assembly form excluding installation costs (labor & equipment). Overhead, transportation, and taxes shall be included in materials costs.

Material Cost: $ _____ OR Unit Cost: $ _____ per _____ unit

# of units installed: _____

2. Recycled Content - FOR MATERIALS IN DIVS. 2 - 10 ONLY

* If the product is NOT an assembly of various components:

  * What percentage of the product is post-consumer? _____ %

    post-consumer = product went through consumer stream as another product

  * What is the source of this information? (Submittal, cost sheet, product brochure, letter from mfg., etc) _____

  * What percentage of the product is pre-consumer / post-industrial: _____ %

    pre-consumer/post-industrial = product is by-product from a manufacturing process

  * What is the source of this information? (Submittal, cost sheet, product brochure, letter from mfg., etc) _____

* If the product is an assembly of various components, fill in the table below.

Assembly: (List Product) Components	Weight (lbs)	Recycled Content (%)	% By Weight	Recycled Content Source	Company Providing Components

3. Regional Materials - FOR MATERIALS IN DIVS. 2 - 10 ONLY

* Was the product extracted, recovered, harvested, and manufactured within 500 miles of the project site? _____
* Provide the name and street address of the manufacturing facility. _____
* What is the distance of the manufacturing facility from the job site? _____ miles
* Provide the name and street address of the extraction or harvesting site or facility. _____

1 of 2 Section 01352 Appendix A

SECTION 01352.2 APPENDIX A

PROJECT NAME: REQUIRED FOR ALL SUBMITTALS

Sustainable Construction Submittal Information SUBMITTALS CAN NOT BE APPROVED UNTIL RECEIPT OF THIS COMPLETED FORM.

* What is the distance of the extraction or harvesting site from the project site? _____ miles

* Use table below for assemblies that have multiple sources for the same material:

Materials:	Extraction Site location (address):	Distance in miles	Manufacturing location (address):	Distance in miles

4. Low Emitting Materials

FOR PAINTS, COATINGS, STAINS, ADHESIVES, SEALANTS, CAULK, FIRESTOPPING, OR ANYTHING FROM A BUCKET, TUBE OR AEROSOL CAN
(Inside the weatherproofing system and applied on-site only)

* Does it meet the VOC requirements listed in the Specifications (shown in grams/Liter)?
If yes, provide manufacturer's data sheet with VOC content clearly shown. _____ grams/Liter

FOR CARPET OR CARPET TILE AND CARPET CUSHION

* For carpet, does it meet Green Label Plus certification? Yes or No
If yes, provide manufacturer's data sheet stating Green Label Plus certification has been met.

* For cushion, does it meet Green Label Plus certification? Yes or No
If yes, provide manufacturer's data sheet stating Green Label Plus certification has been met.

FOR COMPOSITE WOOD AND AGRIFIBER PRODUCTS (particleboard, MDF, plywood, wheatboard, strawboard, panel substrates and door cores)
(Inside the weatherproofing system and applied on-site only)

* Does it meet requirement of containing no added urea-formaldehyde resins? Yes or No
If yes, provide manufacturer's data sheet stating no added urea-formaldehyde resins are contained in material/product.

LAMINATING ADHESIVES USED TO FABRICATE ON-SITE AND SHOP-APPLIED COMPOSITE WOOD AND AGRIFIBER ASSEMBLIES

* Does the adhesive meet the requirement of containing no added urea-formaldehyde resins? Yes or No
If yes, provide manufacturer's data sheet stating no added urea-formaldehyde resins are contained in adhesive.

5. Rapidly Renewable Material

INCLUDES MATERIALS SUCH AS: BAMBOO, CORK, COTTON, LINOLEUM, WOOL AND WHEAT
What percentage, if any, does the manfacturing process use any rapidly renewable materials _____ %

Wood Product Type	Cost	Percentage of product by weight	Manufacturer/Vendor

6. Certified Wood

INCLUDES WOOD PRODUCTS SUCH AS: FRAMING, FLOORS, DOORS AND FINISHES
What percentage, if any, of the wood based materials are FSC Certified? _____ %

Product Name	Cost	Percentage of product by weight	FSC Chain of Custody Number	Manufacturer/Vendor

END

CONSTRUCTION EQUIPMENT EMISSIONS REDUCTION PLAN
Section 01353

1. GENERAL

1.1. RELATED DOCUMENTS

A. This Section applies to Drawings and all provisions of Contract.

1.2. SUMMARY – CONSTRUCTION EQUIPMENT EMISSIONS PLAN

A. The OWNER, as part of the Council Resolution No. 20100211-019, has decided to take steps to reduce emissions associated with construction process including Nitrogen Oxides (NOx), particulate matter and greenhouse gas. Construction activity is a source of large quantities of particulate matter and ozone forming Nitrogen Oxides that adversely affect the health of our community and the natural environment.

B. The CONTRACTOR shall employ practices and take actions that reduce emissions from NOx, particulate matter (black soot) and greenhouse gases resulting from activities associated with new construction and demolition Projects.

C. The CONTRACTOR shall maximize the use of equipment and vehicles with advanced emission controls in support of the City's goals, utilizing equipment that meets defined EPA emissions standards.

1.3. DEFINITIONS

A. "Construction Equipment" means equipment powered by an internal combustion engine and used for performing or otherwise advancing the Work on the Project, other than motor vehicles intended for use on public highways and registered pursuant to Section 502.002 of the Texas Transportation Code.

B. The list of applicable Construction Equipment includes, but is not limited to excavators, backhoes, loaders, bulldozers, graders, rock saws, generators, and other similar equipment.

C. "EPA" means the United States Environmental Protection Agency.

D. "Low-Use Equipment" means any piece of construction equipment which is used for less than ten (10) hours per week on site for a single construction contract.

E. "Greenhouse Gases" are emissions that absorb and emit radiation within the atmosphere. Greenhouse Gases can be one or a combination of, these gases: carbon dioxide, methane, nitrous oxide and three groups of fluorinated gases (sulfur hexafluoride, hydro fluorocarbons, and perfluorocarbons)

1.4. REQUIREMENTS – Not Used

1.5. SUBMITTALS

A. CONSTRUCTION EQUIPMENT EMISSIONS REDUCTION PLAN:

1. The CONTRACTOR agrees to prepare a draft Emissions Reduction Plan (referred to as PLAN) prior to start of construction. This PLAN shall include an inventory report containing

identifying data for each piece of equipment to be used on the worksite and shall include the following:

- Vehicle/Equipment: Make & Model Year
- Vehicle/Equipment: Engine Make & Model Year
- Vehicle/Equipment: Fuel Type
- Vehicle/Equipment: Expected gallons or hours used for project duration

a) The OWNER will provide Emissions Reduction Toolkit to help the CONTRACTOR in preparation of the PLAN and inventory.

2. The CONTRACTOR shall develop a list of strategies to be used in this Project in order to reduce emissions from NOx, particulate matter and greenhouse gas (CO_2 equivalent). Once prepared, the agreed upon strategies shall be incorporated into the PLAN. The PLAN will then be signed by the CONTRACTOR and made ready for implementation. Implementation progress will be reviewed once a month in regularly scheduled project progress meetings. The PLAN may be modified during construction if changes are made to the Project, but adjustments shall be approved by the OWNER prior to implementation.

3. This PLAN may be used by the Owner's Representative or Inspector to conduct site inspections and/or verify compliance with specification elements.

4. If additional equipment is brought on-site after construction begins, the Contractor shall provide this same inventory information to the Owner's Representative for the new equipment on or before the day it begins work on-site. All additional equipment shall conform to the PLAN.

5. Reports shall be provided for all equipment used on-site.

B. EQUIPMENT EMISSIONS CLOSEOUT DOCUMENTATION:

1. Submit the following prior to final payment:

a) Record of changes made to the original PLAN and reasons.

b) Provide a summary and documentation of strategies used and estimated reductions in fuel & emissions.

c) Provide documentation of amount and % of alternative fuel used.

2. PRODUCTS

Not used

3. EXECUTION

3.1. GENERAL

A. Implement the submitted PLAN. Provide personnel, documentation, equipment, signage, transportation, and other items as required to implement the PLAN during the entire duration of the Contract.

3.2. EQUIPMENT EMISSIONS PLAN IMPLEMENTATION

A. Plan Coordinator (Could be same as superintendent): Designate an on-site person responsible for instructing workers on the Owner's intent to reduce emissions, overseeing implementation and documenting results of the PLAN for the Project.

B. Plan Review: Review the PLAN in monthly progress meeting and include comments in the meeting notes.

C. Instruction: Provide on-site instructions to all subcontractors of emissions reduction methods to be used by all parties for the appropriate activities of the Project.

D. Discuss Owner's goals and requirements at the following meetings:

1. Pre-bid conference.

2. Pre-construction conference.

3. Progress meetings (monthly).

3.3 EQUIPMENT EMISSIONS REDUCTION TOOLKIT

A. Equipment Emissions Reduction Toolkit available at:

1. Website: (http://austintexas.gov/department/capital-improvement-program)

2. City of Austin Public Works Department, Project Management Division, One Texas Center, Suite 900

3. Construction Job Site Office (after contract award)

B. Equipment Emissions Reduction Toolkit consists of:

1. A list of Construction Equipment Emissions Reduction Strategies

2. EPA fuel savings calculator by idling reductions

3. Posting of Anti-idling signs

4. Memorandum of Agreement by Local Area Governments

5. Equipment Inventory Form

3.4 A LIST OF EQUIPMENT EMISSIONS REDUCTION STRATEGIES

The following are suggested emissions reduction strategies and references. As per the specification section 01353, 1.5 Submittals, the CONTRACTOR shall develop a list of strategies to be used in this Project at the start of construction.

C-1 Anti-Idling Strategies:

1. Implement and enforce anti-idling practices for all equipment and vehicles on and adjacent to the site and associated with the project. City will provide a construction site sign and stickers for vehicles and equipment. Add Hyperlink to COA Idling flyer location TBD

Also refer to:

https://www.nctcog.org/trans/quality/air/for-everyone/engine-off-north-texas

Another potential resource for the COA website on emission specifications:
https://www.tceq.texas.gov/airquality/mobilesource/vehicleidling.html

2. Limit all idling of project associated vehicles and equipment operations to five (5) minutes unless the idling is applicable to one or more of the following exceptions:

   a) Idling is being used for emergency response purposes;

   b) Idling is necessary for component of mechanical operation, maintenance, or diagnostic purposes; or

   c) Idling is for the health or safety of the equipment operator.

3. Provide education to all staff, vendors and subcontractors about emissions hazards and anti-idling practices and encourage use of EPA calculator for fuel savings.

4. To the extent possible, do not stop or idle haulage trucks directly under tree limbs and foliage overhanging the street along the haul route. Further avoid such damage from truck exhaust by means of exhaust diversion devices to redirect or diffuse exhaust from being directed in a concentrated manner to tree limbs and foliage.

5. Avoid vehicle loitering or queuing outside or inside the gates of the work area to minimize degradation of localized air quality.

   (http://austintexas.gov/airquality/)

C-2 Alternative Fuels:

6. Utilize **alternative fuels** including, Texas LED Compliant B20 (or higher) biodiesel, Compressed Natural Gas (CNG), propane and electric. (Refer to EPA Energy Policy Act for full list).

7. Avoid unnecessary fuel use by providing on-site fuelling for alternate fuels.

   (http://www.tceq.texas.gov/airquality/mobilesource/txled/cleandiesel.html)

   (http://www.eere.energy.gov/cleancities)

   (http://lonestarcfa.org)

C-3 Vehicle/Equipment Improvements:

8. It is recommended that CONTRACTOR takes advantage of the **Texas Emission Reduction Plan (TERP)** grant incentives to upgrade (replace or repower) vehicles with retrofitted emission reduction technologies. (http://www.tceq.texas.gov/airquality/terp/index.html) or (www.terpgrants.com)

9. Utilize **battery powered and/or solar powered equipment** where available. This strategy can be combined with anti-idling strategies by using this technology for sign boards. (evtransportal.org/dieselengineidlereduction.pdf)

10. Consider using voluntary and mandatory sections of the City of Chicago Clean Diesel Program related to https://www.chicago.gov/city/en/progs/env/clean-diesel.htmlfile:///C:/Users/user/Documents/Downloads/O2011-1418.pdf

11. Consider an air quality training section administered by a governmental entity to help comply with an updated

COA Construction Equipment Emission Reduction Plan by using the California Air Resources Board (CARB) training section in the link below:
https://ww2.arb.ca.gov/our-work/topics/construction-earthmoving-equipment

C-4 Maintenance Program:

1. Establish a preventative **maintenance program** addressing issues including but not limited to, fuel use, air emissions, tire pressure, smoke from exhaust and noise.
2. Make all efforts to **prevent oil/fuel spillage** on to site surfaces.

C-5 Resource Management:

3. Utilize equipment companies that are located closest to the construction site.
4. Store equipment on site during construction use or arrange for closest overnight storage including **temporary use of the Right of Way** if possible.
5. To the extent possible, CONTRACTOR shall maximize use of **local and regional materials** to reduce transportation emissions.
6. CONTRACTOR shall maximize **salvage and reuse** of appropriate on-site materials. (http://www.usgbc.org/ShowFile.aspx?DocumentID=1095)
7. To the greatest extent possible, stage equipment and vehicles away from, and minimize operation near, sensitive receptors including, but not limited to, operable windows, fresh air intakes, hospitals, schools, licensed day care facilities, residences and areas where people congregate.

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Division 1 General Requirements

CONSTRUCTION PHOTOGRAPHY & VIDEOS
Section 01380

1. GENERAL

CONTRACTOR shall be responsible for the production of pre-construction, construction progress and post-construction photographs as provided herein. Owner's Representative may also designate additional subjects for photographs in addition to the general guidelines identified below.

2. QUALITY

All photographs must be produced by a competent photographer and shall be digital (6 Mega-Pixel) date-stamped color photography of commercial quality. All CONTRACTOR-generated photographs must be stored in a .jpeg file format Each photograph shall be submitted in duplicate as two 3x5 prints with no more than 3 photos per page of professional quality enclosed in clear plastic sleeve within 3 tab folders. The prints shall be accompanied by digital date-stamped photographs in CD format or other format acceptable to the City. Each print shall be marked with the name and CIP ID number for the Contract, name of CONTRACTOR, description and location of view and identity of photographer.

Each photograph submittal must include a Photo Log that includes the name and CIP ID number of Contract, name of CONTRACTOR, the name of the photographer and company, photograph number, the date of the photograph and the filename that the camera assigns to the photo (e.g. MVC-001.jpg). In addition, appropriate descriptive information to properly identify the location of view must be entered into the Photo Log that includes a project drawing or sketch to assist in maintaining a concise project record (e.g. location of MH 5 - Line A or Sta. 2+00 - Line A or location of Sedimentation Basin 5, sludge pump A).

3. VIEWS AND QUANTITIES

3.1 PRE-CONSTRUCTION PHOTOGRAPHS

INFRASTRUCTURE FACILITIES (i.e. TREATMENT PLANTS, PUMP STATIONS, LIFT STATIONS, RESERVOIRS, ETC) OR BUILDING PROJECTS

All pre-construction photographs must be submitted prior to the CONTRACTOR or Subcontractor beginning any Work that may cause site disturbance and shall be submitted with the initial CONTRACTOR'S Pay Application. As a minimum, Pre-construction photographs must be taken of the following views:

- The entire construction site area (full width and length)
- All curb lines showing all pre-existing curb damage not called for replacement within the Work and shall include major cracks
- All driveways, steps, and curbs and curb ramps (both sides of street adjoining the project site)
- Fence and gate conditions
- Trees, ornamental shrubs, plantings/planter boxes and evidence of irrigation features
- Views of structures, both inside and adjacent to the project site and easements in areas where CONTRACTOR will be working within five (5) feet of said structure
- Other views as requested by the OWNER

3.2 CONSTRUCTION PROGRESS PHOTOGRAPHS.

INFRASTRUCTURE FACILITIES (i.e. TREATMENT PLANTS, PUMP STATIONS, LIFT STATIONS, RESERVOIRS, ETC) OR BUILDING PROJECTS

Construction Progress photos must be taken at least twice per month.

One set of Construction progress photographs, as the work progresses, of the same views taken during pre-construction photography must be taken during the progress of the Work.

One set of the progress photos must be taken to depict the work accomplished during the month that includes:

- Work not yet covered up
- When MEP or building inspections are scheduled
- The beginning of installation of major items of equipment
- After installation of major items of equipment
- Other significant construction activities.

Both sets of photos shall be submitted monthly with the CONTRACTOR'S monthly progress payment application.

3.4 POST CONSTRUCTION PHOTOGRAPHS

Post-construction photographs must be taken of the same views taken during pre-construction photography to fully document the completed project. Post-construction photographs must be taken after cleanup and site restoration, and must be submitted with the final payment.

3.5 ADDITIONAL ASSET PHOTOGRAPHS

INFRASTRUCTURE FACILITIES (I.E. TREATMENT PLANTS, PUMP STATIONS, LIFT STATIONS, RESERVOIRS, ETC)

Additional asset photographs shall be taken to show, identify and locate AWU's assets as they are being installed as part of the work. The quantity of asset photos required is determined by the number of asset items added to AWU's Computerized Maintenance Management System (CMMS) data base as part of the construction of this project. A specific complete list of assets to be installed within this contract is identified in the Submittals Section of the Contract (Section 01300).

Each asset photograph shall be submitted in duplicate as two 3x5 prints with no more than 3 photos per page of professional quality enclosed in clear plastic sleeve within 3 ring folders. The prints shall be accompanied by digital date-stamped photographs in CD format or other format acceptable to the City.

Each print of the asset shall be marked with the following information:

- The CIP ID number for the Contract
- Name of CONTRACTOR
- AWU's CMMS asset number
- The date of installation of the asset
- Location of asset (i.e. Sta. number, or State Plane Coordinate number, or other suitable information identifying where the asset was installed)

Each asset photograph must be included in an Asset Management Photo Log that indicates the AWU CMMS asset number, the CIP ID number of Contract, name of CONTRACTOR, the date of the photograph and the filename that the camera assigns to the photo (e.g. MVC-001.jpg).

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PART 1 - GENERAL

1.1 Related Documents:

Drawings and general provisions of Contract, including General Conditions, Section 00700,and Supplemental General Conditions, Section 00810, and Division 1 requirements.

PART 2 - PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 Office at the Work Site (Job Shack)

During the performance of this Contract, CONTRACTOR shall maintain a suitable office at or near the site of the Work which shall be the headquarters of his superintendent. Any communication given to the superintendent or delivered to CONTRACTOR's office at the site of the Work in his absence shall be deemed to have been delivered to CONTRACTOR.

In addition, CONTRACTOR shall provide a suitable field office with at least 200 square feet of floor space, either adjacent to, or partitioned off from, his office at the site for use by Owner's Representative. The office shall be provided with outside entrance door with a substantial lock, glazed windows suitable for light and ventilation, and adequate heating, air conditioning, and lighting facilities. CONTRACTOR shall pay all electricity and heating bills and shall provide telephone services with a telephone as specified hereinafter. The office shall be furnished with a desk, two four-drawer filing cabinets, a table, two chairs, a plan rack, and a locker for storage of surveying instruments. The doors on the locker shall be equipped for padlocking. The general arrangement of the office and facilities provided shall be acceptable to Owner's Representative.

3.2 Water for Construction

All water required for and in connection with the Work to be performed shall be furnished by and at the expense of the CONTRACTOR through meters installed on hydrants, except for water used in the "disinfection of potable water lines" process per Specification 510.3(29). All water used in the disinfection process shall not be metered, but rather shall be measured by calculation. Such water use does not require a meter, but a double-check valve assembly is required when connecting to a fire hydrant or a City main. CONTRACTOR shall submit a written plan for the disinfection process for review and approval by OWNER prior to commencing Work. The written plan shall include the CONTRACTOR's plan for final flushing and discharge of chlorinated water, and shall specify the quantities of potable water that will be required for the procedure and dosage plan proposed by the CONTRACTOR. Water used in the disinfection process shall be supplied by the OWNER through hydrants or connection through a City main at no charge to the CONTRACTOR for the initial disinfection procedure up to the quantities agreed to in the written plan for the disinfection process. Should the initial disinfection procedure fail to produce acceptable bacteriological sample test results, the cost of water at standard rates used for subsequent disinfection procedures shall be the responsibility of the CONTRACTOR with quantities determined through calculations.

For all water required for and in connection with the Work to be performed other than for the disinfection process, water and meters will be available from OWNER at standard rates. All costs for obtaining a water meter shall be the responsibility of the CONTRACTOR. The CONTRACTOR shall contact the Austin Water Utility and arrange to pick up the meter. CONTRACTOR shall install a double-check valve assembly on the fire hydrant between the hydrant and the meter, to prevent backflow in the event of pressure failure. CONTRACTOR shall supply all necessary tools, hose and pipe, and shall make necessary arrangements for securing and transporting such water and shall take water in such a manner, and at such

times, that will not produce a harmful drain or decrease of pressure in the OWNER's water system. It shall be the CONTRACTOR's responsibility to make arrangements with the Austin Water Utility for the metering and reporting of the amount of water used. Water shall not be used in a wasteful manner. Standard hydrant wrenches shall be used for opening and closing of fire hydrants. In no case shall pipe wrenches be used for this purpose. Temporary lines shall be removed when no longer required.

"If applicable, after the installation of the City of Austin's water meter(s) for the Project, the CONTRACTOR has the option to utilize the water available from this service at the CONTRACTOR's expense. An adjustment to the Contract amount will be made by Change Order at the end of the Project for the costs incurred by the City of Austin for the water."

3.3 Telephone Service

CONTRACTOR shall make all necessary arrangements and pay all installation charges for telephone lines in his offices at the site and shall provide all telephone instruments. The telephone service shall be available to the Owner's Representative for toll free calls.

3.4 Sanitary Facilities

CONTRACTOR shall furnish temporary sanitary facilities at the site, as provided herein, for the needs of all construction workers and others performing Work or furnishing services on the Project.

Sanitary facilities shall be of reasonable capacity, properly maintained throughout the construction period, and obscured from public view to the greatest practical extent. If toilets of the chemically treated type are used, at least one toilet shall be furnished for each 20 employees. CONTRACTOR shall enforce the use of such sanitary facilities by all personnel at the site.

3.5 Protection of Public and Private Property

CONTRACTOR shall protect, shore, brace, support and maintain all underground pipes, conduits, drains, and other underground construction uncovered or otherwise affected by the CONTRACTOR's operations. All pavement, surfacing, driveways, curbs, walks, buildings, utility poles, guy wires, fences, and other surface structures affected by construction operations, together with all sod and shrubs in yards, parkways, and medians, shall be restored to their original condition, whether within or outside the easement/right-of-way. All replacements shall be made with new materials.

CONTRACTOR shall be responsible for all damage to streets, roads, curbs, sidewalks, highways, shoulders, ditches, embankments, culverts, bridges, or other public or private property, which may be caused by transporting equipment, materials, or men to or from the Work, whether by him or his Subcontractors. CONTRACTOR shall make satisfactory and acceptable arrangements with the owner of, or the agency having jurisdiction over, the damaged property concerning its repair or replacement or payment of costs incurred in connection with the damage.

All fire hydrants and water control valves shall be kept free from obstruction and available for use at all times.

3.6 Tree and Plant Protection

All trees and other vegetation which must be removed to perform the Work shall be removed and disposed of by the CONTRACTOR; however, no trees or cultured plants shall be unnecessarily removed unless their removal is indicated on the Drawings. All trees and plants not removed shall be protected against injury from construction operations.

No tree shall be removed outside of permanent easement(s), except where authorized by the E/A. Whenever practicable, CONTRACTOR shall tunnel beneath trees in yards and parking lots when on or near the line of trenching operations. Hand excavations shall be

employed as necessary to prevent injury to trees. Care shall be taken with exposed roots, unearthed during construction, so that roots do not dehydrate causing tree damage.

Trees considered by the E/A to have any significant effect on construction operations are indicated on the Drawings and those which are to be preserved are so indicated.

CONTRACTOR shall take extra measures to protect trees designated to be preserved, using methods shown on the Drawings and as specified in Standard Specification Item No. 610S "Preservation of Trees and other Vegetation".

3.7 Security

CONTRACTOR shall be responsible for protection of the site, and all Work, materials, equipment, and existing facilities hereon, against vandals and other unauthorized persons.

No claim shall be made against OWNER by reason of any act of an employee or trespasser, and CONTRACTOR shall make good all damage to the OWNER's property resulting from CONTRACTOR's failure to provide security measures as specified.

Security measures shall be at least equal to those usually provided by OWNER to protect existing facilities during normal operations, and shall also include such additional security fencing, barricades, lighting, and other measures as required to protect the site. When required, the CONTRACTOR shall provide a security plan to the OWNER for review as to appropriateness of the security measures proposed.

3.8 Access Roads

CONTRACTOR shall establish and maintain temporary access roads to various parts of the site as required to complete the Project. Such roads shall be available for the use of all others performing Work or furnishing services in connection with the Project.

3.9 Parking

CONTRACTOR shall provide and maintain suitable parking areas for the use of all construction workers and others performing Work or furnishing services in connection with the Project, as required, to avoid any need for parking personal vehicles where they may interfere with public traffic, the OWNER's operations, or construction activities.

3.10 Dust Control

Dust Control during construction of this Project shall conform to Standard Specifications Item No. 220S, "Sprinkling for Dust Control". No direct payment will be made for dust control. Dust Control shall be considered subsidiary work relating to various Bid items of the Contract.

3.11 Temporary Drainage Provisions

CONTRACTOR shall be responsible for providing for the drainage of stormwater and such water as may be applied or discharged on the site in performance of the Work. CONTRACTOR shall obtain E/A approval for temporary drainage facilities which will handle, carry through, or divert around his Work all drainage flow, including storm flow and flows created by construction activity, to prevent silting of waterways or flooding damage to the property and adjacent property.

3.12 Erosion Control

CONTRACTOR shall prevent erosion of soil on the site and adjacent property resulting from his construction activities. Effective measures shall be initiated prior to the commencement of clearing, grading, excavation, or other operations which will disturb the natural protection.

CONTRACTOR shall use controls found in "Environmental Criteria Manual" or developed from successful techniques elsewhere as approved by E/A.

3.13 Pollution Control

CONTRACTOR shall prevent the pollution of drains and watercourses by sanitary wastes, sediment, debris and the substances resulting from construction activities. No sanitary wastes will be permitted to enter any drain or watercourse. No sediment, debris or other substance will be permitted to enter sanitary sewers and reasonable measures shall be taken by CONTRACTOR to prevent such materials from entering any drain or watercourse.

CONTRACTOR shall observe the rules and regulations of the State of Texas and agencies of the U.S. Government prohibiting the pollution of any lake, stream, river, or wetland by the dumping of any refuse, rubbish, dredge material, or debris therein.

CONTRACTOR is specifically cautioned that disposal of materials into any water of the State must conform to the requirements of the Texas Commission on Environmental Quality (TCEQ), and any applicable permit from the U.S. Army Corps of Engineers.

3.14 Noise Control

CONTRACTOR shall comply with the City of Austin's Noise Ordinance. CONTRACTOR shall take reasonable measures to avoid unnecessary noise. Such measures shall be appropriate for the normal ambient sound level in the area during working hours. All construction machinery and vehicles shall be equipped with practical sound-muffling devices, and operated in a manner to cause the least noise consistent with efficient performance of the Work.

3.15 CIP Sign

CONTRACTOR shall erect install and maintain CIP signs as specified. Signs shall be constructed in accordance with City Standard Specification Item No. 802S "Project Signs," as indicated on the Drawings.

3.16 Fences

All existing fences affected by the Work shall be maintained by the CONTRACTOR until completion of the Work. Fences which interfere with construction operations shall not be relocated or dismantled until written permission is obtained from the owner of the fence, and the period the fence may be left relocated or dismantled has been agreed upon. Where fences must be maintained across any construction easement, adequate gates shall be installed. Gates shall be kept closed and locked at all times when not in use.

Upon completion of the Work across any tract of land, CONTRACTOR shall restore all fences to preconstruction, or to a better, condition and to their preconstruction location.

3.17 Mail Boxes

CONTRACTOR shall remove, reset temporarily, and relocate permanently all mail boxes that are within construction site limits conforming to requirements of United States Postal Service. Mailboxes shall not be laid on the ground, but shall be temporarily reset the same day as removed. Payment for removing and resetting of mail boxes will not be paid for directly, but will be considered subsidiary to the various Bid items. Any damage to mail boxes or posts shall be the responsibility of the CONTRACTOR.

3.18 Emergency Facilities

Free access shall be maintained at all times to fire lanes and emergency and utility control facilities such as fire hydrants, fire alarm boxes, police call boxes, and utility valves, manholes, junction boxes, etc. In the event that it is necessary to make one of these facilities temporarily inaccessible, CONTRACTOR shall obtain approval of such action and schedule of Work from the OWNER. CONTRACTOR shall also provide at least 24 hours prior notice to the Fire Department, Police Department, and City Department governing the affected utility. The same Department(s) shall be promptly notified by the CONTRACTOR when such facilities are placed back in unobstructed service.

3.19 Notification of Owners

Unless otherwise indicated, the OWNER will notify property owners abutting the right-of-way of impending construction. The CONTRACTOR shall exercise diplomacy and tact with individual property owners.

3.20 Maintenance of Traffic

CONTRACTOR shall conduct his Work to interfere as little as possible with public travel, whether vehicular or pedestrian. Whenever it is necessary to cross, obstruct, or close roads, driveways, and walks whether public or private, the CONTRACTOR shall provide and maintain suitable safe bridges, detours or other temporary measures to accommodate public and private travel, and shall provide reasonable notice to owners of private drives before interfering with them. Such maintenance of traffic will not be required when CONTRACTOR has obtained written permission from the owner and the tenant of the private property, or from the authority having jurisdiction over public property involved, to obstruct traffic at the designated point. A copy of the initial written permission shall be provided to the Owner's Representative.

Safety and conveyance of traffic shall be regarded as prime importance. Unless otherwise directed, all portions of streets associated with this Project shall be kept open and provided a dust free, smooth and comfortable ride to traffic. It shall be the responsibility of the CONTRACTOR to ensure that two-way traffic may safely bypass the construction site and that access is provided to abutting private property. In making open cut street crossings, the CONTRACTOR shall not block more than one-half of the street at one time without approval of the OWNER. Whenever possible, CONTRACTOR shall widen the shoulder on the opposite side to facilitate traffic control. Temporary surfacing shall be provided as necessary on shoulders.

Prior to beginning Work, CONTRACTOR shall designate, in writing, a competent person who will be responsible and available on the Project site, or in the immediate area, to ensure compliance with the traffic control plan. CONTRACTOR shall provide documentation to demonstrate the sufficient training in Traffic Control for his competent person. Owner will designate a qualified person to observe implementation and who will have authority to assure compliance with the traffic control plan.

The CONTRACTOR shall perform the necessary cleanup and finishing immediately after all or a portion of the Work is completed. When the Work includes paving operations, the entire site shall be kept clean to facilitate placement of required traffic control devices. Temporary and permanent striping lay-out shall be approved by the Transportation Department prior to placement, when included in the Work.

1. Detours

Where indicated on the traffic control plan CONTRACTOR shall erect and maintain detours around construction activities. Should CONTRACTOR desire to propose a detour, not already included in the traffic control plan, it shall be his responsibility to prepare a revised traffic control plan showing the detour, and obtain approval of the revised traffic control plan from the Transportation Department, prior to implementation of the detour. The Transportation Department has final authority as to the acceptability of any proposed revisions to the traffic control plan. The CONTRACTOR shall bear all costs for revising the traffic control plan and for maintaining the proposed detour.

2. Barricades and lights

CONTRACTOR shall place and maintain in good condition, standard barricades at each end of the Project and at other locations where traffic is rerouted or blocked from using regular traffic lanes. Barricades and warning signs shall be in accordance with the Texas Manual on Uniform Traffic Control Devices (MUTCD) and City of Austin Standard Specification Item No. 803S, "Barricades, Signs and Traffic Handling". Signs, barricades, and warning devices informing the public of construction features will be placed and maintained by the CONTRACTOR, who shall be solely responsible for their maintenance. The decision to use a

particular device at a particular location as indicated in the traffic control plan or as determined by the CONTRACTOR, shall be the sole responsibility of the CONTRACTOR.

All open trenches and other excavations shall have suitable barricades, signs, and lights to provide adequate protection to the public. Obstructions, such as material piles and equipment shall be provided with similar warning signs and lights.

All barricades and obstructions shall be illuminated with warning lights from sunset to sunrise. Material storage and conduct of the Work on, or along side, public streets and highways shall cause a minimum obstruction and inconvenience of the traveling public.

3.21 Required Job Site Postings and Notices

CONTRACTOR shall post the following postings and notices in English and Spanish at one or more conspicuous locations on the job site. In the case of Projects with multiple sites, the notices and postings must be displayed at each site. In the case of Projects that do not have a job shack or other temporary facility on the site, CONTRACTOR shall post all notices on a temporary bulletin board. Other special conditions are noted below.

Required for all Projects	
Poster	Available at:
Baseline Schedule for Project identifying when all subcontractors will be used	N/A (as required under Section 00700, paragraph 2.4.2.1.)
Wage Rates as required under Section 00830.	Section 00830BC and/or Section 008300HH
City of Austin Wage Contact posters	Provided at Pre-Construction meeting (English and Spanish)
City of Austin Equal Employment Opportunity posters	http://austintexas.gov/department/wage-compliance (English and Spanish)
Texas Commission on Environmental Quality "Construction Site Notice" form, if applicable, as required or the required TPDES information	http://www.tceq.state.tx.us/assets/public/permitting/waterquality/attachments/stormwater/txr152d2.pdf (Option 1 – as required under Section 00810, 6.7.4.2 N/A (Option 2 – as required under Section 00810, 2.6.7.4.3)
OSHA poster "Job Safety and Health: It's the Law"	http://www.osha.gov/Publications/osha3165.pdf (English) http://www.osha.gov/Publications/osha3167.pdf (Spanish)
City of Austin Rest Break Ordinance Signs	http://austintexas.gov/department/wage-compliance (English and Spanish) As required to be posted in English and Spanish under Ordinance No. 20100729-047
Texas Payday Law Poster	http://www.twc.state.tx.us/ui/lablaw/ll10.pdf (English) http://www.twc.state.tx.us/ui/lablaw/ll10s.pdf (Spanish)
Texas Workers Compensation notice that the employer does or does not carry Workers Compensation insurance	Does not carry Workers Compensation Insurance: http://www.tdi.state.tx.us/forms/dwc/notice5.pdf (English) http://www.tdi.state.tx.us/forms/dwc/notice5s.pdf (Spanish) Does carry Workers Compensation Insurance: http://www.tdi.state.tx.us/forms/dwc/notice6.pdf (English) http://www.tdi.state.tx.us/forms/dwc/notice6s.pdf (Spanish)
TWC Employer's Notification of the	http://www.oiec.state.tx.us/documents/Employer_Notice_of_O.pdf (both versions)

Ombudsman Program to Employees	
DOL – The Uniformed Services Employment and Reemployment Rights Act (USERRA)	http://www.dol.gov/vets/programs/userra/USERRA_Private.pdf
EEOC Equal Employment Act and the Americans with Disabilities Act (ADA)	http://www.dol.gov/ofccp/regs/compliance/posters/pdf/eeopost.pdf (English) http://www.dol.gov/ofccp/regs/compliance/posters/pdf/eeosp.pdf (Spanish)
Fair Labor Standards Act (FLSA) Minimum Wage Poster	http://www.dol.gov/whd/regs/compliance/posters/flsa.htm (English) http://www.dol.gov/whd/regs/compliance/posters/flsaspan.htm (Spanish)
If applicable: Employee Rights for Workers with Disabilities/Special Minimum Wage Poster – Employment Standards	http://www.dol.gov/whd/regs/compliance/posters/disabc.pdf http://www.dol.gov/whd/regs/compliance/posters/disabspanc3p.pdf
"Your Rights Under the Family and Medical Leave Act (FLMA)"	http://www.dol.gov/whd/regs/compliance/posters/fmlaen.pdf (English) http://www.dol.gov/whd/regs/compliance/posters/fmlasp.pdf (Spanish)
Title VI Rights Poster	http://austintexas.gov/department/wage-compliance
Additional Postings Required for Federally Funded Projects	
"Employee Rights Under the Davis-Bacon Act"	http://www.dol.gov/whd/regs/compliance/posters/fedprojc.pdf (English) http://www.dol.gov/whd/regs/compliance/posters/davispan.pdf (Spanish)
Applies to USDOT/FHWA funded projects: "Notice of False Statements Concerning Highway Projects"	http://www.mdt.mt.gov/publications/docs/forms/dbe/eeo_board/false_statements.pdf (as required in Section 00810A Standard Federal-Aid Assurances)
Applies to USDOT/FHWA funded projects; "Contractors EEO Policy"	N/A (as required in Section 00810A Standard Federal-Aid Assurances)

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SECTION 01505.1

Building Projects

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

1. Division 01 Section 01200 "Project Meetings"
2. Division 01 Section 01500 "Temporary Facilities"
3. Division 01 Section 01700 "Contract Closeout"
4. Division 02 Section 02220 "Demolition".
5. Division 01 Section 01352 "Sustainable Construction Requirements".

1.2 SUMMARY

A. The Owner has established that the Project shall minimize the creation of construction and demolition waste on the Project site and shall recycle and/or salvage non-hazardous construction, demolition, and land clearing debris to divert waste from Landfills.

1. Contractor shall minimize factors that contribute to waste such as over packaging, improper storage, ordering error, poor planning, breakage, mishandling, and contamination.

2. Contractor shall reuse, salvage, or recycle as many of the non-hazardous waste materials as economically feasible.

3. As an incentive to encourage resourcefulness, all profits resulting from salvaging and recycling shall go to the Contractor.

4. In cases where there is little to no cost difference between recycling/salvaging and land-filling of items not required to be recycled or salvaged, the Contractor is directed to recycle/salvage.

5. Contractor shall minimize waste disposal in landfills.

B. Hazardous materials are an exception to this Section. Comply with applicable requirements of Local, State and Federal regulations.

C. This Section includes administrative and procedural requirements for the following:

1. Salvaging non-hazardous demolition and construction waste

2. Recycling non-hazardous demolition and construction waste

3. Disposing of non-hazardous demolition and construction waste.

1.3 REFERENCES

A. The standards listed below form a part of this Section to the extent referenced. Standards are referred to in the text by basic reference only.

1. LEED-Reference Guide MR credit 2 (Reference only, Certification is not required)
2. Sustainable Building Sourcebook – Austin Energy Green Building:

   www.austinenergy.com/Energy%20Efficiency/Programs/Green%20Building/Sourcebook/constructionWasteManagement.htm

3. Resource Exchange Network for Eliminating Waste (RENEW), TCEQ (MC-112), Biannual catalog lists materials available and wanted; serves Texas and surrounding states; lists are posted on the Internet: http://www.tceq.state.tx.us/assistance/P2Recycle/renew/renew.html
4. Recycle Texas Online, A service of the Texas Commission on Environmental Quality. Contains information on about 1000 businesses and local governments handling materials from Texas. Organizations' information is self-reported and listings are free of charge. http://www.tceq.state.tx.us/assistance/P2Recycle/rtol/rtol.htm
5. The "Construction Materials Management Guidelines", a publication of AIA/Austin for the Governor's Energy Office provides construction waste recycling economics worksheets, recycling market information and other related information that may be useful in estimating the construction waste quantities and recycling costs for this project. Available from AIA/Austin (512) 452-4332.
6. "WasteSpec", Triangle J Council of Governments, Research Triangle Park, NC 27709, (919) 549-9390.

1.4 DEFINITIONS

A. Chemical Waste: Includes petroleum products, bituminous materials, salts, acids, alkalis, herbicides, pesticides, organic chemicals, and inorganic wastes.

B. Clean: Untreated and unpainted, not contaminated with oils, solvents, caulk, or the like.

C. Co-mingled: Keeping mixed recyclable materials in one container on site. The container is then taken to a material recovery facility where materials are separated for recycling.

D. Deconstruction: Process of carefully dismantling a building in order to salvage components for reuse and recycling. Also known as "construction in reverse".

E. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.

F. Demolition: Process of removing structures as quickly as possible by using heavy machinery and generating large amounts of waste.

G. Disposal: Acceptance of solid wastes at legally permitted and operating facility for the purposes of land-filling.

H. Diversion: Avoidance of demolition and construction waste sent to landfill or incineration. Diversion does not include using materials for landfill, alternate daily cover on landfills, or materials used as fuel in waste-to-energy processes.

I. Hazardous Waste: Byproducts of society that can pose a substantial or potential hazard to human health or the environment when improperly managed, and possessing at least 1 of 4 of the following characteristics, or appearing on a special Environmental Protection Agency (EPA) list.

1. Ignitability.
2. Corrosivity.

3. Reactivity.

4. Toxicity.

J. Non-Hazardous Waste: Solid wastes, such as building materials, packaging, rubbish, debris, and rubble resulting from construction, remodeling, repair, and demolition operations, possessing none of the 4 characteristics of hazardous substances, i.e., ignitability, corrosivity, reactivity, or toxicity.

K. Landfill: Authorized land waste disposal site that is located to minimize waste pollution from runoff and leaching. Waste is spread in thin layers, compacted and covered with a fresh layer of soil each day to minimize pest, aesthetic, disease and air and water pollution problems.

L. Municipal Solid Waste Landfill: A permitted facility that accepts solid, non-hazardous waste such as household, commercial, and industrial waste, including construction and demolition waste.

M. Non-hazardous: Exhibiting none of the characteristics of hazardous substance, i.e. ignitability, corrosiveness, toxicity or reactivity.

N. Non- toxic: Neither immediately poisonous nor poisonous after a long period of exposure.

O. Recyclable: The ability of a product or material to be recovered at the end of its life cycle and remanufactured into a new product for reuse by others.

P. Recycle: To remove a waste material from the Project site to another site for remanufacture into a new product for reuse by others.

Q. Recycling: The process of sorting, cleansing, treating, and reconstituting solid waste and other discarded materials for the purpose of using the altered form. Recycling does not include burning, incinerating, or thermally destroying waste.

R. Return: To give back reusable items or unused products to vendors for credit.

S. Reuse: A strategy to return materials to active use in the same or a related capacity.

T. Salvage: To remove a waste material from the Project site to another site for resale or reuse by others.

U. Source Separation: The act of keeping different types of waste materials separate beginning from the first time they become a waste.

V. Toxic: Poisonous to living beings either immediately or after a long period of exposure.

W. Trash: Any product or material unable to be reused, returned, recycled, or salvaged.

X. Waste: Extra material or material that has reached the end of its useful life in its intended use. Waste includes salvageable, returnable, recyclable, and reusable material.

All materials removed from the Project site to be land-filled, recycled, or salvaged for reuse. Pallets, containers, packaging and packing materials in which construction products are delivered to the Project site are considered waste materials. New, leftover materials that are returned to the material suppliers are <u>not</u> considered waste.

Y. Waste Management Plan: A Project-related plan for the collection, transportation, and disposal of the waste generated at the construction site. The purpose of the plan is to ultimately reduce the amount of material being land-filled.

1.5 SUBMITTALS

A. ***Draft Waste Management Plan***: Within 14 calendar days after date of the Notice to Proceed, or prior to any waste removal, whichever occurs first, submit a draft Waste Management Plan outlining how demolished items and waste material will be removed from the Project Site.

An example template is included as "Appendix A" to this section.

1. The Waste Management Plan shall include the following:

a. Identify each type of demolished and waste material produced as a result of the Work on the Project Site.

b. Identify each type of demolished and waste material intended to be recycled or reused.

c. Identify estimated quantities for each type of demolished and waste material that can be recycled or reused.

d. Identify material separation requirements.

e. Identify location of temporary on-Site storage for recycled and reused materials.

f. Identify final destination for each recycled and reused material.

g. Identify means of transportation for each recycled and reused material to their final destination.

h. Identify the name/phone number of the Coordinator of the Waste Management Plan. The Coordinator is Contractor-designated on-site party responsible for workers and overseeing and documenting results of Waste Management Plan.

i. Indicate permit or license and the location of the municipal solid waste landfills and other disposal area(s) to be used.

j. List of materials that cannot be recycled or reused.

B. ***Final Construction Waste Management Plan:*** Once the Owner has determined which of the recycling options addressed in the draft Construction Waste Management Plan are acceptable, revise and resubmit, within 14 calendar days, a final Construction Waste Management Plan. Approval of Contractor's Plan will not relieve the Contractor of responsibility for compliance with applicable environmental regulations.

C. ***Waste Management Reports:*** Prepare and maintain through Project duration a record of waste management. An Example template of a waste management record form is attached as "Appendix B" of this Section. With each application for progress payment, Contractor shall submit a summary of solid waste generated by the construction and demolition operations. Submit an electronic version of the updated form (showing new and cumulative information), indicating solid waste generated by the construction and means of disposal or diversion. Failure to submit updated reports with each Application for Progress Payment may delay payment. Include as a minimum the following information on the form: manifests, weight tickets, receipts and invoices, specifically identifying the Project and waste material for:

1. Municipal solid waste landfills.

2. Recycling centers.

3. Non-Profit organizations.
4. Landfill or Incinerator Disposal: Updates to the form and other updates required as part of the Waste Management Report shall include:
    a. Land-fill Materials Description. Include date removed from jobsite.
    b. Land-fill Hauler and Location of disposal or incineration.
    c. Quantity of Land-filled (or incinerated) Waste
    d. Submit electronic copy of manifests, weight tickets, receipts, and invoices as evidence of quantity and cost.
    e. The amount (in tons or cubic yards) of material land-filled from the Project, the identity of the landfill, the total amount of tipping fees paid at the landfill, and the total disposal cost.
    f. For each material recycled, reused, or salvaged from the Project, include the amount (in tons or cubic yards, pounds, feet, square yards, gallons, etc.), the date removed from the Project site, the receiving party, the transportation cost, the amount of any money paid or received for the recycled or salvaged material, and the net total cost or savings of salvaging or recycling each material.
5. Recycled and Salvaged Materials: Updates to the form shall include the following information:
    a. Diverted / Recycled Materials Description, including those retrieved by installer for use on other projects, those taken by the Contractor's staff or subcontractors for use on their projects, and those donated to charitable organizations. Include date item was removed from jobsite.
    b. Diversion / Recycling Hauler and Location, indicating name of person or company removing the material for future use and the location to which the item was removed.
    c. Quantity of Diverted / Recycled Waste
    d. Submit electronic copy of manifests, weight tickets, receipts, and invoices as evidence of quantity and cost.
    e. The City of Austin Project manager may request further information regarding how the diverted material was used or is intended to be used.

D. ***CWM Closeout Documentation:*** Submit the following upon the completion of The Work and prior to final payment:
    a. The completed Project Waste Management Record Form with Contract closeout documents, "signed" by the Contractor's representative and including calculations on end-of-project recycling rates, salvage rates, and landfill rates demonstrating that 100% of all non-hazardous construction wastes were recycled, salvaged or disposed of properly.
    b. Copy of all receipts, manifests, weight tickets, and other documentation of materials recycled, salvaged, land-filled or incinerated, that have not already been documented.
    c. Electronic copy of a final summary.

2 PART 2 - PRODUCTS

Not used

3 PART 3 – EXECUTION

3.1 GENERAL

A. Implement the waste management plan as approved by the City of Austin Project Manager. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.

3.2 WASTE MANAGEMENT PLAN IMPLEMENTATION

A. Plan Coordinator: Designate an on-site party (or parties) responsible for instructing workers, overseeing implementation and documenting results of the Waste Management Plan for the Project.

B. Plan Distribution: Provide copies of the Waste Management Plan to the Contractor's superintendent, each Subcontractor, the Owner, and the E/A.

C. Instruction: Provide on-site instruction of appropriate separation, handling, and recycling, salvage, reuse, and return methods to be used by all parties at the appropriate stages of the Project. Contractor is responsible for requiring participation of subcontractors.

D. Meetings: Conduct construction waste management meetings. Include subcontractors affected by the Waste Management Plan. At a minimum, discuss and develop a mutual understanding for achieving all of the Owner’s waste management goals at the following meetings:

1. Pre-bid conference.

2. Pre-construction conference.

3. Progress meetings.

E. Careful Ordering.

F. Materials Handling Procedures: Protect materials to be recycled from contamination. Handle, store and transport in a manner that meets the requirements set by the designated facilities for acceptance. All materials shall be covered during transportation to prevent contamination and littering.

G. Separation Facilities: The Contractor shall lay out and label a specific area to facilitate separation of materials for potential recycling, salvage, reuse, and return. Recycling and waste bin areas shall be kept neat and clean and clearly marked in order to avoid contamination of materials.

H. Handling:

1. Clean materials which are contaminated prior to placing in collection containers. Deliver materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to recycling process.

2. Arrange for collection by, or delivery to, the appropriate recycling or reuse facility.

I. Hazardous Wastes: shall be separated, stored, and disposed of according to local prevailing regulations, and in accordance with the appropriate section of this specification.

3.3 RECYCLING REQUIREMENTS

A. Materials: Refer to individual specification sections for detailed Waste Management requirements. In general, the following types of construction waste materials generated during the course of this project that are not salvaged shall be recycled:

1. Asphalt concrete pavement.

2. Concrete.

3. Concrete block.

4. Metals, including the following.

a. Banding straps.
b. Reinforcing steel.
c. Iron.
d. Brass and bronze.
e. Lead.
f. Extruded aluminum.
g. Aluminum sheet.
h. Stainless steel sheet.
i. Steel studs.
j. Copper pipe.
k. Steel pipe.
l. Galvanized steel pipe.
m. Metal ductwork.

5. Clean dimensional lumber.

6. Broken wood crates and pallets.

7. Glass and glass containers.

8. Plastics.

9. Plaster.

10. Gypsum board.

11. Acoustic ceiling tile.

12. Carpet and pad.

13. Paint and paint containers.

14. Metal toilet partitions.

15. Food service equipment.

16. HVAC heating and cooling coils.

17. HVAC equipment.

18. Plumbing fixtures.

19. Electrical conduit.

20. Electrical wiring.

21. Light fixtures.

22. Cardboard, paper, and packaging.

23. Beverage containers.

B. Methods: The following recycling methods may be used.
   1. On-site separation: Each material to be recycled shall be separated at the Project site and delivered to the recycling markets or directly from the Project site.
      a. If on-site separation method is used, designate a specific area or areas to facilitate separation of materials for potential reuse, salvage, recycling, and return.
      b. Maintain recycling and waste bin areas neat and clean and clearly marked, both in Spanish and in English, in order to avoid commingling of materials.
      c. Protect bins during non-working hours from off site contamination.
   2. Off-site separation: Materials to be recycled are delivered unsorted from the Project site to a materials recovery facility or transfer station where recyclable materials are separated from other waste.
      a. If this method is selected, Contractor shall verify that the entity responsible for the off-site separation has a market for all of the materials that are required to be recycled that it receives from the Project site.
      b. The same Submittals procedures shall apply.
      c. Protect bins during non-working hours from off site contamination.
   3. A combination of each of the above methods.

C. Area Recyclers: A reference for waste recycling markets and resources for the Austin, Texas area is included at the end of this Section.

3.4 REUSE

A. Contractor is encouraged to reuse as many demolished and waste materials as possible.

B. Reuse of demolished and waste materials includes the following:
   a. Salvaging existing materials scheduled for resale.
   b. Off-Site storage of demolished materials for future reuse by Contractor on other projects.
   c. Returning reusable materials, such as packaging and pallets, to vendor.
   d. Returning unused new materials to vendor.
   e. Assemble designated reuse items in a single location safe from damage, for review and approval by the Owner's Representative.

C. Submit a list of reused materials as part of the Waste Management Record

D. Contractor shall investigate the possibility of off-Site reuse of demolished and removed materials in the Austin, Texas metropolitan area.

3.5 SALVAGE

A. Salvage materials as identified on the Architectural and Engineering Demolition Plans.

B. Salvage Guidelines:
   1. The contractor shall salvage as many items as deemed economically possible, considering that each item salvaged saves on land filling fees and may be of use to others.

2. Assemble potentially salvageable items in one area for review by the City of Austin Project Manager. No items may be donated or sold to the public without prior approval by the City of Austin Project Manager.
3. The Contractor, with assistance requested from the City of Austin Waste Reduction Assistance contact and Engineer, shall consider several possible markets for salvaged items. Examples of potential markets are:
    a. Habitat for Humanity Restore.
    b. Project site display for public purchase/donation
    c. Demolition Contractor's sales yard/area
4. Salvage items shall be stored in a manner that prevents damage.
5. All proceeds from the sale of salvaged items shall go to the contractor.
6. The contractor shall submit a list of items salvaged as part of the Waste Management Records.

3.6 SCHEDULE OF MATERIAL DISPOSAL & RECYCLING SERVICES

A. The following list is provided for informational purposes only. Additional opportunities may be available. All information contained in this list is from the Austin Energy Green Building Program. Shortcut to: http://www.austinenergy.com/Energy%20Efficiency/Programs/Green%20Building/Sourcebook/constructionWasteManagement.htm

Contractor shall re-verify any crucial information prior to making arrangements that involve any of the firms listed.

Appendix A. Sample Construction Waste Management Plan

Construction Waste Management Plan

Project:
Contractor:
Date:
Contact:
Phone:
Prepared by:

Diversion Goal: Salvage and recycle at least **50%** *(by weight or volume) of land-clearing and construction waste*

Complete all sections below that are required by or pertinent to this project as outlined in the Construction Documents.

I. Coordination and Training

a. Name of Contractor's representative responsible for CWM implementation & coordination:

b. How will Contractor's staff and subcontractors be instructed and updated regarding demolition and construction phase **salvaging** activities?

c. How will Contractor's staff and subcontractors be instructed and updated regarding proper **recycling and separation** procedures, and how will contamination of separated waste materials will be prevented?

d. Describe and/or show on an attached site map where the temporary waste material storage area(s) will be located.

e. Recycling and trash containers and areas shall be clearly marked in English and Spanish in order to avoid contamination. Architect's review and approval of the storage area(s) and signage will be required as part of the approval of this Construction Waste Management Plan.

II. Waste Minimization

a. What waste minimization techniques will be employed during the construction phase? (See "Waste Minimization" subsection in specifications Section 01505, Construction Waste Management)_____

b. Which employees and / or subcontractors will be involved with each technique?

III. Construction Waste Analysis (including site / land-clearing materials, as applicable)

a. ***Diverted Materials***: For each of the materials anticipated to be reused or recycled (and thereby diverted from the landfill) to meet the minimum **50%** diversion goal, provide information to complete the table below. (Note: Whenever possible, please make efforts to use or donate usable construction waste materials rather than recycling.)

Material or Item	Storage Method (roll-off, bin, area, on pallet, etc.)	Quantity estimate (no., linear ft., square ft., etc.)	Proposed Recipient

Add rows (or paper pages) as required

b. ***Landfill***: For construction phase trash and materials / items that will not be diverted, complete the following table:

Quantity estimate (weight or volume)	Number and size of roll offs anticipated	Proposed landfill site

Appendix B. Summary of Solid Waste Disposal and Diversion

Project name _____ Project Number _____
Contractor Name _____ License Number_____
Contractor Address_____

Solid Waste Material	**Date Material Disposed/ diverted**	**Amount Disposed/ Diverted** (Ton or cubic yd.)	**Municipal Solid Waste Facility** (Name, address, Phone)	**Recycling/Reuse Facility** Name Address Phone	**Comment** (If disposed state why not diverted)
Land Clearing Debris					
Asphalt					
Concrete					
Metal					
Wood					
Debris					
Glass					
Clay Brick					
Paper/Cardboard					
Plastic					
Gypsum					
Paint					
Carpet					
Other					
Other					

Signature _____ Date _____

END

PART 1 - GENERAL

1.1 Related Documents:

Drawings and general provisions of Contract, including General Conditions, Section 00700, and Supplemental General Conditions, Section 00810, and Division 1 requirements.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 General

CONTRACTOR shall maintain reasonable local vehicular and pedestrian dust free traffic, including use of driveways, to proceed safely with minimum inconvenience, except during actual construction operations. CONTRACTOR provided flaggers shall assist traffic when a street is operating under a single lane. Two-way traffic shall be maintained at all other times unless otherwise authorized by Owner.

CONTRACTOR shall provide, at the work zone location during temporary traffic control installation, a designated Competent Traffic Control Person to ensure compliance with the traffic control plans and the provisions of the Contract. Training Certificates for the designated Competent Person shall be provided with submittals at the Precon. Training certificates for competent persons shall be good for four (4) years from the date of training. After such time the competent person must show that additional training or re-certification has been completed to maintain competent person status.

CONTRACTOR shall maintain a smooth and safe ride for traffic by placing steel plates with Asphaltic concrete berms, temporary fill or bridging and temporary surfacing with cold or hot-mix Asphaltic concrete paving in accordance with applicable City Standards.

Sidewalks shall not be obstructed, except by special permission of Owner or E/A. Access to private dwelling and to commercial establishments shall be provided at all times.

CONTRACTOR shall plan and execute his operations in a manner that will cause a minimum interference with traffic. The CONTRACTOR shall place and maintain in good condition, standard barricades at each end of the Project and at other locations where traffic is rerouted or blocked from using regular traffic lanes. Barricades and warning signs shall be in accordance with Texas Manual on Uniform Traffic Control Devices (MUTCD) and the City of Austin Transportation Criteria Manual.

Signs, barricades and warning devices informing public of construction features shall be placed and maintained by the CONTRACTOR who shall be solely responsible for their maintenance.

Unless otherwise specified elsewhere in Division 1, neither explosives nor blasting shall be permitted on this Project.

3.2 Traffic Control

3.2.1 It shall be the sole responsibility of the CONTRACTOR to furnish, install, maintain and remove barricades, detour signs, warning signs, lights and all regulatory traffic control devices of the size and type specified, at locations indicated, or as directed or approved by the OWNER in accordance with the Texas Manual on Uniform Traffic Control Devices, (MUTCD), Part VI, Traffic Control for Street and Highway Construction and Maintenance Operations and the City of Austin Transportation Criteria Manual. Upon phase completion, the Contractor shall immediately revise the

temporary traffic devices to reflect the next phase or if the project is complete remove them from the public right of way.

3.2.2 Throughout the life of the Contract, all existing roads and Traffic Control devices included in the Work shall be maintained by the CONTRACTOR to a condition, in the opinion of the OWNER, which is equal to or better than that which existed when Work commenced. Maintenance of existing roads and devices shall take priority over all other Work items and shall be subject to a seven-day-a-week, 24-hours-per-day time frame. The CONTRACTOR shall provide a smooth and safe riding surface for all vehicles along the route of this Project. This could include, but not be limited to, small cars, motorcycles, mopeds and bicycles. If the condition of the street surface deteriorates, for any reason, CONTRACTOR shall take necessary steps to insure immediate restoration.

3.2.3 During construction of streets, drainage, and utility projects, if conditions of existing street surface require maintenance to upgrade from their state when the Work began, a separate pay item may be included in Bid. Otherwise, maintenance work will not be paid for directly but will be considered subsidiary to various Bid items of this Contract.

3.2.4 In the event that CONTRACTOR fails, in opinion of OWNER, to maintain a smooth surface for public comfort, fails to provide ingress and egress to private property, and/or does not provide and maintain proper traffic control devices, OWNER may provide these services and deduct any cost thereof, including overtime and administrative expenses, from all estimates thereafter due the CONTRACTOR. Such action by the OWNER shall not relieve the CONTRACTOR of his liability to protect the public at construction site. Owner may also assess an investigation fee, as established by separate Fee Ordinance, for violations resulting in more than one deficiency report issued to Contractor.

3.2.5 A permit must be obtained from Texas Department of Transportation (TxDOT), prior to Work being performed on state highway routes passing through the City.

3.2.6 CONTRACTOR shall notify the Owner's Representative, Police Department, Fire Department, EMS, and Right of Way Management Division at least seven Calendar Days in advance of beginning proposed Work, with intention to close or partially block any street or any part thereof, or of any construction affecting free flow of traffic. The CONTRACTOR shall plan and adequately provide barricades and warning devices. The same parties shall be notified when normal traffic flow is restored.

3.2.7 Should the CONTRACTOR, in his operations, reduce an existing two-way roadway to less than 20 feet in width, CONTRACTOR shall provide a route through or around the narrowed area as approved by Owner or E/A.

3.2.8 The CONTRACTOR's Flaggers shall be required any time it is necessary for the CONTRACTOR's equipment to move into or across an open traffic lane, or at other such times as directed by the Owner's Representative. A flagger shall be utilized to aid exit of hauling equipment from open traffic lanes to the Work area, and entry of hauling equipment from Work area to open traffic lanes. Flaggers shall be dressed and conduct operations in accordance with Texas Manual on Uniform Traffic Control Devices and the Transportation Criteria Manual. Flagging operations shall be the sole responsibility of the CONTRACTOR.

3.2.9 The CONTRACTOR and Subcontractors shall confine their activities to the immediate area of the construction site and provide the following:

a. Appropriate temporary fences, barricades, and/or Metal Beam Guard Fence if required, for site work involving excavation, utility extensions, remote construction work or other circumstances involving safety of public or protection of the work in progress.

b. Warning lights at open trenches, excavations, etc., during hours from dusk to dawn each day. Protection of structures, utilities, sidewalks, pavements, and other facilities immediately adjacent to excavations, from damages caused by settlement, lateral movement, undermining, washout and other hazards.

3.3 Spoil Disposal

CONTRACTOR may make other arrangements for spoil disposal subject to E/A evaluation of the CONTRACTOR-supplied proof that the Owner(s) of the proposed site(s) has a valid fill permit issued by the appropriate governmental agency. Finally, the CONTRACTOR shall submit a haul route plan including a map of the proposed route(s) for the E/A and Owner's approval.

3.4 Restoration

WATER AND WASTEWATER CONSTRUCTION REQUIREMENTS

3.4.1 In order to minimize environmental and potential flood impacts, the sum of the amount of trench opened in advance of the completed line and the amount of trench left unfilled at any time shall be restricted to one (1) full block or 300 linear feet, whichever is less.

3.4.2 Restoration shall be an on-going process during construction operations and shall immediately precede completion of construction of each successive section of the line, which shall not exceed 1,200 linear feet without approval of the E/A.

3.5 Street Markers and Traffic Control Signs

It shall be responsibility of the CONTRACTOR to remove, preserve and reset, as required, Street Marker and Traffic Control Signs that are within construction limits to the line and heights as described in Texas Manual on Uniform Traffic Control Devices before any sidewalks or street excavation is begun. Signs shall not be laid on the ground. No payment will be made for this work but shall be considered subsidiary to the various Bid items. Traffic Sign Activity Section of the Transportation Department (457-4850) shall be notified a minimum of five Working Days prior to completion of the Project so that signs may be checked for damage. Any damage to signs or posts shall be paid for by the CONTRACTOR.

3.6 Burning Permit

Open burning within City limits will not be allowed. Trench burning shall require a permit from the Fire Marshal. Burning permits outside City limits shall be obtained from the appropriate authority.

The CONTRACTOR shall secure and pay for all burning permits.

3.7 Driveways

Unless otherwise indicated, the approach grade of existing driveways shall be modified as indicated and as directed by the Owner's Representative. The OWNER will contact property owners whose driveways require grade modification beyond street right-of-way and the OWNER will obtain their concurrence for approach grade modification. Within the right-of-way, all driveways shall be replaced with concrete driveways. Outside the right-of-way, when approach grade modifications are required, flexible base shall be placed by the CONTRACTOR to resurface existing dirt or gravel driveways; asphalt and concrete drives shall be replaced in kind by the CONTRACTOR. Excavation, Flexible Base, Portland Cement Concrete and Asphaltic Concrete, used for driveways as prescribed above shall not be measured for payment but shall be considered subsidiary to various Bid items in the Contract unless payment is included as a separate Contract pay item.

3.8 Removal or Relocation of Fences and Sprinkler Systems

Removal or relocation of privately owned fences and sprinkler systems not specified in Bid, and within public right-of-way is the primary responsibility of the property owner. OWNER

will cause property owners to be aware of any known conflicts and encourage them to make desired adjustments in advance of construction. In the event the property owner does not, or will not, make adjustments necessary for construction of improvements to be made under this Contract, CONTRACTOR, after receiving written approval from the OWNER, shall remove those portions that interfere with the Work, as follows:

3.8.1 Fences shall be disassembled, by hand, into hand manageable sizes and placed on the private property.

3.8.2 For sprinkler systems, the CONTRACTOR, after assuring that electrical and/or mechanical controls are disconnected, shall remove sprinkler heads, valves, controls, and any other miscellaneous items, including distribution pipe, or wire, saw cut from the system. The CONTRACTOR shall present these materials to the property owner. Where piping is cut, the pipe shall be permanently capped or plugged, unless otherwise directed by the OWNER.

Work for removal or relocation of fences and sprinkler systems shall not be paid for directly but shall be subsidiary to the various Bid items.

END

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section covers the environmental protection requirements related to construction of the Ullrich Water Treatment Plant Low Service Pump Station Electrical Feed Renewal project

B. This section covers general environmental protection relative to complying with the Endangered Species Act, specifically listed and candidate species, the Regional Balcones Canyonlands Preserve (BCP) Section 10(a)(B)(1) permit and Habitat Conservation Plan (HCP) for Travis County. Authorization included as Attachment A.

C. This section governs notification requirements for voids and water flow features discovered during excavation activities of this project.

1.2 RELATED DOCUMENTS

A. The following Sections apply to the Work of this Section. Other Sections not referenced below shall also apply to the extent required for proper performance of the Work.

1. Section 658S – Void and Water Flow Mitigation
2. Series 600 – Environmental Enhancement
3. Section 01010 – Summary of Work
4. Section 01352 – Sustainable Construction Requirements
5. Section 01505 – Construction and Demolition Waste Management
6. Section 02220 – Demolition
7. Section 02442 – Dewatering
8. Section 17100 – Process Instrumentation and Control Systems (PCIS)

Additional specific environmental protection requirements are shown on the Drawings.

1.3 SUBMITTALS

A. Submit in accordance with Section 01300 – Submittals:

1. Qualifications and personnel pertinent to the outlined scope of work.
2. Plans specified or referenced in this Section.
3. Void and Water Flow Mitigation material submittals: Submit in accordance with Section 658S.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Crushed Stone: Rocks shall be sound with a minimum of 3 inches (75 mm) in smallest dimension and 5 inches (125 mm) in largest dimension. Open-graded rock of the size indicated on Details and fines removed, shall be used.

B. Controlled Low Strength Material (CLSM): This material shall meet the requirements for CLSM as specified in Section 03300.

C. Concrete is included in series 400.

D. Filter Fabric: This material shall meet the requirements for filter fabric as specified in Standard Specification Item 620S.

E. Polypropylene Bags filled with pea gravel. Pea gravel shall meet requirements of Standard Specification Item 510.2 (5).

F. Gravel Backfill: Gravel backfill shall meet requirements of Standard Specification Item 510.2 (2) (a) for pipe bedding stone.

G. High density, high molecular weight tubing, ASTM D2737 per City of Austin SPL WW-65.

PART 3 - EXECUTION

3.1 STORMWATER MANAGEMENT AND GROUNDWATER PROTECTION

A. Erosion Control

1. Contractor shall prevent erosion of soil and deposition of sediment on the construction site and adjacent property resulting from his construction activities. Effective measures shall be initiated prior to the commencement of Work which will disturb the natural protection as noted on the Drawings, in accordance with the City of Austin (COA) Environmental Criteria Manual Section 1.4, and the requirements included in the Storm Water Pollution Prevention Plan (SWPPP).
2. This Work is subject to the Texas Pollution Discharge Elimination System (TPDES) permitting requirements for the installation and maintenance of temporary and permanent erosion and sediment controls and stormwater pollution prevention measures throughout the construction period. As noted in Section 00810 – Supplemental General Conditions, the Owner has prepared a Storm Water Pollution Prevention Plan (SWPPP). The SWPPP includes several best management practices that Contractor must abide by, including but not limited to, the following:
    - Provisions for stabilized construction entrances, placement of gravel, mulching, dust control, and other measures to prevent dirt from migrating offsite on vehicles. Vehicle tire washing may be implemented if other measures are not effective, as determined by the Environmental Compliance Manager.
    - Requirements for a Spill Prevention and Control Plan to be prepared by Contractor. Refer to Paragraph 3.6 of this section for additional information pertaining to spill and leak management.
    - Additional requirements as indicated on the Erosion and

Sediment Control Drawings, including no herbicides or pesticides onsite, unless approved by the Environmental Compliance Manager.

3. Refer to Section 01010 – Summary of Work and Section 01143 – Coordination with Owner's Operations for additional Contractor responsibilities and Owner obligations related to erosion control and the SWPPP. Refer to Attachment of the Project Manual for the complete SWPPP. Also, refer to the attached Attachment B for COA Environmental Criteria Manual Section 1.4 for Erosion Control.

B. Pollution Control

1. Contractor shall prevent the pollution of caves, karst, drains, and watercourses by sanitary wastes, sediment, debris and the substances resulting from construction activities. No sanitary wastes will be permitted to enter any drain or watercourse. Contractor shall comply with the COA Environmental Criteria Manual Section 1.4 to prevent off-site migration of sediment.
2. Contractor shall observe the rules and regulations of the State of Texas and agencies of the U.S. Government prohibiting the pollution of any lake, stream, river, or wetland by the dumping of any refuse, rubbish, dredge material, or debris therein.
3. Contractor is specifically cautioned that disposal of materials into any water of the State must conform to the requirements of the Texas Commission on Environmental Quality (TCEQ), the Texas Water Code, and COA water quality standards.

C. Control, Discharge, and Treatment of Project Construction and Testing Water

D. Requirements for controlling, treating, and discharging construction water as well as water from near surface piping and structure excavations to the existing sanitary sewers and proposed storm drain system are outlined in Sections 02442 –Dewatering . Dust Control

1. Dust control during construction shall conform to Standard Specification Item No. 220S - Sprinkling for Dust Control and Section 01406 Control of Work. Contractor shall be responsible for monitoring and implementing dust control measures, including placement of mulch and gravel as shown on the erosion and sediment control drawings. Potable water shall be used for dust control at the construction sites. No dust shall be visible outside the limits of construction to the maximum extent practicable, as determined by the Environmental Compliance Manager.

E. Sustainable Construction Requirements

1. Refer to Section 01352 – Sustainable Construction Requirements. Refer to Section 01505 – Construction and Demolition Waste Management for a waste management plan to be prepared by Contractor.

3.2 CRITICAL ENVIRONMENTAL FEATURE PROTECTION AND GROUNDWATER PATHWAYS PRESERVATION

A. General:

1. Significant voids within the Edwards Limestone were not specifically identified in the exploratory borings completed for this project or borings in close proximity that were completed for other projects. Refer to Section 00220 for geotechnical investigations.

2. Should significant voids be encountered during excavation activities then a mitigation measure may be required before continuing with excavation.

3. Excavated rock surfaces shall be observed for significant voids or water features by an Owner's Representative in accordance with Section 658S.

4. Contractor shall be responsible to provide 24-hour prior notice of excavation activity to Owner's Representative. The Contractor shall be responsible for ensuring that the Owner's Representative has the opportunity to observe the face of all excavations prior to the installation of structural elements or placement of fill materials.

5. The City of Austin will make the determination on whether or not identified voids and/or water flow features require mitigation measures.

6. If required, mitigation measures will be performed in accordance with Section 658S.

.

3.3 REVEGETATION AND INVASIVE SPECIES CONTROL

A. As noted on the Drawings, Contractor will be required to revegetate with native grass seeding (COA Standard Specification Item No. 609S) (COA Standard Specification Item No. 604S). Topsoil with compost shall be used as required by City of Austin Standard Specification Item No. 601S. Contractor shall clean all equipment for invasive species control, to the satisfaction of the Owner and Resident Engineer, prior to its use onsite.

3.4 TREE AND PLANT PROTECTION

A. All trees and other vegetation which must be removed to perform the Work shall be mulched and used onsite as indicated on the Drawings. Precautions shall be undertaken by the Contractor to prevent fires. Precautions shall include watering of mulch during dry periods, minimizing spark potential, prohibiting smoking, and other actions as deemed necessary by the Environmental Compliance Manager. No trees or cultured plants shall be unnecessarily removed unless their removal is indicated on the Drawings. All trees and plants not removed within the limits of construction shall be fenced and protected against injury from construction operations.

B. No tree shall be removed or damaged outside of permanent easement(s), except where authorized by the Owner. Hand excavations shall be employed as necessary to prevent injury to trees. Care shall be taken with exposed roots, unearthed during construction, so that roots do not dehydrate causing tree damage. All exposed cuts shall be treated as specified in the City's Oak Wilt Policy

C. Trees considered to have any significant effect on construction operations are indicated on the Drawings and those which are to be preserved are so indicated.

D. Contractor shall take extra measures to protect trees designated to be preserved, using methods shown on the Drawings and as specified in Standard Specification Item No. 610S - Preservation of Trees and other Vegetation, including the City's Oak Wilt Policy, attached to this Section as Attachment C.

3.5 SPILL AND LEAK MANAGEMENT

A. The SWPPP includes best management practices related to spill and leak management that Contractor must abide by including, but not limited to, the following:

1. Secondary containment for fueling equipment shall be utilized.
2. Spills or leaks shall be cleaned up immediately including work stoppage if necessary to facilitate clean up. Contaminated water shall be contained in a temporary holding facility and hauled offsite for proper disposal.
3. Fuel shall be stored offsite.
4. Onsite lubrication shall be conducted on secondary containment pads with sorbent pads placed under equipment. All construction equipment shall be equipped with containers and sorbent pads. No major equipment maintenance will be allowed onsite, unless approved by the Environmental Compliance Manager.
5. All spills regardless of size/quantity shall be immediately reported to

the Environmental Compliance Manager and cleaned up immediately in accordance with TCEQ Spill Rules, 30 TAC Chapter

6. The Environmental Compliance Manager will report the spills to TCEQ and the Environmental Hotline (974-2550). Spills older than 180 days shall be remediated in accordance with TCEQ Spill Rules, 30 TAC Chapter 350. The Spill Rules require cleanup to background or pre-release conditions.

3.6 NOISE ABATEMENT AND CONTROL

A. Contractor shall comply with the City of Austin's Noise Ordinance. Contractor shall take reasonable measures to avoid unnecessary noise. Such measures shall be appropriate for the normal ambient sound level in the area during working hours. All construction machinery and vehicles shall be equipped with practical sound-muffling devices, and operated in a manner to cause the least noise consistent with efficient performance of the Work. Refer to Section 01500 Temporary Facilities for additional requirements.

3.7 LIGHT CONTROL

A. Contractor shall provide lighting systems that minimize fugitive light impacts and be energy efficient. Contractor shall submit a plan and data for temporary lighting at the construction site for review by Resident Engineer and Owner. The submittal shall include an isometric foot-candle distribution diagram demonstrating the distribution of light at the edges of the limits of construction.

3.8 ORIENTATION AND TRAINING

A. All Contractor personnel working on the project shall attend a one (1) hour orientation and training session conducted by the Owner to review the environmental protection requirements for this Project.

PART 4 – MEASUREMENT AND PAYMENT

4.1 MEASUREMENT AND PAYMENT

A. No separate measurement or payment shall be made for the environmental work described in this section, except for void and water flow mitigation measures. Include cost for environmental protection other than void and water flow mitigation in the Lump Sum Price for the Project.

B. Measurement and payment for void and water flow mitigation shall be agreed upon based on unit price for mitigation procedures described in Section 658S and agreed upon by the Contractor, Engineer, and Owner.

END

Attachment A – BCP Authorization

February 21, 2020

Robyn Haasch
City of Austin
505 Barton Springs Road
Austin, TX 78704

Re: Ullrich Low Service Pump Station (LSPS) Electrical Feed Renewal Project

Dear Ms. Haasch,

Thank you for your application on behalf of the City of Austin regarding the Ullrich Low Service Pump Station (LSPS) Electrical Feed Renewal project. The site location provided on the Balcones Canyonlands Conservation Plan (BCCP) Infrastructure Habitat Assessment Application is as follows: Ullrich Water Treatment Plant - 1000 Forest View Dr., Austin, TX 78746

The project site lies outside the preserve acquisition boundary for the Balcones Canyonlands Preserve. Based upon a review of the project plans submitted with the application, this project is eligible to participate in the regional Balcones Canyonlands Section 10 (a) permit. Participation under the BCCP permit will cover incidental take of endangered species habitat, particularly golden-cheeked warbler habitat and karst species habitat that the project might impact.

This application and determination covers the proposed Ullrich Low Service Pump Station (LSPS) Electrical Feed Renewal Project. The project is to upgrade the existing 15kV switchgear at the Ullrich Water Treatment Plant (WTP). The replacement switchgear will be enclosed in a building north of the existing Austin Energy substation along Forest View Drive. The duct bank would be located under a new asphalt access road along the eastern portion of the project from the new switchgear building to the existing LSPS. The access road would provide maintenance access to the duct bank manholes, and also improve access to the LSPS. A small duct bank would be installed along Forest View Drive from the new switchgear building to the existing powdered activated carbon (PAC) building located on the western extension of the project, and improvements to the electrical equipment outside of the PAC would be completed. A small section of 16-inch potable water line, located southwest of the new switchgear building would be relocated.

Heavy equipment would be utilized for land clearing and construction activities. Onsite staging of materials would be required for installation of the duct banks and construction of the new switchgear building. Erosion and sedimentation controls would be used to minimize impacts to water quality and in accordance with the project's stormwater pollution prevention plan and

water pollution abatement plan. The duct bank, access road, and areas surrounding the new building will require restoration of vegetation due to construction and heavy equipment disturbance. Plants and grasses native to the Edwards Plateau ecoregion would be used for landscaping and revegetation of the site. Clean, imported fill will be required at the low point of the proposed access road to allow for the road to be constructed to acceptable standards of grade.

The proposed project site is wooded, portions of the project area have been previously disturbed. Construction of the proposed new switchgear building, duct bank, and access road are expected to require the removal of eleven trees (as shown on the submitted project schematic), and the clearing of understory vegetation. The remainder of the trees on-site would remain, and the clearing of vegetation will be minimized to the extent practicable.

Grading would occur to prepare the site for construction of the new switchgear building and roadway. The new switchgear building would be built on piers due to uneven ground surface elevations. Drilled pier installation would involve mostly below ground disturbances and would minimize cut and fill within the limits of the proposed building. Grading for the new asphalt roadway and retaining walls would occur and the duct bank would be installed to a depth of approximately six feet below the existing ground surface. Previously disturbed areas along Forest View Drive and near the existing LSPS would also be disturbed for the installation of small ductbank to the PAC and for improvements to the existing electrical equipment near the LSPS.

Based on BCCP Habitat Zone Maps, and maps provided with the application, the project as described will impact 1.72 acres of BCCP Karst Mitigation Zone 1 and a partially overlapping 1.31 acres of BCCP Golden-cheeked Warbler Mitigation Zone 1. Only the highest fee zone is calculated when zones overlap. All mitigation acreages are rounded up to the next 0.1 acre increment under calculation procedures approved by the Balcones Canyonlands Coordinating Committee, thus the mitigation amount will be 1.8 acres, and it will be deducted from the City of Austin mitigation bank.

As stated, construction activities will occur within areas designated as Golden-cheeked Warbler habitat. When participating under the BCCP permit, there are important requirements that relate to site clearing and subsequent construction activity that must be observed. Clearing of woody vegetation should be completed during the months from September through February. After March 1, such vegetation work must cease since Golden-cheeked Warblers will have returned to the area to nest. Construction may proceed beyond the March 1 deadline once the natural vegetation has been removed and in accordance with USFWS protocol.

There is also the potential to spread Oak Wilt with the clearing or pruning of Live Oaks and Red Oaks. Therefore it will be necessary to strictly adhere to the City of Austin's Oak Wilt Prevention Policy. Please ensure all personnel on site adhere to this policy.

Please keep a copy of this letter at the project site. If you have any further questions regarding this assessment or encounter any problems, please feel free to call me at (512) 972-1686.

Kind Regards,

Kimberlee C. Harvey

Kimberlee C. Harvey
BCCP Coordinating Committee Secretary

cc: File #: 20-002
Travis County BCCP Coordinator
David Gimnich, BCCP Infrastructure Coordinator
Tanya Sommer, Consultations Branch Chief, USFWS

Attachment B – COA Environmental Criteria Manual Section 1.4

1.4.0 - EROSION AND SEDIMENTATION CONTROL CRITERIA

1.4.1 - Introduction

The purpose of this section is to provide a resource document and policy for the protection of land and water resources, so as to minimize the adverse effects of erosion and sedimentation per the City of Austin's Land Development Code. Additionally, the criteria have been fashioned to complement the language of the Texas Pollution Discharge Elimination System (TPDES) Construction General Permit.

The conversion of land from its natural state or agricultural use to urban use accelerates the processes of erosion and sedimentation. These negatively impact the city's drinking water supply, aquatic life and the recreational resource provided by them.

Construction related sediment can be a significant pollutant of streams, lakes, ponds and reservoirs. Not only does sediment reduce the quality of water for boating, fishing, swimming and other water-oriented recreation, it also creates maintenance problems due to excessive wear on pumps and due to the reduced capacity of streams, lakes and other waterways. Another problem associated with sediment is the affinity of pesticides, phosphates and many other chemical pollutants for soil particles. These pollutants are carried to the waterway on the sediment and further reduce the quality of the water.

Mankind accelerates the erosion process by modifying the topography, soil conditions, vegetative cover and drainage patterns during construction to suit its needs. The clearing and grading of land to convert it from a natural state to cultivated row crops greatly increases the potential for erosion. The magnitude of this increase can be as much as 200 times. In addition, earth moving and construction to convert agricultural land to urban uses such as roads, houses, shopping centers, schools and airports increases the erosion potential another ten (10) times (Erosion and Sedimentation Control Guidelines for Developing Areas in Texas, U.S.D.A., S.C.S., Temple, Texas, 1976). After full urbanization takes place in a watershed, however, erosion usually decreases several fold from that experienced during the period of construction (Virginia Erosion and Sedimentation Control Handbook, Second Edition, 1980) and may decrease from that occurring before construction.

As additional development and urban growth takes place in Austin, the value of all land and water resources increases. The conservation of these resources is easier and less expensive than their restoration.

On most development projects, the major period for erosion potential exists between the time when the existing vegetation is removed to begin site work and the completion of construction and revegetation. There are numerous activities associated with construction and land development that accelerate the rate of erosion. Virtually all of these actions involve the removal of vegetation and/or the movement of the native geologic structure to provide a construction site. The adverse impact upon the site and the environment in general can be reduced if these actions are taken with some thought to the resultant erosion.

The control criteria included in this manual provide several methods to address the dual problems of erosion and sedimentation, but are in no way a complete outline of the possible actions to provide adequate reductions. We therefore encourage innovation and suggestions to improve or expand on these concepts. Any questions concerning the criteria or the use of measures not included in the manual should be directed to the Watershed Protection and Development Review Department.

The Erosion and Sedimentation Control Criteria are established and reviewed by the Environmental Resource Management Division of the Watershed Protection Department. Development permit review is conducted by the Development Services Department and construction inspection oversight by the Environmental Inspection Section of the Site and Subdivision Inspection Division.

Source: Rule No. R161-17.12 , 6-13-2017.

1.4.2 - City of Austin Erosion and Sedimentation Control Policy

A. **Purpose and Application.**

The City of Austin Erosion and Sedimentation Control policy shall govern the planning, design, installation, maintenance and inspection of temporary and permanent erosion and sedimentation controls associated with development within the City of Austin and all areas subject to its extraterritorial jurisdiction. Finally, this policy is the official criteria manual required by the TPDES MS4 permit, and as such strives to comply with all federal and state mandates updating the permit. At this time, neither the NPDES nor the TPDES General Permits require Effluent Limit Guidelines (ELG). However, as of November, 2008, EPA has sent notice that it will impose ELG upon Construction General Permits. At such time, COA will update ECM 1.4 to comply with EPA mandates.

B. **Policy.**

It shall be the policy of the City of Austin that erosion and sedimentation controls are required for all construction and development, conducted with or without a permit, including without limitation commercial, multi-family, single-family, and duplex construction, the construction of all roads, utilities, parks, golf courses, water quality basins, detention basins, and all other activities utilizing clearing, trenching, grading or other construction techniques. It is the intent of City of Austin policy to closely parallel the requirements set forth in the Texas Pollution Discharge Elimination System (TPDES) Construction General Permit, the City of Austin's MS4 permit and any applicable updates to NPDES or TPDES.

The objectives of this policy are to:

- Minimize the erosion and transport of soil resulting from development activities.

- Prevent sedimentation in streams, creeks, lakes, waterways, storm drains, etc. by ensuring no off-site transport of disturbed sediment for the 2-year 24-hour storm during construction and through establishment of permanent controls.

- Protect and improve the quality of surface water in the Austin environment and maintain and improve the quality and quantity of recharge to groundwater supplies, especially the Edwards aquifer.

- Minimize flooding hazards and silt removal cost associated with excessive sediment accumulation in storm drains and waterways.

- Preserve and protect existing vegetation to the greatest extent possible, particularly native plant and wildlife habitats.

The following sections present the minimum requirements for the planning, design, construction, operation and maintenance of erosion and sedimentation control facilities and should be used as a resource document to help developers and engineers plan and implement their projects to provide protection from erosion or sedimentation. The adequacy of the plan to meet the letter and intent of this section will be determined by the Development Services Department. Please note that projects that require a building permit, but not a site plan permit, are required to complete the TPDES Construction Site Notice (Small or large depending on size. See Appendix V, Figures 1- 2, 1-3, 1-4, 1-5. Or click on TCEQ link at:

http://www.tceq.state.tx.us/assets/public/permitting/waterquality/attachments/stormwater/txr150000.pdf

Figure 1-1.1 (Appendix V) outlines the general sequence of events that take place in the planning, review, approval, construction and inspection of an Erosion and Sedimentation Control Plan. See Section 1.4.4(B)3 for the E&S control plan submittal requirements. The City of Austin and the Watershed Protection and Development Review Department shall not be responsible to anyone for the use or reliance on any portion of this manual and shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation, or reliance on any specification or guidelines contained herein.

C. **Plans and Computations.**

Plans and computations to support all erosion and sedimentation control designs shall be submitted to the Development Services Department for review. Plans and computations shall be in such form as to allow for timely and consistent review and to be made a part of the permanent record for future reference. Computations shall be required for BMPs that rely on detention, sedimentation, filtration, diversion and velocity control. The reviewer may deny an application if the applicant cannot support Erosion and Sedimentation control designs with appropriate calculations. All engineering computations shall be certified by a Licensed Professional Engineer with competence in this area as required by Texas Engineering Practice Act, Section 137. All ESCPs shall be signed by a Licensed Professional Engineer (TX) or a Certified Professional in Erosion and Sedimentation Control {(CPESC)(http://cpesc.org/)}. If the ESCP itself contains engineering calculations, then a Licensed Professional Engineer must seal and sign the ESCP. All drainage calculations shall be done in accordance with the guidelines in the Drainage Criteria Manual.

D. **Ordinance Authority.**

The information in the following sections is intended to define the technical design criteria needed to achieve the policy goals identified in the Land Development Code relating to erosion and sedimentation control. A brief summary of specific code sections relating to the requirements for erosion and sedimentation control is included below:

Title 6-5-51: Discharges into Storm Sewers or Watercourses.

25-1-441: Cease and desist order ("Red Tag").

25-1-288: Requirements for a pre-construction inspection; owner's demonstration of compliance; modifications to controls and plans.

25-7-61 and 25-7-65: Adequate temporary and permanent erosion and sedimentation control plans required for final plat, subdivision construction plan, or site plan approval; estimated cost of fiscal security; fiscal security insures no cost to the city.

25-8-181 to 25-8-184: Erosion and sedimentation control required for all construction; restoration required for a complete project; modifications to plans allowed.

25-8-321 to 25-8-323: Topsoil to be protected against erosion; existing vegetation to be left in place where possible; limitation of time between rough cutting and final surfacing of roadways.

25-8-341 and 25-8-342: Cuts and fills to be restored and stabilized.

25-8-343: Restoration and revegetation of spoil disposal sites required.

25-8-281 and 25-8-282: Special erosion controls required to protect critical environmental features.

Work done under this policy is subject to all provisions of the Land Development Code. No work shall be done by the contractor until all required permits have been obtained. To find out exactly what permits are required, an inquiry should be made to the Development Services Department.

E. **Innovative and Alternative Practices.**

Innovative practices, or alternatives to those presented in this section, are not considered or approved by staff on a case by case basis. Rather, twice each year, staff evaluates new technologies and suggestions and determines which practices to formally adopt into the manual. The ECM will then be formally updated by the rules adoption process to allow use of these products/technologies across all appropriate projects. Suggestions or requests for product evaluation should be submitted to the Manager of the Stormwater Treatment Section of Environmental Resources Management.

Source: Rule No. R161-17.12 , 6-13-2017.

1.4.3 - Definitions (in accordance with TPDES General Permit and COA technical manuals)

Arid Areas - Areas with an average annual rainfall of 0 to 10 inches.

Baseflow - The discharge in a channel that is relatively constant, occurring between storm runoff events. That flow which can be expected on a daily basis without storm flows.

Best Management Practices (BMPs) - Schedules of activities, prohibitions of practices, maintenance procedures, structural controls, local ordinances, and other management practices to prevent or reduce the discharge of pollutants. BMPs also include treatment requirements, operating procedures, and practices to control construction site runoff, spills or leaks, waste disposal, or drainage from raw material storage areas.

Bonded Fiber Matrix (BFM) - Bonded Fiber Matrix shall consist of long thermally refined wood fibers produced from grinding clean, whole wood chips and cross-linked hydro-colloidal tackifiers.

Certified Inspector - A person who has received training and is licensed by CPESC, CESSWI or CISEC to inspect and maintain erosion and sediment control practices.

Clearing - Any activity that removes the vegetative surface cover. Mass clearing is defined as the practice of clearing the entire site of all vegetation (except protected trees) to prepare for final grading. This is opposed to Selective clearing, which only disturbs the soil and vegetation where a road or infrastructure will be placed.

Commencement of Construction - The initial disturbance of soils associated with clearing, grading, or excavation activities, as well as other construction-related activities (e.g., stockpiling of fill material, demolition).

Common Plan of Development - A construction activity that is completed in separate stages, separate phases, or in combination with other construction activities. A common plan of development (also known as a "common plan of development or sale") is identified by the documentation for the construction project that identifies the scope of the project, and may include plats, blueprints, marketing plans, contracts, building permits, a public notice or hearing, zoning requests, or other similar documentation and activities. A common plan of development does not necessarily include all construction projects within the jurisdiction of a public entity (e.g., a city or university). Construction of roads or buildings in different parts of the jurisdiction would be considered separate "common plans," with only the interconnected parts of a project being considered part of a "common plan" (e.g., a building and its associated parking lot and driveways, airport runway and associated taxiways, a building complex, etc.). Where discrete construction projects occur within a larger common plan of development or sale but are located ¼ mile or more apart, and the area between the projects is not being disturbed, each individual project can be treated as a separate plan of development or sale,

provided that any interconnecting road, pipeline or utility project that is part of the same "common plan" is not included in the area to be disturbed.

Control Plan - indicating the specific measures and sequencing to be used to control sediment and erosion on a development site during and after construction.

Discharge - For the purposes of this permit, the drainage, release, or disposal of pollutants in storm water and certain non-storm water from areas where soil disturbing activities (e.g., clearing, grading, excavation, stockpiling of fill material, and demolition), construction materials or equipment storage or maintenance(e.g., fill piles, borrow area, concrete truck washout, fueling), or other industrial storm water directly related to the construction process (e.g., concrete or asphalt batch plants) are located.

Drainage Way - Any channel that conveys surface runoff throughout the site.

Edwards Aquifer - As defined under Texas Administrative Code § 213.3 of this title (relating to the Edwards Aquifer), that portion of an arcuate belt of porous, water-bearing, predominantly carbonate rocks known as the Edwards and Associated Limestones in the Balcones Fault Zone trending from west to east to northeast in Kinney, Uvalde, Medina, Bexar, Comal, Hays, Travis, and Williamson Counties; and composed of the Salmon Peak Limestone, McKnight Formation, West Nueces Formation, Devil's River Limestone, Person Formation, Kainer Formation, Edwards Formation, and Georgetown Formation. The permeable aquifer units generally overlie the less-permeable Glen Rose Formation to the south, overlie the less permeable Comanche Peak and Walnut Formations north of the Colorado River, and underlie the less permeable Del Rio Clay regionally.

Edwards Aquifer Contributing Zone - The area or watershed where runoff from precipitation flows downgradient to the recharge zone of the Edwards Aquifer. The contributing zone is located upstream (upgradient) and generally north and northwest of the recharge zone for the following counties: all areas within Kinney County, except the area within the watershed draining to Segment 2304 of the Rio Grande Basin; all areas within Uvalde, Medina, Bexar, and Comal Counties; all areas within Hays and Travis Counties, except the area within the watersheds draining to the Colorado River above a point 1.3 miles upstream from Tom Miller Dam, Lake Austin at the confluence of Barrow Brook Cove, Segment 1403 of the Colorado River Basin; and all areas within Williamson County, except the area within the watersheds draining to the Lampasas River above the dam at Stillhouse Hollow reservoir, Segment 1216 of the Brazos River Basin. The contributing zone is illustrated on the Edwards Aquifer map viewer at
http://www.tceq.state.tx.us/compliance/field_ops/eapp/mapdisclaimer.html

Edwards Aquifer Recharge Zone - Generally, that area where the stratigraphic units constituting the Edwards Aquifer crop out, including the outcrops of other geologic formations in proximity to the Edwards Aquifer, where caves, sinkholes, faults, fractures, or other permeable features would create a potential for recharge of surface waters into the Edwards Aquifer. The recharge zone is identified as that area designated as such on official maps located in the offices of the Texas Commission on Environmental Quality and the Construction General Permit TPDES General Permit TXR150000 The Edwards Aquifer Map Viewer, located at
http://www.tceq.state.tx.us/compliance/field_ops/eapp/mapdisclaimer.html

can be used to determine where the recharge zone is located.

Erosion Control - A measure that prevents erosion.

Erosion and Sediment - A set of plans prepared by or under the direction of a certified professional

Facility or Activity - For the purpose of this permit, a construction site or construction support activity that is regulated under this general permit, including all contiguous land and fixtures (e.g., ponds and materials stockpiles), structures, or appurtances used at a construction site or industrial site described by this general permit.

Fiber Reinforced Matrix (FRM) - Fiber Reinforced Matrix shall consist of long thermally refined wood fibers produced from grinding clean, whole wood chips, crimped interlocking fibers, cross-linked hydro-colloidal tackifiers and performance enhancing additives.

Final Stabilization - A construction site status where any of the following conditions are met:

(a) All soil disturbing activities at the site have been completed and a uniform (i.e., evenly distributed, without large bare areas) perennial vegetative cover with a density of at least 95% of the vegetative cover for the area has been established on all unpaved areas and areas not covered by permanent structures, or equivalent permanent stabilization measures (such as the use of riprap, gabions, or geotextiles) have been employed.

(b) For individual lots in a residential construction site by either:

(1) the homebuilder completing final stabilization as specified in condition (a) above; or

(2) the homebuilder establishing temporary stabilization for an individual lot prior to the time of transfer of the ownership of the home to the buyer and after informing the homeowner of the need for, and benefits of, final stabilization. If temporary stabilization is not feasible, then the homebuilder may fulfill this requirement by retaining perimeter controls or other best management practices, and informing the homeowner of the need for removal of temporary controls and the establishment of final stabilization.

(c) For construction activities on land used for agricultural purposes (e.g. pipelines across crop or range land), final stabilization may be accomplished by returning the disturbed land to its preconstruction agricultural use. Areas disturbed that were not previously used for agricultural activities, such as buffer strips immediately adjacent to surface water and areas that are not being returned to their preconstruction agricultural use must meet the final stabilization conditions of condition (a) above.

Fugitive sediment - Sediment resulting from earth disturbing activities that is mobilized by wind or water and transported from the construction site to any point outside the limits of construction.

Grading - Excavation or fill of material, including the resulting conditions thereof.

Hyperchlorination of Waterlines - Treatment of potable water lines or tanks with chlorine for disinfection purposes, typically following repair or partial replacement of the waterline or tank, and subsequently flushing the contents.

Indian Country Land - (from 40 CFR 122.2) (1) all land within the limits of any Indian reservation under the jurisdiction of the United States government, notwithstanding the issuance of any patent, and, including rights-of-way running through the reservation; (2) all dependent Indian communities with the borders of the United States whether within the originally or subsequently acquired territory thereof, and whether within or without the limits of a state; and (3) all Indian allotments, the Indian titles to which have not been extinguished, including rights-of-way running through the same.

Indian Tribe - (from 40 CFR 122.2) any Indian Tribe, band, group, or community recognized by the Secretary of the Interior and exercising governmental authority over a Federal Indian Reservation.

Large Construction Activity - Construction activities including clearing, grading, and excavating that result in land disturbance of equal to or greater than five (5) acres of land. Large construction activity also includes the disturbance of less than five (5) acres of total land area that is part of a larger common plan of development or sale if the larger common plan will ultimately disturb equal to or greater than five (5) acres of land. Large construction activity does not include routine maintenance that is performed to maintain the original line and grade, hydraulic capacity, or original purpose of the site (e.g., the routine grading of existing dirt roads, asphalt overlays of existing roads, the routine clearing of existing right-of-ways, and similar maintenance activities.)

Municipal Separate Storm Sewer System (MS4) - A separate storm sewer system owned or operated by the United States, a state, city, town, county, district, association, or other public body (created by or pursuant to state law) having jurisdiction over the disposal of sewage, industrial wastes, storm water, or other wastes, including special districts under state law such as a sewer district, flood control or drainage district, or similar entity, or an Indian tribe or an authorized Indian tribal organization, that discharges to surface water in the state.

Notice of Change (NOC) - Written notification to the executive director from a discharger authorized under this permit, providing changes to information that was previously provided to the agency in a notice of intent form.

Notice of Intent (NOI) - A written submission to the executive director from an applicant requesting coverage under this general permit.

Notice of Termination (NOT) - A written submission to the executive director from a discharger authorized under a general permit requesting termination of coverage.

Operator - The person or persons associated with a large or small construction activity that is either a primary or secondary operator as defined below:

Primary Operator - the person or persons associated with a large or small construction activity that meets either of the following two criteria:

(a) the person or persons have operational control over construction plans and specifications, including the ability to make modifications to those plans and specifications; or

(b) the person or persons have day-to-day operational control of those activities at a construction site that are necessary to ensure compliance with a storm water pollution prevention plan (SWP3) for the site or other permit conditions (e.g., they are authorized to direct workers at a site to carry out activities required by the SWP3 or comply with other permit conditions).

Secondary Operator - The person whose operational control is limited to the employment of other operators or to the ability to approve or disapprove changes to plans and specifications. A secondary operator is also defined as a primary operator and must comply with the permit requirements for primary operators if there are no other operators at the construction site.

Outfall - For the purpose of this permit, a point source at the point where storm water runoff associated with construction activity discharges to surface water in the state and does not include open conveyances connecting two municipal separate storm sewers, or pipes, tunnels, or other conveyances that connect segments of the same stream or other water of the U.S. and are used to convey waters of the U.S.

Perimeter Control - A barrier that prevents sediment from leaving a site by detaining sediment-laden runoff or diverting it to a sediment trap or basin.

Permanent Stabilization - The use of practices that prevent exposed soil from eroding upon achieving final grade. Permanent stabilization includes a broad range of items such as vegetation, structures which cover the soil to protect, paving, and post development stormwater controls that shall be implemented within 7 calendar days after completion of construction activities or each phase of construction. For the purposes of this section, construction activities are considered complete upon submittal of the engineer's concurrence letter per LDC 25-1-332 and 25-8-182.

Permittee - An operator authorized under this general permit. The authorization may be gained through submission of a notice of intent, by waiver, or by meeting the requirements for automatic coverage to discharge storm water runoff and certain non-storm water discharges.

Phasing - Clearing a parcel of land in distinct phases, with the stabilization of each phase completed before the clearing of the next.

Point Source - (from 40 CFR §122.2) Any discernible, confined, and discrete conveyance, including but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock concentrated animal feeding operation, landfill leachate collection system, vessel or other floating craft from which pollutants are, or may be, discharged. This term does not include return flows from irrigated agriculture or agricultural storm water runoff.

Pollutant - Dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, filter backwash, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt, and industrial, municipal, and agricultural waste discharged into any surface water in the state. The term "pollutant" does not include tail water or runoff water from irrigation or rainwater runoff from cultivated or uncultivated rangeland, pastureland, and farmland. For the purpose of this permit, the term "pollutant" includes sediment.

Pollution - (from Texas Water Code §26.001(14)) The alteration of the physical, thermal, chemical, or biological quality of, or the contamination of, any surface water in the state that renders the water harmful, detrimental, or injurious to humans, animal life, vegetation, or property or to public health, safety, or welfare, or impairs the usefulness or the public enjoyment of the water for any lawful or reasonable purpose.

Rainfall Erosivity Factor (R factor) - the total annual erosive potential that is due to climatic effects, and is part of the Revised Universal Soil Loss Equation (RUSLE).

Sediment Control - Measures that prevent eroded sediment from leaving the site.

Semiarid Areas - areas with an average annual rainfall of 10 to 20 inches.

Separate Storm Sewer System - A conveyance or system of conveyances (including roads with drainage systems, streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains), designed or used for collecting or conveying storm water; that is not a combined sewer, and that is not part of a publicly owned treatment works (POTW).

Site Development - The construction or reconstruction of a building or road; the placement of a structure on land; the excavation, mining, dredging, grading or filling of land; the removal of vegetation from land; or the deposit of refuse or waste on land.

Small Construction Activity - Construction activities including clearing, grading, and excavating that result in land disturbance of equal to or greater than one (1) acre and less than five (5) acres of land. Small construction activity also includes the disturbance of less than one (1) acre of total land area that is part of a larger common plan of development or sale if the larger common plan will ultimately disturb equal to or greater than one (1) and less than five (5) acres of land. Small construction activity does not include routine maintenance that is performed to maintain the original line and grade, hydraulic capacity, or original purpose of the site. (e.g., the routine grading of existing dirt roads, asphalt overlays of existing roads, the routine clearing of existing right-of-ways, and similar maintenance activities.)

Start of Construction - The first land-disturbing activity associated with a development, including land preparation such as clearing, grading, and filling and demolition; installation of streets and walkways; excavation for basements, footings, piers, or foundations; erection of temporary forms; and installation of accessory buildings such as garages.

Storm Water (or Storm Water Runoff) - Rainfall runoff, snow melt runoff, and surface runoff and drainage.

Storm Water Associated with Construction Activity - Storm water runoff from a construction activity where soil disturbing activities (including clearing, grading, excavating) result in the disturbance of one (1) or more acres of total land area, or are part of a larger common plan of development or sale that will result in disturbance of one (1) or more acres of total land area.

Structural Control (or Practice) - A pollution prevention practice that requires the construction of a device, or the use of a device, to capture or prevent pollution in storm water runoff. Structural controls and practices may include but are not limited to: silt fences, earthen dikes, drainage swales, sediment traps, check dams, subsurface drains, storm drain inlet protection, rock outlet protection, reinforced soil retaining systems, gabions, and temporary or permanent sediment basins.

Surface Water in the State - Lakes, bays, ponds, impounding reservoirs, springs, rivers, streams, creeks, estuaries, wetlands, marshes, inlets, canals, the Gulf of Mexico inside the territorial limits of the state (from the mean high water mark (MHWM) out 10.36 miles into the Gulf), and all other bodies of surface water, natural or artificial, inland or coastal, fresh or salt, navigable or nonnavigable, and including the beds and banks of all water-courses and bodies of surface water, that are wholly or partially inside or bordering the state or subject to the jurisdiction of the state; except that waters in treatment systems which are authorized by state or federal law, regulation, or permit, and which are created for the purpose of waste treatment are not considered to be water in the state.

Temporary Stabilization - A condition where exposed soils or disturbed areas which are dormant for 14 days or longer are provided a protective cover or other structural control to prevent the mobilization and migration of pollutants. Use of bark mulch, Fiber Reinforced Matrix (FRM), Bonded Fiber Matrix (BFM), soil retention blanket, Turf Reinforcement Mat (TRM), sod, rock rip rap, or other cover that prevents the detachment of soil particles until final stabilization is achieved.

Waters of the United States - (from 40 CFR, Part122, Section 2) Waters of the United States or waters of the U.S. means:

(a) all waters which are currently used, were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide;

(b) all interstate waters, including interstate wetlands;

(c) all other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds that the use, degradation, or destruction of which would affect or could affect interstate or foreign commerce including any such waters:

  (1) which are or could be used by interstate or foreign travelers for recreational or other purposes;

  (2) from which fish or shellfish are or could be taken and sold in interstate or foreign commerce; or

  (3) which are used or could be used for industrial purposes by industries in interstate commerce;

(d) all impoundments of waters otherwise defined as waters of the United States under this definition;

(e) tributaries of waters identified in paragraphs (a) through (d) of this definition;

(f) the territorial sea; and

(g) wetlands adjacent to waters (other than waters that are themselves wetlands) identified in paragraphs (a) through (f) of this definition.

Waste treatment systems, including treatment ponds or lagoons designed to meet the requirements of CWA (other than cooling ponds as defined in 40 CFR '423.11(m) which also meet the criteria of this definition) are not waters of the United States. This exclusion applies only to manmade bodies of water which neither were originally created in waters of the United States (such as disposal area in wetlands) nor resulted from the impoundment of waters of the United States. Waters of the United States do not include prior converted cropland. Notwithstanding the determination of an area's status as prior converted cropland by any other federal agency, for the purposes of the Clean Water Act, the final authority regarding Clean Water Act jurisdiction remains with EPA.

Watercourse - Any body of water, including, but not limited to lakes, ponds, rivers, streams, and bodies of water delineated by City of Austin, USGS, USACE or TCEQ.

Waterway - A channel that directs surface runoff to a watercourse or to the public storm drain.

Source: Rule No. R161-15.12, 1-4-2016 .

1.4.4 - Plan Development and Implementation

A. **Erosion and Sedimentation Control Process Outline.**

Implementation of an effective erosion and sedimentation control plan requires a project management approach where responsibility is assigned during each phase to assure proper design, installation, maintenance, inspection, and when necessary, repair or replacement of controls during the construction. The project owner, engineer and contractor are all integrally involved in this process from start to finish. In addition, an understanding by the responsible individuals of the complete process required to design and implement erosion and sedimentation controls will assist them in preparing appropriate plans, speed the review and approval process, result in fewer on-site changes or problems, and provide the appropriate degree of protection for the environment.

B. **Construction Phase Controls.**

1. General Concepts.

The goal of erosion and sedimentation control is to limit as much as possible the detachment and transport of sediment from construction sites and the finished projects they eventually become. Sediment is transported off-site through one of four means:

- Stormwater runoff,
- Water discharges (e.g. pumping of water out of trenches, open channels (creeks, rivers, ditches) or foundation and basement excavations),
- Vehicles, and
- Wind.

Stormwater runoff and water discharges are the primary means by which sediment is transported from construction sites.

Sediment becomes suspended in runoff as it flows over or out of disturbed areas seeking the lowest path of least resistance. It is very important to realize that in order to control this suspended sediment, the means by which it is transported, water, and must first be successfully controlled. The principal tasks are to keep the sediment from entering the runoff or, once in it, to separate and trap the suspended sediment before it can leave the

site. The techniques to accomplish this consist of two basic types: site management practices and structural controls.

Site management practices focus on the prevention of erosion and include methods such as minimizing the area of the site that is disturbed at any one time during construction, preserving the existing natural vegetation to the greatest extent feasible, covering exposed soils with temporary stabilization soon after disturbance and restoring vegetation as rapidly as possible in disturbed areas. A related method would be to revegetate between phases of a project, when there will be a delay between these phases. Additional site management techniques include keeping the velocity of stormwater below the erosive level, promoting sheet flow rather than concentrated flow, and protecting and maintaining stable slopes.

Structural controls utilize engineered devices (such as channels, berms, silt fences, ponds, etc.) to keep sediment on-site. This is accomplished in a two-stage process consisting of drainage control followed by sediment removal.

Drainage Control .

The control of on-site drainage is essential to the process, as this must be accomplished first in order to successfully separate and trap suspended sediment. Drainage control is accomplished by strategically placing structural controls at locations where they will intercept stormwater runoff as it flows towards the lower portions of a site. These control devices must be substantial enough to withstand the anticipated runoff velocity and either must direct the flow to another control device or must be shaped to temporarily pool the runoff behind the structure. At this point in the process, trapping of sediment can occur. If the drainage control stage is unsuccessful or only partially successful, it will correspondingly limit the amount of sediment that will be trapped. Reviewers shall require calculations to demonstrate that drainage controls have the capacity to withstand the velocity of the 10-year 24-hour storm and all detention sedimentation controls shall be shown to have capture volume for the two-year 24-hour storm as well as the volume of sediment generated from a two-year 24-hour storm. Drainage controls shall have a drawdown time of 72 hours.

Sediment Control .

Sediment trapping, i.e. the separation of the sediment from the runoff, occurs primarily by sedimentation: when suspended materials settle out as runoff velocity is decreased, and the sediment is trapped and left behind to be removed later, while the runoff is released to drain off-site.

The other methods by which sediment leaves a site, vehicles and wind, can be controlled in a manner similar to runoff. The first step is to control the mechanism that moves the sediment and the second step is to capture the sediment. For vehicles this entails directing them to a limited number of stabilized exits where most of the attached soil or mud can fall or be washed off. Wind-blown dust, although generally not a major problem, can be controlled with barriers that slow velocity and prevent transport. In addition, excessive dust can be controlled with regular wetting of the dust source. Special additives to the water used for dust control (i.e. dust palliatives) will assist in preventing the resuspension of dust when the moisture has evaporated. Article V, Chapter 4-3 of the City Code of 1981, however, does not allow the use of oil, diesel fuel or other pollutants which may wash into streams and watercourses for the control of dust.

The previous paragraphs describe the basic process that occurs in implementing successful structural erosion and sedimentation controls. Variations of this process can be employed, depending on the type, number, and location of structural control devices used. However, the basic concepts and engineering functions involved in successful erosion and sedimentation control applications remain the same regardless of which specific structural

devices or techniques are employed. Whether or not a plan is judged to be able to adequately meet the letter and intent of the policy in section 1.4.2 (B) will be determined by the Development Services Department Staff. Because each site is unique, this volume cannot prescribe an upfront pre-approved recipe that will ensure site plan approval. However, following the submittal requirements in section 3 will demonstrate to the reviewer that a thoughtful, rigorous analysis of the potential pollutants, runoff pathways, and methods for control have been considered.

In the following sections, design of temporary and permanent controls for sites will be more fully examined.

2. Design Guidelines

There are several methods available to reduce erosion and sedimentation problems at construction sites. Site management methods are one of the most economical ways to accomplish this control. This section introduces several new or underutilized methods that will be required as part of the Plan Submittals. Phasing, limiting the extent of existing vegetation that is disturbed, planning the necessary locations of the disturbance, restricting construction traffic to those locations, and revegetating or otherwise stabilizing any disturbed area are examples of this type of planning, hereafter referred to as Prevention.

More common methods, however, use structural controls to take advantage of the reduced ability of water to carry sediment when its velocity is reduced. Temporary structural control devices can be grouped into one or more functional categories, defined by its particular application on a site. Recognition of the function of each control at the point where it is to be used is critical in choosing the most effective measure for each location. Three functional categories have been identified and are described below:

• Diversion - A control device used for diversion is strategically placed on a site to intercept runoff and divert it to another location. A diversion may be installed to keep clean water from crossing and eroding a disturbed area or to move runoff with silt to a location where it can be treated more effectively. (see COA Standards 621S-1 and 622 S-1) All sites that receive off-site runoff must install flow diversion devices designed to handle the concentrated flow and divert it around the disturbed area in a non-erosive manner to the receiving drainage system downstream of the site. Diversion capacity shall be the runoff volume of the 10-year, 24-hour storm. All diversions shall be designed to withstand erosion from the velocity of the 10-year, 24-hour storm.

• Flow Spreading/Velocity Reduction - This category of control applies to smaller flow amounts which may be diverted onto undisturbed ground while at the same time allowing a small amount of flow to pass over and through the device. The control device can also function as a grade control to reduce the length and steepness of a slope to prevent rills and gullies. These controls are normally situated at a right angle to the flow path and are spaced to ensure not erosive velocities. This form of control attempts to restore a sheet flow condition such that the velocity and depth of flow are so low that sediment cannot be effectively carried by the runoff. (See Figure 1.6.7 B.3 level spreader or rock berm)

• Detention/Sedimentation - Runoff is ponded behind a structure allowing the sediment to drop out of suspension and be trapped in the detention pool because of the reduction in runoff velocity.

Previously, silt fences were classified as detention/filtration devices. Recent research by the University of Texas and Texas Department of Transportation demonstrated that silt fences function primarily as detention/sedimentation due to clogging of the pores. They were found often to be undersized and improperly installed as detention/sedimentation devices. Therefore, silt fence criteria in section 1.4 have been updated to reflect the actual function of silt fences under field conditions.

Detention/sedimentation structures must be designed to withstand the force and velocity from a 10-year frequency storm without failing. Larger storms shall be bypassed via stabilized conveyances. Those devices that employ sedimentation must provide the storage volume for the runoff from a 2-year, 24-hour storm under compacted site conditions. The sedimentation basins must be designed such that drawdown time is 72 hours via surface skimmers. The design must include considerations for overflows to ensure that the device and its detention pool remain intact. Detention/sedimentation structures shall not be sited in natural drainage channels, draws or ravines that are directly connected to off-site drainage features like creeks, rivers, ponds or recharge features. In particular, this means that silt fences shall not be used to control concentrated or channelized flow and sedimentation basins shall not be constructed in natural draws because failures of the earthen retaining system are often catastrophic to the downstream receiving waters.

The procedure for developing an effective erosion and sedimentation control plan (henceforth adopting the NPDES nomenclature of Erosion and Sedimentation Control Plan (ESCP)) for a construction project involves several required steps, as indicated below. During plan review, the City of Austin Plan reviewer shall have final authority regarding the proper implementation of the ESCP. The submittals must demonstrate to the satisfaction of the reviewer that all potential sources of sediment and other construction related pollution have been identified and minimized. The plan shall not move forward until the reviewer has been satisfied that the letter and intent of this section have been satisfied.

3. Submittal Requirements

   Submittals to satisfy the requirements for Erosion & Sedimentation control plans consist of two parts:

   a. Completed Erosion and Sedimentation Control Plan template.

   b. Plan sheets that include the graphics necessary to illustrate, review and construct the systems outlined in the ESCP (specific submittal requirements enumerated and explained below). Plan sheets shall clearly show the following:

- Existing conditions.
- Demolition plan, as required.
- Site preparation and grading operation.
- Tree Preservation, as required.
- BMP layout.
- Sequence of construction/phasing.
- Final grades.

• Permanent stabilization.

• Details and notes.

The ESCP must be signed and certified by a Licensed Professional Engineer (TX) or a Certified Professional in Erosion and Sedimentation Control (CPESC). If the ESCP includes engineering calculations, then ESCP must be sealed and signed by Licensed Professional Engineer.

Section 1 - Existing Conditions Site Evaluation, Assessment and Planning

• Project Site Information (e.g. name, location).

• Contact Information/Responsible Parties (Owner, ESCP designer, Construction Phase ESCP contact).

• Representative photograph of site that shows the designer on-site.

• Description of Soils-Use NRCS Soil Survey, USGS or Bureau of Economic Geology Geologic maps. Geotechnical reports are acceptable to define subsurface soil properties.

• Delineation of existing topography and drainage patterns, including overland and concentrated flow; contributing drainage area for flow paths that drain at least 1 acre, presence or absence of baseflow, USGS stream type (ephemeral, intermittent or perennial).

• Slope steepness.

• List the receiving water to which the site drains; if receiving water is impaired or subject to Total Maximum Daily Loads, list pollutants causing impairment and requirements in TMDL applicable to construction sites. State how ESCP prevents discharge of these pollutants.

• Description and location of Critical Environmental Features.

• Photos and description of predominant vegetation.

Section 2 - Construction Activities and Site Management Practices (see http://www.epa.gov/npdes/pubs/exampleswppp_residential.pdf for examples)

• Nature of Construction Activity (e.g. residential, commercial, utility, etc.).

• Phasing and construction sequence plan- maps and schedules of disturbances, phasing, temporary and permanent stabilization. Phasing is a preventive measure defined as: One portion of the site is disturbed at any one time to construct the infrastructure necessary to complete that phase. Subsequent phases are not started until earlier phases are substantially complete and exposed soils are stabilized. In the case of subdivision construction, it is defined that the activities associated with ROW construction (including utilities) are distinct phases from the activities associated with mass clearing and grading for subdivisions, which are also distinct from the activities associated with individual lot construction. If the permit allows for all three

activities, then the ESCP must address the sequence, timing, appropriate BMPs, installation and maintenance for all three phases. In addition, ROW construction must be accepted prior to beginning the phase of clearing and grading or individual lot construction. If the application for subdivision development anticipates clearing and grading of individual lots, then the ESCP must show the interior and perimeter controls that will be in place and maintained until final stabilization of individual lots. ROW and utility construction will not be accepted by the City of Austin if any mass grading on lots has occurred without an approved ESCP that anticipates construction through permanent stabilization of individual lots. Stormwater ponds are accepted separate from other utilities and ROW.

• For site plan review purposes, the construction sequence must show the duration of each activity, as opposed to specific start and end dates. Prior to the start of construction, though, the ESCP must be updated with actual dates of start/finish for each activity outlined in the sequence. The ESCP must be kept updated to reflect any changes, or the inspector may red tag the site. Environmental Inspection will make the determination regarding the level of submittal needed for ESCP updates. The determination will follow these general guidelines:

1) If the changes do not require a site plan revision or correction (certain changes like changes to LOC require revisions) and the EV Inspector, PE and/or CPESC all agree on a revision to planned E&S controls, then the ESCP update log can be used to document the updates. Any graphics that are necessary for documentation shall be physically added to the ESCP file. The construction sequence shall include at a minimum, the following:

a. Length of time to install construction phase E&S controls.

b. Length of time for each identified phase of construction from initial groundbreaking to final grade and any intermediate steps that would require modification of E&S controls (temporary and permanent storm water ponds, clearing and grubbing, rough grade, final grade, utilities, roads, etc.).

c. Identification of areas within the LOC that will require temporary stabilization and the times of installation, modification, removal. Sequencing of grading and cut and fill activities will be required to show how disturbed and stockpiled sediment is accounted for each time it is transported from initial disturbance to permanent stabilization. For subdivisions, the sequence must show when construction of utilities and ROW construction ends, when grading of lots begins and ends, and when the individual lot construction phase begins.

d. Identify schedule for permanent stabilization.

e. Identify schedule for converting temporary controls to permanent functions (e.g. basins).

f. Identify schedule for removal of E&S controls.

• Maintenance schedule for Construction Phase BMPs.

• Calculations of cut/fill volumes per phase; include description of how spoils will be handled during construction (e.g. kept on site, hauled off; if on-site how will spoils be protected from erosion?).

• Identify all potential sources of pollution during construction (not just sediment); describe pollution control procedures and devices.

Section 3 - Grading & Erosion/Sediment Control BMPs

- Plan sheets that show:

  a. Direction of flow during grading operations.

  b. Location, description and calculations for off-site flow diversion structures.

  c. Areas that will not be disturbed; natural features to be preserved.

  d. Delineation of and contributing drainage area to each proposed BMP (e.g. silt fence, sediment basin, etc.).

  e. Location and type of E&S BMPs for each phase of disturbance.

  f. Calculations for BMPs as required.

  g. Location and description of temporary stabilization measures.

  h. Location of on-site spoils; description of handling and disposal of borrow materials; On-site permanent spoils disposal areas, including size, depth of fill and revegetation procedures. (Off-site disposal requires a separate site development permit. A note shall be made on the plan to specify that "the contractor shall notify the city's inspector about the location and permit number of the disposal site 48 hours prior to the removal.")

  i. Location of vehicle entrance, description of stabilization measures and procedures for removing accumulated sediment to prevent off-site transport.

Section 4 - Permanent Stabilization

It is required that submittals for permanent stabilization contain the same level of detail as that stated above for temporary controls. Permanent stabilization should occur within seven (7) days after completion of construction activities or each phase of construction. It is given that some of the language is only applicable to temporary controls, but when it is appropriate for the word "permanent" to be substituted for the word "temporary" in sections 1—3 above, it is the reviewer's prerogative to require such submittals without them being individually itemized again in section 4.

Additional requirements for permanent stabilization submittals include, but are not limited to:

a. Location and type of permanent stabilization (e.g. vegetation, slope stabilization, sodding, seed/soil retention blanket, Fiber Reinforced Matrix, Bonded Fiber Matrix, or rock rip rap).

b. Establishment irrigation and maintenance plan for permanent vegetation. Revegetation plans for all disturbed areas on the site in accordance with the vegetative practices section of this manual. Information provided by the engineer should include any of the following which are applicable:

- Topsoil requirements, see Standard Specification 601S.3.A, Salvaging and Placing Topsoil, as well as ECM 1.4.7,

- Seed, sod, and mulch type and rate of application (see section 1.4.7),

- If seed is used to revegetate, include the soil retention blanket, FRM or BFM to be used until establishment,

• Irrigation schedule for permanent vegetative establishment, (see Special Specification for 609S),

• Application technique,

• Maintenance requirements for each specific area,

• If vegetation is to be temporary,

• If vegetation is to be permanent,

• A clear definition of criteria to be utilized in determining when acceptable revegetation has taken place (minimum requirements are 95 percent coverage with no bare areas exceeding 10 square feet with a 1½ inch stand of grass).

Landscape installation and natural area restoration requirements may be applicable to certain developments. To find out what regulations may apply, an inquiry should be made to the Development Services Department.

c. Specific locations shall be noted for the following:

• Where special slope stabilization techniques are to be utilized and the extent of stabilization to be achieved.

• Location and type of permanent Stormwater management facilities (e.g. detention ponds, water quality ponds, outlet protection/velocity dissipaters).

• A schematic representation of each control measure for each phase of construction, with adequate specifications for the measure, such as dimensions and length (or size) and references to the City of Austin Standards and Standard Specifications, so that the feature can be built and maintained as intended.

• For detention/diversion/sedimentation control devices, a summary of calculations for runoff from the ten-year, 24-hour storm. Calculations shall include velocity for each of the drainage sub basins to a control in the pre-disturbance, under construction, and permanently stabilized conditions.

Section 5 - Additional Considerations and Further Discussion on Submittal Requirements and Design Guidelines

This section describes in more detail practices and BMPs noted above to guide the applicant in developing appropriate ESCP submittals. The reviewers may require demonstration that the following have been considered:

I. **Site Management**

a. Phasing - Phasing is a preventive measure defined as: One portion of the site is disturbed at any one time to construct the infrastructure necessary to complete that phase. Subsequent phases are not started until earlier phases are substantially complete and exposed soils are stabilized. The plan reviewers will not allow a site

plan to proceed without the applicant demonstrating that all feasible opportunities for phasing have been implemented. Construction sites greater than 25 acres are required to show phasing of disturbance tailored to the specific site conditions. Items that shall be considered to determine the effectiveness in phasing include: size of disturbed area, compatibility with construction sequence (e.g. Stormwater controls, then utilities, then roads, then pads), proximity to CEFs or waterways, slope steepness. Sites less than 25 acres must demonstrate on the grading plan the areas to be disturbed and how it was minimized.

b. Temporary Stabilization - The designer must anticipate the construction process and identify times when disturbed areas will be dormant (i.e. not making progress toward a benchmark phase) for 14 days or longer. These areas must be identified on the ESCP and the temporary stabilization practices described. Inspectors will make note of length of time of dormant disturbed areas and require coverage on Day 15. Approved practices include: rock rip rap for concentrated flow areas and vehicle access; Fiber Reinforced Matrix (FRM), Bonded Fiber Matrix (BFM), Turf Reinforcement Mat or Rolled Erosion Control Product for Slopes steeper than 4:1, and bark or wood chip mulch or sod for areas flatter than 2:1 slopes. Spoil piles will require daily cover or demonstration of adequate perimeter containment to prevent the migration of spoils outside of the defined spoil pile footprint. Unacceptable practices include broadcasting seed, paper based hydromulch, and wood fiber based hydromulch without a tackifier. Inspectors will require invoice from applicator showing certification of mix as FRM or BFM. Inspectors have authority to require additional application of temporary stabilizer if visual inspection shows inadequate coverage.

c. No offsite flow can flow onto the Limits of Construction of the disturbed phase. ESCP must show locations where pass-through flows may be safely diverted around disturbed areas and routed at a properly stabilized discharge point to downstream drainage conveyance. Proper stabilization shall be determined by the Environmental Inspector.

d. ESCP must show all designated construction access points and equipment travel paths. In particular, if there are any CEFs, protected water ways or trees, the ESCP must demonstrate that construction access is diverted at least 25 feet from such features. In addition to temporary stabilization measures for construction access, plans must demonstrate methods for ensuring that construction vehicles do not track sediment onto roadways.

e. Spoils may not be located in the 100-year flood plain, Critical Water Quality Zone, within 150 feet of a CEF or within 25 feet of a concentrated flow path with more than 5 acres contributing drainage area.

II. **Drainage Control Points and Sediment Control BMPs**

Using the information gathered in the above analysis, the designer must determine the most practical and effective locations for controls to be installed. These controls should be located:

• As close to the source of sediment as possible, but sufficiently distant from areas under construction or from site traffic in order to avoid constant disturbance,

• In areas that permit access for maintenance to remove sediment build-up,

• Where they will not cause flooding of adjacent properties due to diversion or ponding of stormwater, and

- In areas where they will not be removed and replaced frequently.

III. **Determining the Function of the Control**

The designer must determine which functional category of control (diversion, flow spreading, detention/filtration, or detention/ sedimentation see section 1.4.4 B.2. Design Guidelines) will be appropriate at each location. In addition, the designer should be able to recognize which controls must be removed or relocated and which ones can remain in place throughout the entire construction period.

Using the base information developed previously, the designer can identify the location and function of controls and where phasing in the installation of controls is to occur. Phasing of the temporary controls is particularly important for construction projects that take significant periods of time to complete or where the construction work itself is divided into distinct phases. Such projects include major utility installations, large sites, and street and drainage improvements and subdivisions.

Perimeter controls are placed at the edge of a project's disturbed area prior to the beginning of construction. All perimeters downslope from the construction site and any existing channels draining the site should be protected by temporary erosion and sedimentation controls. These control measures generally remain in place throughout the construction period since they are located outside the construction zone and should need only small adjustments. It should not be assumed that perimeter controls by themselves are adequate to control erosion and sedimentation. In all cases, perimeter controls shall be the secondary failsafe controls installed in conjunction with interior controls. For example, silt fence along the contours of the Limits of Construction (LOC) may be used as perimeter control in conjunction with interior controls such as site management practices, rock berms, mulch berms and sedimentation controls around spoils.

Interior controls are added inside the project perimeters during and after clearing, rough cut and fill operations when the site topography is rapidly changing. They are dynamic controls that, generally, must be modified to accommodate the changing conditions on the site in order to achieve optimum results. Examples of these types of controls would be temporary stabilization measures as outlined in previous sections, silt fence located below roadway fill sections, mulch berms on contour, protection of detention pond outlets and controls across backfilled utility trenches.

In addition, work in a channel that drains more than five acres shall employ a dewatering system that bypasses channel base flow around the site. At no time shall construction be permitted in any channel that does not have an approved bypass system. The most common and effective system consists of a temporary dam (not earthen) upstream of the construction site with a sump pump with the capacity to handle the flow rate of the baseflow. Plans will need to show details of the berm/pump system to ensure pump/pipe capacity and that discharge is in a non-erosive manner downstream of the construction activity.

Where temporary channel crossings are required, compacted earth is not allowed. The designer must demonstrate that the proposed crossing is capable of withstanding a 25-year storm and that failure would not result in a discharge of construction materials.

IV. **Choosing the Control Device**

At this point the designer must determine which specific structural device will be effective at each location where control is needed. Choice of the specific control device for each location is dependent on the function to be accomplished (i.e.

diversion, flow/spreading, or detention/sedimentation), the amount of flow, and the type of flow (i.e. sheet or concentrated flow) to be controlled. The designer may use any of the approved practices shown in this manual which are appropriate (see Figure 1-1 in Appendix V). Figures 1-1.1 through 1-1.5 in Appendix V of this manual shows the example site plan with specific control devices, anticipated phasing, and associated runoff flow direction.

Sedimentation basins shall not be allowed as stand-alone BMPs. Applicant must demonstrate appropriate site management practices, temporary stabilization measures, perimeter and internal controls instead of just relying on a sediment basin at the outlet of the project. Temporary sediment basins and traps are not allowed to be constructed where concentrated flow paths, draws, creeks or other drainage features exist that have contributing drainage areas greater than 10 acres.

Each control device must be able to function as designed when controlling the peak runoff resulting from the two-year, 24-hour storm. Flow calculations must be provided to reviewer and they should be based upon the methods presented in the City of Austin Drainage Criteria Manual. Calculations must assume a precondition of maximum allowable sediment accumulation. Therefore, the control devices must be designed for capacity of both the water flowing through as well as the sediment that could accumulate over normal operations. The designer must demonstrate that each device will be able to detain the water, and contain the volume of sediment that may be mobilized during the 10-year storm (use Modified Universal Soil Loss Equation to quantify soil loss for 10-year storm). Mobilization includes sheet, rill and gully erosion as well as mass failures of cuts and stockpiles. Care must be taken to determine the location of any low points in control devices when assessing the flow capacity of the barrier. Table 1-1 summarizes the characteristics of several typical temporary controls, including recommended maximum drainage area and maximum flow-through rate.

Summary Check List

Upon completing the design of the temporary controls the engineer should check the design for compliance with the following list of guidelines:

- Control devices shall be located as close as possible to the source of sediment.

- They shall be situated to catch runoff prior to its entering drainage ways.

- Controls shall be located approximately perpendicular to the direction of runoff flow for effective interception.

- Controls shall be used within their drainage acreage limits.

- Controls shaped to create detention areas shall have adequate space behind them for ponding of water and sediment accumulation including the volume of soil that can be transported by the 10-year, 24-hour storm (using MUSLE procedures).

- Perimeter controls shall be installed along the contour, if possible, to evenly spread the detained runoff. When their function is to divert water to another location, the control should gently slope downhill and the design shall include additional controls to slow velocity and prevent erosion along the flow path of the diversion.

• Detention controls that cannot be installed along the contour shall have reinforced low points to protect against washouts from concentrated flow.

• Controls shall be located in areas that allow access for removal of sediment accumulations.

• Controls shall not be located in areas where they will be frequently disturbed during construction.

• Controls shall not be located where they will cause a flooding problem to adjacent property or rights-of-way.

• When controls must be removed to accommodate equipment, they shall be restored at the end of each working day.

It is recommended that the designer also review site management practices (as stated in section 1.4.4 B) in conjunction with the final temporary erosion and sedimentation control design.

4. Permanent Erosion and Sedimentation Control.

The design of effective permanent erosion and sedimentation controls and their installation as a part of the construction process is an obvious and necessary final step. Without adequate permanent controls, exposed or disturbed soil may erode, stream banks may become unstable, and sedimentation will occur in streams and lakes decreasing the recreational and aesthetic potential, reducing the diversity of plant and animal life, and potentially, threatening the quality of drinking water. Permanent controls include a broad range of items such as vegetation to hold soil in place, structures which cover the soil to protect it, and water quality improvement devices (e.g. sedimentation/ filtration basins) which remove sediment once it is being carried by runoff.

Permanent controls shall be designed for less frequent (i.e. larger) storm flows than temporary controls, in order to maintain long-term effectiveness. The City of Austin Drainage Criteria Manual requires all drainage facilities, including channels, storm sewers inlets, detention ponds and water quality facilities, to be designed to intercept and transport runoff from a 25-year frequency storm. Flows greater than a 25-year frequency up to and including a 100-year frequency storm must be contained within defined rights-of-way or drainage easements. The project engineer, therefore, shall design these facilities such that velocities are below erosive values for the particular soil conditions and the 25-year, 24-hour storm event, and that all structures can withstand the forces generated by the expected flows of the 25-year, 24-hour storm event. Likewise, on-site, privately owned drainage facilities and other areas subject to runoff shall be designed to withstand the maximum projected flows and velocities.

Permanent vegetation for minimizing erosion and sedimentation should be selected for its suitability in the general area, proposed land uses, and desired aesthetic, or landscaping, effect. In general, revegetation of disturbed areas using species of plants found naturally in the area of the site will have the best long-term success, especially in locations where care is likely to be minimal (e.g. in utility easements and road right-of-way). Using a mixture of grasses, forbs, shrubs and trees will maximize the ability of the vegetation to hold and protect the soil, by providing a variety of root structures at varying depths. Anytime that revegetation is achieved by seeding, it shall be accompanied by the appropriate soil retention blanket from Standard Specification 605 or with a FRM or BFM. Broadcasting of seed is not acceptable, nor is paper-based hydromulch or wood-fiber based with no

tackifier acceptable. Additional information regarding revegetation can be found in Section 2, Landscape, and Section 5, Construction in Parks, in this Manual.

Care should be taken to avoid introducing aggressive species of non-native plants in sensitive environmental areas where they may supplant natives. Top soil imported from outside the site area often is source on undesirable weeds and grasses. See COA Standard Specifications 130S and 601S and 609S.

Similar to the design of temporary controls, the design of permanent facilities must assess the expected permanent drainage characteristics of the site. Factors to be investigated include:

- Patterns of flow on the site, including locations of sheet or channelized flow, with calculated depths and velocities.

- Off-site flows that must be passed through the site.

- Discharge characteristics of all proposed structures that intercept drainage - e.g. culverts, streets and drives, detention ponds, sedimentation/filtration basins, storm sewers, etc.

With this information, the designer can determine the type and extent of permanent controls that will be required.

Where runoff is concentrated the engineer should attempt to return the flow to a sheet flow condition. This will generally result in much lower velocity with less erosion. In addition, flow will encourage vegetative filtration of the runoff to remove sediment and other pollutants, including those originating on adjacent impervious surfaces. When flow occurs over vegetated ground, the type of plants and their ability to withstand the expected velocity should be investigated.

If velocities are high, it should be determined if the rate of flow can be decreased without causing significant flooding. This might be done by reducing the slope, roughening the surface or modifying the shape of the channel. Where velocities are too high to permit vegetation, structural methods to protect the surface should be investigated. In general, the most "natural" technique should be used commensurate with the degree of protection needed and any risks involved - i.e. stone rip-rap would be preferable to concrete rip-rap; stacked stone walls would be preferred over formed concrete walls.

In those locations where it is feasible, flows should be released onto undisturbed well-vegetated areas. If it is necessary, permanent structural devices may be utilized to spread flow and reduce velocity.

Where flows are released into channels, erosion shall be prevented by assuring adequate vegetative cover, using appropriate protective materials or reducing velocity. Channel transitions, cuts, and fills without structural protection shall be smooth and natural to avoid unstable banks or slopes that might erode or collapse.

Whatever the site conditions, it is incumbent upon the designer to demonstrate to the reviewer, via accepted scientific and engineering methodology, that the permanent conditions are sufficient to withstand the erosive forces (shears and velocities) of the 25 year, 24 hour storm event. Use the DCM for acceptable calculations.

Good site management techniques will also benefit permanent erosion and sedimentation control. Proper land grading to achieve stable, maintainable slopes, the use of terraces in steeper cut areas, and vigorous stands of mixed vegetation (grasses, forbs, and trees) will

retard stormwater flow, prevent erosion of soil, and capture sediment and pollutants from upslope areas.

Submittal requirements for permanent stabilization controls are the same as for the temporary construction phase controls. Refer to section 1.4.4(B).

- All detention, sedimentation, or sedimentation/filtration ponds.

C. **Plan Review Procedures.**

According to the Land Development Code, designs for erosion and sedimentation controls included with subdivision, site plan or site development permit applications will be reviewed by the Development Services Department. General criteria for review of plans are provided below. Reviewers shall not approve plans unless satisfied that the specific and general criteria provided in ECM 1.4 have been demonstrated and certified by a Licensed Professional Engineer (TX) or a Certified Professional in Erosion and Sedimentation Control (CPESC).

In addition, for all plans, the applicant must post fiscal surety, consisting of a letter-of-credit, cash, or a bond, for the cost of the erosion and sedimentation controls proposed for the site and the anticipated cost of clean-up of a sediment discharge as outlined in Appendix S. This money may be used by the city to provide controls, if the contractor does not properly install or maintain the temporary controls; it may be used to complete the revegetation of a site if the owner refuses or is unable to do so; it may be used to clean-up any on-site or off-site sediment spills that degrade public or private property if the contractor refuses to abide by the clean-up plan specified by the Development Services Department. This fiscal surety must be approved and accepted by the Watershed Protection and Development Review Department prior to final approval of the plans.

D. **Procedures During Construction.**

Proper installation, maintenance, and inspection of the approved control methods during the construction of a project are the final steps in assuring effective control of erosion and sedimentation. Implementation requires the combined efforts of the project engineer, contractor, owner, city inspectors, and, when needed, reviewers working together to achieve the best feasible control. The following sections highlight specific areas of individual and shared responsibility during the construction phase.

1. Project Management.

Knowledgeable and committed on-site management is important for the successful implementation of erosion and sedimentation controls, especially temporary control measures during construction. To accomplish this, it is required that the owner designate a "project manager" or "site supervisor". This requirement takes effect October 4, 2010. The designated city inspector(s) responsible for the inspection and enforcement of erosion and sedimentation regulations can work with this individual to ensure that these requirements are met. The design engineer and the project manager working with a knowledgeable and involved city inspector will help to assure that effective controls are properly implemented and maintained.

2. On-site Pre-construction Meeting

Prior to the beginning of any development activities, the erosion/sedimentation controls (per the ESCP) and tree and natural area protection specified in the approved plan must be in place. As required by Section 25-1-288 of the code, the owner will request the appropriate city department to schedule a preconstruction conference to assure that controls are in compliance with this manual and the approved plan and to correct any inadequacies in the plan that are identified during the inspection. This inspection will be held within five (5) days of notification and will be attended by the permit holder, design

engineer, ESCP designer, contractor and representatives from all relevant city departments. No construction activities other than those required for installation of the erosion sedimentation control plan can proceed until this inspection is completed. Subsequent to this inspection and completion of any necessary corrections, the contractor may begin construction activity.

At a minimum, the following items should be discussed at this meeting:

• The first phase of temporary controls (i.e. all perimeter controls installed at the edge of the disturbed area) and tree protection measures and all installation and maintenance specifications, adjustments, and additions (such as interior controls after rough cut and fill operations) necessary during upcoming stages of construction.

• The site management requirements for the project, including sequence of construction, phasing, temporary stabilization, temporary and permanent spoil disposal areas (on and off site), haul roads and site access, designated construction storage and staging areas, limits of clearing and disturbance, and requirements for construction in and around stream channels or other critical environmental areas.

• Permanent controls, such as detention and filtration ponds, related grading and drainage, revegetation schedule, seed mixes and special requirements.

• City inspection and inspection-related administrative procedures, such as duties and responsibilities of individual Departments' inspectors, coordination between inspectors, requirements for final project release, Certificates of Occupancy, etc.

At this stage the inspector should assure himself that the erosion and sedimentation control plan appears adequate. The following guidelines should be used in determining the adequacy of the plan:

• Controls should be located such that they will intercept and capture or divert the intended flow without bypassing runoff from the 2-year storm.

• All control devices should be used within specified contributing drainage acreage limits and in appropriate site applications.

• All disturbed areas that could cause sedimentation should be protected by at least one temporary control in addition to the Limits of Construction perimeter controls.

• All disturbed areas such as fills, steep slopes and channels must have control measures that will remain in place and trap sediment resulting from at least the two-year storm.

• The plan must be adequately phased to be effective during all stages of construction.

In addition, it is recommended that the city inspector and other involved personnel inspect and note existing natural conditions adjacent to and downstream of the controls prior to construction. Reinspection of these areas during construction can reveal evidence of disturbance or sedimentation resulting from inadequate control measures on the project.

3. Inspection by the Contractor.

   To assure continued effective operation of each methodology, a licensed engineer (or person directly supervised by the licensed engineer) or certified inspector (CPESC, CPESC - IT, CISEC, CISEC - IT, CESSWI, or CESSWI - IT), (hereafter referred to as owner's representative) shall conduct ongoing inspections of all erosion/sedimentation controls and direct the person or firm responsible for maintenance to make any repairs or modifications necessary, within 48 hours of the initial notification. The owner's representative shall inspect the controls daily and keep on the job site an inspection log with updated entries at a minimum of once every 5 business days. Appendix P-8 contains a template of an acceptable inspection log. The log shall contain at a minimum the following information: date and time of inspection, recording of previous days weather conditions, including rainfall, a list of all controls and a map of the contributing sub-basins to each control; condition of controls for each sub-basin; required maintenance; date that maintenance was performed; construction sequence for temporary stabilization, phasing and movable BMPs. Signature of owner's representative. The City inspector shall have the right to request and review the inspection log at the job site.

   Daily inspections shall be made by the contractor and silt accumulation upstream of temporary control measures must be removed when depth reaches six (6) inches or one-third (⅓) of the installed height of the control whichever is less. Prior to acceptance or approval of the project by the City, haul roads and waterway crossings constructed for temporary access must be removed, accumulated sediment removed from the waterway and any basins that will be used as permanent stormwater controls and the area returned to original grade and revegetated. All land clearing debris shall be disposed of prior to acceptance of the project by the City.

4. Compliance Inspection by the City.

   The Development Services Department is primarily responsible for the inspection and enforcement of erosion and sedimentation control requirements on site developments and subdivisions. The City will monitor compliance with plan requirements and judge the effectiveness of the controls during different stages of construction and before and after significant rainfall.

   Compliance Criteria

   The criteria used to determine the compliance or non-compliance of a project's temporary erosion and sedimentation controls include the following:

- The project must have a valid, current city development permit or site plan.

- The project must be in substantial compliance with the approved plans and specifications (ESCP) for the development permit. This is determined by inspection of various items at the site.

Structural control practices which should be inspected are the following:

- Controls must be installed in all required areas in accordance with approved plans and specifications.

- Materials must meet minimum requirements.

- Maintenance must be performed when trapped sediment exceeds allowed limits.

• Disturbances to erosion and sedimentation controls by construction activity or runoff must be repaired within 48 hours of discovery (as determined by the inspection log or by the City inspector).

• Temporary removal of portions of controls during necessary construction activities is allowed if the controls are replaced by the end of the work day. Additions or adjustments to the ESCP are necessary if the controls cannot be replaced in their original location.

Site Management practices which should be reviewed include the following:

• Construction sequence and phasing must follow approved plans.

• Disturbed areas cannot be outside the LOC as shown on the approved plans, including fill areas, haul roads, and storage areas.

• All temporary and permanent spoil disposal areas, both on and off-site, must comply with approved plans and ordinances.

• All disturbed areas which are dormant for 14 days or longer shall be temporarily stabilized during construction to prevent soil detachment from wind or rain.

• Construction in creek channels requires that upstream flows be impounded upstream of the work site and routed around the construction area anytime there is equipment in the channel. Spoils must be removed from the channel of any creek or drainage way and its associated floodplain at the end of each work day.

The installed controls must prevent sedimentation in off-site or undisturbed areas.

If the installed erosion and sedimentation controls are in compliance with the approved plans but are not adequate to prevent the transport of sediment from the disturbed areas, plan adjustments or a plan revision must be made.

Inspection Before and After Rainfall

Controls and adjacent downstream areas should be carefully inspected just prior to expected significant (> one-half inch) rainfall and inspected following significant rainfall events to assess the effectiveness of the controls and any adjustments, repair, or maintenance necessary. Inspection of the erosion and sedimentation controls this time is the most effective way to determine whether the plan is adequate.

The following guidelines can be used to determine the adequacy of controls after a rainfall:

• All visible drainage patterns left on-site after rainfall, especially areas of channelized flow (e.g. rills and gullies), should be carefully noted and the resulting effects of these on the structural controls should be observed. Concentrated flow areas, low points in perimeters, and channels adjacent to the project will usually be the critical areas where off-site sedimentation will be most likely to occur.

• Overtopping, undermining, or bypassing of the structural controls will require repairs, adjustments, relocation, or additional controls. Before taking these actions, determine if failures were due to inadequate installation, improper location, or greater runoff than the control was designed to handle.

• Above all, note where sediment has been carried on or off site. If controls appear to be intact and contain visible, significant amounts of sediment build up, this is evidence that they are working correctly. Visible amounts of sediment carried off of the project site is evidence that the temporary controls are not working as intended and that adjustments are needed. Any sediment carried off-site shall be retrieved by the contractor and returned to the site and stabilized. Any off-site damages that occur from fugitive sediment that exits a site shall be mitigated by the contractor per a mitigation plan approved by COA. If contractor refuses to remediate, COA may retain fiscal surety deposited to cover remediation.

The inspector and site personnel can recognize sediment that has been carried off of a particular project site by noting similarities in color, texture, and grain size to the soil existing on the site. It is recommended that existing off-site conditions be noted or documented before construction in order to help assess the effectiveness of the erosion and sedimentation controls during construction. Inspectors should also note the condition and operating characteristics of detention and water quality ponds under inspection after rainfall events in order to assess their performance prior to acceptance of a project.

Revisions to Controls

Most erosion and sedimentation controls will normally require some minor adjustments or additions during construction. These are known as "field revisions" and will not require a plan revision if approved by the Engineer and the inspector. Significant modifications to the controls or the ESCP, however, may require a plan correction or revision and resubmittal to COA.

Enforcement of Non-compliance by the City

The city inspector responsible for environmental regulations can take enforcement action under Section 25-1-441 of the city's Land Development Code for non-compliance with erosion and sedimentation requirement on a project site. Enforcement action can be by way of the issuance of a Stop Work Order. Issuance of a Stop Work Order stops all city inspection services and utility connections from all departments until the deficiencies are corrected and the Stop Work Order is released by the City. Violations of environmental regulations may also be enforced by the City through the suspension of the site plan or through the court system.

On projects that have obtained the required development permit/site plan from the city and where routine inspections reveal inadequacies in the controls, the inspector will give a verbal warning to the responsible personnel at the site of any noted and what corrective action is necessary. If, after a minimum period of 24 hours from this verbal warning, the deficiencies are not corrected, the inspector may deliver a written notice of non-compliance to the responsible on-site personnel. If, after an additional minimum period of 24 hours, the deficiencies are not corrected, the inspector can issue a Stop Work Order to stop work on the project until the deficiencies are corrected.

If the temporary or permanent controls fail such that construction sediment migrates off the site, it shall be the responsibility of the Contractor to: 1) retrieve the fugitive sediment to the satisfaction of the City of Austin inspector 2) restore the off-site areas impacted by fugitive sediment to pre- disturbance conditions (determined by the City inspector, pre-disturbance

photos and the impacted landowner(s)); 3) revise or repair erosion and sedimentation controls within 48 hours of failure to the satisfaction of City Inspector.

Enforcement action can proceed immediately without a 48-hour warning period by the city inspector in some situations. These include the following:

• Project is within the jurisdiction of the city but has started construction without obtaining the required development permit or site plan.

• Project has a valid permit but work was initiated without the required preconstruction meeting and without installation of temporary controls.

• When significant or irreparable damage is judged to be occurring on a permitted site, the inspector may first ask the contractor to cease all work in the area of the violation. If the contractor complies with the verbal stop-work order and immediately institutes corrective measures in the area of the job violation, the inspector will not issue a Stop Work Order. If the work in violation is not stopped and corrective measures are not taken, the inspector may issue a Citation or Stop Work Order for the entire project.

5. Project Release or Acceptance by the City.

Upon completion of the site construction and revegetation of a project site, the design engineer shall submit an engineer's letter of concurrence to the Development Services Department indicating that construction, including revegetation, is complete and in substantial conformity with the approved plans. After receiving this letter, a final inspection will be scheduled by the appropriate city inspector.

As part of the final inspection, the city will inspect for the following environmental requirements:

• Determine that grass coverage and revegetation, including type of grasses, topsoil, temporary and permanent stabilization, are complete and in accordance with the plan requirements.

• Determine that all drainage facilities, including water quality facilities and permanent structural controls, are installed in accordance with the plans. Any water quality facilities with sediment deposits will not be accepted until the contractor cleans the facilities and re-installs the appropriate media such that it is per specifications of ECM 1.6.7.

• Note any unauthorized disturbance of the site or vegetation and ensure that all disturbed areas, including haul roads and spoil sites are revegetated.

• Determine that all special environmentally related requirements, such as replacement trees and buffer zone restoration, are complete.

• Note all temporary erosion and sedimentation control measures that will still be required due to incomplete revegetation. All controls and sediment must be removed upon the completion of revegetation and before the full fiscal deposit for erosion and sedimentation controls is released through the Development Services Department.

When all revegetation is completed as required by the plans and specifications the project can be certified for acceptance.

Developer's Contracts

Section 25-8-181 of the Land Development Code requires that a separate and enforceable agreement to ensure revegetation be signed by the city and the developer of a project if maintenance responsibility for constructed facilities is accepted, or a temporary certificate of occupancy is issued, by the city before the required revegetation coverage is complete.

This agreement is in the form of a standard Developer's Contract in which the developer agrees to complete the required revegetation within a specified period of time, normally a 4-month period. The contract is tied to a fiscal surety in the form of a letter of credit, a cash deposit, or a bond. The amount of this fiscal surety is determined by the amount of disturbed area that will be required to be revegetated for the project. All areas disturbed as part of the project and any adjacent areas that were disturbed by the construction of the project will be required to be revegetated. The Contract states that if the required revegetation is not completed within the specified period of time, the city will use the deposited funds to ensure revegetation is completed.

The city can consider longer Developer's Contract periods for projects accomplishing revegetation with native grasses. The factors that will be considered for approval of longer revegetation periods than four months will be: (a) the erosion and sedimentation potential of a particular project area which will be exposed to erosion for a longer period of time (temporary erosion and sedimentation measures must be constantly maintained until completion), (b) the use of only minimum amounts of topsoil to reduce erosion potential, (c) postponement of initial seeding until a more suitable seasonal time, (d) the good faith effort on the part of the developer/owner to accomplish project completion and revegetation as soon as practically possible.

Upon satisfactory completion of any outstanding items identified by the inspector, final release or acceptance of the project can occur.

E. **Failure to Complete a Project.**

F. **Maintenance Responsibilities After Construction.**

Following release or acceptance of a project (and termination of the development permit) the property owner is responsible for maintaining the project site. The release of excessive amounts of sediment in stormwater runoff is prohibited by the Environmental Control and Conservation Code (6-5-53). Any person causing stoppage, damage or restriction of flow in any storm sewer or watercourse may be liable to the city for repairs to these waterways.

G. **Additional Recommendations and Requirements for Selected Projects.**

It has been recognized that particular types of construction projects or projects in particular areas have common problems that are less frequently experienced in other circumstances. This section provides additional guidance for the engineer, reviewer, contractor, and inspector in order to better design, install and maintain effective temporary erosion and sedimentation controls.

1. Major Utility Projects.

   Major water and waste water line installations can be challenging projects in which to accomplish effective temporary controls because of the limited working space and easements often involved. The location of waste water lines along creeks and in flood plains can create additional problems. Maintenance and access roads are frequently added after construction is complete, rather than being designed into the project.

Silt fence can be an effective perimeter control along the route of the pipeline. Rock berms and reinforced rock berms are appropriate for use as flow diverters, energy dissipators, grade control, and level spreaders. Hay bales dikes generally are not recommended for use. Triangular filter dikes can be used in short sections across the disturbed area. The triangular dikes must be placed such that the bottom of the dike is in full contact with the ground.

A two-phased plan should be implemented for these type of projects. Prior to construction, perimeter controls should be required parallel to the line installation and to provide protection at channels, spoil areas, and haul roads. These controls should not be directly disturbed by the trenching activity. In the second phase, after the pipe is installed and backfilled, interior controls may be located perpendicular to or diagonally over the pipe installation area. These will control runoff and sediment in areas which do not drain into the parallel controls to the side. These controls are especially necessary on steep slopes which drain parallel to the line installation. These interior controls should be installed as soon after the backfilling of the trench as possible and should be situated to still allow access to the rest of the project by the contractor.

Site Management Practices

Site management is crucial to the success of temporary erosion and sedimentation controls on this type of project. Especially important are temporary and permanent spoil disposal areas which must be adequate to handle the amount of material generated by the project, or the spoil material can overwhelm the easements, erosion controls, and tree protection.

Projects should follow the recommendations for construction adjacent to creeks and waterways and water discharges from construction sites discussed later in this section. This is especially true if any boring or tunneling operations will be performed as part of the job. In addition, there must be adequate accessways and haul roads approved for the project beforehand to allow access and equipment passage while keeping the limits of disturbance as small as possible.

Utility installations along or within existing paved roadways should follow the guidelines for protection of existing drainage facilities with temporary erosion and sedimentation controls.

2. Construction in Creeks and Channels (> 5 Acres).

Projects in this category include some utilities, creek and channel improvements, regional detention ponds, bridges and culverts. In general, a two phase plan should be implemented for these drainage improvements. Construction in creek channels requires that upstream flows be impounded upstream of the work site and routed around the construction area anytime there is equipment in the channel. Spoils must be removed from the channel of any creek or drainage way and its associated floodplain at the end of each work day. It shall be the responsibility of the Engineer of Record or the ESCP preparer to designate on the ESCP and construction plans the method of dewatering the drainage feature. The ESCP shall include the sequence of construction and the temporary and permanent stabilization of the drainage feature after disturbance. If significant areas adjacent to but above the channel are disturbed, silt fence should be installed parallel to the top of the bank to prevent from entering the waterway from the sides. All erosion and sedimentation controls for upland areas shall be located outside of concentrated flow paths.

Bridge construction, which has localized impact on the channel, may require only a single phase plan with appropriate field adjustments. These silt fences should be adjusted as necessary as the bridge construction progresses.

When constructing detention ponds, a perimeter control, typically of silt fence, should be placed first along the downslope sides of the pond beyond the limits of the proposed grading work. After the pond is graded and the outlet is complete, the silt fence should be adjusted such that it passes over the top of the outlet pipe on the outside of the pond. A semi-circular section of reinforced rock berm or silt fence can be added inside the pond at the outlet to improve sedimentation inside the pond. Figure 1-1.6 in Appendix V of this manual indicates how these controls might be installed.

Site Management Practices

Good site management practices are essential to the success of erosion and sedimentation controls for projects in larger waterways. Examples of several practices are provided below:

• Fill Material Storage - At the end of each work day the contractor should remove all loose excavated material from the channel and 100-year floodplain as delineated on the approved plan. No construction or fill materials can be stored within the limits of the channel or 100-year floodplain.

• Temporary Creek Crossings - Temporary crossings composed of soil may not be used. They must be removed entirely from the stream bed as soon as possible.

• **Flow Across construction Operations in a Channel**

Water-filled channels should always be de-watered if possible rather than attempting to conduct construction operations directly in them. This prevents the water from coming in contact with the disturbed soil and becoming silted. In larger channels de-watering can be done in one-half of the stream at a time. The design of dikes or berms to direct flow in channels should consider the possibility of these structures increasing flood levels during high flow conditions or eroding and contributing to increased downstream sedimentation. These structures and all associated construction should remain in the channel for the shortest time possible.

Dewatering or Diversion of Stream Flow - The temporary damming and diversion (by pumping or gravity) of base flow around construction activities under way in a channel is required. This flow is then safely discharged further downstream and prevented from coming in contact with areas disturbed by the construction activity. Any time construction equipment or activity is placed in the channel, the flow at that time shall be diverted around the construction site and discharged in a non-erosive manner downstream of the channel construction. Sandbags are not an acceptable diversion structure in channels.

• Stream flow that does become silted from construction activity must not be discharged directly back into the stream, but must be temporarily detained until the sediment has settled out. All water discharges should comply with the recommendations for Water Discharges from Construction Sites.

• Bore Pit Locations - Bore pits should be located as far as possible from the main channel of any waterway. Bore pits located near stream beds greatly increase sedimentation into the waterway and are susceptible to frequent flooding.

• Frequent removal of sediment collected in treatment devices will reduce the risk of sediment release due to a sudden failure of an overloaded control.

3. General Permit Utilities and Maintenance Activities.

Work which is considered under permits for general utility installation and maintenance includes:

• Natural gas main service/repair for pipelines less than 200 feet in length.

• TV cable installation/repair within subdivisions and right-of-way.

• Telephone cable installation/repair within subdivisions and right-of-way.

• City of Austin water or waste water extensions less than 300 feet in length and routine and emergency repairs of existing facilities.

• City of Austin Parks Department installation, repair or landscaping of minor park facilities.

• City of Austin street and drainage maintenance and repair.

• City of Austin Electric Utility Department routine installation and maintenance of overhead electric distribution system facilities.

For small utilities projects, the two-phase erosion and sedimentation control plan used for major utilities can also be implemented. The first phase would include perimeter controls parallel to the line installation. The second phase would include interior controls installed perpendicular and diagonally over the trenched line after it is backfilled. Often, few temporary controls are necessary in flat areas for these types of small projects. Key areas for temporary control are roadside ditches or drainage swales, stream crossings, and steep slopes. Silt fences, rock berms, and small lengths of triangular filter dikes are recommended controls.

Site Management Practices

For these projects, close on-site supervision and management of the fill material generated by the construction and timely removal of the excess spoil can often be more effective than temporary controls. In addition, appropriate protection of existing drainage facilities and revegetation after construction should be considered during design and installation phases.

4. Water Discharges from Construction Sites.

A common erosion and sedimentation control problem other than stormwater runoff that can cause significant off-site sedimentation problems from construction sites is the discharge of silted water during certain construction operations. Title 6, Article V of the Austin City Code, entitled "Discharges to Storm Sewers and Watercourses", contains the minimum water quality compliance requirements for any water discharges into city storm sewers or waterways. Section 6-5-53 specifically includes water discharges from construction site excavations. Pump and Filter Press systems are acceptable and appropriate for removing sediment from water prior to discharging into surface water or storm drain. Mobile filter presses that have capacity to remove up to -400 mesh particle size are recommended and acceptable. The following list contains the five most common

types of water discharges from construction sites that can cause significant off-site sedimentation problems and the recommended control techniques used in these situations.

Boring or Tunneling Operations That Discharge Sediment Laden Water.

All silted water and slurry generated by the construction can be pumped into one or more temporary earthen pits or metal tanks to allow the sediment to settle before discharging the clean water. These temporary sedimentation facilities must be adequately sized to be most effective and may be constructed in series to improve sediment removal.

Groundwater or Channel Flow Seepage into Trenches or Excavations.

Settling or removing of the silt laden water can be done as described in the item above. In addition, the work area can be de-watered by temporarily damming the flow and pumping the flow around the construction, to prevent it from entering the trench or excavation. Innovative or alternative methods, such as end-of-pipe socks, may also be proposed.

Accumulated Stormwater in Trenches or Excavations After Rainfall.

Recommended solutions are as described above.

Flushing Water From Water and Wastewater Utility Lines or Storage Tanks.

Prior to placing the utility lines in service, they must be flushed to remove accumulated debris or to sterilize the pipelines. If this water does not contain silt, use a hose extension to allow the water to be discharged to an undisturbed, vegetated area. Discharging clean water over an unvegetated area may create an erosion and sedimentation problem if velocities are high enough to erode the disturbed earth. If the water to be discharged contains silt, it should be treated using the techniques described above: detention/sedimentation or removal off-site.

5. Protection of Existing Drainage Facilities.

   Construction projects located in or adjacent to developed areas with existing drainage facilities often require partial protection of these drainage facilities for effective erosion and sedimentation control. This must be done in a manner that will effectively trap sediment without impeding the stormwater drainage flow and function of the facility. Inlets should never be completely sealed.

   Curb Inlets. (see 1.4.5P)

   Area Inlets.

   Surround the inlet with reinforced silt fencing or reinforced rock berms. Sediment will be trapped mainly by detention/ sedimentation with some filtration.

   Detention Pond Outlets.

   Reinforced rock berms or reinforced silt fencing should be placed around the outlet on the inside of the pond to enhance sedimentation, especially during low flow events and when the pond is not fully revegetated. Temporary controls preferably should be placed inside the pond outlet rather than outside. If placed outside, a semicircular rock berm or reinforced rock berm should be placed immediately below the outlet headwall.

Source: Rule No. R161-15.12, 1-4-16 ; Rule No. R161-16.19, 11-14-2016 ; Rule No. R161-17.03 , 3-2-2017; Rule No. R161-17.12 , 6-13-2017.

1.4.5 - Temporary Structural Practices

A. **Mulching** (See Specifications manual item 645S-1 for detail)

1. Description.

Mulching is the process of applying wood mulch, wood chips, or other organic material to the exposed soil surface to protect it from erosive forces (wind, water, etc.) and to conserve soil moisture until plants can become established. Mulching shall not be considered a primary erosion control, but shall be used in conjunction with other approved controls.

The effectiveness of using Mulching as an erosion control technique depends on:

- The type of mulch used
- Mulch morphology
- Application rate
- Method of application: the mulching material can be placed mechanically or by hand.
- Soil type
- Slope
- Climatic characteristics
- Proper preparation of application area (uniform application surface to ensure optimal mulch to soil contact)

2. Materials.

Mulching material can be manufactured on or off the project site. It consists primarily of organic material, separated at the point of generation, and may include: shredded bark, stump grindings, or composted bark

The mulching shall have the following composition:

- Use wood chips produced from a 3 (three) inch minus screening process (equivalent to TXDOT Item 161 Section 1.6.2.B Wood Chip requirements).
- Large portions of silts, clays, or fine sands are not acceptable in the mix.

Mulching material is composed of a well-graded mixture of particle sizes and may contain rocks less than 2″ in diameter. Mulching material must be free of refuse, physical contaminants, and material toxic to plant growth. It is not acceptable for the mulching material to contain ground construction debris, biosolids, or manure.

Prior to placement a representative sample of the mulching material must be accepted by the project engineer or his/her designee and by the city inspector.

3. Installation.

Mulching is performed after grading and soil surface preparation is completed.

• Mulching is not recommended on 2:1 slopes or steeper.

• Mulching on slopes of 3:1 or flatter use a minimum depth of 4 inches. Apply mulching material a minimum of three (3) feet over the shoulder and beyond the base of the slope or into existing vegetation where possible to prevent rill formation and transport of the material (Figure 1.4.5.A).

• The mulch may be placed with a hydraulic bucket, a pneumatic blower, or by hand.

• The effectiveness of the mulching material depends on good contact between the soil and mulching material. Maximum contact with the soil promotes increased infiltration and sediment trap formations. If the mulching material does not make full contact with the soil, is perched above the soil by clods, or stays suspended above depressed areas, severe rill erosion can occur beneath it. Therefore mulching material must be placed to ensure maximum contact with the soil. Provide a smooth application surface by tracking, rolling, raking, etc. to ensure an optimal mulch to soil contact.

• The mulching material shall be placed evenly and uniformly to provide 100% coverage.

4. Where mulching is not allowed as an erosion control:

• On slopes with groundwater seepage;

• At low points with concentrated flows and in gullies;

• On slopes equal to or steeper than 2:1;

• At the bottom of steep perimeter slopes exceeding 100 feet in length (large up-gradient watershed);

• Below culvert outlet aprons, and

• Around catch basins and closed storm system outlets.

• Within a stormwater control structure.

• No mulching material shall be placed within 100 feet of any source of surface water or drinking water supply.

• Mulching shall not be used as a primary perimeter site erosion control.

5. Inspection and Maintenance.

• The mulched area shall be inspected regularly and after each large rainfall. Any required repairs shall be made immediately, with additional mulching material placed on top of the mulch to reach the recommended thickness.

• When the mix is decomposed, clogged with sediment, eroded or ineffective, it must be replaced or repaired.

• Vegetation adds stability and should be promoted.

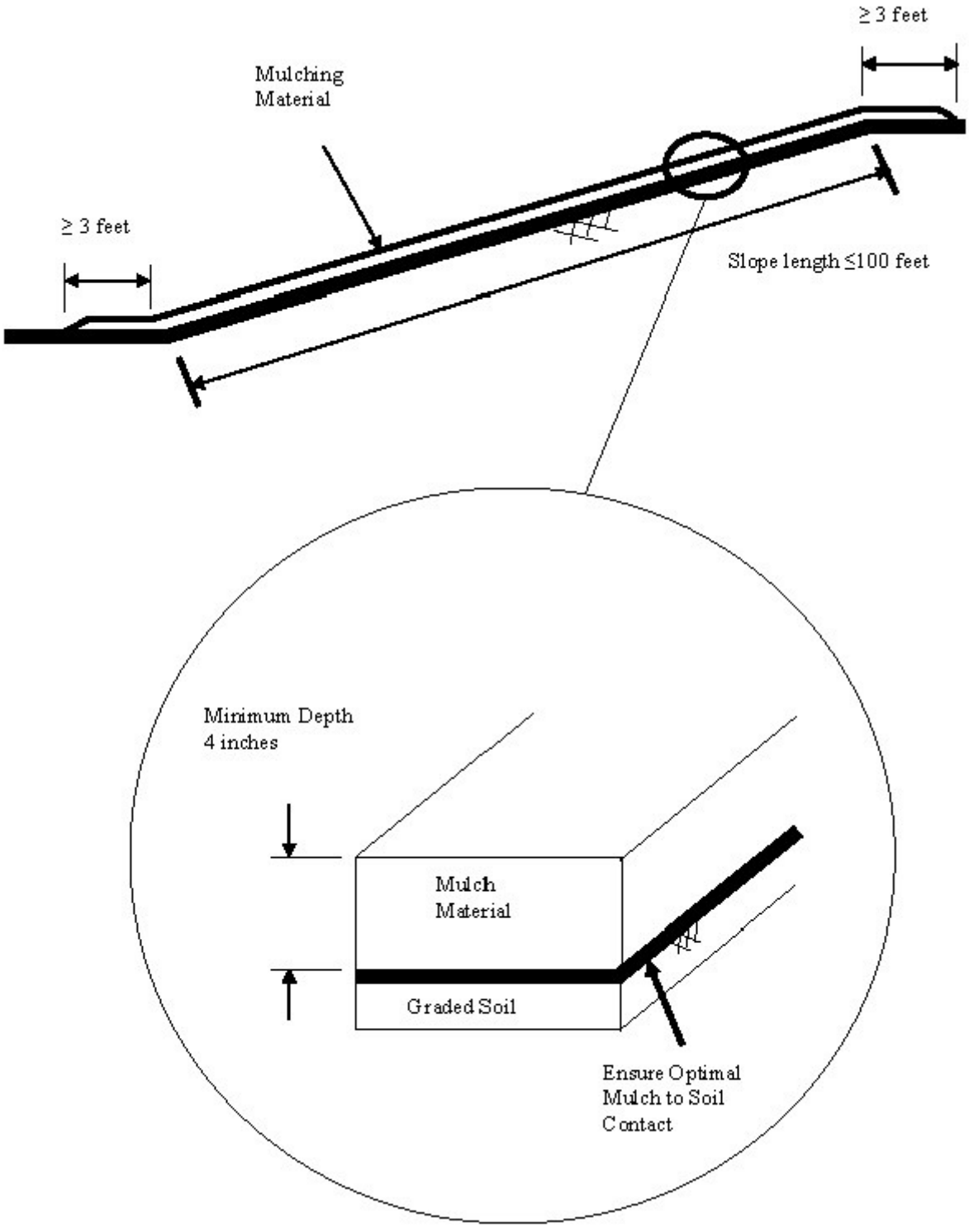
• If the mulch is not removed prior to revegetation, it should be spread out into the landscape to a depth that will not prevent seed germination and will encourage effective revegetation of the site.

References:

1. Foltz, Dooley (2003), Comparison of Erosion Reduction Between Wood Strand and Agricultural Straw, Trans. ASAE 46(5): 1389-1396.
2. Demars, Long, and Ives (2000), Use of Wood Waste Materials for Erosion Control, NETCR 20
3. McCoy and Noble (2002), Use of Compost & Mulch for Storm Water Management, Erosion & Sediment Control, TCEQ
4. Wischmeier, W.H. and D.D. Smith (1978), "Predicting Rainfall Erosion Losses - A Guide to Conservation Planning" U.S. Department of Agriculture, Agriculture Handbook No. 537

NOTE: THIS METHOD IS NOT A PRIMARY EROSION CONTROL AND SHOULD BE USED IN CONJUNCTION WITH MULCH SOCKS, SILT FENCES, MULCH BERMS, AND OTHER APPROVED METHODS OF SEDIMENTATION AND EROSION CONTROL.

Figure 1.4.5.A.1 Mulching Detail



B. **Diversion, Interceptor and Perimeter Dikes.** (See Standard Specifications manual items 622S, 630S, and 635S and Specifications manual items 622S-1, 630S-1, and 635S-1 respectively for detail)

1. Definition.

   A temporary ridge of compacted soil located either (1) immediately above cut or fill slopes, (2) across disturbed areas or rights of way or (3) along the perimeter of the site or disturbed areas.

2. Purpose.

• A diversion dike intercepts runoff from small upland areas and diverts it away from exposed slopes to a stabilized outlet, such as a rock berm, brush berm or stone outlet structure.

• An interceptor dike shortens the length of exposed slopes by intercepting runoff and diverting it to a stabilized outlet.

• A perimeter dike prevents off-site runoff from entering the disturbed area and prevents sediment laden storm runoff from leaving the construction-site or disturbed area.

3. Conditions Where Practice Applies.

   Dikes are generally used for the period of construction to intercept and reroute runoff around disturbed areas to prevent excessive erosion until permanent drainage features are installed and/or slopes are stabilized. The repose characteristics of the material of construction should be considered for installations on steep slopes.

4. Design Criteria.

   The following criteria shall be observed.

• Drainage Area - Less than five (5) acres (recommended)

• Top Width - Two (2) feet minimum

• Height (compacted fill) - 18 inches minimum height measured from the top of the existing round at the upslope toe to top of the dike

• Side Slopes - 2:1 or flatter

• Stabilization - Where slope of channel is one (1) to five (5) percent, stabilization is required if velocity exceeds one (1) foot per second; over five (5) percent, stabilization shall be required.

• Stabilization, when required, shall be demonstrated to prevent erosion up to the 25-year, 24-hour storm.

• Spacing.

• Slope of disturbed areas above dike	greater than 10%	5-10%	less than 5%
• Maximum distance between dikes:	100 ft.	200 ft.	300 ft.

5. Outlet.

• Diverted runoff from a protected or stabilized area shall outfall directly to an undisturbed stabilized area or into a level spreader (see Section 1.4.3 C) or grade stabilization structure (see Section 1.4.3 H).

• Diverted runoff from a disturbed or exposed upland area shall be conveyed to a sediment trapping device such as a rock berm, brush berm, stone outlet structure, sediment trap or sediment basin or to an area protected by any of these practices.

C. **Interceptor and Perimeter Swales.** (See Standard Specifications manual items 631S and 636S and Specifications manual items 631S-1 and 636S-1 for detail)

1. Definition.

   A temporary excavated drainageway located across disturbed areas or rights of way or along the perimeter of a construction site.

2. Purpose.

   Interceptor swales shorten the length of exposed slope by intercepting runoff. Perimeter swales prevent off-site runoff from entering the disturbed area or prevent sediment-laden runoff from leaving the construction site or disturbed area. The outflow from a swale must be directed to a stabilized outlet or sediment trapping device.

3. Conditions Where Practice Applies.

   Interceptor swales are constructed across disturbed easements/rights of way, such as for utility cuts and streets or disturbed areas such as graded parking lots or land fills. The perimeter swale is used for the period of construction at the perimeter of the disturbed area. The perimeter swale also is used to prevent storm runoff from entering the disturbed area.

   This runoff shall be adequately handled to prevent damage due to flooding or erosion to adjacent property. Swales shall remain in place until the disturbed area is permanently stabilized.

4. Design Criteria.

   The following criteria shall be observed.

• Drainage Area - Less than five (5) acres (recommended)

• Top Width - Four (4) feet minimum and the bottom shall be level.

• Depth - One (1) foot minimum

• Side Slopes - 2:1 or flatter

• Grade - One (1) to three (3) percent; must have positive drainage (sufficient grade to drain) to an adequate outlet.

• Stabilization - Where slope of channel is one (1) to five (5) percent, stabilization is required if velocity exceeds one (1) foot per second; over five (5) percent, stabilization shall be required.

Stabilization, when required, shall demonstrate that erosion is prevented for up to the 2-year, 24-hour storm flow.

• Traffic Crossings - all points where vehicles will cross swales must be stabilized as above, except the stone lining shall be at least six (6) inches in thickness for the full width of the traffic crossing.

• Spacing

Slope of right of way or disturbed area:	greater than 10%	5-10%	less than 5%
Minimum distance	100 ft.	200 ft.	300 ft.

5. Outlet.

• Diverted runoff from a protected or stabilized upland area shall outlet directly onto an undisturbed stabilized area, level spreader or into a grade stabilization structure.

• Diverted runoff from a disturbed or exposed upland area shall be conveyed to a sediment trapping device, such as a rock berm, brush berm, stone outlet structure, sediment trap or sediment basin or to an area protected by any of these practices.

• The on-site location of the swale may need to be adjusted to meet field conditions in order to utilize the most suitable outlet.

D. **Stone Outlet Structures.** (See Standard Specifications manual item 643S and Specifications manual item 643S-1 for detail)

1. Definition.

   A temporary crushed stone dike installed in conjunction with and as a part of a diversion dike, interceptor dike or perimeter dike.

2. Purpose.

   The purpose of the stone outlet structure is to provide a protected outlet for a diversion dike, interceptor dike or perimeter dike to provide for diffusion of concentrated flow and to allow the area behind the dike to dewater.

3. Conditions Where Practice Applies.

   Stone outlet structures apply to any point of discharge where there is need to dispose of runoff at a protected outlet or to diffuse concentrated flow for the duration of the period of construction.

4. Design Criteria.

The drainage area above the structure is recommended to be less than five (5) acres. The minimum length, in feet, of the crest of the stone outlet structure shall be equal to six (6) times the number of acres of contributing drainage area. Maximum allowable flow through rate is 40 gallons per minute per foot squared. The crest of the stone dike shall be at least six (6) inches lower than the lowest elevation of the top of the earth dike and shall be level. The stone shall be crushed stone. Unless otherwise specified, all aggregate used in a stone outlet structure shall be three (3) to five (5) inches open graded rock or larger. A fabric core consisting of geotextile wrapped stone having a minimum diameter of one (1) foot shall be incorporated into the structure. The stone outlet structure shall be located so as to discharge onto an already stabilized area or into a stable watercourse. Stabilization shall consist of complete vegetative cover, paving, etc., sufficiently established to be erosion resistant.

Fabric core specification shall be nonwoven polypropylene, polyethylene or polyamide geotextile, minimum unit weight 4-½ ounces per square yard, mullen burst strength exceeding 250 pounds per square inch, ultraviolet stability exceeding 70 percent and equivalent opening size exceeding 40.

5. Maintenance.

   The area upstream from the stone outlet structure shall be maintained in a condition which will allow sediment to be removed following the runoff of a rainfall event. Periodic inspections (after each rainfall) shall be made by the contractor and when the silt reaches a depth equal to 1/3 the height of the structure or one (1) foot, whichever is less, accumulated silt shall be removed and disposed of at an approved site in a manner that will not contribute to additional siltation. The structure shall be reshaped as needed during inspection. The structure shall be left in place until all upstream areas are stabilized and accumulated silt is removed.

E. **Rock Berm.** (See Standard Specifications manual item 639S and Specifications manual item 639S-1 for detail)

1. Description.

   A temporary berm constructed of open graded rock installed at the toe of a slope or the perimeter of a developing or disturbed area. Rock berms are appropriate for use as flow diverters, energy dissipators, grade control, and level spreaders to release the water in sheet flow.

2. Conditions Where Practice Applies.

   The rock berm is used:

- To convert concentrated flow to sheet flow or to prevent sheet flow from concentrating.
- Where the contributing drainage area is generally less than five (5) acres.

3. Design Criteria.

   A rock berm is constructed at the perimeter of a disturbed site within the developing area. It is not to be constructed outside the property lines without obtaining a legal easement from the affected adjacent property owners.

   The following criteria shall be observed.

- Drainage Area - Less than five (5) acres (recommended)

• Height - 18 inches minimum height measured from the top of the existing ground at the upslope toe to top of the berm.

• Top Width - Two (2) foot minimum

• Side Slopes - 2:1 or flatter

• Woven Wire Sheathing - Hexagonal opening hardware netting (such as poultry netting) secured with hog rings.

Width = as required

Wire = 20 gauge, galvanized

Opening = Hexagon, one (1) inch in diameter

Woven wire sheathing is required when there is concentration of water above the berm.

• Grade - Berms will be built along the contour at zero (0) percent grade or as near as possible.

• Material - Open graded rock three (3) to five (5) inches diameter (for sheet flow or concentrated flow condition).

4. Outlet.

   Runoff shall outfall directly to an undisturbed stabilized area.

5. Maintenance.

   The area upstream from the rock berm shall be maintained in a condition which will allow sediment to be removed following the runoff of a rainfall event. Weekly or after each rainfall, inspection shall be made by the responsible party and if the sediment reaches a depth equal to 1/3 the height of the berm or one (1) foot, whichever is less, it shall be removed and the accumulated sediment disposed of at an approved site in a manner that will not contribute to additional sedimentation.

F. **Mulch Socks.** (See Specifications manual item 648S-1 and Standard Specifications manual item 648S for details)

1. Description.

   A mulch sock is mulch material encased in mesh to form a tube/roll. A technique used to intercept sheet flow and pond runoff, allowing sediment to fall out of suspension, and often filtering sediment as well. Mulch socks provide an environmentally-sensitive and cost-effective alternative to sediment fence.

2. Material.

   Mulching material can be manufactured on or off the project site. It consists primarily of organic material, separated at the point of generation, and may include: shredded bark, stump grindings, or composted bark.

   The mulch shall have the following composition:

• Use untreated wood chips produced from a 3 (three) inch minus screening process (equivalent to TxDOT Item 161, Compost, Section 1.6.2.B, Wood Chip requirements).

• Large portions of silts, clays, or fine sands are not acceptable in the mix.

• The pH should fall between 5.5 and 8.5.

• The organic matter content is ≥25%, dry weight basis.

Mulch material must be free of refuse, physical contaminants, and material toxic to plant growth. It is not acceptable for the mulch material to contain ground construction debris, biosolids, or manure.

The sock material mesh opening shall be equal to or less than 3/8 inch (10 mm) and the material tensile strength shall be equal to or greater than 202 psi (14.2 kg/cm ^{2}).

Prior to placement, a representative sample of the mulching material must be accepted by the project engineer or his/her designee and by the city inspector.

3. Installation.

• Use 12 or 18 inch diameter mulch socks for all sediment control applications. The 18 inch diameter sock material has proven to be the most consistent for all sediment control applications (TxDOT, April 2006).

• Mulch socks should be used at the base of slopes no steeper than 2:1 and should not exceed the maximum spacing criteria provide in Table 1.4.5.F.1 for a given slope category. The spacing criteria are based on the maximum drainage area, in square feet, above a 100 feet wide section of mulch sock.

• Place mulch socks at a 5' or greater distance away from the toe of slopes to maximize space available for sediment deposition.

• When placed on level contours sheet flow of water should be perpendicular to the mulch sock at impact and un-concentrated.

• Install mulch socks using rebar stakes with a minimum 3/8 inch diameter and a minimum length of 48-inches, wood stakes with a minimum dimensions of 1 inch by 2 inch and a minimum length of 48 inches, or earth anchors placed behind the mulch sock on 4-foot centers. Drive the stakes in the ground to a minimum depth of 24-inches leaving less than 12-inches of post above the exposed mulch socks. It is preferable to cut the post flush with the top of the mulch sock.

• In order to prevent the movement or floating of the mulch log during rain events or construction operations, install stakes on the front side placed on 4-foot centers.

• In order to prevent water flowing around the ends of mulch socks, point the ends upslope to place them at a higher elevation.

• In order to prevent water flowing between the gaps between the joints of adjacent ends of mulch socks lap the ends of adjacent mulch socks a minimum of 12 inches. Never stack mulch socks on top of one another.

• Mulch socks can be placed around the perimeter of affected areas, if the area is flat or the perimeter is on contour. Socks should be placed using 'smiles' and j-hooks. (See Section 1.4.5.G., Silt Fence for proper placement and J hook details.)

• Do not place socks where they cannot pond water.

• For steeper slopes, an additional sock can be constructed on the top of the slope and within the slope area as determined by specific field conditions. Multiple socks are recommended on steeper slopes.

• Do not use mulch socks in areas of concentrated flow, as they are intended to control sheet flow only.

4. Where mulch socks are not allowed as a sediment control:

   • On slopes with groundwater seepage;

   • In concentrated flow situations or in runoff channels;

   • On slopes equal to or steeper than 2:1;

   • At the bottom of steep perimeter slopes exceeding 100 feet in length (large up-gradient watershed);

   • Below culvert outlet aprons, and

   • Around catch basins and closed storm system outlets.

   • Within a stormwater control structure.

5. Inspection and Maintenance

   • Inspect mulch socks after installation for gaps under the mulch socks and for gaps between the joints of adjacent ends of mulch socks.

   • Inspect every 7-days and within 24-hours of a rainfall event of 0.5-inches or greater event and replace or repair if necessary.

   • Sediment retained by the sock shall be removed when it has reached 1/3 of the exposed height of the sock. Alternatively, the sediment and sock can be stabilized with vegetation at the end of construction.

   • Mulch socks can be vegetated or unvegetated. Vegetated mulch socks can be left in place. The vegetation grows into the slope, further anchoring the filter sock. Unvegetated filter socks are often cut open when the project is completed, and the mulch is spread around the site as soil amendment. The mulch should be spread out into the landscape to a depth that will not prevent seed germination and encourage effective revegetation of the site.

References:

1. Demars, Long, and Ives (2001), Performance Specifications for Wood Waste Materials As An Erosion Control Mulch And As A Filter Berm, NETCR 25.
2. City of Austin, Mabel Davis Park Site Remediation, Standard Technical Specifications, Compost/Mulch Filter Berm - Section 02273 (2004), Volume 2.
3. Storey, et al. (2006), Water Quality Characteristics and Performance of Compost Filter Berms, Report 0-4572-1, Texas Department of Transportation.

Table 1.4.5.F.1 Mulch Socks and Maximum Slope Lengths for 12" and 18" Sock Diameters.

PART I - GENERAL

1.01 SUMMARY

A. Section Includes:

1. The procedure for requesting the approval of substitution of a product that is not equivalent to a product which is specified by descriptive or performance criteria or defined by reference to one or more of the following:

   a. Name of manufacturer.

   b. Name of vendor.

   c. Trade name.

   d. Catalog number.

2. Substitutions are not "or-equals."

3. This Specification Section does not address substitutions for major equipment.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 0 - Procurement and Contracting Requirements.

2. Division 1 - General Requirements.

C. Request for Substitution - General:

1. Base all bids on materials, equipment, and procedures specified.

2. Certain types of equipment and kinds of material are described in specifications by means of references to names of manufacturers and vendors, trade names, or catalog numbers.

   a. When this method of specifying is used, it is not intended to exclude from consideration other products bearing other manufacturer's or vendor's names, trade names, or catalog numbers, provided said products are "or-equals," as determined by Engineer.

3. Other types of equipment and kinds of material may be acceptable substitutions under the following conditions:

   a. Or-equals are unavailable due to strike, discontinued production of products meeting specified requirements, or other factors beyond control of Contractor; or,

   b. Contractor proposes a cost and/or time reduction incentive to the Owner.

1.02 QUALITY ASSURANCE

A. In making request for substitution or in using an approved product, Contractor represents they:

1. Have investigated proposed product, and have determined that it is adequate or superior in all respects to that specified, and that it will perform function for which it is intended.

2. Will provide same guarantee for substitute item as for product specified.

3. Will coordinate installation of accepted substitution into Work, to include building modifications if necessary, making such changes as may be required for Work to be complete in all respects.

4. Waives all claims for additional costs related to substitution which subsequently arise.

1.03 DEFINITIONS

A. Product: Manufactured material or equipment.

1.04 PROCEDURE FOR REQUESTING SUBSTITUTION DURING BIDDING PERIOD

A. See Section 00100 - Instructions to Bidders.

1.05 PROCEDURE FOR REQUESTING SUBSTITUTION AFTER AWARD OF CONTRACT

A. Substitution will only be considered under the conditions stated herein.

B. Written request through Contractor only.

C. Transmittal Mechanics:

1. Follow the transmittal mechanics prescribed for Shop Drawings in Specification Section 01300.

a. Product substitution will be treated in a manner similar to "deviations," as described in Specification Section 01300.

b. List the letter describing the deviation and justifications on the transmittal form in the space provided under the column with the heading DESCRIPTION.

1) Include in the transmittal letter, either directly or as a clearly marked attachment, the items listed in Paragraph D below.

D. Transmittal Contents:

1. Product identification:

a. Manufacturer's name.

b. Telephone number and representative contact name.

c. Specification Section or Drawing reference of originally specified product, including discrete name or tag number assigned to original product in the Contract Documents.

2. Manufacturer's literature clearly marked to show compliance of proposed product with Contract Documents.

3. Itemized comparison of original and proposed product addressing product characteristics including but not necessarily limited to:

   a. Size.

   b. Composition or materials of construction.

   c. Weight.

   d. Electrical or mechanical requirements.

4. Product experience:

   a. Location of past projects utilizing product.

   b. Name and telephone number of persons associated with referenced projects knowledgeable concerning proposed product.

   c. Available field data and reports associated with proposed product.

5. Data relating to changes in construction schedule.

6. Data relating to changes in cost.

7. Samples:

   a. At request of Engineer.

   b. Full size if requested by Engineer.

   c. Held until substantial completion.

   d. Engineer not responsible for loss or damage to samples.

1.06 APPROVAL OR REJECTION

A. Written approval or rejection of substitution given by the Engineer.

B. Engineer reserves the right to require proposed product to comply with color and pattern of specified product if necessary to secure design intent.

C. In the event the substitution is approved, the resulting cost and/or time reduction will be documented by Change Order in accordance with the General Conditions.

D. Substitution will be rejected if:

1. Submittal is not through the Contractor with his stamp of approval.

2. Request is not made in accordance with this Specification Section.

3. In the Engineer's opinion, acceptance will require substantial revision of the original design.

4. In the Engineer's opinion, substitution will not perform adequately the function consistent with the design intent.

E. Reimburse Owner for the cost of Engineer's evaluation whether or not substitution is approved.

PART II - PRODUCTS (NOT USED)

PART III - EXECUTION (NOT USED)

END

PART I - GENERAL

1.01 SUMMARY

A. This Section specifies the general minimum training requirements associated with equipment and systems installed by the Contract.

B. Training requirements for the various plant components, systems, etc. are described in various sections of the specifications.

C. All costs for training, testing, startup, installation, supervision, etc., shall be the responsibility of the CONTRACTOR.

D. Training is applicable, but not limited to the following equipment and systems specified herein.

1.02 RELATED REQUIREMENTS

A. Work as called for on PLANS, and in this or other Specification Sections including 01300 and 01730.

B. This section specifies the general minimum requirements for the contract. Other more specific requirements may be described in various sections of the specifications. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

C. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of the CONTRACTOR's Work.

D. CONTRACTOR shall develop and administer a training log consisting of all training identified in the Contract. CONTRACTOR shall submit training log for Engineer/OWNER review and approval.

E. Description of Requirements

1. General

a. Contract Requirements: Testing, training, and start-up are prerequisite to the satisfactory completion of the Contract.

b. Complete testing, training, and start-up within the Contract Times.

c. Allow realistic durations in the Progress Schedule for testing, training, and start-up activities.

d. Provide dedicated line item for training in Contract schedule of values.

e. Furnish all labor, materials, equipment, and incidentals necessary to train the OWNER staff on the equipment, products, and systems provided under the Contract.

f. Objective of Training: The objective of the training shall be to convey the knowledge needed by OWNER operations, maintenance, and engineering staff to safely operate, maintain, and repair the equipment and systems provided under this Contract. OWNER's staff who will participate in this training have existing full-time work assignments and this training is an additional assigned work task. OWNER's staff regularly shift work schedules, as facilities are operated on an around-the-clock basis. Training shall be focused to the skills and job classifications of the staff attending the classes, e.g., plant manager, water treatment plant operator, maintenance technician, electrician, and engineering. Supporting documentation, such as training aids, agendas, operation and maintenance manuals to assist the instruction learning process and to serve as a source of information to OWNER staff after training, shall be furnished.

g. CONTRACTOR is required to document all training in dedicated/organized section/manual in the O&M Manual. Including training schedules, agenda, materials, aids, etc.

1.03 NOT USED

1.04 DEFINITIONS (List that apply to this Section)

1.05 TRAINING REQUIREMENTS

A. Training of OWNER'S Personnel

1. Instruction Format: The training for operations personnel and for maintenance personnel shall be provided as separate entities. The training for maintenance personnel shall be further subdivided into trade groups: mechanical maintenance, electrical maintenance, SCADA Support, and instrumentation and controls maintenance.

2. Class Agenda: The agenda shall include a listing of subjects to be presented, time estimated for each subject, list of documentation to be used or furnished to support training, and instructor name. Agendas shall include an allocation of time for OWNER staff to ask questions and discuss the subject matter. The OWNER may request that particular subjects be emphasized and the agenda shall be adjusted to accommodate these requests. Copies of the agenda shall be distributed to each student at the beginning of each training class.

3. Number of Students: It is estimated that five (5) to ten (10) persons will attend each training class. The actual number of students will be determined by OWNER. The OWNER will provide an estimated "headcount" one week prior to the class, so that the instructor can furnish the correct number of training aids for participants.

4. Training Location: If necessary and appropriate as determined by the OWNER, training shall be conducted at off-Site locations or the actual installed location of the equipment, product, or system.

5. Instructor Qualifications: Instructors shall be completely knowledgeable in the products, systems, and functions for the equipment provided. Sales representatives are not qualified instructors unless they possess the detailed operating and maintenance knowledge required for proper class instruction. If, in

the opinion of the OWNER, the scheduled training was not provided by an appropriately knowledgeable person, such training shall be rescheduled and repeated with a suitable instructor at no additional cost to the OWNER.

6. Training Aids: Each instructor is encouraged to use audio-visual devices, P&IDs, models, charts, and so forth to increase the transfer of knowledge. The organization conducting the training shall furnish all such equipment (televisions, video cassette recorder/player, projectors, screens, easels, etc.), models, and charts for each class. It shall be the responsibility of the organization conducting the training to confirm in advance that the class room will be appropriate for the types of audio visual equipment to be employed.

7. Classroom Documentation: If training is being completed on equipment, systems, or products for which an operations and maintenance manual is required, this operations and maintenance manual shall be complete and be used during the classroom instruction. The quantity of operations and maintenance manuals required under Section 01730 – O&M, shall be available for classroom use supplied by training instructor. Supplemental documentation handouts shall be furnished to support instruction. All written materials shall be identified with the name of the training module, subject matter, date of training, and instructor name.

8. Testing: Test OWNER operation and maintenance personnel following the completion of operational and safety training. The purpose of this testing shall be to determine the effectiveness of the training program and to determine the ability of OWNER personnel to safely operate and maintain said processes. Testing shall be comprised of multiple choice and true/false questions. Test results for each attendee shall be turned over to the OWNER.

9. Safety and Health Training: Furnish safety and health training to OWNER personnel that describe the procedures required to safely and healthfully operate and maintain the equipment. Safety and health training shall also include standard procedures for emergency response and safe shutdown of equipment in emergency conditions. Incorporate appropriate OSHA regulations including personal protective equipment and its use and other means of injury and illness prevention such as precautions and engineering controls.

10. Videotaping: The CONTRACTOR shall videotape all training sessions and provide a copy for the OWNER. OWNER reserves the right to videotape, photograph, audio record, and otherwise document any or all training classes. The organization(s) conducting the training and the CONTRACTOR shall cooperate with OWNER in making such videotapes, photographs, or audio recordings, which shall remain the exclusive property of OWNER.

11. Point of Contact: The CONTRACTOR shall designate and provide one or more persons to be responsible for coordinating and expediting his/her training duties. The person or persons so designated shall be present at all training coordination meetings with the OWNER.

1.06 SUBMITTALS

A. Prior to scheduling training, all satisfactory functional testing must be complete for that piece of equipment or system.

B. Submit written training plan to OWNER for review and approval prior to conducting training including the following:

1. Equipment included in training session.

2. Intended audience.

3. Location of training.

4. Objectives.

5. Subjects covered.

6. Duration of training on each subject.

7. Instructor for each subject.

8. Instructional methods to be used.

C. Prior to scheduling training, Instructor name and qualifications shall be submitted not less than one (1) month prior to start of training. Instructors shall be completely knowledgeable in the products, systems, and functions for the equipment provided.

D. Prior to scheduling training, the CONTRACTOR's coordinator shall coordinate the training periods with OWNER personnel and manufacturer's representatives, and shall submit a training schedule and agenda for each piece of equipment or system for which training is to be provided. Such training schedule and agenda shall be submitted not less than four (4) weeks prior to the time that the associated training is to be provided and shall be based on the current plan of operation.

E. Prior to scheduling training, all course materials must be submitted, and approved.

F. Prior to scheduling training, all relevant O&M manuals must be submitted, and approved one (1) month prior to training session for that piece of equipment or system.

1.07-1.11 NOT USED

PART II - PRODUCTS (NOT USED)

PART III - EXECUTION

3.01-3.08 NOT USED

3.09 SCHEDULING OF TRAINING

A. Unless specifically indicated otherwise, all training shall be scheduled in accordance with the following general requirements.

1. Training shall not be scheduled until the manufacturer has verified that the equipment is installed and performs properly. Startup services and training services will be required at separate times which will involve separate trips.

2. Coordinate training sessions to prevent overlapping sessions. Arrange sessions so that individual operators and maintenance technicians do not attend more than two (2) sessions per week.

3. Training shall be coordinated in accordance with the Progress Schedule to occur during system installation, startup, and operation. The OWNER will approve and confirm class schedules. The CONTRACTOR shall schedule training classes at the times requested by the OWNER, within the period 7 a.m. to 3 p.m. Monday through Thursday. Classes covering identical material shall be conducted on different days.

4. Number of Classes on Each Subject: A minimum of two (2) classes on identical subject matter shall be conducted unless otherwise indicated. The purpose of having two classes on each subject is to accommodate the attendance of as many OWNER personnel working different shifts as possible. The OWNER shall have the option, however, of requiring two (2) total classes, but each class shall contain different training material.

5. A maximum of one class per day shall be held on consecutive days unless otherwise approved by the OWNER. Multiple classes should be scheduled if the class duration is longer than four (4) hours. Times shall be scheduled at the discretion of the OWNER.

6. Each session shall be subdivided into two (2) to four (4)-hour modules, or as appropriate for the subject matter being discussed.

7. Training Sessions: Provide training sessions for equipment/system as specified in the individual equipment specification sections.

8. Length of Training: Each individual training session shall be planned to be completed within no more than four (4) hours, including two (2) fifteen (15)-minute break and a one (1) hour lunch period unless otherwise indicated. Requests for longer sessions must be specifically approved by the OWNER.

3.10 NOT USED

3.11 MEASUREMENT AND PAYMENT

A. No separate payment for work performed under this Section. Include cost of same in Contract price bid for work of which this is a component part.

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PART I - GENERAL

1.01 SUMMARY

A. SCOPE OF WORK This Section specifies administrative and procedural requirements for project closeout, including but not limited to:

1. Closeout procedures.

2. Final cleaning.

3. Adjusting.

4. Project record documents.

5. Spare parts and maintenance materials.

1.02 RELATED WORK

A. Operation and Maintenance Data are included in Section 01730.

B. Additional closeout procedures are included in Sections 00700.

1.03 CLOSEOUT PROCEDURES

A. Submit in accordance with Article 14 of the Conditions of the Contract written certification that Contract Documents have been reviewed, work has been inspected and that work is complete in accordance with Contract Documents and ready for Engineer's inspection.

B. Provide submittals to Engineer that are required by governing or other authorities.

C. Submit Application for Final Payment identifying total adjusted Contract Sum, previous payments and sum remaining due.

1.04 SUBSTANTIAL COMPLETION

A. When the Contractor considers the Work to be Substantially Complete, he shall submit to the Engineer:

1. A written notice that the Work, or designated portion thereof, is substantially complete.

2. A list of items to be completed or corrected.

B. Within a reasonable time after receipt of such notice, the Engineer will make an inspection to determine the status of completion.

C. Should the Engineer determine that the Work is not Substantially Complete:

1. The Engineer will notify the Contractor in writing, giving the reasons therefore.

2. Contractor shall remedy the deficiencies in the Work, and send a second written notice of substantial completion to the Engineer.

3. The Engineer will reinspect the Work.

1.05 FINAL INSPECTION

A. When Contractor considers the Work is complete, he shall submit written certification that:

1. Contract Documents have been reviewed.

2. Work has been inspected for compliance with Contract Documents.

3. Work has been completed in accordance with Contract Documents.

4. Equipment and systems have been successfully tested in the presence of Owner's representatives and are operational.

5. Work is completed and ready for final inspection.

B. The Engineer will make an inspection to verify the status of completion with reasonable promptness after receipt of such certification.

C. Should the Engineer consider that the Work is incomplete or defective:

1. The Engineer will promptly notify the Contractor in writing, listing the incomplete or defective work.

2. Contractor shall take immediate steps to remedy the stated deficiencies, and send a second written certification to the Engineer that the Work is complete.

3. The Engineer will reinspect the Work.

D. When the Engineer finds that the Work is acceptable under the Contract Documents, he shall request the Contractor to make closeout submittal.

1.06 REINSPECTION FEES

A. Should the Engineer perform reinspections due to failure of the Work to comply with the claims of status of completion made by the Contractor:

1. Owner will compensate the Engineer for such additional services.

2. Owner will deduct the amount of such compensation from the final payment to the Contractor.

1.07 CONTRACTOR'S CLOSEOUT SUBMITTALS TO ENGINEER

A. Evidence of compliance with requirements of governing authorities.

B. Project Record Documents.

C. Operation and Maintenance Data, and Care and Cleaning Instruction: In accordance with requirements of Section 01730.

D. Warranties and Bonds: In accordance with requirements of the General Conditions and Section 01740.

E. Tools, Spare Parts and Maintenance Material: To requirements of Section 01170.

F. Evidence of Payment and Release of Liens: To requirements of General and Supplementary Conditions.

1.08 FINAL CLEANING

A. Complete the following cleaning operations before requesting inspection for Certification of Substantial Completion.

1. Remove labels that are not permanent labels.

2. Clean exposed exterior and interior hard surfaced finishes to a dust free condition, free of stains, films and similar foreign substances

3. Wipe surface of mechanical and electrical equipment. Remove excess lubrication and other substances.

1.09 FINAL ADJUSTMENT OF ACCOUNT

A. Submit a final statement of accounting to the Engineer.

B. Statement shall reflect all adjustments to the Contract Sum:

1. The original Contract Sum.

2. Additions and deductions resulting from:

a. Previous Change Orders.

b. Allowances.

c. Unit Prices.

d. Deductions for uncorrected Work.

e. Deductions for reinspection payments.

f. Other adjustments.

3. Total Contract Sum, as adjusted.

4. Previous payments.

5. Sum remaining due.

C. Engineer will prepare a final Change Order, reflecting approved adjustments to the Contract Sum which were not previously made by Change Orders.

1.10 FINAL APPLICATION FOR PAYMENT

A. Contractor shall submit the final Application for Payment in accordance with procedures and requirements stated in the General Conditions. Costs for reinspections due to failure of the Work to comply with Contractor's representations of status of completion shall be deducted from amounts due and payable to Contractor.

END

PART I - GENERAL

1.01 SUMMARY

A. Furnish as described by this Section.

1.02 RELATED REQUIREMENTS

A. Work as called for on PLANS, or in this or any other CONTRACT Specification Sections (e.g. 01300 Submittals, 01650 Facility Startup/Commissioning, 01700 Project Close-out, and other applicable specifications)

B. This section specifies the general minimum requirements for the contract. Other more specific requirements maybe described in various sections of the specifications. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

C. Description of Requirements

1. General

a. When required by individual Specification Sections or requested by OWNER, submit Operation and Maintenance (O&M) data, which is specifically applicable to the scope of work and is a complete and concise depiction of the provided equipment or product. Data containing extraneous information that has to be sorted through to find applicable instructions will not be accepted. Present information in sufficient detail to clearly explain user O&M requirements at the system, equipment, and component level. Include an index preceding each submittal.

b. Package Content: For each product, system, or piece of equipment requiring submission of O&M data, submit the package required in the individual Specification Section.

c. Furnish four (4) draft Operations and Maintenance Manuals explaining the proper installation, operation, and maintenance for each piece of equipment supplied. Draft O&M Manuals will be reviewed by the ENGINEER for compliance with this Section. One (1) draft O&M Manual will be returned to CONTRACTOR noted as either "Revise & Resubmit" or "No Exception Taken".

d. CONTRACTOR to check and approve O&M Manuals for compliance with requirements of CONTRACT and will so certify by placing CONTRACTOR stamp of approval on each manual prior to submitting to ENGINEER. Any manual submitted without CONTRACTOR's stamp will not be reviewed and will be promptly returned for proper submission. OWNER may assess CONTRACTOR a charge for reviews of same items in excess of three (3) times.

e. After all O&M Manuals are in acceptable form, CONTRACTOR to furnish to the ENGINEER eight (8) bound hard copies and (8) compact disk-read only memory (CD-ROM) copies, complete sets of Operation and Maintenance Manuals consisting of printed material previously accepted by the ENGINEER for this purpose. Manuals are to be bound in a heavy duty; fabric reinforced fiberboard, three post, and expandable binder with a maximum binding width

of 5". Three-ring vinyl reinforced binders will not be acceptable. Each binder to have an index outlining all information in the set of volumes.

f. Retainage will not be released until the Operation and Maintenance Manuals have been submitted and approved by the ENGINEER.

2. Format

a. Provide each manual with a project cover sheet identifying – OWNER, facility name, facility address, manual volume number, number of volumes in the set, and date.

b. Divide manual/s into sections paralleling the Equipment Class and sequence as the technical specifications; include additional and/or other specific section/s where designated and/or required.

c. Within each manual, provide a Table of Contents for that manual. If more than one manual is necessary for a Class of Equipment, place a complete Table of Contents for that Class of Equipment within each manual of that Class.

d. Sections shall be separated with tabbed index sheets to correlate with the Table of Contents of the manual. The front of each section shall have a cover sheet indicating the equipment sections, provide a legible copy of all vendor supplied drawings for each piece of equipment in a separate binder and include as a drawing volume in the O&M Manual/s set.

e. Furnish each volume with a complete index for all volumes in the set. The index is to indicate the volume and section for each piece of equipment.

f. All diagrams, drawings, and illustrations shall be of original quality, reproducible by the dry copy method.

g. Materials in manuals to be suitable for photographic reproduction. Where copies of identical material are included, clarity and quality of copies to be equal to the original, square to the page. Faxed copies will not be accepted.

h. Manual/Binder to be 8.5 X 11 inches. Drawings shall be 11 X 17 inches folded to 8.5 X 11 inches size for inclusion in 8.5 x11 inches manual. If 8.5 X 11 inches or 11 X 17 inches drawing is not practical, drawing/s may be folded accordingly and inserted into an envelope/tab provided in the appropriate section of the manual binder. Manual/s to be three post, hard cover, and heavy duty binders with information printed on the front cover of each binder as well as the binder backing. Paper shall be white 20-pound minimum. Each binder shall have an index outlining all information in the set of volumes. Binder size not to exceed four inches (4") thickness; as required, utilize multiple volumes of binders, numbered accordingly.

D. Types of Information Required in O&M Data Packages

1. Each manual shall be specific to this CONTRACT. All non-applicable information shall be neatly crossed out, and the applicable information shall be color highlighted or otherwise indicated in a manner to prevent confusion of those utilizing the manuals. The O&M Manual/s shall contain complete information on all mechanical, electrical, instrumentation and control equipment and/or system/s furnished and installed including, but not limited to, the following:

a. Title Page/Cover Sheet

1) Identification of equipment covered by the manual by providing CONTRACT name, CIP NO., and equipment name and position tag number. These names and tag numbers will be provided to the CONTRACTOR by OWNER Representative.

2) Name of responsible principal, address, telephone number, and area of responsibility of:

a) CONTRACTOR

b) Subcontractor or installer

c) Product manufacturer

d) Nearest service center or maintenance CONTRACTOR, as appropriate

e) Nearest sour of supply for parts, materials, supplies, or replacement products.

f) Neatly typewritten Title Page/Cover Sheet to include:

I. Table of Contents

II. Table of Contents

III. Bill of Materials

IV. Equipment Data Sheets

V. System and Component Description

VI. Installation Instructions

VII. Operation Procedures

VIII. Maintenance Schedule

IX. Maintenance Summary Form

X. Troubleshooting Guide

XI. Spare Parts, Part Identification, and Drawings

XII. Technical Data

XIII. Warranties, Bonds, and Service Contracts

XIV. Appendices

XV. Video of O&M training

b. Bill of Material

1) Detailing the model, rating and size of each specific component used in the installation. Provide a list of equipment used in the installation. List shall detail the tag name used in the installation, model number, ratings, serial numbers of all pumps, motors, electrical apparatus and instrumentation, and enough information to purchase a replacement.

c. Equipment Data Sheets

1) An equipment data sheet shall be prepared for each piece of equipment or product covered by the manual.

2) Each data sheet shall list the actual equipment nameplate data, process name, and equipment position tag number of an individual product, date of installation, and all data given on the manufacturer's equipment nameplate for that product. When the product consists of separate component; e.g., pump, coupling, and motor; the data sheet shall have separate sections for each component. When a nameplate is not supplied by the manufacturer, design data for the product shall be given.

3) The appropriate model/size/item shall be highlighted on all equipment data sheets submittals.

d. System and Component Description

1) A brief description of the system that the product is a part of, to include all other applicable components of the system.

2) A brief description of the relationship between the system components and how they function as a unit.

3) Process flow diagram with system/equipment highlighted, as applicable.

e. Installation Instructions

1) Manufacturer's instructions for installation of the product, to include all applicable specifications, figures, and drawings.

f. Operation Procedures

1) Provide written instructions (with control diagrams and other applicable information).

2) Applicable start-up and break-in procedures as recommended by the manufacturer, including manual and automatic mod procedures.

3) Normal operational procedures.

4) System/equipment regulating and control procedures.

5) Normal shutdown procedures.

6) Seasonal operating instructions.

7) Emergency start-up and shut-down procedures.

8) Special operation instructions.

g. Maintenance Schedule

1) All maintenance tasks required or suggested by the manufacturer shall be listed in schedule form to include a description of the task, frequency at which the task is to be done, and other applicable information, such as type of lubricant required, amount of lubricant required or specified test/measurement limits.

h. Maintenance Summary Form

1) All Operations and Maintenance Manuals are to include a Maintenance Summary Form in the format and style of the example form attached to this Section as Attachment A. Manuals will not be accepted for review without this form. The Maintenance Summary Form is to be a typed document prepared by the equipment manufacturer specifically for the equipment furnished. Title and subheadings are to be as shown on Attachment A – they are not to be modified. If a subheading is not applicable to the specific piece of equipment, it is to be noted by the words "Not Applicable" after the heading. Additional notes and comments may be added to the end of the form at the manufacturer's discretion.

2) Format

a) Size: 8½" × 11" (portrait orientation only).

b) Margins: Top - 1", Left - 0.75", Right - 0.75", Bottom - 0.75".

c) Font:

I. Title: Arial - 16 point - bold.

II. Title: Arial - 16 point - bold.

III. Subheadings: Arial - 12 point - bold.

IV. Text: Arial - 12 point - regular.

V. Tables: As shown in Attachment A - minimum text size Arial - 10 point - regular.

d) Specific Instructions

I. Equipment Item: Include generic name for equipment along with service and specification reference.

II. Manufacturer: List manufacturer's physical address for shipping and receiving and mailing address (if different from physical address). Include telephone number and facsimile telephone number.

III. Equipment Identification Number(s): Provide list of equipment serial numbers cross-referenced to equipment tag numbers in

tabular form. When multiple items are provided, list each item separately.

IV. Total Weight: Note the assembled weight of the equipment.

V. Nameplate Data: Reproduce the nameplate data exactly as it appears on the equipment. For driven equipment, include the driver nameplate data.

VI. Manufacturer's Local Representative: Provide the name, address, and phone numbers of the local representative.

VII. Safety precautions. List personnel hazards and equipment or product safety precautions for all operating conditions.

VIII. Environmental Conditions: Include a list of environmental conditions (temperature, humidity, and other relevant data) for each product or piece of equipment under which it is best suited to operate.

IX. Testing Equipment and Special Tool Information: Include information on test equipment required to perform specified tests and on special tools needed for the operation, maintenance, and repair of components.

X. Maintenance Requirements

i. Maintenance Operation: List briefly each maintenance operation required to maintain warranty in effect and refer to specific information in manufacturer's standard maintenance manual.

ii. Preventative Maintenance: Preventative Maintenance Plan and Schedule to include manufacturer's schedule for routine preventative maintenance and inspections required to ensure proper and economical operation and to minimize corrective maintenance and repair. Provide manufacturer's projection of preventative maintenance man-hours on an annual basis.

iii. Recommended calibration instructions and frequency. Instructions shall provide detailed description of the procedure to calibrate the unit.

iv. Complete disassembly, repair, and reassemble procedures in proper step sequence.

v. Manufacture specification for alignment, clearances, tolerances, and adjustments where applicable.

vi. Corrective Maintenance Man-Hours: Include manufacturer's projection of corrective maintenance man-hours. Corrective maintenance that requires participation of the equipment manufacturer to be identified and tabulated separately.

vii. Applicable labeled section and exploded assembly drawings, and other drawings, figures and sketches as required for clarity of instructions.

viii. Refer by symbol to lubricant list.

XI. Lubricant List: List each recommended lubricant by symbol, noting generic type of lubricant, and a minimum of two manufacturers. The recommended lubrication products shall include a specific cross reference to an equivalent Exxon (Mobil) product.

XII. CONTRACTOR's Work Order: Identify CONTRACTOR's Work order number.

XIII. Closest Service Technician: Identify the closest, factory trained, and authorized, service technician by name, address and telephone number. Include pager number if applicable.

XIV. Closest Parts and Service Center: List closest factory authorized parts and service center, the physical address for shipping and receiving and mailing address (if different from physical address). Include telephone number and facsimile telephone number.

i. Troubleshooting Guides and Diagnostic Techniques

1) Include step-by-step procedures to promptly isolate the cause of typical malfunctions. Describe clearly why the checkout is performed and what conditions are to be sought. Identify tests or inspections and test equipment required to determine whether parts and equipment may be reused or requires replacement. Emergency shutdown and troubleshooting guide. Provide information to shut down and startup the equipment under emergency conditions.

j. Spare Parts, Part Identification, and Drawings

1) Spare Parts and Supply Lists: Include lists of spare parts and supplies required for maintenance and repair to ensure continued service or operation without unreasonable delays.

2) Parts Identification: Provide identification and coverage for all parts of each component and accessory of the end items subject to replacement. Include special hardware requirements, such as requirement to use high-strength bolts and nuts. Identify parts by make, model, serial number, and source of supply to allow reordering without any further identification required. Provide clear and legible illustrations, drawings, and exploded views to enable easy identification of the items. When illustrations and separate listing to show the index, reference, or key number which will cross-reference the illustrated part to be the listed part. Parts shown in the listings to be grouped by components.

a) Manufacturer's Standard Commercial Practice (MSCP): The parts data may cover more than one model or series of equipment, components,

attachments, or accessories, such as a master parts catalog, in accordance with the manufacturer's standard commercial practice.

b) Other than Manufacturer's Standard Commercial Practice (MSCP): Final assembly manufacturer may add a cross-reference to implement components' assemblies and parts requirements when implementation in manual form varies significantly from the style, format, and method of manufacturer's standard commercial practice. Use the format in the following example:

Final Assembly Manufacturer's Alphanumeric Sequence	Actual Manufacturer's Name and MSCP	Actual Manufacturer Part No.
100001	John Doe & Co. 00000	2000002

k. Technical Data

1) Detailed description of the function of each principal component in the system. Provide a written description of the individual components function in the overall operation outlined above.

2) Test procedures and factory test results if required. Provide a copy of all factory tests performed and a copy of the test results, and performance curves, where applicable.

3) Manufacturer's Certified Pump Curves and field pump tests data and pump curves.

4) Documentation of field functional tests and performance test described in the specifications. Include the test results and calibration reports of all equipment.

l. Warranties, Warranty/Asset Management Tracking Form, Affidavits of Installation, and Service Contracts

m. Prime Contractor will remain single point of contact after final completion for all warranty work.

n. Warranty Information: List and explain the various warranties and include the servicing and technical precautions prescribed by the manufacturers or CONTRACT documents to keep warranties in force.

o. The CONTRACTOR shall complete and submit the Asset Management Tracking Form included at the end of this Section. Asset management tag numbers along with warranty information shall be tracked using the form provided and submitted with the required affidavits at the completion of the project. The excel file of the form included will be provided to the CONTRACTOR upon request. The electronic file as well as hard copies shall be provided to the OWNER as required by the Specifications.

p. This Asset Management Tracking Form list must be broken down in sufficient detail and approved by OWNER: Sheet to be provided any time that a warranty period is initiated per CONTRACT DOCUMENTS. Provide data for all tagged equipment and components.

q. The OWNER will provide asset tags for equipment and the CONTRACTOR will be responsible for affixing the tags on the equipment. The CONTRACTOR shall not affix asset management tags until OWNER has accepted the installation.

1) Supplemental Documentation

a) General

I. Manufacturer's original printed and maintenance instructions for couplings, belt drives, chain drives, or other means of equipment connection, to include applicable tolerances and specifications.

II. Manufacturer's original printed operation and maintenance instructions for appurtenances such as solenoid valves, or hydraulic cylinder operators that are a supplied or integral part of the system or product.

III. Calibration data sheet including set points. Include all calibration data sheets, as outlined in Calibration and Testing Section.

b) Submission of Operation and Maintenance Manuals is applicable to but not limited to the following:

1.03 NOT USED

1.04 NOT USED

1.05 NOT USED

1.06 SUBMITTALS

A. No CD-ROM version of manuals shall be submitted prior to the approved final version of the manuals.

B. Only one (1) copy of the manual shall be written and submitted on a CD. Multiple copies of the manual submitted on one (1) CD will not be accepted.

C. Manuals shall be electronically transcribed matching the title, content, details, page number and sequence of the hard copy versions of the manuals.

D. Each CD or copy of the manual shall contain the latest version of Acrobat Reader software, which will allow the OWNER to access and read CD regardless of user's software. The CONTRACTOR can readily download software from the Internet.

E. CONTRACTOR shall also provide a CD video (DVD) of all O&M training sessions as part of the O&M submittals.

F. All drawings, cross-sectional view drawings, wiring diagram drawings, connection detail drawings, physical layout and detail drawings, elevations, etc., shall be

developed electronically using AutoCAD® Release 14 software (or latest AutoCAD® Release).

G. All Bill of Material sheets and/or tables indicating product data, quantities, physical location and reference, catalog number, reference, wiring diagram drawing number reference, cost, and any other field entered in the bill of materials sheet and/or any other spreadsheets and/or any other table and/or listings of references, etc., shall all be electronically developed and submitted in a database format, using the latest version of Microsoft® Access software. This applies to all summary sheets, material listings, etc., to be submitted for this Project. Submittals shall include hard-copies and an electronic version developed in Microsoft® Access. Electronic version shall be submitted on CD-ROM and loaded to project FTP site.

H. AutoCAD® drawings shall be developed in full adherence to the formats and drawing standards defined in the AWU CADD Manual. A copy of the manual may be obtained from the City of Austin Water & Wastewater Utility. Any drawing that is developed or customized for this project by CONTRACTOR, Subcontractor, Supplier or Manufacturer shall be developed in or converted to AutoCAD format and shall be submitted in both electronic AutoCAD format and hard copy with the O&M Manual and loaded to project FTP site.

I. All Operation and Maintenance - Maintenance Instruction Manuals, catalog sheets, product and component data sheets, and factory and on-site (field) test reports/data shall be submitted in bound hard-copies and electronic copies. Electronic copies shall be in Adobe Acrobat® (*.pdf files) latest edition and in the source software, where possible, including MS Word, Excel, Access, or AutoCAD. Other documents not prepared using these software packages shall be submitted in Adobe Acrobat® (*.pdf files) latest edition, and shall be submitted on CD-ROM and loaded to project FTP site.

J. Binders and File Organization of the Electronic Copies: Clearly label each CD-ROM copy of the electronic version of the O&M Manuals. The CD-ROM volume numbers, organization of the electronic files contained within, and labeling formats shall match and be identical to those of the hard-copies. Additionally, in each electronic volume (a CD-ROM), a navigation tool shall be installed that shall guide and navigate the user to open and/or close a desired section and/or subsection (within each volume) simply by clicking on the section/subsection name and number. Install a hard copy of the table of contents in the case (enclosure) of each CD-ROM and CD-ROM copies. All labels and tables of contents shall be neatly typed and labeled. Handwritten labels and/or tables of contents will not be accepted. Organize each set (a complete series) of O&M electronic copies in a CD-ROM hard-plastic case with locking and hinged cover. Install a neatly typed label on each case that shall provide all the information required to be listed on the cover of the O&M Manuals by these Specifications. This cover information should be repeated on the binder spine so that it is easy to read when all binders are stacked on a shelf.

K. It is the sole responsibility of the CONTRACTOR to ensure that all data submitted by the equipment supplier has been properly translated and incorporated onto the CD-ROM copies of the manuals. All hard and CD-ROM copies of the manuals shall match. All discrepancies and deviations between the hard and CD0-ROM copies of the manuals shall be corrected at the cost of the CONTRACTOR, unless OWNER's Representative has provided written approval of the deviation.

1.07 -1.11 NOT USED

PART II - NOT USED

PART III - EXECUTION

3.01 GENERAL

A. Submittal Schedule

1. Manuals shall be submitted according to the following schedule:

a. The preliminary copies of manuals shall be submitted following approval of the shop drawings, and no later than the on-site delivery for each piece of equipment.

b. The Final Operations & Maintenance Manuals will be the source documents for all manufacturer training, when specified, and subsequently for all check-out or start-up activities.

3.02 – 3.11 NOT USED

3.12 MEASUREMENT AND PAYMENT

A. No separate payment for work performed under this Section. Include cost of same in CONTRACT price bid for work of which this is a component part.

ATTACHMENT A

MAINTENANCE SUMMARY FORM

1. EQUIPMENT ITEM:

2. MANUFACTURER INFORMATION:

3. EQUIPMENT IDENTIFICATION NUMBER(S):

Equipment Tag Number	***Equipment Serial Number***	***Driver Serial Number***

4. TOTAL WEIGHT:

5. NAMEPLATE DATA (HP, Voltage, Speed, etc.):

6. MANUFACTURER'S LOCAL REPRESENTATIVE:

7. MAINTENANCE REQUIREMENTS:

Maintenance Operation	1. Frequency	***Lubricant*** (if applicable)	***Comments***

8. LUBRICANT LIST:

9. SPARE PARTS:

Part Description	***Quantity***	***Part Number***

10. CONTRACTOR'S JOB ORDER:

11. CLOSEST SERVICE TECHNICIAN:

12. CLOSEST PARTS AND SERVICE CENTER

City of Austin
Austin Water Utility
Asset Management Tracking Form

Facility	Project Number	Project ID

Equipment Position /Location Tag	Equipment Description	Manufacturer	Model	Serial Number	Asset Number Sticker	Startup Date	Warranty Expiration Date	Estimated Replacement Material Cost	Estimated Replacement Labor Cost	Expected Useful Life	Start Reading	Expiration Reading	Service Contract Available?

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PART I - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Administrative and procedural requirements for instruction of operations and maintenance personnel.

2. Qualifications requirements for Suppliers' training personnel.

3. General requirements for training.

4. Schedule of required training sessions.

B. Scope:

1. Contractor shall furnish services of Suppliers' operation and maintenance training specialists to instruct Owner's personnel in recommended operating and maintenance procedures for materials and equipment furnished, in accordance with the Contract Documents.

2. Each Supplier shall provide a combination of classroom and field training at the Site, unless otherwise required elsewhere in the Contract Documents.
Owner reserves the right to record training sessions on video for Owner's later use in instructing Owner's personnel.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Scheduling of Training Sessions:

1. General:

a. Contractor shall coordinate training services with checkout, startup, and initial operation of materials and equipment on days and times, and in manner, acceptable to Owner, in accordance with the Contract Documents.

b. Training may be required outside of normal business hours to accommodate schedules of operations and maintenance personnel. Provide training services at the required days and times at no additional cost to Owner.

2. Prerequisites to Training:

a. At option of Owner or Engineer, training may be allowed to take place before, during, or after checkout and startup of materials and equipment.

3. Training Schedule Submittal:

a. Training Schedule Required: Contractor shall prepare and submit proposed training schedule for review and acceptance by Engineer and Owner. Proposed

training schedule shall show and indicate all training required in the Contract Documents, and shall demonstrate compliance with specified training requirements relative to number of hours of training for various elements of the Work, number of training sessions, and scheduling.

b. Training Schedule Coordination: When Project has multiple prime contracts, prime Contractors shall comply with this Specifications section. All prime Contractors shall coordinate with the General Contractor in developing a single training schedule Submittal for the entire Project, to be submitted by General Contractor. All prime Contractors shall implement training in accordance with the approved training schedule.

c. Timing of Training Schedule Submittal: Submit initial training schedule not less than 60 days before scheduled start of first training session. Submit final training schedule, incorporating revisions in accordance with Engineer's comments, not later than 30 days prior to starting the first training session.

d. Owner reserves the right to modify personnel availability for training in accordance with process or emergency needs at the facility.

B. Training Scheduling Conference:

1. Prior to preparing initial training schedule Submittal, schedule and hold training scheduling conference at the location where progress meetings are held, to review:

a. Training requirements indicated in the Contract Documents.

b. Work to be completed prior to commencing training.

c. Work progress and Progress Schedule relative to startup and training.

d. Scheduling constraints for Owner's personnel, relative to days and times of training sessions.

e. Preferred days for training.

f. Location where training will be performed and facilities available.

g. Required Submittals relative to training.

h. Other issues relative to training of operations and maintenance personnel.

2. Attendance is mandatory for the following:

a. Contractor's project manager.

b. Contractor's Site superintendent.

c. Project manager of Subcontractors responsible for furnishing materials and equipment for which training of operations and maintenance personnel is required.

d. Suppliers invited by Contractor.

e. Engineer.

f. Resident Project Representative (RPR).

g. Owner's Site Representative (OSR).

h. Facility manager's staff responsible for training coordination, and staff responsible for scheduling operations and maintenance personnel.

3. If additional information must be developed to adequately cover agenda items, reconvene conference as soon as possible.

4. Contractor shall prepare minutes summarizing the discussions of conference, decisions made, and agreements and disagreements, and distribute the minutes to each conference attendee and others as appropriate.

1.03 QUALITY ASSURANCE

A. Qualifications:

1. Supplier's Instructors:

a. Shall be factory-trained by manufacturer of material or equipment.

b. Supplier's instructors shall be proficient and experienced in performing training of the types required.

c. Instructors shall be proficient, clear, and easily understandable in spoken and written English language.

d. Qualifications of instructors are subject to acceptance by Engineer. If Engineer does not accept qualifications of proposed instructor, provide services of replacement instructor with acceptable qualifications.

1.04 SUBMITTALS

A. Action Submittals: Submit the following:

1. Training Schedule: Detailed schedule of training sessions, demonstrating compliance with number of training sessions, hours required in the Contract Documents, and complying with the Contract Times. Submit training schedule Submittals in accordance with time frames specified in this Specifications section.

B. Informational Submittals: Submit the following:

1. Lesson Plan: Acceptable lesson plan for training on each material or equipment item, in accordance with Table SS01792-A and the Contract Documents. Lesson plan shall comply with requirements of this Specifications section as may be supplemented by Specifications sections where materials and equipment are specified. Include with lesson plan copy of handouts that will be used during

training sessions. Submit lesson plan Submittals in accordance with time frames specified in this Specifications section.

2. Qualifications:

   a. Credentials of Supplier's proposed operations and maintenance instructor(s). Credentials shall demonstrate compliance with requirements of this Specifications section and shall include brief resume' and specific details of instructor's operating, maintenance, and training experience relative to the specific material and equipment for which instructor will provide training.

3. Minutes of training scheduling conference.

C. Closeout Submittals: Submit the following:

1. Trainee sign-in sheets for each training session. Submit to Owner's training coordinator with copy to Engineer.

1.05 LESSON PLAN

A. Supplier's lesson plan shall describe specific instruction topics, system components for which training will be provided, and training procedures. Handouts, if any, to be used in training shall be included with the lesson plan. Describe in lesson plan "hands-on" demonstrations planned for training sessions.

B. Submit acceptable lesson plan not less than 21 days prior to starting associated training.

C. Indicate in lesson plan estimated duration of each training segment.

D. Lesson plan shall include the following:

1. Material and Equipment Overview (required for all types of operations and maintenance training):

   a. Describe material and equipment's operating (process) function and performance objectives.

   b. Describe material and equipment's fundamental operating principles and dynamics.

   c. Identify equipment's mechanical, electrical, and electronic components and features. Group related components into subsystems and describe function of subsystem and subsystem's interaction with other subsystems.

   d. Identify all support materials and equipment associated with operation of subject equipment, such as air intake filters, valve actuators, motors, and other appurtenant items and equipment.

   e. Identify and describe safety precautions and potential hazards related to operation.

f. Identify and describe in detail safety and control interlocks.

2. Operations Personnel Training:

   a. Material and Equipment Overview: As described in Paragraph 1.5.D.1 of this Specifications section.

   b. Operation:

      1) Describe operating principles and practices.

      2) Describe routine operating, startup, and shutdown procedures.

      3) Describe abnormal or emergency startup, operating, and shutdown procedures that may apply.

      4) Describe alarm conditions and responses to alarms.

      5) Describe routine monitoring and recordkeeping procedures.

      6) Describe recommended housekeeping procedures.

   c. Troubleshooting:

      1) Describe how to determine if corrective maintenance or an operating parameter adjustment is required.

3. Mechanical Maintenance Training:

   a. Material and Equipment Overview: As described in Paragraph 1.5.D.1 of this Specifications section.

   b. Material and Equipment Preventive Maintenance:

      1) Describe preventative maintenance inspection procedures required to:

         a) Inspect materials and equipment in operation.

         b) Identify potential trouble symptoms and anticipate breakdowns.

         c) Forecast maintenance requirements (predictive maintenance).

      2) Define recommended preventative maintenance intervals for each component.

      3) Describe lubricant and replacement part recommendations and limitations.

      4) Describe appropriate cleaning practices and recommend intervals.

      5) Identify and describe use of special tools required for maintenance of materials and equipment.

6) Describe component removal, installation, and disassembly and assembly procedures.

7) Perform "hands-on" demonstrations of preventive maintenance procedures.

8) Describe recommended measuring instruments and procedures, and provide instruction on interpreting alignment measurements, as appropriate.

9) Define recommended torqueing, mounting, calibrating, and aligning procedures, tolerances, and settings, as appropriate.

10) Describe recommended procedures to check and test equipment following corrective maintenance.

c. Troubleshooting:

1) Define recommended systematic troubleshooting procedures.

2) Provide component-specific troubleshooting checklists.

3) Describe applicable materials and equipment testing and diagnostic procedures to facilitate troubleshooting.

4) Describe common corrective maintenance procedures with "hands-on" demonstrations.

4. Instrumentation/Controls and Electrical Maintenance Training:

a. Materials and Equipment Overview: As described in Paragraph 1.5.D.1 of this Specifications section.

b. Preventative Maintenance and Troubleshooting of Instrumentation and Control Systems: In accordance with Divisions 16 and 17.

c. Engineer may grant waiver(s) to allow all training for a given system to be at the location of Owner's training facility.

d. Preventative Maintenance and Troubleshooting of Other Electrical Systems: In accordance with requirements for Paragraph 1.5.D.3 of this Specifications section.

1.06 TRAINING AIDS

A. Supplier's instructor(s) shall incorporate training aids as appropriate to assist in the instruction. Provide handouts of text, tables, graphs, and illustrations as required. Other appropriate training aids include:

1. Audio-visual aids, such as videos, Microsoft PowerPoint presentations, overhead transparencies, posters, drawings, diagrams, catalog sheets, or other items.

2. Equipment cutaways and samples, such as spare parts and damaged equipment.

3. Tools, such as repair tools, customized tools, and measuring and calibrating instruments.

B. Handouts:

1. Supplier's instructor(s) shall distribute and use descriptive handouts during training. Customized handouts developed especially for training for the Project are encouraged.

2. Photocopied handouts shall be good quality and completely legible.

3. Handouts shall be coordinated with the instruction, with frequent references made to the handouts.

4. Provide not less than 15 paper copies of each handout for each training session.

C. Audio-Visual Equipment: Training provider shall provide audio-visual equipment required for training sessions. If suitable equipment is available at the Site, Owner may make available facility's expiring audio-visual equipment; however, do not count on facility's expiring audio-visual equipment, if any, being available. Audio-visual equipment that training provider shall provide, as required, includes:

1. Laptop computer, presentation software, and suitable projector.

2. Power cords, power strips/surge protectors.

3. As required, extension cords, HDMI cables and other video cabling, and spare bulb for projector.

4. Laser pointer/slideshow remote controller with extra batteries.

PART II - PRODUCTS (NOT USED)

PART III - EXECUTION

3.01 TRAINING DELIVERY

A. Training Delivery – General:

1. Instructors shall be fully prepared for the training sessions. Training delivery shall be communicative, clear, and proceed according to lesson plan accepted by Engineer, with lesson content appropriate for trainees. If Owner or Engineer deems that training delivery does not comply with the Contract Documents, training shall be postponed, rescheduled, and re-performed in acceptable manner at no additional cost to Owner.

2. Trainee Sign-in Sheets: In format acceptable to Owner, furnish sign-in sheet for trainees for each session. Sign-in sheets shall include the Project name; materials, equipment, or system for which training was provided; and type of training (e.g., operations, mechanical maintenance, instrumentation/controls and electrical maintenance, or other), and full name and operator license number (when

applicable) of each trainee. Upon completion of training, submit copy of each sign-in sheet as indicated in Article 1.4 of this Specifications section.

B. "Hands-on" Demonstrations:

1. Supplier's instructor(s) shall present "hands-on" demonstrations of operations and maintenance of materials and equipment for each training session, in accordance with lesson plan accepted by Engineer.

2. Contractor and manufacturer shall furnish tools necessary for demonstrations.

END

ARTICLE 1 - GENERAL

1.1 RELATED DOCUMENTS

The following documents are a part of this section:

All documents in Bidding Requirements, Contract Forms and Conditions of the Contract.

Other sections of Division 1 - General Requirements apply to this section.

1.2 DESCRIPTION AND INTENT OF THE WORK

No asbestos containing material (ACM) shall be brought onto the Project site, and/or incorporated into the Project construction without the written consent of the OWNER. Any asbestos containing material found at any time including after contract completion, to have been brought onto the site or incorporated into the Project construction by the CONTRACTOR, or any Subcontractors, Sub-Subcontractors or Suppliers, shall be removed and disposed of in accordance with the then current governmental regulatory standards.

All costs associated with the inspection, sampling, testing, removal and disposal of ACM as described above shall be paid by the CONTRACTOR.

1.3 DEFINITIONS

ASBESTOS: The asbestiform varieties of serpentine (chrysotile), riebeckite (crocidolite) cummingtonite-grunerite (amosite), anthophyllite, actinolite and tremolite.

ASBESTOS CONTAINING MATERIAL (ACM): Any material containing more than one percent (1%) by weight of asbestos of any type or mixture of types.

ASBESTOS CONTAINING BUILDING MATERIAL (ACBM): Any material used in the construction of, or incorporated into the construction of, any building that contains more than one percent (1%) by weight of asbestos of any type or mixture of types.

MSDS: A material safety data sheet (MSDS) is a form containing data regarding the properties of component substances that comprise a manufactured product. They are a basic hazard communication tool that gives details on chemical and physical dangers, safety procedures, and emergency responses for chemicals.

1.4 QUALITY ASSURANCE

The E/A has signed the following:

A. 01900A Statement of Non-Inclusion of Asbestos Containing Material (E/A, Prior to Design): stating that the Engineer/Architect shall not specify, request or approve any ACM in this Project without prior written approval of OWNER.

B. 01900B Statement of Non-Inclusion of Asbestos Containing Material (E/A, After Design): stating that the Engineer/Architect has not specified, requested or approved any ACM in this Project without the prior written approval of the OWNER, and that any ACM allowed in this Project is identified in the Statements.

These Statements are included in the Construction Documents.

ASBESTOS CONTAINING MATERIALS PROHIBITED FROM SITE

No asbestos containing materials will be permitted as part of the Project construction. The following list is intended to be used as a general guide to show which types of materials are suspected to contain asbestos:

- Cement Pipes
- Cement Wallboard
- Cement Siding
- Asphalt Floor Tile
- Vinyl Floor Tile
- Vinyl Sheet Flooring/vinyl wall coverings
- Flooring Backing
- Construction Mastics (floor tile, carpet, ceiling tile, etc.)
- Acoustical Plaster
- Decorative Plaster / stucco
- Textured Paintings/Coatings
- Ceiling Tiles and Lay-in Panels
- Spray-Applied Insulation
- Blown-in Insulation
- Fireproofing Materials
- Taping Compounds (thermal)
- Packing Materials (for wall/floor penetrations)
- High Temperature Gaskets
- Laboratory Gloves
- Fire Blankets
- Fire Curtains
- Elevator Equipment Panels
- Elevator Brake Shoes
- HVAC Duct Insulation
- Boiler Insulation
- Breeching Insulation
- Ductwork Flexible Fabric Connections
- Cooling Towers
- Pipe Insulation (corrugated air-cell, block, etc.)
- Heating and Electrical Ducts
- Electrical Panel Partitions
- Electric Cloth
- Electric Wiring Insulation
- Chalkboards
- Roofing Shingles / tiles / membranes
- Roofing Felt
- Roof Coatings
- Base Flashing
- Thermal Paper Products
- Fire Doors
- Caulking/Putties
- Adhesives / mastics
- Wallboard
- Joint Compounds
- Spackling Compounds
- Laboratory hoods/tabletops
- CMU block fill materials

If any of these suspect materials are specified for use on the Project, and if they do not have specific labelling identifying them as asbestos free, then the CONTRACTOR shall notify the OWNER immediately. Laboratory analysis of the material by an OWNER-approved laboratory shall be performed at CONTRACTOR's expense in order to warrant that the material does not contain asbestos. A copy of the package labelling or results of laboratory testing must be provided to the OWNER prior to inclusion of the specified material during construction. Contractor's construction submittals must include MSDSs for all new materials used in construction of buildings, facilties and infrastructure.

1.5 SUBMITTALS

NON-USE OF ASBESTOS AFFIDAVITS

At the time that the CONTRACTOR signs the Agreement, they shall sign a Non-Use of Asbestos Affidavit (Contractor Prior to Construction), Contract Document 00680. This Affidavit certifies that the CONTRACTOR agrees that they will not allow any asbestos containing materials to be incorporated into the construction of the Project or allow any asbestos containing building materials on the site for which the OWNER has not given prior written approval.

Prior to final payment, the CONTRACTOR will provide to the OWNER a Non-Use of Asbestos Affidavit (Contractor After Construction), Contract Document 00681. This Affidavit certifies that the CONTRACTOR did not allow asbestos containing materials to be incorporated into the construction or allowed any asbestos containing building materials on the site for which the OWNER of the Project did not give prior written approval.

ASBESTOS CONTAINING MATERIALS: When any asbestos containing materials are used on the Project, provide the following information:

A detailed description of the material containing the asbestos.

The type and percent of asbestos contained in the material.

The quantity of the materials used, including the square footage, or in the case of pipe insulation, the size and linear footage.

A drawing showing the exact location of any asbestos containing materials.

Final payment shall be withheld until the above described Affidavits, submittals and/or information are received and approved.

END

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CITY OF AUSTIN

STATEMENT OF NON-INCLUSION OF ASBESTOS CONTAINING MATERIAL

STATE OF TEXAS
COUNTY OF TRAVIS

ENGINEER/ARCHITECT PRIOR TO DESIGN

"My name is William Wehner, hereinafter known as Authorized Representative.

"I am over the age of 18 years and I have never been convicted of a crime. I am the Engineer of HDR Engineering hereinafter known as ENGINEER/ARCHITECT.

"I am fully competent to make this statement. I have personal knowledge of the facts set forth below and they are all true and correct.

"WHEREAS ENGINEER/ARCHITECT has been selected to provide designs, to prepare the bid and construction documents, and to assist the City of Austin, Texas, hereinafter known as OWNER, during the construction of Ullrich Low Service Pump Station Electrical Feed Renewal Project, located at 1000 Forest View Dr., Austin, TX 78746, Austin, Texas, hereinafter known as Project, and

"WHEREAS asbestos in a dust form is a recognized health hazard, and
"WHEREAS the OWNER desires not to have any asbestos containing materials used or incorporated into the construction of the Project;
"THEREFORE the ENGINEER/ARCHITECT affirms that to the best of its knowledge and belief:

1. The ENGINEER/ARCHITECT, any person, firm or organization representing or represented by the ENGINEER/ARCHITECT, shall not knowingly specify, request, or approve for use in conjunction with the Project, any asbestos containing materials or any other materials defined as containing asbestos by any laws, rules or regulations promulgated by the United States Government, the State of Texas or any governmental organization or agency operating under the authority of either of those entities.
2. Realizing that there might be materials required in which a satisfactory non-asbestos containing material cannot be obtained, the ENGINEER/ARCHITECT will do the following before specifying any asbestos containing material:
   A. Inform the OWNER's Project Manager for this Project, in writing, of any intent to specify asbestos containing materials.
   B. Receive written approval from the City of Austin Project Manager for the specifying of any asbestos containing materials.
   C. At the completion of the design phase, and before the OWNER receives any bids for this Project, provide to the Project Manager, in writing, the proposed location of any asbestos containing materials, the type of asbestos they contain, and the percent of asbestos by types.
3. The ENGINEER/ARCHITECT states its understanding that if any asbestos containing materials not approved by the OWNER for inclusion into the Project, are determined, as a result of any inspection and sample analysis performed by an individual(s) and/or firm(s) certified and/or licensed to perform such inspection by the United States Government and/or the State of Texas, to have been knowingly specified, requested and/or approved by the ENGINEER/ARCHITECT for inclusion in the Project, the OWNER shall look to the ENGINEER/ARCHITECT for reimbursement of any and all costs incurred in the removal and/or other abatement of said asbestos containing materials.
4. ENGINEER/ARCHITECT further understands that OWNER shall also look to the ENGINEER/ARCHITECT for any and all damages to OWNER which result from the inability of the OWNER to use any portion or all of the Project due to the incorporation of asbestos containing materials that have been knowingly specified, requested and/or approved by the ENGINEER/ARCHITECT.
5. ENGINEER/ARCHITECT further understands that OWNER will pursue reimbursement of any said cost and compensation for any said damages from the ENGINEER/ARCHITECT by any and every means within OWNER's right and power.

Signature of Authorized Representative: William Wehner

STATE OF TEXAS
COUNTY OF TRAVIS

ON July 7th, 2020 personally appeared William Wehner and been duly sworn by me, subscribed to the foregoing statement and has stated that the facts stated therein are true and correct.

TERI MORGAN
Notary Public, State of Texas
Comm. Expires 12-28-2020
Notary ID 411337-3

Notary Public, State of Texas Teri J Morgan

Printed Name of Notary Teri J Morgan

My Commission Expires: 12-28-2020

01605A.00/110392

CITY OF AUSTIN

STATEMENT OF NON-INCLUSION OF ASBESTOS CONTAINING MATERIAL

STATE OF TEXAS
COUNTY OF TRAVIS

ENGINEER/ARCHITECT AFTER DESIGN

"My name is William Wehner, hereinafter known as Authorized Representative.

"I am over the age of 18 years and I have never been convicted of a crime. I am the Engineer of HDR Engineering hereinafter known as ENGINEER/ARCHITECT.

"I am fully competent to make this statement. I have personal knowledge of the facts set forth below and they are all true and correct.

"WHEREAS ENGINEER/ARCHITECT has been selected to provide designs, to prepare the bid and construction documents, and to assist the City of Austin, Texas, hereinafter known as OWNER, during the construction of Ullrich Low Service Pump Station Electrical Feed Renewal Project, located at 1000 Forest View Dr., Austin, TX 78746 Austin, Texas, hereinafter known as Project, and

"WHEREAS asbestos in a dust form is a recognized health hazard, and
"WHEREAS the OWNER desires not to have any asbestos containing materials used or incorporated into the construction of the Project;
"THEREFORE the ENGINEER/ARCHITECT affirms that to the best of its knowledge and belief:

1. The ENGINEER/ARCHITECT, any person, firm or organization representing or represented by the ENGINEER/ARCHITECT, shall not knowingly specify, request, or approve for use in conjunction with the Project, any asbestos containing materials or any other materials defined as containing asbestos by any laws, rules or regulations promulgated by the United States Government, the State of Texas or any governmental organization or agency operating under the authority of either of those entities.
2. The only exceptions to the above statement are the following materials that are required because a satisfactory non-asbestos containing material cannot be obtained. The inclusion of these materials has been approved by the OWNER's Project Manager for this Project.

   _____

   _____

   _____

   _____

3. The ENGINEER/ARCHITECT states its understanding that if any asbestos containing materials not approved by the OWNER for inclusion into the Project, are determined, as a result of any inspection and sample analysis performed by an individual(s) and/or firm(s) certified and/or licensed to perform such inspection by the United States Government and/or the State of Texas, to have been knowingly specified, requested and/or approved by the ENGINEER/ARCHITECT for inclusion in the Project, the OWNER shall look to the ENGINEER/ARCHITECT for reimbursement of any and all costs incurred in the removal and/or other abatement of said asbestos containing materials.
4. ENGINEER/ARCHITECT further understands that OWNER shall also look to the ENGINEER/ARCHITECT for any and all damages to OWNER which result from the inability of the OWNER to use any portion or all of the Project due to the incorporation of asbestos containing materials that have been knowingly specified, requested and/or approved by the ENGINEER/ARCHITECT.
5. ENGINEER/ARCHITECT further understands that OWNER will pursue reimbursement of any said cost and compensation for any said damages from the ENGINEER/ARCHITECT by any and every means within OWNER's right and power.

Signature of Authorized Representative: William Wehner

STATE OF TEXAS
COUNTY OF TRAVIS

ON July 7th, 2020 personally appeared William Wehner and been duly sworn by me, subscribed to the foregoing statement and has stated that the facts stated therein are true and correct.

TERI MORGAN
Notary Public, State of Texas
Comm. Expires 12-28-2020
Notary ID 411337-3

Notary Public, State of Texas Teri J Morgan

Printed Name of Notary Teri J Morgan

My Commission Expires: 12-28-2020

01605B/110392

1. OVERVIEW AND PROJECT INFORMATION

Following is a summary of information for this Project. Bidder is cautioned to refer to other sections of the Project Manual, Drawings and Addenda (Bid Documents) for further details.

The City of Austin, hereafter called OWNER, is requesting Bids for furnishing all labor, materials, equipment, supervision, and incidentals, and for performing all Work required for the following:

Project:	Ullrich WTP Low Service Pump Station Electrical Feed Renewal
Located at:	Austin, TX
CIP ID No.:	5335.016
Solicitation No.:	CLMC822

The Work consists of the construction of the Ullrich Low Service Pump Station electrical switchgear enclosure (Substation No. 4) and service road, the installation of ductbank and equipment pads for Austin Energy primary metering equipment, the installation of 919 LF of 4FTx5FT Ductbank, 585 LF of 12INx18IN Ductbank, the installation of 10 electrical manholes, renovation of the 480 volt power distribution system at the Low Service Pump Station, replacement of the medium voltage service transformer at the Powder Activated Carbon building, and all associated electrical, mechanical, and instrumentation work required to build a fully functional system.

2. BID DOCUMENTS

Bid Documents are obtained through the City's Vendor Connection website, log on www.austintexas.gov/financeonline/vendor_connection/index.cfm. A complete set of Bid Documents, including all sections of the Project Manual and Drawings, are included in the attachments section of each solicitation.

All addenda and answers to Bidders' questions will also be posted in the attachments section for each solicitation on the City's Vendor Connection website.

3. SUBMISSION OF BIDS

Sealed Bids may be submitted to the Capital Contracting Office Bid Opening Desk located at One Texas Center, 505 Barton Springs Rd., Suite 1045-B, Austin, Texas 78704, or may be submitted electronically (see eResponse, Attachment 1 -Submitting Bids in Austin Finance Online).

Sealed Bid may be mailed using address below:

Address for US Mail (If mailed to the physical address, the proposal will be returned unopened)	**Address for Hand Delivery, FedEx, UPS or Courier**
City of Austin	City of Austin, One Texas Center
Capital Contracting Office	Capital Contracting Office
P. O. Box 1088	505 Barton Springs Road, Suite 1045-C
Austin, Texas 78767-8845	Austin, Texas 78704

NOTE: Bids must either be received and time stamped in the Capital Contracting Office prior to the Due Date and Time or submitted electronically via Austin Finance Online. The time of record for those electronically submitted is the time received in Austin Finance OnLine. It is the responsibility of the Offeror to ensure that their Bid arrives at the reception desk in the Capital Contracting Office or electronically prior to the time and date indicated. Arrival at the City's mailroom, mail terminal, or post office box will not constitute the Proposal arriving on time.

Public Bid Opening Update
Due to the unprecedented event of COVID-19 and to help prevent the further spread, Capital Contracting Office will NOT be conducting an in person bid opening. Bidders must either submit their bids and compliance plans no earlier than 10:00 AM and prior to 2:00 PM on the date bids are due to One Texas Center, 505 Barton Springs Rd., Suite 1045-B, Austin, Texas 78704; or must submit Bids and Compliance Plans electronically via Austin Finance Online prior to 2:00 PM on the day proposals are due. Bids and compliance plans submitted after 2:00 PM on the date bids are due will not be accepted. The Capital Contracting Office will open both the sealed bids and bids received electronically via Austin Finance Online at 3:00 PM on the date bids are due.

Bidders may watch the bid opening online using the following Web link: CCO Web Bid Opening Click Here

Disclaimer: The result of the bid opening does not become final until all bids are verified, and the bid tab is certified. The pencil bid tab and certified bid tab will be posted in Austin Finance Online at the following link:

https://www.austintexas.gov/financeonline/account_services/solicitation/solicitations.cfm

ALL BIDS ARE DUE PRIOR TO (Austin time) 2:00 PM, Thursday October 22nd, 2020.

ALL COMPLIANCE PLANS ARE DUE PRIOR TO (Austin time) 2:00 PM, Thursday October 22nd, 2020.

BIDS WILL BE OPENED AT (Austin time) 3:00 PM, Thursday October 22nd, 2020.

ALL BIDS AND COMPLIANCE PLANS NOT RECEIVED PRIOR TO THE DATE AND TIME SET FORTH ABOVE WILL NOT BE ACCEPTED FOR CONSIDERATION. The time stamp clock in SUITE 1045B is the time of record and is verified with www.time.gov, the official U.S. time. For Bids submitted electronically via Austin Finance Online, the time of record is the time received in Austin Finance Online.

4. VENDOR REGISTRATION AND NON-DISCRIMINATION

Prime Contractors must be registered with the OWNER prior to submitting a Bid electronically via Austin Finance Online. All CONTRACTORS must be registered to do business with OWNER prior to the Contract Award. All Subcontractors must be registered with the OWNER prior to execution of a contract. Prime Contractors are responsible for ensuring that their Subcontractors are registered as vendors with the City of Austin. Registration can be done through the OWNER's on-line Vendor Registration system. Log onto and follow directions: https://www.austintexas.gov/financeonline/account_services/account/login.cfm

The City of Austin, in accordance with the provisions of Title VI of the Civil Rights Act of 1964 (78 Stat. 252, 42 U.S.C. §§ 2000d to 2000d-4) and the Regulations, hereby notifies

all bidders that it will affirmatively ensure that any contract entered into pursuant to this advertisement, disadvantaged business enterprises will be afforded full and fair opportunity to submit bids in response to this invitation and will not be discriminated against on the grounds of race, color, or national origin in consideration for an award.

5. MBE/WBE PROCUREMENT PROGRAM

All City procurements are subject to the City's Minority-Owned and Women-Owned Business Enterprise Procurement Program found at Chapter 2-9-A of the City Code, as amended. The Program provides Minority-Owned and Women-Owned Business Enterprises (MBEs/WBEs) or Disadvantaged Business Enterprises (DBEs) full opportunity to participate in all City contracts. Goals for MBE/WBE or DBE participation are stated for each solicitation. Information on achieving the goals or documenting good faith efforts to achieve the goals are contained in the MBE/WBE Procurement Program Package or DBE Procurement Program Package attached to the solicitation. When goals are established, Bidders are required to complete and return the MBE/WBE or DBE Compliance Plan with their Bid. If a Compliance Plan is not submitted prior to the date and time set forth in the solicitation, the Bid will not be accepted for consideration. (See Section 00820 for MBE/WBE requirements on "no goal" solicitations.)

6. BID GUARANTY

All Bids shall be accompanied by an acceptable Bid guaranty in an amount of not less than five percent (5%) of the total Bid, as specified in Section 00100, Instructions to Bidders.

7. BONDS AND INSURANCE

Performance and payment bonds when required shall be executed on forms furnished by OWNER. Each bond shall be issued in an amount of one hundred percent (100%) of the Contract Amount by a solvent corporate surety company authorized to do business in the State of Texas, and shall meet any other requirements established by law or by OWNER pursuant to applicable law.

Minimum insurance requirements are specified in Section 00810, Supplemental General Conditions.

8. WAGE COMPLIANCE

Minimum wage rates have been established and are specified in Section 00830, Wage Rates and Payroll Reporting.

9. CONTRACT TIME

Contract Time is of the essence and all Work shall be substantially completed within 960 Calendar Days after date specified in the Notice to Proceed, in accordance with the Bid Form, Section 00300L.

Final completion shall be achieved within 30 Calendar Days after substantial completion.

Liquidated damages are one thousand six hundred and sixty dollars ($1,660) per Calendar Day for failure to substantially complete the work and six hundred and fifty dollars ($650) per Calendar Day for failure to achieve final completion within 30 Calendar Days after substantial completion, in accordance with the Bid Form, Section 00300L.

10. OWNER'S RIGHTS

OWNER reserves the right to reject any or all Bids and to waive any minor informality in any Bid or solicitation procedure (a minor informality is one that does not affect the competitiveness of the Bid).

11. PRE-BID CONFERENCE

A **mandatory** Pre-Bid Conference will be held on Thursday, September 17th at 10:00 AM (Austin time), via Microsoft Teams. Click Here

Attendance is mandatory unless otherwise stated. Bidders must attend any mandatory Pre-Bid Conference and are encouraged to attend any non-mandatory Pre-Bid Conference to ensure their understanding of OWNER's bidding and contracting requirements, particularly MBE/WBE or DBE Procurement Program requirements. If the Pre-Bid Conference is mandatory the Bidder must arrive and sign-in within fifteen (15) minutes of the scheduled start time of the meeting, otherwise the Bidder will not be allowed to submit a Bid for the project.

12. ANTI-LOBBYING AND PROCUREMENT

On June 14, 2018, the Austin City Council adopted Ordinance No. 20180614-056 replacing Chapter 2.7, Article 6 of the City Code relating to Anti-Lobbying and Procurement. The policy defined in this Code applies to Solicitations for goods and/or services requiring City Council approval under City Charter Article VII, Section 15 (Purchase Procedures). The City requires Offerors submitting Offers on this Solicitation to certify that the Offeror has not in any way directly or indirectly had communication restricted in the ordinance section 2-7-104 during the No-Lobbying Period as defined in the Ordinance. The text of the City Ordinance is posted on the Internet at:

https://assets.austintexas.gov/purchase/downloads/New_ALO_Ordinance_No_20180614-056.pdf

13. AUTHORIZED CONTACT PERSONS

The persons listed below may be contacted for information regarding the Invitation for Bid.

PROJECT MANAGER: Robyn Haasch, PMP, 512-974-2624, email robyn.haasch@austintexas.gov

CAPITAL CONTRACTING OFFICE CONTACT: Steven Cocke, phone 512-974-7998, email steven.cocke@austintexas.gov

SMALL & MINORITY BUSINESS RESOURCES DEPARTMENT CONTACT: Kenneth Kalu, phone 512-974-7621, email kenneth.kalu@austintexas.gov

END

PART I - GENERAL

1.01 SUMMARY

A. Section Includes:

1. General requirements for cutting and patching Work.

B. Scope:

1. Contractor shall perform cutting and coring, and rough and finish patching of holes and openings in existing construction.

2. Provide cutting, coring, fitting, and patching, including attendant excavation and fill, required to complete the Work, and to:

a. remove and replace defective Work;

b. remove samples of installed Work as specified or required for testing;

c. remove construction required to perform required alterations or additions to existing construction;

d. uncover the Work for Engineer's observation of covered Work, testing, or inspection by testing entities, or observation by authorities having jurisdiction;

e. connect to completed Work not performed in proper sequence;

f. remove or relocate existing utilities and piping that obstruct the Work in locations where connections are to be made;

g. make connections or alterations to existing or new facilities.

C. Related Requirements:

1. Division 3 - Concrete.

2. Section 09900 – Painting.

1.02 SUBMITTALS

A. Action Submittals: Submit the following:

1. Cutting and Patching Request:

a. Submit written request to Engineer, well in advance of executing cutting or alteration that affects one or more of the following:

1) Design function or intent of Project.

2) Work of Owner or other contractors retained by Owner.

3) Structural capacity or integrity of an element of the Project, building, or structure.

4) Integrity or effectiveness of weather-exposed or moisture-resistant elements or systems.

5) Efficiency, operational life, maintenance, or safety of operational elements.

6) Visual qualities of elements that will be exposed to view after completion of the Work.

b. Request shall include:

1) Identification of Project and Contract designation.

2) Description of affected Work of Contractor and work of others (if any) retained by Owner.

3) Necessity for cutting.

4) Effect on work or operations of Owner and other contractors (if any) retained by Owner, and on structural and weatherproof integrity of Project, building, or structure.

5) Description of proposed Work, indicating: scope of cutting and patching; trades that will execute the cutting and patching Work; materials and equipment to be used; extent of refinishing; schedule of operations; alternatives (if any) to cutting and patching, and net effect on aesthetics following completion of finishing Work.

6) Indication of entity responsible for cost of cutting and patching, when applicable.

7) Written permission of other prime contractors (if any) whose work will or may be affected.

2. Recommendation Regarding Cutting and Patching:

a. Should conditions of work or schedule indicate a change of materials or specified methods, furnish Submit written recommendation to Engineer including:

1) Conditions indicating change.

2) Recommendations for alternative materials or alternatives to specified methods.

3) Material manufacturer's printed recommendations for the proposed product and recommendations of manufacturer's technical representative for the specific application(s). The latter shall be on technical representative's letterhead and shall explicitly indicate the Project and specific cutting and patching application(s) to which the recommendation(s) apply.

4) Items required with request for approval of substitute, in accordance with the substitution request requirements of the Contract Documents.

3. Product Data:

a. Submit manufacturer's published data for the protective compound to be applied to core-drilled surfaces and cut concrete surfaces.

b. When not required under other Specifications sections, submit manufacturer's published data on materials to be used for finishing around the cut or patched area(s), together with indication of the location(s) where each is proposed for use.

c. Furnish Submittals for patching materials under the associated Specifications section. Submittal to include letter of recommendation from product manufacturer's technical representative indicating on technical representative's letterhead, explicitly indicating:

1) Project name and facility name;

2) specific cutting and patching application(s) to which the recommendations apply;

3) that product manufacturer's technical representative has personally observed and is familiar with conditions in the work area(s) of the subject cutting and patching;

4) materials that are the subject of the Submittal are appropriate for the condition(s) of the proposed patch and will remain durable in the patch's final exposure upon Substantial Completion; and.

5) Patching material manufacturer's technical representative's recommendations for surface preparation, installation of patching material(s), and curing.

B. Informational Submittals: Submit the following:

1. Written Notification of Cutting and Patching:

a. Furnish as a Submittal written indication designating the day and time that the construction associated with cutting and patching will be uncovered to allow for observation. Do not begin cutting or patching operations until submittal is accepted by Engineer.

2. X-ray Investigations:

a. Proposed method of investigation. Submit and obtain Engineer's acceptance prior to performing x-ray inspections.

b. Report of x-ray evaluation of slabs, floors, and walls to be cut or core-drilled.

PART II - GENERAL

2.01 MATERIALS

A. Materials – General:

1. Provide materials that comply with the Contract Documents.

2. If not shown or indicated in the Contract Documents, use materials identical to existing materials affected by cutting and patching Work.

3. For exposed surfaces, use materials that visually match existing adjacent surfaces to fullest extent possible. If identical materials are unavailable or cannot be used, provide materials whose installed performance will equal or surpass that of existing materials.

4. Replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, using materials that do not void required or existing warranties.

B. Compound Applied to Core-Drilled Surfaces and Cut Concrete Surfaces:

1. After core-drilling or sawcutting (as applicable) and before installing the utility or equipment through the penetration, coat exposed concrete and exposed steel with solvent-free, two-component, protective, epoxy resin coating.

2. Color shall approximate the finish color of the existing surface to be coated.

3. Product and Manufacturer: Subject to compliance with the Contract Documents, the following products and manufacturers are acceptable:

a. Sikagard 62, by Sika Corporation.

b. Or equal.

C. Grout Materials:

1. Comply with Division 3.

D. Epoxy Bonding Adhesive:

1. Provide two-component, moister-insensitive adhesive manufactured for the purpose of bonding fresh concrete to hardened concrete.

2. Comply with Division 3.

3. Product and Manufacturer: Subject to compliance with the Contract Documents, the following products and manufacturers are acceptable:

a. Euco No.452 MV by Euclid Chemical Co.

b. Sikadur 32, Hi-Mod by Sika Corporation.

c. Or equal.

E. Epoxy Patch Material:

1. ProducT: Sikadur.

2. Engage the manufacturer's representative to observe and recommend a suitable patching material of the actual construction conditions.

3. Subject to compliance with the Contract Documents, the following products and manufacturers are acceptable:

a. Depth of patch greater than 3/4 IN:

1) Five Star MP Epoxy Patch.

2) Or equal.

b. Depth of patch between 1/8 IN and 3/4 IN:

1) Five Star Fluid Epoxy.

2) Or equal

PART III - EXECUTION

3.01 EXAMINATION

A. Examination and Assessment – General:

1. Examine surfaces to be cut or patched, and conditions under which cutting or patching will be performed before starting cutting or patching Work.

2. Report unsatisfactory or questionable conditions to Engineer in writing.

3. Do not proceed with cutting or patching Work until unsatisfactory conditions are corrected.

B. Non-Destructive Investigation:

1. In advance of cutting or coring through existing slabs or walls, use x-ray or other non-destructive methods accepted by Engineer to determine location of reinforcing steel, electrical conduits, and other items embedded in slabs and walls.

2. Submit to Engineer written report of findings of evaluation.

3. Perform x-ray investigation and submit results to Engineer sufficiently in advance of cutting Work to allow time to identify and implement alternatives, if changes to the Work are necessary because of conduit or other features in floor or wall.

3.02 PREPARATION

A. Provide temporary support required to maintain structural integrity of facilities, to protect adjacent work from damage during cutting, and to support the element(s) to be cut.

B. Protection of Existing Construction during Cutting and Patching:

1. Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of the Project and facility that will be exposed during cutting and patching operations.

2. Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.

3. Do not cut existing pipe, conduit, ductwork, or other utilities serving facilities scheduled to be removed or relocated until provisions have been made to bypass them.

3.03 CUTTING AND PATCHING - GENERAL

A. Perform cutting and coring in such manner that limits extent of patching required.

B. Structural Elements:

1. Do not cut or patch structural elements in manner that would change the element's structural load-carrying capacity as load deflection ratio.

C. Operating Elements:

1. Do not cut or patch operating elements in manner that would reduce their capacity to perform as intended.

2. Do not cut or patch operating elements or related components in manner that would increase maintenance requirements or decrease operational life or safety.

D. Replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, using methods that do not void required or existing warranties.

E. Provide adequate temporary covering over openings (whether cut or core-drilled) where not in use. Avoid creating tripping hazards for openings provided in floors and slabs.

3.04 CORING

A. Use core-drilling to make penetrations through concrete and masonry walls, slabs, or arches, unless otherwise accepted by Engineer in writing.

B. Coring:

1. Perform coring with non-impact rotary tool using diamond core-drills. Size holes for pipe, conduit, sleeves, equipment or mechanical seals, as required, to be installed through the penetration.

2. Do not core-drill through electrical conduit or other utilities embedded in walls or slabs without approval of Engineer. To extent possible, avoid cutting reinforcing steel in slabs and walls.

C. Protection:

1. Protect existing equipment, utilities, and adjacent areas from water and other damage caused by or resulting from core-drilling operations.

2. After core-drilling and before installing the utility or equipment through the penetration, coat exposed concrete and steel with protective coating material indicated in Paragraph 2.1.B of this Specification Section. Apply protective coating in accordance with manufacturer's instructions.

D. Cleaning:

1. After core-drilling, vacuum or otherwise remove slurry and tailings from the work area.

3.05 CUTTING

A. Cutting – General:

1. Cut existing construction using methods least-likely to damage elements retained and adjoining construction and that provide proper surfaces to receive subsequent installation or repair.

2. In general, use hand tools or small power tools suitable for sawing or grinding. When possible, avoid using hammering and avoid chopping. Carefully chip out concrete where necessary and as indicated in the Contract Documents.

3. Cut holes and slots as small as possible, neatly to the size required, and with minimum disturbance of adjacent surfaces.

4. Prior to starting cutting, provide adequate bracing of area to be cut.

5. To avoid marring existing finished surfaces, cut or drill from exposed or finished side into concealed side.

6. Use equipment of adequate size to remove the cut panel or "coupon".

B. Cutting – Concrete and Masonry:

1. Cut through concrete and masonry using concrete wall saw with diamond saw blades.

2. On both sides of the element being cut, provide for control of slurry generated during sawing.

3. Concrete Cutting:

a. Make openings by sawing through existing concrete. Core drill with 6 IN DIA core at the corners of openings to avoid overcutting at corners.

b. When the cut-out concrete or "coupon" cannot be removed in one piece, or where concrete is too thick for saw to penetrate fully, break out concrete after initial saw cuts.

c. Where saw cutting is not possible:

1) Make openings by drilling holes around perimeter of required opening and subsequently carefully chip out concrete.

2) Holes shall be sufficient in quantity to prevent damage to remaining concrete.

3.06 PATCHING

A. Patching – General:

1. Patch large openings to be filled with concrete in accordance with the Contract Documents. Before installing new concrete, apply bonding adhesive [indicated in Paragraph 2.1.C of this Specifications section] in accordance with manufacture's recommendations.

2. Where large openings to be filled with concrete are indicated on the Drawings as requiring reinforcing steel, provide reinforcing steel as shown and indicated in the Contract Documents. Where openings in existing reinforced concrete are larger than 2 FT in diameter or 2 FT by 2 FT and the Drawings or elsewhere in the Contract Documents do not expressly require reinforcing steel for the opening, submit a request for interpretation to Engineer and obtain Engineer's response before proceeding.

3. Where concrete infill or grout repair materials are not used, patch using epoxy patch material indicated in Paragraph 2.1.D of this section unless otherwise indicated on Drawings.

4. Patch construction by filling, repairing, refinishing, closing-up, and similar operations following performance of other Work.

5. Patch with durable seams that are as inconspicuous as possible. Provide materials and comply with installation requirements indicated in the Contract Documents and the published installation instructions of the material's manufacturer.

6. Patch to provide airtight and watertight connections to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.

7. Where feasible, test patched areas to demonstrate integrity of installation.

B. Restoration:

1. Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in manner that eliminates evidence of patching and refinishing.

2. For continuous surfaces, refinish to nearest intersection.

3. For an assembly, refinish the entire unit that was patched.

4. Patch, repair, or rehang existing ceilings as necessary to provide an even-plane surface of uniform appearance.

3.07 CLEANING

A. Cleaning and Restoration:

1. Perform cleaning promptly after associated cutting, coring, and patching.

2. Clean areas and spaces where cutting, coring, or patching were performed.

3. Clean piping, conduit, and similar constructions before applying paint or other finishing materials.

4. Restore damaged coverings of pipe and other utilities to original condition.

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PART I - GENERAL

1.01 SUMMARY

A. Section Includes:

1. General provisions applicable to all demolition and removals.
2. Civil/site demolition and removals.
3. Architectural and structural demolition and removals.
4. Mechanical demolition and removals
5. Electrical demolition and removals.
6. Disposal of demolition debris, materials, and equipment.

B. Scope:

1. Contractor shall provide all labor, materials, equipment, tools, and incidentals as shown, specified and required for demolition, removals, and disposal Work.
2. The Work under this Specifications section includes, but is not necessarily limited to:
    a. Demolition and removal of existing materials and equipment as shown or indicated in the Contract Documents. The Work includes demolition of structural concrete, foundations, structural steel, metals, masonry, attachments, appurtenances, piping, electrical and mechanical systems and equipment, pavement, curbs, and similar existing materials, equipment, and items.
3. Demolition and removal of all above-grade piping and facilities and Underground Facilities underneath, building(s) and structures shown or indicated for demolition, unless the Underground Facilities or above-grade facilities are shown or indicated as to remain.
4. Remove from slabs, foundations, walls, and footings that are to be demolished all utilities and appurtenances embedded in such construction.
5. Demolitions and removals indicated in other Specifications sections shall comply with requirements of this Specifications section.
6. Perform demolition Work within areas shown or indicated.
7. Pay all costs associated with transporting and, as applicable, disposing of materials and equipment resulting from demolition and removals Work.

1.02 QUALITY ASSURANCE

A. Referenced Standards:

1. National Fire Protection Association (NFPA):

    a. 241, Safeguarding Construction, Alteration, and Demolition Operations.

B. Regulatory Requirements:

1. Edit regulatory requirements, below, to suit the Project and jurisdiction. Do not attempt to indicate all applicable Laws and Regulations; rather, address only those that are either directly pertinent to demolition and removals or that must, by statute, be cited in the Contract Documents. Normally, the model language below is sufficient. Edit to suit requirements of authorities having jurisdiction.

2. Refer to the "Additional User Notes" at the end of this Section 02 41 00, in the section titled, "Laws and Regulations, and Permits" for critical guidance and advice on determining regulatory requirements for general demolition (including pollution controls), coordination with utility owners, blasting, and other matters.

3. Demolition, removals, and disposal Work shall be in accordance with 29 CFR 1926.850 through 29 CFR 1926.860 (Subpart T – Demolition), and all other Laws and Regulations.

4. Comply with requirements of authorities having jurisdiction.

C. Qualifications:

1. Electrical Removals: Entity and personnel performing electrical removals shall be electrician(s) legally qualified to perform electrical construction and electrical work in the jurisdiction where the Site is located.

2. Plumbing Removals: Entity and personnel performing plumbing removals shall be plumber(s) legally qualified to perform plumbing construction and plumbing work in the jurisdiction where the Site is located

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Review procedures under this and other Specifications sections and coordinate the Work that will be performed with or before demolition and removals.

1.04 SUBMITTALS

A. Informational Submittals: Submit the following:

1. Procedure Submittals:

    a. Demolition and Removal Plan: Not less than ten days prior to starting demolition Work, submit acceptable plan for demolition and removal Work, including:

        1) Plan for coordinating shut-offs, capping, temporary services, and continuing utility services.

2) Other proposed procedures as applicable.

3) Equipment proposed for use in demolition operations.

4) Recycling/disposal facility(ies) proposed, including facility owner, facility name, location, and processes. Include copy of appropriate permits and licenses, and compliance status.

5) Planned demolition operating sequences.

6) Detailed schedule of demolition Work in accordance with the Schedule accepted by Engineer.

2. Notification of Intended Demolition Start: Submit in accordance with Paragraph 3.1.A of this Specifications Section.

3. Field Quality Control Test Results:

   a. Results of megger-testing of existing motors to remain Owner's property.

4. Qualifications Statements:

   a. Name and qualifications of entity performing electrical removals, including copy of licenses required by authorities having jurisdiction.

   b. Name and qualifications of entity performing plumbing removals,

1.05 SITE CONDITIONS

A. Owner makes no representation of condition or structural integrity of area(s) to be demolished or where removals are required by the Contract Documents.

PART II - PRODUCTS - (NOT USED)

PART III - EXECUTION

3.01 PREPARATION

A. Notification:

1. Not less than 48 HRS prior to commencing demolition or removal, advise Engineer in writing of planned start of demolition Work. Do not start removals without permission of Engineer.

2. Where demolition or removals has potential to affect adjacent properties, occupants, streets, or other public thoroughfare, transportation facilities, and utilities, furnish required notices to owners and occupants of properties, buildings, and structures that may be affected by the demolition of removal.

3. In accordance with Laws and Regulations, furnish to authorities having jurisdiction, including emergency services as necessary, appropriate notices of planned demolition and removals.

4. Submit to Engineer copies of notices furnished to adjacent property owners, occupants, and authorities having jurisdiction.

B. Protection of Adjacent Areas and Facilities:

1. Perform demolition and removal Work in manner that prevents damage and injury to property, structures, occupants, the public, and facilities. Do not interfere with use of, and free and safe access to and from, structures and properties unless allowed by the Contract Documents otherwise allowed in writing by Owner.

2. Closing or obstructing of roads, drives, sidewalks, and passageways adjacent to the Work is not allowed unless indicated otherwise in the Contract Documents. Conduct the Work with minimum interference to vehicular and pedestrian traffic.

3. Provide temporary partitions between demolition work areas and (a) areas that will be occupied during demolition and removals, and (b) areas accessible to the public or visitors. Temporary partitions shall be sturdy, braced plywood in good condition, of dimensions sufficient to adequately screen demolition work from view of occupants, public, and visitors. Maintain temporary partitions in place until demolition and removals work in the subject area is complete or until other Work requires removal of temporary partitions.

4. Provide appropriate temporary barriers, lighting, sidewalk sheds, and other necessary protection.

5. Repair damage to facilities that are to remain which such damages results from Contractor's operations.

C. Existing Utilities: In addition to requirements of the General Conditions, Supplementary Conditions, and Division 01 Specifications, perform the following:

1. Should unforeseen, unknown, or incorrectly shown or indicated Underground Facilities be encountered, Contractor responsibilities shall be in accordance with the General Conditions as may be modified by the Supplementary Conditions. Cooperate with utility owners in keeping adjacent services and facilities in operation.

2. Sanitary Sewerage: Before proceeding with demolition, locate and cap all sewer lines and service laterals discharging from the building or structure being demolished.

3. Storm Water Sewerage: Existing storm water system shall remain in place until demolition of existing building or structure is complete. Upon completing demolition, cut and cap storm sewerage at locations shown on the Drawings. Remove existing storm water piping and related structures between points of cutting, and backfill, restore to grade, and stabilize the area over the removed facilities in accordance with the Contract Documents.

4. Water Piping and Related Facilities: Before proceeding with demolition, locate and cap all potable and non-potable waterlines and service laterals serving the building or structure being demolished. Ensure compliance with Laws and Regulations regarding water quality.

5. Other Utilities: Before proceeding with demolition, locate and cap as required all other utilities, such as fuel and gas; compressed air; heating, ventilating, and air conditioning; electric; and communications; and service laterals serving the building or structure being demolished.

6. Shutdown of utility services shall be coordinated by Contractor, assisted by Owner as required relative to contacting utility owners.

D. Remediation

1. Prior to performing demolition Work involving PCB's remediation in accordance with Section 16800 – Calibration, Testing, and Settings.

3.02 DEMOLITION - GENERAL

A. Locate construction equipment used for demolition Work and remove demolished materials and equipment to avoid imposing excessive loading on supporting and adjacent walls, floors, framing, facilities, and Underground Facilities.

B. Pollution Controls:

1. Use water sprinkling, temporary enclosures, and other suitable methods to limit emissions of dust and dirt to lowest practical level. Comply with Section 01595 - Environmental Protection.

2. Do not use water when water may create hazardous or objectionable conditions such as icing, flooding, or pollution.

3. Clean adjacent structures, facilities, properties, and improvements of dust, dirt, and debris caused by demolition Work, in accordance with the General Conditions.

C. Explosives:

1. Explosives are not allowed at the Site. Do not use explosives for demolition and removal Work.

D. Comply with Section 02072 - Cutting and Patching and NFPA 241.

E. Building or Structure Demolition and Removals:

1. Unless otherwise approved by Engineer, proceed with demolition from top of building or structure to the ground. Complete demolition Work above each floor or tier before disturbing supporting members of lower levels.

2. Demolish concrete and masonry in small sections.

3. Remove structural framing members and lower to ground using hoists, cranes, or other suitable methods. Do not throw or drop to the ground.

4. Break up and remove foundations, mats, and slabs-on-grade unless otherwise shown or indicated as remaining in place.

5. Temporary Bracing and Supports:

6. Provide temporary bracing and supports sufficient to maintain safety, stability, and resist all loads to which the structure may be subject during demolition and removals, until entirety is permanently removed or permanently stabilized.

7. Temporary bracing and supports shall be sufficient for associated dead load, live load, transient loading, and dynamic loads such as wind, seismic, and other loads to which the temporary bracing or support may be subject.

8. Where appropriate, retain a professional structural engineer, duly licensed and registered in the same jurisdiction as the Site, to design temporary bracing and supports.

F. Salvage and Ownership:

1. Materials and equipment to remain Owner's property shall be:

a. Carefully removed and appropriately handled by Contractor to avoid damage and invalidation of warranties in effect. Brace motors attached to flexible mountings until reinstallation or delivery to Owner's storage location. Fully remedy to pre-construction condition or replace items damaged during removal or handling by Contractor.

b. Removed as functional units, together with all appurtenances required for operation.

c. Cleaned, listed, and tagged for storage.

d. Protected from damage.

e. Delivered to designated storage location at the Site or other site indicated in the Contract Documents, at place designated by Engineer or Owner.

2. Preparation of Owner's existing equipment for storage:

a. Where appropriate, identify each component with markings or tags to indicate its position in the assembly and the assembly of which it is part.

b. Place small parts in appropriate, durable boxes and clearly mark contents on the outside of box or container.

c. Remove oil from oil-lubricated bearings and gear boxes and replace with storage oil.

d. Grease grease-lubricated bearings.

e. Replace breather plugs with solid plugs.

f. Megger-test motor windings: Attach report of the test results to the associated motor and submit copy to Engineer.

g. Attach unit to suitable crate bottom.

h. Enclose unit in polyethylene film and seal all seams and the film to the base of the unit with tape.

i. Construct crate of wood slats around top and sides of unit.

j. Attach permanent instruction tag to outside of crate stating "This unit has been prepared for storage. Replace oil, vent plugs, and lubricant in accordance with manufacturer's instructions before start-up."

G. Finishing of Surfaces Exposed by Removals: Unless otherwise shown or indicated in the Contract Documents, surfaces of walls, floors, ceilings, and other areas exposed by removals, and that will remain as finished surfaces, shall be repaired and re-finished with materials that match existing adjacent surface, or as otherwise approved by Engineer.

3.03 STRUCTURAL REMOVALS

A. Remove structures to lines and grades shown or indicated, unless otherwise directed by Engineer. Where limits are not shown or indicated, limits shall be four inches outside item to be installed. Removals beyond limits shown or indicated shall be at Contractor's risk and expense and such excess removals shall be reconstructed to satisfaction of Engineer without additional cost to Owner.

B. Recycling and Reuse of Demolition Materials:

1. All concrete, brick, tile, masonry, roofing materials, reinforcing steel, structural metals, miscellaneous metals, plaster, wire mesh, and other items contained in or upon building or structure to be demolished shall be removed, transported, and disposed of away from the Site, unless otherwise approved by Engineer.

2. Do not use demolished materials as fill or backfill adjacent to structures, in pipeline trenches, or as subbase under structures or pavement.

C. After removing concrete and masonry walls or portions thereof, mats, slabs, and similar construction that ties in to the Work or to existing construction, neatly repair the junction point to leave exposed only finished edges and finished surfaces.

D. Where parts of existing structures are to remain in service following demolition, remove the portions shown or indicated for removal, repair damage, and leave the building or structure in proper condition for the intended use.

1. Remove concrete and masonry to the lines shown or indicated by sawing, drilling, chipping, and other suitable methods. Leave the resulting surfaces true and even, with sharp, straight corners that will result in neat joints with new construction and be satisfactory for the purpose intended.

2. Do not damage reinforcing bars beyond the area of concrete and masonry removal. Do not saw-cut beyond the area to be removed.

3. Reinforcing bars that are exposed at surfaces of removed concrete and masonry that will not be covered with new concrete or masonry shall be removed to 1.5 IN below the final surface. Repair the resulting hole, with repair mortar for concrete and grout for masonry, to be flush with the surface.

4. Where existing reinforcing bars are shown or indicated to extend into new construction, remove existing concrete so that reinforcing bars are clean and undamaged.

E. Removal of Anchorages and Protruding Metals:

1. Where equipment or material anchored to concrete or masonry are removed and anchors are not to be re-used, and where existing metals (and to be removed) protrude from concrete, remove the anchors and other metal to not less than 1.5 IN beneath surface of concrete or masonry member. Repair the resulting hole, using repair mortar for concrete and grout for masonry, to be flush with the surface.

2. Alternately, when the anchor is stainless steel, the anchor may be cut flush with the surface of the concrete or masonry, when so approved by Engineer.

F. Jambs, sills and heads of windows, passageways, doors, or other openings (as applicable) cut-in to the Work or to existing construction shall be dressed with masonry, concrete, or metal to provide smooth, finished appearance.

G. Where anchoring materials, including bolts, nuts, hangers, welds, and reinforcing steel, are required to attach the Work to existing construction, provide such materials under this Specifications section, unless specified elsewhere in the Contract Documents.

3.04 MECHANICAL REMOVALS

A. Mechanical demolition and removal Work includes dismantling and removing existing:

1. Piping systems and ductwork systems.

2. Mechanical equipment and appurtenances.

3. Mechanical elements of instrumentation and control systems, such as sensors and transmitters and similar items.

4. Mechanical removals include cutting and capping as required, except that cutting of existing piping and ductwork to make connections is included under Section 01 73 29 - Cutting and Patching; Specifications sections in which requirements for coordination with Owner's operations are indicated; and applicable Specifications of Division 21 - Fire Suppression, Division 22 - Plumbing, Division 23 - Heating, Ventilating, and Air Conditioning, Division 40 - Process Interconnections, and others as applicable.

5. Mechanical removals as required herein apply to systems exposed to view, hidden from view, and Underground Facilities. Mechanical removals may require work in spaces that may be classified confined spaces.

B. Life-Safety Systems:

1. Retain existing life-safety systems, including but not limited to fire suppression systems, in place for as long as possible prior to performing associated demolition and removals.

2. Where demolishing buildings or structures equipped with life-safety systems, remove or deactivate life-safety systems only in the area where active demolition operations are in progress.

C. Demolition and Removals of Piping, Ductwork, and Similar Items:

1. Scope:

a. Safety purge piping and tanks (as applicable) of chemicals, fuel, solids, liquids, and gases (as applicable) and make safe for removal and capping. Discharge contents of existing piping appropriately while avoiding damaging property; restricting access to or use of property; and cresting unsafe, unsanitary, nuisances, and noisome conditions.

b. To the extent shown or indicated, remove existing piping conveying water (potable and non-potable), waste and vent, fuel (liquids and gases), heating fluids (such as water-glycol solutions), chemicals, solids and slurries, sludge, wastewater, other fluids, and processes gases, and other piping.

c. Remove piping to the nearest structurally sound (or "solid") piping support, and provide caps on ends of remaining piping.

d. Where piping to be demolished passes through existing walls to remain, cut off and cap pipe on each side of the wall.

2. Caps, Closures, Blind Flanges, and Plugs – General (All Piping and Ducts):

a. Provide closure pieces, such as blind flanges and caps, where shown or required to complete the Work.

b. Where used in this Specifications section, the term "cap" means the appropriate type closure for the piping or ductwork being closed, including caps, blind flanges, and other closures.

c. Caps shall be compatible with the piping or ductwork on which the cap is installed, fluid-tight and gastight, and appropriate for the fluid or gas conveyed in the pipe or duct.

d. Unless otherwise shown or indicated, caps shall be mechanically fastened, fused, or welded to pipe or duct. Plug piping with means other than specified in this Specifications section only when expressly so shown or indicated in the Contractor Documents or when allowed by Engineer.

3. Underground Facilities:

a. When Underground Facilities are altered or removed, properly cut and cap piping left in place, unless otherwise shown or indicated.

4. Waste and Vent Piping; Ductwork:

a. Remove waste and vent piping, and ductwork to extent shown and cap as required.

b. Where demolished vent piping, stacks, and ductwork passes through existing roofing, patch the roof with the same or similar materials as existing, and fully compatible with ensign materials. Completed patch shall be watertight and comply with roofing manufacturer's recommendations.

5. Potable Water Piping; Plumbing; Fire Suppression Piping and Systems; Heating Piping:

a. Modifications to potable water piping, fire suppression systems, other plumbing piping, and heating system piping shall comply with Laws and Regulations.

b. All portions of potable water systems that have been modified or opened shall be hydrostatically tested and disinfected in accordance with the Contract Documents, and Laws and Regulations. Hydrostatically test other, normally-pressurized, plumbing and fire suppression piping and heating piping systems.

D. Equipment Demolition and Removals:

1. To the extent shown or indicated and as required for the Work, remove existing mechanical equipment, including (but not limited to):

a. Facility equipment, such as food service equipment, laundry equipment, dumbwaiters, and similar facility items.

b. Conveying equipment such as elevators, escalators, and similar general-use conveying systems.

c. Fire suppression and plumbing equipment.

d. Heating, ventilating, and air conditioning equipment.

e. Standby power generators.

f. Security systems equipment.

g. Transportation-related equipment.

h. Flow control gates and valves.

i. Hoisting equipment.

j. Bulk materials conveying equipment.

k. Process heating and cooling equipment.

l. Blowers, compressors, air filters, air dryers, and similar equipment.

m. Pumps.

n. Tanks.

o. Process equipment, including purification equipment, pollution control and solid waste equipment, and treatment process equipment.

p. Turbines.

q. Appurtenances (including motors, drive systems, controls, cooling water and seal water systems) as shown, indicated, and required for completion of the Work.

2. Where required, disassemble equipment to avoid imposing excessive loading on supporting walls, floors, framing, facilities, and Underground Facilities. Disassemble equipment as required for access through and egress from building or structure. Disassembly and removal shall comply with Laws and Regulations. Provide required means to remove equipment from building or structure.

3. Remove control panels, operator stations, and instruments associated with equipment being removed, unless shown or indicated otherwise.

E. Tanks and Equipment Containing Process Material:

1. Purge contents in accordance with Paragraph 3.5.A of this Specifications Section and other requirements of the Contract Documents, as applicable.

2. When removing generators, remove associated fuel storage tanks unless otherwise indicated to remain.

3. Where contents of tank or equipment item may pose a potential hazard, such as hydrocarbon fuels or chemicals, properly dispose of contents in accordance with Laws and Regulations and the Contract Documents.

4. Where tank or equipment contains wastewater or liquid sludge, and the Site is a wastewater treatment facility, transport and dispose of stored contents onsite at location acceptable to Owner and facility manager (if other than Owner) unless otherwise indicated in the Contract Documents. If Site is other than a wastewater treatment facility, dispose of contents appropriately in accordance with Laws and Regulations.

5. Where tank or equipment contains solid or slurry-type material, remove, handle, and transport the contents and appropriately dispose of the materials offsite in accordance with Laws and Regulations, unless otherwise indicated in the Contract Documents.

6. Remove equipment supports as applicable, anchorages, base, grout, and piping. Remove anchorage systems in accordance with the “Structural Removals” Article in this Specifications section.

7. Remove small-diameter piping back to header unless otherwise indicated.

8. Remove access platforms, ladders, and stairs related to equipment being removed, unless otherwise shown or indicated.

9. Instrumentation and Control Systems Removal:

a. Remove instrumentation and controls equipment in accordance with this Specifications section’s requirements for mechanical removals and electrical removals.

b. Comply with this Specifications section's "Disposal of Demolition Debris" Article for restrictions on sales of removed items.

3.05 ELECTRICAL REMOVALS

A. Electrical demolition Work includes removing existing:

1. Disconnecting cabling from motors, electrical sources, control panels, control stations, instrumentation and control items, and similar devices and equipment.

2. Conduits, raceways, cable trays, hangers and supports, cabling, and related items.

3. Switches, panelboards, control stations, and similar items.

4. Transformers, distribution switchboards, control panels, motors, starters, variable speed controllers, and similar items.

5. Lighting fixtures and related items.

6. Utility poles, site lighting standards, and overhead cabling.

7. Appurtenances and miscellaneous electrical equipment, as shown, specified, or required.

B. Electrical Removals – General:

1. Comply with Laws and Regulations, including the National Electric Code.

2. Lock Out and Tagging:

a. Contractor shall lock out and tag circuit breakers and switches operated by Ownerand shall verify that affected cabling are de-energized to ground potential before commencing electrical removals Work.

b. Upon completion of electrical removals Work, remove the locks and tags and promptly advise Resident Project Representative (RPR) or Engineer and Owner that existing facilities are available for use.

3. Remove existing electrical equipment, fixtures, and systems to avoid damaging systems to remain, to keep existing systems in operation, and to maintain integrity of grounding systems.

4. Disconnect and remove motors, control panels, and other electrical gear where shown or indicated.

5. Store removed motors, microprocessors and electronics, and other electrical gear to be reused in accordance with its manufacturer's recommendations and requirements of the Contract Documents.

C. Motor Control Centers and Switchgear:

1. Remove or modify motor control centers and switchgear as shown or indicated.

2. Modified openings shall be cut square and dressed smooth to dimensions required for installation of equipment.

D. Removal of Cabling, Conduits, Raceways and Similar Items:

1. Verify the function of each cable before disconnecting and removing.

2. Remove cabling, conduits, hangers and supports, and similar items back to the power source or control panel, unless otherwise shown or indicated.

3. Remove cabling, conduits, and similar items where shown or indicated for removal. Abandoned conduits concealed in floor, ceiling slabs, or in walls shall be cut flush with the slab or wall (as applicable) at point of entrance, suitably capped, and the area repaired in a flush, smooth manner acceptable to Engineer.

4. Disassemble and remove exposed conduits, junction boxes, other electrical appurtenances, and their supports.

5. Repair all areas of the Work to prevent rusting on exposed surfaces.

6. Underground Electric:

a. Conduits in Underground Facilities not scheduled for reuse shall be suitably capped watertight where each enters building or structure to remain.

b. Where shown or indicated, remove direct-burial cabling. Openings in buildings for entrance of direct-burial cabling shall be patched with repair mortar or other material approved by Engineer for such purpose, and made watertight.

E. Electrical Service Entrances and Outdoor, Overhead Electrical Utilities:

1. Existing poles and overhead cabling shall be removed or abandoned as shown and specified.

2. Completely remove from the Site poles not owned by electric utility, including site lighting standards and appurtenances, shown or indicated for removal.

3. Existing substation(s) and poles owned by electric utility will be removed by the electric utility.

4. Make necessary arrangements with electric utility owner for removal of utility owner's transformers and metering equipment after new electrical system has been installed and energized.

F. Lighting fixtures, wall switches, receptacles, starters, and other miscellaneous electrical equipment, not designated as remaining as Owner's property, shall be removed and properly disposed off-Site as required in accordance with Laws and Regulations.

3.06 DEMOLITION OF SITE IMPROVEMENTS

A. Pavement, Sidewalks, Curbs, and Gutters:

1. Demolition of asphalt or concrete pavement, sidewalks, curbs, and gutters, as applicable, shall terminate at cut edges. Edges shall be linear and have a vertical cut face.

2. To cut pavement, sidewalks, curbs, and gutters, use machinery or tools that provides a smooth-cut edge, appropriate for the required. Where cut edges are not smooth, repair the cut edge to remain to provide a smooth, even appearance.

B. Fencing, Guardrails, and Bollards:

1. Remove to the limits shown or indicated on the Drawings.

2. Completely remove below-grade posts and concrete.

C. Manholes, Vaults, Chambers, and Handholes:

1. Remove to the limits shown or indicated on the Drawings.

2. If not shown or indicated on the Drawings, remove to not less than three feet below finished grade indicated on the Drawings.

D. Underground Facilities Other than Manholes, Vaults, Chambers, and Handholes:

1. Remove to the extent shown or indicated on the Drawings.

2. Unless otherwise shown or indicated, cap ends of piping to remain in place in accordance with the "Mechanical Removals" Article in this Specifications section.

E. Other Site Improvements: When the Contract Documents require removal of other site improvements not addressed above, copy with Contract requirements for removal of buildings or structures.

3.07 DISPOSAL OF DEMOLITION DEBRIS

A. Disposal – General:

1. Promptly remove from the Site all debris, waste, rubbish, material, and equipment resulting from demolition and removal operations. Promptly upon completion of demolition and removal operations, remove from the Site construction equipment used in demolition Work.

2. Do not sell at the Site demolition materials or removed equipment. If materials, equipment or debris will be sold by Contractor, remove the items from the Site and perform the sale or transaction elsewhere, in accordance with Laws and Regulations.

B. Transportation and Disposal:

1. Non-Hazardous Materials, Equipment, and Debris: Properly transport and dispose of non-hazardous demolition materials, equipment, and debris at appropriate landfill or other suitable location, in accordance with Laws and Regulations. Non-hazardous material does not contain Constituents of Concern such as (but not

limited to) asbestos, PCBs, petroleum, hazardous waste, radioactive material, or other material designated as hazardous in Laws or Regulations.

2. Hazardous Materials, Equipment, and Debris: When handling and disposal of items containing Constituents of Concern is included in the Work, properly transport and dispose of such items in accordance with the Contract Documents and Laws and Regulations.

C. Submit to Engineer information required in this Specification Section on proposed facility(ies) where demolition materials, equipment, and debris will be recycled. Upon request, Engineer or Owner, shall be allowed to visit recycling facility(ies) to verify adequacy and compliance status. During such visits, recycling facility operator shall cooperate and assist Engineer and Owner.

END

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PART 1 - GENERAL

1.1 SUMMARY

A. Scope
   1. This Section specifies the requirements for dewatering including the design, installation, operation, maintenance, and removal of dewatering systems to facilitate excavation, earthwork and other construction.
   2. This Section applies to all excavations, including, but not limited to, utility trenches, pipe chases, retaining wall footings, and duct banks as well as relatively shallow excavations that expose shallow groundwater.
   3. The dewatering system shall meet all the following requirements:
      a. Provide reasonably dry base of excavation.
      b. Draw down to 2 feet below bottom of excavation and finished subgrade until backfill is at least 1 foot above normal static groundwater level.
      c. Filter native material and prevent loss of soil through dewatering system.
      d. Prevent damage to nearby existing and completed structures and utilities/conduits, including roadways, protected trees, slopes, and all other nearby facilities.
      e. Provide filtering and/or sediment removal for discharged water to the minimum quality specified herein.
      f. Dewatering system design and operation shall be coordinated with the requirements of 509S – Excavation Safety Systems.

1.2 QUALITY ASSURANCE (NOT USED)

1.3 SUBMITTALS

A. Preconstruction/Action Submittals: The following minimum submittals shall be submitted prior to construction of this element of the Work in accordance with Section 01300 – Submittals.
   1. A copy of this Section, with addendum updates included, and all referenced and applicable Sections, with addendum updates included, with each paragraph check-marked to indicate Specification compliance or marked to indicated requested deviations from Specification requirements or those parts which are to be provided by the Contractor or others shall be provided. Check marks (✓) shall denote full compliance with a paragraph as a whole.
      a. If deviations from the Specifications are indicated, and therefore requested, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The City Representative shall be the final authority for determining acceptability of requested deviations.
      b. The remaining portions of the paragraph not underlined shall signify compliance with the Specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the requirements of the Specification shall be cause for rejection of the entire submittal and no further submittal material will be reviewed.

2. Before dewatering commences, the Contractor shall submit drawings of the proposed dewatering system, signed and stamped by a Professional Civil or Geotechnical Engineer currently registered in the State of Texas, for the City's review. The dewatering system drawings shall be in sufficient detail to indicate power source, sizes of pumps, piping, cut-off walls, sheet piling, appurtenances, placement of wells, settlement monitoring program, and the ultimate disposal point and maximum allowable sediment content for water; and to permit the City to review the overall completeness and effectiveness of the proposed system. The submittal shall also show means of evaluating drawdown in real-time (e.g., piezometers). Review of the dewatering drawings by the City in no way relieves the Contractor of complete responsibility for providing effective and safe dewatering of the construction area. Dewatering system submittal shall demonstrate coordination with the Contractor-designed shoring and bracing method and submittal, the geotechnical instrumentation submittal, and the dewatering discharge permits.
3. Submit shoring plan in accordance with Section 509S – Excavation Safety Systems.
4. Demonstrate that the dewatering activity is in compliance with over-riding construction sequencing requirements specified herein or explicitly stated elsewhere in the contract documents.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CONTROL OF WATER

A. The Contractor shall keep excavations reasonably free from water during construction. The static water level shall be drawn down a minimum of 2 feet below the bottom of all excavations to maintain the undisturbed state of natural soils and allow the placement of any fill to the specified density. Disposal of water shall not damage property, create a public nuisance, or cause a plume of visible sediment in the receiving water. Refer to Section 3.4, Desilting, below for further requirements detailing quality of discharged water. The Contractor shall have on hand pumping equipment and machinery in good working condition for emergencies and shall have workers available for its operation.

B. Control groundwater to prevent softening of the bottom of excavations, or formation of "quick" conditions. If foundation soils are disturbed or loosened by the upward seepage of water or an uncontrolled flow of water, excavate the affected areas and replace with suitable material per all applicable Earthwork standard technical specifications, at no cost to the City.

C. Dewatering systems shall not remove natural soils. Control surface runoff to prevent entry or collection of water in excavations.

D. Dewatering systems shall operate continuously (24-hours per day) until backfill has been completed to 1 foot above the normal static groundwater level. Contractor shall provide backup power source and pumps to ensure continuous operation of dewatering systems. Release of groundwater to its static level shall be controlled to prevent disturbance of the natural foundation soils or compacted fill and to prevent flotation or movement of structures or pipelines. No concrete footings, foundations, manhole bases, or floors shall be constructed in water, nor shall water be allowed to rise over them until the concrete has set at least twenty-four (24) hours. Do not allow water to rise unequally against walls or slabs until concrete has attained its twenty-eight (28) day strength.

E. Do not drain water into a pipeline under construction nor an existing sanitary sewer unless written approval is obtained from the City.

F. Dewatering shall control subsurface water as well as surface water. Where applicable, coordinate with the stormwater management plan in accordance with the Stormwater Prevention Pollution Plan (SWPPP).

G. Provide a completely separate electrical service for the dewatering systems with its own meter, which shall be dedicated solely for the dewatering systems and separate from all other electric service.

H. Provide 24-hour monitoring by personnel skilled in operation and maintenance of the system, and capable of procuring work required to maintain continuous dewatering operation.

3.2 MONITORING

A. Provide monitoring wells located midway between dewatering points and at sufficient number of locations outside excavation to demonstrate that groundwater level is lowered as required.

B. Where dewatering wells are installed within 200 feet of existing structures, the Contractor shall implement monitoring systems.

3.3 POINT OF DISCHARGE

A. The Contractor shall obtain dewatering discharge permits as required by the State of Texas and City of Austin, if applicable.

B. The Contractor shall collect and transport water samples to City approved laboratory for analysis and reporting as required by the dewatering discharge permits.

C. The Contractor shall discharge groundwater and surface water to locations approved by the City. The Contractor shall take all necessary precautions to avoid discharge of oil, grease, and excessive suspended solids, including using settling tanks or other methods approved by permit.

D. Dewatering water may be discharged into sewers when permitted by the City. Prior to discharge of dewatering water into any sanitary sewer, soil, silt, or any other suspended solids shall be removed to the extent required by the City using settling tanks or other approved method.

E. No water shall be discharged into unprotected, i.e., erodible, drainage ways or otherwise unprotected by adequate erosion and sedimentation controls. The Contractor shall repair any damage, remove and dispose of any solids deposition or accumulation caused by the Contractor's operations, and restore all areas to pre-existing conditions at no additional cost to the City.

3.4 DESILTING

A. At a minimum, provide a desilting capability capable of achieving a 30 micron removal of sediment for treatment of all ground water effluent before discharge into City facilities, receiving conveyances or waters. Desilting capability may be provided in the form of a filtering bags, a temporary water quality pond during initial operations, the use of the permanent water quality pond once it is constructed and in place, or a mobile tank with sufficient retention time based on estimated average dewatering pump flow rate. Mobile tanks shall be equipped with a sample port on the discharge line for subsequent sampling and monitoring of the effluent by the City. Measures employed by the Contractor shall be located in an accessible location for maintenance and cleaning as necessary by the Contractor. The location of a rough cut pond is indicated on the plans but this and other locations proposed by the Contractor will be reviewed and approved prior to implementation of the dewatering system.

3.5 DEWATERING SYSTEM REMOVAL AND ABANDONMENT

A. Upon completion of the dewatering, remove all dewatering system facilities including sumps and gravel drains.

B. Upon completion of the dewatering, remove wells or abandon wells in place using licensed water well Contractor. Abandon all wells per Texas Commission on Environmental Quality (TCEQ) Monitoring Well Standards.

C. Notify the City twenty-four (24) hours prior to abandonment of any wells. Do not abandon or remove any well without prior written acceptance by the City.

D. Submit written documentation of abandonment of all wells, or other penetrations below the excavation subgrade including unique well designation, location coordinates, date and time of abandonment, intended use of the well, and the City Representative observing the abandonment.

E. Abandonment of any wells, or other penetrations below the excavation subgrade not observed by the City will be over drilled to the original depth of the installation and re-abandoned at the Contractor’s own expense.

F. Remove all structure settlement monitoring stations and restore surfaces to the conditions existing before installation.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Dry-installed drilled piers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Design Mixtures: For each concrete mixture.
C. Shop Drawings: For concrete reinforcement.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.
B. Material certificates.
C. Material test reports.
D. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Record drawings.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   2. AWS D1.4/D1.4M, "Structural Welding Code - Reinforcing Steel."

1.6 FIELD CONDITIONS

A. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner is not responsible for interpretations or conclusions drawn from this data.
   1. Make additional test borings and conduct other exploratory operations necessary for drilled piers.
   2. The geotechnical report is referenced elsewhere in the Project Manual.
B. Survey Work: Engage a qualified land surveyor or professional engineer to perform surveys, layouts, and measurements for drilled piers. Before excavating, lay out each drilled pier to lines and levels required. Record actual measurements of each drilled pier's location, shaft diameter, bottom and top elevations, deviations from specified tolerances, and other specified data.
   1. Record and maintain information pertinent to each drilled pier and indicate on record Drawings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Drilled-Pier Standard: ACI 336.1 except as modified in this Section.

2.2 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

2.3 CONCRETE MATERIALS

A. Refer to section 03300.

2.4 CONCRETE MIXTURES AND MIXING

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.
B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 limits as if concrete were exposed to deicing chemicals.
C. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent by weight of cement.
D. Proportion normal-weight concrete mixture as follows:
   1. Compressive Strength (28 Days): As indicated.
E. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Unclassified Excavation: Excavate to bearing elevations regardless of character of surface and subsurface conditions encountered.
B. Excavate shafts for drilled piers to indicated elevations. Remove loose material from bottom of excavation.
C. Notify and allow testing and inspecting agency to test and inspect bottom of excavation. If unsuitable bearing stratum is encountered, make adjustments to drilled piers as determined by Architect.
   1. Do not excavate shafts deeper than elevations indicated unless approved by Architect.
   2. Payment for additional authorized excavation is according to Contract provisions for changes in the Work.
D. Temporary Casings: Install watertight steel casings of sufficient length and thickness to prevent water seepage into shaft; to withstand compressive, displacement, and withdrawal stresses; and to maintain stability of shaft walls.
   1. Remove temporary casings, maintained in plumb position, during concrete placement and before initial set of concrete.
E. Tolerances: Construct drilled piers to remain within ACI 336.1 tolerances.

3.2 INSTALLATION

A. Comply with recommendations in CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
B. Place concrete in continuous operation and without segregation immediately after inspection and approval of shaft by a qualified Special Inspector.
C. Place concrete to fall vertically down the center of drilled pier without striking sides of shaft or steel reinforcement.
D. Coordinate withdrawal of temporary casings with concrete placement to maintain at least a 60-inch head of concrete above bottom of casing. Vibrate top 60 inches of concrete after withdrawal of temporary casing.

3.3 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
   1. Drilled piers.

2. Excavation.
3. Concrete.

B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

C. Drilled-Pier Tests and Inspections: For each drilled pier, before concrete placement.
1. Soil Testing: Bottom elevations, bearing capacities, and lengths of drilled piers indicated have been estimated from available soil data. Actual elevations and drilled-pier lengths and bearing capacities are determined by testing and inspecting agency. Final evaluations and approval of data are determined by Architect.

D. Concrete Tests and Inspections: ACI 301.

3.4 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION

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PART 1 - GENERAL

1.1 SUMMARY

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes specifically.
B. This specification applies to the enclosure building, columns, piers, retaining walls, and water quality pond structures. For all other items, refer to City of Austin standard specification 403S.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Design Mixtures: For each concrete mixture.
C. Steel Reinforcement Shop Drawings: Placing Drawings that detail fabrication, bending, and placement.

1.3 INFORMATIONAL SUBMITTALS

A. Material certificates.
B. Material test reports.
C. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer, detailing fabrication, assembly, and support of formwork.

1.4 QUALITY ASSURANCE

A. 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."
B. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1.5 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on concrete mixtures.

1.6 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with ACI 306.1.
   1. 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 ACI 305.1.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
   1. ACI 301.
   2. ACI 117.

2.2 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
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.

2.3 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.
C. 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."

2.4 CONCRETE MATERIALS

A. Cementitious Materials:
   1. Portland Cement: ASTM C 150/C 150M, Type I/II,.
   2. Fly Ash: ASTM C 618, Class F or C.
   3. Slag Cement: ASTM C 989/C 989M, Grade 100 or 120.
B. Normal-Weight Aggregates: ASTM C 33/C 33M, graded.
   1. Maximum Coarse-Aggregate Size:
      a. 1-1/2 inches nominal, unless noted otherwise
      b. 1 inch nominal at retaining walls and retaining wall footings
   2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
C. Air-Entraining Admixture: ASTM C 260/C 260M.
D. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do 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.
E. Water: ASTM C 94/C 94M.

2.5 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
D. Water: Potable.

2.6 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork. Where in contact with water or

sewage: closed cell neoprene, ASTM D1056, Class SC (oil resistant and medium swell) of 2 to 5 PSI compression deflection (Grade SCE41).

B. Waterstops:
   1. Plastic: COE CRD-C572.
   2. Serrated with center bulb.
   3. Thickness: 3/8 IN.
   4. Length (general use): 6 IN unless indicated otherwise.
   5. Expansion joints:
   6. Length: 9 IN.
   7. Center bulb: 1 IN OD x 1/2 IN ID.

2.7 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.

B. Cementitious Materials: Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.

C. Admixtures: Use admixtures according to manufacturer's written instructions.
   1. Use water-reducing 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.

2.8 CONCRETE MIXTURES FOR ENCLOSURE BUILDING ELEMENTS

A. Normal-Weight Concrete:
   1. Minimum Compressive Strength: As indicated at 28 days.
   2. Maximum W/C Ratio: As indicated.
   3. Slump Limit: 5 inches, plus or minus 1 inch.
   4. Air Content: 5.5 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.
   5. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch nominal maximum aggregate size.
   6. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.

2.9 CONCRETE MIXTURES FOR RETAINING WALL ELEMENTS AND WATER QUALITY POND STRUCTURES

A. Normal-Weight Concrete:
   1. Minimum 28-day Compressive Strength: 4000 psi
   2. Air Entrainment: Provide air entrainment in all concrete resulting in a total air content percent by volume of 6 ±1-1/2 percent. Air content to be measured in accordance with ASTM C231, ASTM C173, or ASTM C138.
   3. Slump – 4 inches maximum, 1 inch minimum. 8 inches maximum after addition of superplasticizer (if used). Determine slump per ASTM C143
   4. Selection of Proportions:
      a. Minimum cement: 564 lbs/cu yd.
      b. Maximum water cement ratio by weight: 0.45
   5. Fly ash: A maximum of 25 percent by weight of Portland cement content per cubic yard may be replaced with fly ash at rate of 1 LB fly ash for 1 LB of cement. When fly ash is used, the water to cementitious materials ratio shall not exceed the maximum value specified herein.

2.10 FABRICATING REINFORCEMENT

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

2.11 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, 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.

PART 3 - EXECUTION

3.1 FORMWORK INSTALLATION

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. Chamfer exterior corners and edges of permanently exposed concrete.

3.2 EMBEDDED ITEM INSTALLATION

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.

B. Waterstops, General:
   1. Lap all types of waterstop to create continuous water tight joints.
   2. Do not mix different types of waterstop materials in the same structure without specific approval from the Engineer.
   3. Contractor is responsible for waterstop selection and installation to provide leak-tight joints, to the minimum standard shown in the Contract Documents.
   4. Base selection on anticipated differential movement of mating surfaces.
   5. Waterstop manufacturer’s representative shall provide on-site training of waterstop installation, splicing, welding and inspection procedures prior to construction, and at no additional cost.

C. Waterstops - Preformed StripType:
   1. Install in a bed of swelling sealant on a smooth surface of hardened concrete by use of nails, screws or other means as recommended by manufacturer to prevent movement of waterstop during placement of new concrete.
   2. Roughened joints shall be specially prepared during concrete placement to provide smooth surface for proper waterstop installation.
   3. Unless otherwise noted, use in joints against existing concrete and where indicated on Drawings.

3.3 STEEL REINFORCEMENT INSTALLATION

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
   1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

3.4 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.

3.5 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections are completed.
B. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is 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. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.

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.
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 1 part portland cement to 1-1/2 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 matches 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 1 part portland cement and 1 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 matches 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, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
B. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats. Restraighten, cut down high spots, and fill

low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.

1. Apply float finish to surfaces to receive trowel finish.

C. 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 exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
2. Finish and measure surface, so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.- long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/4 inch.

D. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.

1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

3.8 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 305.1 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 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 remainder of curing period.

D. 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.
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, 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.
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.
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.

3.9 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.

3.10 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a to perform field tests and inspections and prepare test reports.

END OF SECTION

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PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Materials and procedures for applying protective penetrating concrete sealant.

1.2 RELATED SECTIONS NOT USED

1.3 REFERENCES

A. AASHTO T 242: Standard Test Method for Frictional Properties of Paved Surfaces Using a Full-Scale Tire.

1.4 DEFINITIONS NOT USED

1.5 SUBMITTALS

A. Manufacturer's product data, specifications, and recommended installation instructions.

B. Certification of a minimum Friction Number of 40 for at least 90 percent of friction numbers. Refer to AASHTO T 242.
   1. Applies only to traveled way surfaces where the plans require sealant.

PART 2 - PRODUCTS

2.1 PENETRATING CONCRETE SEALANTS

A. Choose from the following list:
   1. Silane
   2. Siloxane
   3. Silicate/Siliconate Polymer

B. Physical Properties:
   1. Crystal clear (non-yellowing)
   2. High-gloss finish

C. Compliance:
   1. ASTM C-1315 Type I Class A
   2. NCHRP 244 Chloride Ion
   3. Meets USDA and ADA non-slip requirements (use of non-slip admixtures is permitted to meet these standards.
   4. VOC Content <5g/L

D. Acceptable products include (but are not limited to):
   1. EUCO Diamond Hard Densifier and Sealer as manufactured by Euclid Chemical.

PART 3 - EXECUTION

3.1 PREPARATION

A. Keep surfaces dry and free of laitance, dirt, dust, paint, grease, oil, rust, and other contaminants.

B. Remove any curing compound from the surface of the concrete before applying penetrating sealant.

C. Use one of the following cleaning methods:

1. Hydroblasting - 700 psi min.
2. Shotblasting
3. Sandblasting
4. Etching
5. Keep concrete surface matrix intact without exposing any large aggregate.

D. Cure concrete for 28 days before sealant application.

E. Obtain approval from the Architect before applying material.

3.2 APPLICATION

A. Application Rate:
   1. Apply according to manufacturer's recommendations for each of the following surfaces:
      a. Horizontal. Unless otherwise noted, all horizontal exposed concrete surfaces within the building shall be finished with penetrating concrete sealant.

B. Application Drying Time: Select a sealant with maximum drying time of 1½ hours.

C. Do not apply sealant to portland cement concrete pavement (PCCP). Meet the minimum Friction Number of 40 for at least 90 percent of friction numbers when plans specify application to other traveled way surfaces such as approach slabs, bridge decks, etc. Refer to AASHTO T 242.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section includes materials, design, and installation of precast concrete vaults with factory applied exterior coating/waterproofing.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300 – Submittals

B. Division 31 – Earthwork

C. Division 3 – Concrete

1.3 SUBMITTALS

A. Submit shop drawing packages in accordance with Section 01300 – Submittals.

B. Submit manufacturer's catalog data on precast concrete items. Show dimensions of vault and location of openings including thicknesses of walls, floor, and top slab. Show reinforcing wire and steel. Show materials of construction by ASTM reference and grade.

C. Submit manufacturer's design calculations and certification signed and sealed by a Professional Civil or Structural Engineer registered in the State of Texas that vault design and construction comply with the specified design load conditions and the referenced ASTM specification (e.g., ASTM C 857 and C 858).

D. Submit manufacturer's catalog data, descriptive literature, and installation instructions for the waterproofing material.

E. Submit buoyancy calculations showing that manholes will resist uplift forces for a fully submerged condition and a 1.1 factor of safety.

F. Manufacturer shall certify on the submittal that the products will be delivered to the site free of defects indicated in section 1.4, Inspection, below.

1.4 INSPECTION

A. The City's Representative will conduct an inspection of the vault upon its arrival at the job site. The inspection will review the quality of the concrete surfaces, defects that indicate any imperfect concrete mixing and molding, surface deflects indicated by honey-combed or open texture and damaged areas, any exposed or bare reinforcing steel, and waterproofing that is missing from indicated surfaces or poorly applied. If any of these items are present or exist, the vault will be rejected.

PART 2 - MATERIALS

2.1 MANUFACTURERS

A. Precast concrete vaults shall be manufactured by Forterra or approved equal.

2.2 PRECAST CONCRETE VAULTS

A. Precast concrete vaults shall comply with ASTM C 858 except as modified herein.

B. Design live and dead loads shall be in accordance with ASTM C 857. Design precast concrete vaults to withstand site soil conditions and traffic loading of A-16 per Table 1 of ASTM C 857 with a 30% increase due to impact. Soil lateral loads shall be as determined by ASTM C 857. Alternate design by the strength design method shall include a load factor of 1.7 times the lateral earth or hydrostatic pressures.

C. Design shall also comply with the following restrictions:
   1. The maximum reinforcement ratio allowed is one-half the reinforcement ratio that would produce a balanced strain condition.
   2. Earth pressure shall be converted to a horizontal pressure using a coefficient of earth pressure at rest of 0.5 and not a coefficient of active earth pressure.
   3. Include a live load surcharge of 2 feet of soil in the design of the walls.

D. Precast vault construction shall be in the form of monolithic walls or horizontal wall sections; do not use panel walls.

E. Minimum wall thickness shall be 6-inches. Design knockout wall panels to accommodate loading pressures defined above.

F. Design and construct vaults to be watertight when subjected to groundwater over the entire height of the vault.

G. Provide openings in precast vaults for duct bank conduits and access. Provide cast in place inserts in the roof slab and end walls at the locations as shown in the Drawings. No field coring of openings is allowed.

2.3 PRECAST CONCRETE RISERS

A. Precast concrete grade rings and cones shall comply with ASTM C 478, except that the wall thickness shall be 6-inches minimum. Provide interlocking keyways on rings and cones. Provide cones with cast in place inserts for the manhole frame.

2.4 SEALANTS AND MORTAR

A. Fill joints between precast sections with a double layer of plastic sealing compound and make watertight. Fill with mortar all recesses, lifting inserts, or other cavities not filled with plastic sealing compound. Mortar shall comply with ASTM C 387, Type S.

2.5 CEMENT

A. Cement shall be ASTM C 150, Type II.

2.6 ADMIXTURES

A. Provide concrete admixtures as specified in Section 405S – Concrete Admixtures.

2.7 WATERPROOFING

A. The waterproofing material shall be Horn Dehydratine 4, Select Shield 301-A, or approved equal. The material is a black bituminous compound of brush or spray consistency for application on below grade concrete surfaces.

B. Additional exterior water proofing shall be provided by Manhole Seals in accordance with SPL NO. WW-146A.

2.8 VAULT APPURTENANCES

A. Provide ladders, covers and frames, vents, supports, inserts, eyebolts, and other miscellaneous metalwork.

PART 3 - EXECUTION

3.1 EXCAVATING AND BACKFILLING FOR VAULTS

A. Perform earthwork as specified in Section 111S - Excavation. Provide 6-inch minimum thickness ¾-inch crushed rock over the full width of the vault base and extend 12-inches beyond the edges of the vault. After repairing the waterproofing, backfill and compact around the vault with structural backfill material.

3.2 INSTALLING VAULTS AND RISERS

A. Set each precast concrete vault section or riser plumb on a double layer bed of sealant at least ½-inch thick to make a watertight joint with the preceding unit. Point the inside joint and wipe off the excess sealant.

3.3 WATERPROOFING

A. The specified bituminous waterproofing shall be factory applied to all exterior surfaces of vaults and risers. This includes the bottom of the vault to be coated as an exterior surface. Apply two coats at a rate of 65 square feet per gallon per coat. Prior to backfilling, field apply waterproofing material on joints and damaged surfaces. Protect coating from damage during backfilling and compacting. The selected Manhole Seal from SPL NO. WW-146A shall be field applied.

END OF SECTION

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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. Face brick.
   2. Mortar and grout.
   3. Ties and anchors.
   4. Embedded flashing.
   5. Miscellaneous masonry accessories.

1.3 ACTION SUBMITTALS

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

B. Shop Drawings: For the following:
   1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
   2. Stone Trim Units: Show sizes, profiles, and locations of each stone trim unit required.
   3. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.

C. Samples for Initial Selection:
   1. Face brick.
   2. Colored mortar.

1.4 INFORMATIONAL SUBMITTALS.

A. Material Certificates: For each type and size of the following:
   1. Masonry units.
      a. Include data on material properties substantiating compliance with requirements.
      b. For brick, include size-variation data verifying that actual range of sizes falls within specified tolerances.
      c. For exposed brick, include test report for efflorescence according to ASTM C 67.
   2. Cementitious materials. Include brand, type, and name of manufacturer.
   3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
   4. Grout mixes. Include description of type and proportions of ingredients.
   5. Anchors, ties, and metal accessories.

1.5 QUALITY ASSURANCE

A. Mockup: GC shall construct, for review and approval of Owner, a mockup of the exterior wall of substation building not less than 4’ wide and 4’ high and including brick, CMU backup, and representative examples of flashing, weeps, and other accessories. Mockup shall include a mockup of the CMU jamb condition at the overhead doors.

B. Mockup shall be completed and presented to Owner at least two weeks prior to commencement of masonry (brick or CMU) construction. Should mockup be determined by Owner not to comply with the intent of this specification, mockup shall be revised and resubmitted for approval.

C. Upon approval by Owner, the mockup shall serve as the standard against which completed masonry work shall be evaluated for compliance with the requirements of the Contract.

D. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.

E. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

F. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Always retain first paragraph below in case Contractor uses a preblended, dry mortar mix.

E. Deliver preblended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in covered weatherproof dispensing silos.

F. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.7 PROJECT CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
   1. Extend cover a minimum of 24 inches (600 mm) down both sides of walls and hold cover securely in place.
   2. Where one wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches (600 mm) down face next to unconstructed wythe and hold cover in place.

B. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
   1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
   2. Protect sills, ledges, and projections from mortar droppings.
   3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
   4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

C. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
   1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F (4 deg C) and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.

D. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.1 MASONRY UNITS, GENERAL

A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.

2.2 BRICK

A. Regional Materials: Brick shall be manufactured within 500 miles (800 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site.

B. General: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units.
   1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished
   2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels.
   3. Provide special shapes for applications requiring brick of size, form, color, and texture on exposed surfaces that cannot be produced by sawing.
   4. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.

C. Face Brick: Facing brick complying with ASTM C 216 or hollow brick complying with ASTM C 652, Class H40V (void areas between 25 and 40 percent of gross cross-sectional area).
   1. Products: Subject to compliance with requirements, provide brick complying with the following.
   2. Representative product:
      a. Acceptable products include, but are not necessarily limited to, Denton Blend 105 Golden Sunset, modular size, ruff texture brick as manufactured by Acme Brick.
   3. Grade: SW.
   4. Type: FBS.
   5. Initial Rate of Absorption: Less than 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested per ASTM C 67.
   6. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."

2.3 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

B. Hydrated Lime: ASTM C 207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of Portland cement complying with ASTM C 150, Type I or Type III, and hydrated lime complying with ASTM C 207.

D. Do not use Masonry Cement or Mortar Cement.

E. Aggregate for Mortar: ASTM C 144; except for joints less than 1/4 inch (6.5 mm) thick, use aggregate graded with 100 percent passing the No. 16 (1.18-mm) sieve.
   1. White-Mortar Aggregates: Natural white sand or ground white stone.
   2. Colored-Mortar Aggregates: Natural-colored sand or ground marble, granite, or other sound stone; of color necessary to produce required mortar color.

F. Aggregate for Grout: ASTM C 404.

G. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in masonry mortar.

H. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494, Type C, and recommended by the manufacturer for use in masonry mortar of composition indicated.

I. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with concrete masonry units, containing integral water repellent by same manufacturer.

J. Water: Potable.

K. Available Mortar Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
   1. Portland / Lime Type N as manufactured by Alamo Cement
   2. Color: natural gray, to match existing conditions adjacent.

2.4 REINFORCEMENT

A. Masonry Joint Reinforcement, General: ASTM A 951/A 951M.

2.5 TIES AND ANCHORS

A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:
   1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M; with ASTM A 153/A 153M, Class B-2 coating.
   2. Galvanized Steel Sheet: ASTM A 653/A 653M, Commercial Steel, G60 (Z180) zinc coating.
   3. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, with ASTM A 153/A 153M, Class B coating.

B. Anchor brick through rigid wall insulation with thermal wing-nut anchors equal to Type 304 Stainless Steel Hohmann & Barnard Thermal 2-Seal Adjustable Veneer Anchors.

C. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8-inch (16-mm) cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches (50 mm) parallel to face of veneer.

2.6 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene, urethane or PVC.

B. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

2.7 MASONRY CLEANERS

A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

2.8 2.08 MORTAR MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.
   1. Do not use calcium chloride in mortar.
   2. Use Portland cement-lime, masonry cement or mortar cement mortar unless otherwise indicated.
   3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide Type N unless another type is indicated.

D. Pigmented Mortar: Use colored cement product or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products.
   1. Pigments shall not exceed 10 percent of Portland cement by weight.
   2. Pigments shall not exceed 5 percent of masonry cement or mortar cement by weight.
   3. Mix to match Architect's sample.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.

B. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

C. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
   1. Mix units from several pallets or cubes as they are placed.

D. Matching Existing Masonry: Match coursing, bonding, color, and texture of brick masonry used on existing buildings at the project site.

E. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:
   1. For dimensions in cross section or elevation do not vary by more than plus 1/2 inch (12 mm) or minus 1/4 inch (6 mm).
   2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2 inch (12 mm).
   3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch (6 mm) in a story height or 1/2 inch (12 mm) total.

B. Lines and Levels:
   1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2 inch (12 mm) maximum.
   2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.
   3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2 inch (12 mm) maximum.
   4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.
   5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2 inch (12 mm) maximum.
   6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2 inch (12 mm) maximum.
   7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch (1.5 mm) except due to warpage of masonry units within tolerances specified for warpage of units.

C. Joints:
   1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm), with a maximum thickness limited to 1/2 inch (12 mm); do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch (3 mm).
   2. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm).
   3. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch (1.5 mm) from one masonry unit to the next.

3.4 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.

C. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

3.5 MORTAR BEDDING AND JOINTING

A. Lay hollow brick as follows:
   1. 1With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
   2. With entire units, including areas under cells, fully bedded in mortar at starting course on footings.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

3.6 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
   1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
      Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes.
   2. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
   3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.

4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean brick by bucket-and-brush hand-cleaning method described in "BIA Technical Notes 20."
6. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
7. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.
8. Clean stone trim to comply with stone supplier's written instructions.

9. Clean limestone units to comply with recommendations in ILI's "Indiana Limestone Handbook."

3.7 MASONRY WASTE DISPOSAL

A. Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes unit masonry assemblies consisting of the following:
   1. Concrete masonry units and accessories.

1.2 RELATED REQUIREMENTS

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.

1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only.

A. American Society for Testing and Materials (ASTM):
   1. C 90 - Standard Specification for Loadbearing Concrete Masonry Units.
   2. C 140 - Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
   3. C 426 - Standard Test Method for Linear Drying Shrinkage of Concrete Masonry Units.

1.4 DEFINITIONS

A. Standard Level of Quality: High quality, but conventional, nearly free of chips, cracks or other imperfections detracting from appearance when discernible and identified from distance of 20 feet under diffused lighting. When level of quality is not specified, Standard Level of Quality shall be assumed.

1.5 SUBMITTALS

A. Product Data: For each different masonry unit, accessory, and other manufactured product specified.

B. Samples for Initial Selection: For the following:
   1. Unit masonry Samples in small-scale form showing the full range of colors and textures available for each different exposed masonry unit required.
   2. Colored mortar Samples showing the full range of colors available.

C. Test Reports:
   1. Compressive Strength.
   2. Linear Shrinkage.
   3. Moisture Content (as a percentage of total absorption).
   4. Total Absorbtion.
   5. Unit Weight.

1.6 QUALITY ASSURANCE

A. Mock-Up
   1. Prior to starting construction of masonry, construct minimum 4 foot square mock-up.

2. Use accepted materials, containing each different kind and color of concrete masonry units and water repellant to illustrate wall design.
3. When not accepted, construct another mock-up.
4. When accepted, mock-up will be standard of comparison for remainder of masonry work.
5. Upon completion of Project, dispose of mock-ups in legal manner at offsite location in accordance with Section 01505.

B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, through one source from a single manufacturer for each product required.

C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from one manufacturer for each cementitious component and from one source or producer for each aggregate.

D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Meetings."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Transport and handle concrete masonry units as required to prevent discoloration, chipping, and breakage.

B. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
1. Protect Type I concrete masonry units from moisture absorption so that, at the time of installation, the moisture content is not more than the maximum allowed at the time of delivery.

C. Remove chipped, cracked, and otherwise defective units from jobsite upon discovery.

1.8 PROJECT CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
1. Extend cover a minimum of 24 inches (600 mm) down both sides and hold cover securely in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least 3 days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
1. Protect base of walls from rain-splashed mud and from mortar splatter by coverings spread on ground and over wall surface.
2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
   1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F (4 deg C) and above and will remain so until masonry has dried, but not less than 7 days after completing cleaning.

E. Hot-Weather Requirements: Protect unit masonry work when temperature and humidity conditions produce excessive evaporation of water from mortar and grout. Provide artificial shade and wind breaks and use cooled materials as required.
   1. When ambient temperature exceeds 100 deg F (38 deg C), or 90 deg F (32 deg C) with a wind velocity greater than 8 mph (13 km/h), do not spread mortar beds more than 48 inches (1200 mm) ahead of masonry. Set masonry units within one minute of spreading mortar.

F. Order concrete masonry units well before start of installation to ensure adequate time for manufacturing and minimum 28 days for curing and drying before start of installation. Protect from weather after curing period to avoid moisture increase.

PART 2 - PRODUCTS

2.1 CONCRETE MASONRY UNITS

A. General: Provide shapes indicated and as follows:
   1. Provide special shapes for lintels, corners, jambs, sash, control joints, headers, bonding, and other special conditions.
   2. Provide square-edged units for outside corners.

B. Concrete Masonry Units: Class 3 in accordance ASTM C 90 and as follows:
   1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 1900 psi (13.1 MPa).
   2. Weight Classification: Normal weight.
   3. Provide Type I, moisture-controlled units.
   4. Size (Width): Manufactured to the following dimensions:
      a. 4 inches (102 mm) nominal; 3-5/8 inches (92 mm) actual.
      b. 6 inches (152 mm) nominal; 5-5/8 inches (143 mm) actual.
      c. 8 inches (203 mm) nominal; 7-5/8 inches (194 mm) actual.
      d. 12 inches (305 mm) nominal; 11-5/8 inches (295 mm) actual.
   5. Finish: Exposed faces of the following general description in colors selected from the manufacturer’s full range of standard integral colors. All CMU shall be integrally-colored architectural block.
      a. Normal-weight aggregate, standard (smooth) finish.
      b. Normal-weight aggregate, split-face finish.
   6. Integral Water Repellent: Provide units made with liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive according to ASTM E 514, with test period extended to 24 hours, show no visible water or leaks on the back of the test specimen.

a. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
   1) Block Plus W-10; Addiment Inc.
   2) Dry-Block; W. R. Grace & Co., Construction Products Division.
   3) Rheopel; Master Builders.

2.2 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

B. Hydrated Lime: ASTM C 207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or Type III, and hydrated lime complying with ASTM C 207.

D. Do not use Masonry Cement or Mortar Cement.

E. Aggregate for Mortar: ASTM C 144; except for joints less than 1/4 inch (6.5 mm) thick, use aggregate graded with 100 percent passing the No. 16 (1.18-mm) sieve.
   1. White-Mortar Aggregates: Natural white sand or ground white stone.
   2. Colored-Mortar Aggregates: Natural-colored sand or ground marble, granite, or other sound stone; of color necessary to produce required mortar color.

F. Aggregate for Grout: ASTM C 404.

G. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in masonry mortar.

I. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494, Type C, and recommended by the manufacturer for use in masonry mortar of composition indicated.

J. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with concrete masonry units, containing integral water repellent by same manufacturer.

K. Water: Potable.

L. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
   1. Colored Portland Cement-Lime Mix:
      a. Eaglebond; Blue Circle Cement.
      b. Color Mortar Blend; Glen-Gery Corporation.
      c. Rainbow Mortamix Custom Color Cement/Lime; Holnam, Inc.
      d. Centurion Colorbond PL; Lafarge Corporation.
      e. Lehigh Custom Color Portland/Lime; Lehigh Portland Cement Co.
      f. Riverton Portland Cement Lime Custom Color; Riverton Corporation (The).
   2. Mortar Cement:
      a. Magnolia Superbond Mortar Cement; Blue Circle Cement.
      b. Lafarge Mortar Cement; Lafarge Corporation.
   3. Colored Mortar Cement:
      a. Magnolia Superbond Mortar Cement; Blue Circle Cement.
   4. Colored Masonry Cement:
      a. Magnolia Masonry Cement; Blue Circle Cement.
      b. Brixment-in-Color; Essroc Materials, Inc.

c. Rainbow Mortamix Custom Color Masonry Cement; Holnam, Inc.
d. Centurion Colorbond; Lafarge Corporation.
e. Lehigh Custom Color Masonry Cement; Lehigh Portland Cement Co.
f. Coosa Masonry Cement; National Cement Company, Inc.
g. Flamingo Color Masonry Cement; Riverton Corporation (The).
h. Richcolor Masonry Cement; Southdown, Inc.

5. Mortar Pigments:
   a. True Tone Mortar Colors; Davis Colors.
   b. Centurion Pigments; Lafarge Corporation.
   c. SGS Mortar Colors; Solomon Grind-Chem Services, Inc.
6. Cold-Weather Admixture:
   a. Accelguard 80; Euclid Chemical Co.
   b. Morseled; W. R. Grace & Co., Construction Products Division.
   c. Trimix-NCA; Sonneborn, Div. of ChemRex, Inc.
7. Water-Repellent Admixture:
   a. Mortar Tite; Addiment Inc.
   b. Dry-Block Mortar Admixture; W. R. Grace & Co., Construction Products Division.
   c. Rheopel; Master Builders.

2.3 REINFORCING STEEL

A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M; Grade 60.

2.4 MASONRY JOINT REINFORCEMENT

A. General: ASTM A 951 and as follows:
   1. Hot-dip galvanized, carbon-steel wire for both interior and exterior walls.
   2. Wire Size for Side Rods: W1.7 or 0.148-inch (3.8-mm) diameter.
   3. Wire Size for Cross Rods: W1.7 or 0.148-inch (3.8-mm) diameter.
   4. Provide in lengths of not less than 10 feet (3 m), with prefabricated corner and tee units where indicated.

B. For single-wythe masonry, provide either ladder or truss type with single pair of side rods and cross rods spaced not more than 16 inches (407 mm) o.c.

2.5 TIES AND ANCHORS, GENERAL

A. General: Provide ties and anchors, specified in subsequent articles, made from materials that comply with this Article, unless otherwise indicated.

B. Hot-Dip Galvanized Carbon-Steel Wire: ASTM A 82; with ASTM A 153, Class B-2 coating.

C. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304 or 316.

D. Galvanized Steel Sheet: ASTM A 653/A 653M, G60 (Z180), commercial-quality, steel sheet zinc coated by hot-dip process on continuous lines before fabrication.

E. Steel Sheet, Galvanized after Fabrication: ASTM A 366/A 366M cold-rolled, carbon-steel sheet hot-dip galvanized after fabrication to comply with ASTM A 153.

F. Stainless-Steel Sheet: ASTM A 666, Type 304 or 316.

G. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

2.6 MISCELLANEOUS MASONRY ACCESSORIES

A. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells with loops for holding reinforcing bars in center of cells. Units are formed from 0.142-inch (3.6-mm) steel wire, hot-dip galvanized after fabrication.
   1. Provide units with either two loops or four loops as needed for number of bars indicated.

2.7 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.
   1. Do not use calcium chloride in mortar or grout.
   2. Add cold-weather admixture (if used) at the same rate for all mortar, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in the form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification.
   1. Extended-Life Mortar for Unit Masonry: Mortar complying with ASTM C 1142 may be used instead of mortar specified above, at Contractor's option.
   2. Limit cementitious materials in mortar to portland cement, mortar cement, and lime.
   3. For reinforced masonry and where indicated, use Type S.

D. Pigmented Mortar: Select and proportion pigments with other ingredients to produce color required. Limit pigments to the following percentages of cement content by weight:
   1. For mineral-oxide pigments and portland cement-lime mortar, not more than 10 percent.
   2. For carbon-black pigment and portland cement-lime mortar, not more than 2 percent.
   3. For mineral-oxide pigments and masonry cement or mortar cement mortar, not more than 5 percent.
   4. For carbon-black pigment and masonry cement or mortar cement mortar, not more than 1 percent.

E. Grout for Unit Masonry: Comply with ASTM C 476.
   1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 5 of ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
   2. Provide grout with a slump of 8 to 11 inches (200 to 280 mm) as measured according to ASTM C 143.

F. Epoxy Pointing Mortar: Mix epoxy pointing mortar to comply with mortar manufacturer's directions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance.
   2. Verify that foundations are within tolerances specified.
   3. Verify that reinforcing dowels are properly placed.

4. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Before installation, examine rough-in and built-in construction to verify actual locations of piping connections.

3.2 INSTALLATION, GENERAL

A. Thickness: Build single-wythe walls to the actual widths of masonry units, using units of widths indicated.

B. Build chases and recesses to accommodate items specified in this Section and in other Sections of the Specifications.

C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to the opening.

D. Cut masonry units with motor-driven saws to provide clean, sharp, unchipped edges. Cut units as required to provide a continuous pattern and to fit adjoining construction. Where possible, use full-size units without cutting. Allow units cut with water-cooled saws to dry before placing, unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
   1. Mix units from several pallets or cubes as they are placed.

3.3 CONSTRUCTION TOLERANCES

A. Comply with tolerances in ACI 530.1/ASCE 6/TMS 602 and the following:

B. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/4 inch in 20 feet (6 mm in 6 m), nor 1/2 inch (12 mm) maximum.

C. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), nor 1/2 inch (12 mm) maximum.

D. For conspicuous horizontal lines, such as exposed lintels, sills, parapets, and reveals, do not vary from level by more than 1/4 inch in 20 feet (6 mm in 6 m), nor 1/2 inch (12 mm) maximum.

E. For exposed bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm), with a maximum thickness limited to 1/2 inch (12 mm). Do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch (3 mm).

F. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm). Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch (3 mm).

3.4 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Lay exposed masonry in the following bond pattern; do not use units with less than nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.

1. As indicated on Drawings.

C. Stopping and Resuming Work: In each course, rack back one-half-unit length for one-half running bond or one-third-unit length for one-third running bond; do not tooth. Clean exposed surfaces of set masonry, wet clay masonry units lightly if required, and remove loose masonry units and mortar before laying fresh masonry.

D. Built-in Work: As construction progresses, build in items specified under this and other Sections of the Specifications. Fill in solidly with masonry around built-in items.

E. Fill space between hollow-metal frames and masonry solidly with mortar, unless otherwise indicated.

F. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath in the joint below and rod mortar or grout into core.

G. Fill all cores in hollow concrete masonry units with grout.

4.2 MORTAR BEDDING AND JOINTING

A. Lay hollow masonry units as follows:
1. With full mortar coverage on horizontal and vertical face shells.

B. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than the joint thickness, unless otherwise indicated.

C. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint), unless otherwise indicated.

D. Intersecting and Abutting Walls: Unless vertical expansion or control joints are shown at juncture, bond walls together as follows:
1. Provide individual metal ties not more than 16 inches (406 mm) o.c.
2. Provide continuity with masonry joint reinforcement by using prefabricated "T" units.
3. Provide rigid metal anchors not more than 48 inches (1220 mm) o.c. If used with hollow masonry units, embed ends in mortar-filled cores.

8.2 MASONRY JOINT REINFORCEMENT

A. General: Provide continuous masonry joint reinforcement as indicated. Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch (16 mm) on exterior side of walls, 1/2 inch (13 mm) elsewhere. Lap reinforcement a minimum of 6 inches (150 mm).
1. Space reinforcement not more than 16 inches (406 mm) o.c.

B. Cut or interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.

C. Provide continuity at corners and wall intersections by using prefabricated "L" and "T" sections. Cut and bend reinforcing units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

10.2 LINTELS

A. Provide masonry lintels where shown and where openings of more than 12 inches (305 mm) for brick-size units and 24 inches (610 mm) for block-size units are shown without structural steel or other supporting lintels.

1. Provide prefabricated or built-in-place masonry lintels. Use specially formed bond beam units with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

B. Provide minimum bearing of 8 inches (200 mm) at each jamb, unless otherwise indicated.

13.2 REINFORCED UNIT MASONRY INSTALLATION

A. Temporary Formwork and Shores: Construct formwork and shores to support reinforced masonry elements during construction.
   1. Construct formwork to conform to shape, line, and dimensions shown. Make it sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
   2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements of ACI 530.1/ASCE 6/TMS 602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained sufficient strength to resist grout pressure.
   1. Comply with requirements of ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.

14.2 FIELD QUALITY CONTROL

A. Owner will engage a qualified independent testing agency to perform field quality-control testing indicated below.
   1. Payment for these services will be made by Owner.
   2. Retesting of materials failing to meet specified requirements shall be done at Contractor's expense.

B. Refer to structural drawings for Special Inspections and Testing requirements.

14.3 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
   1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
   2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.

3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent, polyethylene film, or waterproof masking tape.
4. On surfaces adjacent to glass unit masonry assemblies, remove mortar and other residue resulting from glass-block installation, in a manner approved by manufacturers of materials involved.
6. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing the surfaces thoroughly with clear water.
8. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2 applicable to type of stain on exposed surfaces.

15.1 MASONRY WASTE DISPOSAL

A. Recycling: Unless otherwise indicated, excess masonry materials, including masonry waste, are Contractor's property. At completion of unit masonry work, remove from Project site.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Structural steel.
   2. Grout.

1.2 DEFINITIONS

A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show fabrication of structural-steel components.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fabricator.
B. Welding certificates.
C. Mill test reports for structural steel, including chemical and physical properties.
D. Source quality-control reports.
E. Field quality-control and special inspection reports.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.
B. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.
C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
D. Comply with applicable provisions of the following specifications and documents:
   1. AISC 303.
   2. AISC 360.
   3. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Connections: Provide details of simple shear connections required by the Contract Documents to be selected or completed by structural-steel fabricator to withstand loads indicated and comply with other information and restrictions indicated.
   1. Select and complete connections using schematic details indicated.
B. Moment Connections: Type FR, fully restrained.
C. Construction: Combined system of moment frame and shear walls.

2.2 STRUCTURAL-STEEL MATERIALS

A. W-Shapes: ASTM A 992/A 992M.
B. Channels, Angles, M, S-Shapes: ASTM A 36/A 36M.
C. Plate and Bar: ASTM A 36/A 36M.
D. Cold-Formed Hollow Structural Sections: ASTM A 500/A 500M, Grade B, structural tubing.
E. Steel Pipe: ASTM A 53/A 53M, Type E or Type S, Grade B.

F. Welding Electrodes: Comply with AWS requirements.

2.3 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers; all with plain finish.
   1. Direct-Tension Indicators: ASTM F 959, Type 325, compressible-washer type with plain finish.

B. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy-hex head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.
   1. Finish: Mechanically deposited zinc coating.

C. Headed Anchor Rods: ASTM F 1554, Grade 36, straight.
   1. Finish: Plain Hot-dip zinc coating, ASTM A 153/A 153M, Class C.

D. Threaded Rods: ASTM A 36/A 36M.
   1. Finish: Hot-dip zinc coating, ASTM A 153/A 153M, Class C.

2.4 PRIMER

A. Primer: SSPC-Paint 25, Type I, zinc oxide, alkyd, linseed oil primer.

B. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

2.5 GROUT

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

2.6 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," and to AISC 360.

2.7 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
   1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1/D1.1M[**and AWS D1.8/D1.8M**] for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

2.8 SHOP PRIMING

A. Shop prime steel surfaces except the following:
   1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
   2. Surfaces to be field welded.
   3. Surfaces of high-strength bolted, slip-critical connections.
   4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
   5. Galvanized surfaces.
   6. Surfaces enclosed in interior construction.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
   1. SSPC-SP 2, "Hand Tool Cleaning."
   2. SSPC-SP 3, "Power Tool Cleaning."
C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.
B. Maintain erection tolerances of structural steel within AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

3.3 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
   1. Joint Type: Snug tightened.
B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
   1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
   2. Remove backing bars or runoff tabs where indicated, back gouge, and grind steel smooth.
   3. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," for mill material.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
   1. Verify structural-steel materials and inspect steel frame joint details.
   2. Verify weld materials and inspect welds.
   3. Verify connection materials and inspect high-strength bolted connections.
B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
C. Bolted Connections: Inspect bolted connections according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
D. Welded Connections: Visually inspect field welds according to AWS D1.1/D1.1M.
   1. In addition to visual inspection, test and inspect field welds according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

a. Liquid Penetrant Inspection: ASTM E 165.
b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
c. Ultrasonic Inspection: ASTM E 164.
d. Radiographic Inspection: ASTM E 94.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. K-series steel joist substitutes.
   2. LH- and DLH-series long-span steel joists.
   3. Joist accessories.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of joist, accessory, and product.
B. Shop Drawings:
   1. Include layout, designation, number, type, location, and spacing of joists.
   2. Include joining and anchorage details; bracing, bridging, and joist accessories; splice and connection locations and details; and attachments to other construction.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.
B. Manufacturer certificates.
C. Mill Certificates: For each type of bolt.
D. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer certified by SJI to manufacture joists complying with applicable standard specifications and load tables in SJI's "Specifications."
   1. Manufacturer's responsibilities include providing professional engineering services for designing special joists to comply with performance requirements.
B. Welding Qualifications: Qualify field-welding procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. 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:
   1. Canam Steel Corporation; Canam Group, Inc.
   2. CMC Joist & Deck.
   3. New Millennium Building Systems, LLC.
   4. Vulcraft; Nucor Vulcraft Group.

2.2 K-SERIES STEEL JOISTS

A. Steel Joist Substitutes: Manufacture according to "Standard Specifications for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle or -channel members.

2.3 LONG-SPAN STEEL JOISTS

A. Manufacture steel joists according to "Standard Specification for Longspan Steel Joists, LH-Series and Deep Longspan Steel Joists, DLH-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members; of joist type and end and top-chord arrangements as indicated.

2.4 PRIMERS

A. Primer: SSPC-Paint 15, or manufacturer's standard shop primer complying with performance requirements in SSPC-Paint 15.

2.5 JOIST ACCESSORIES

A. Bridging: Provide bridging anchors and number of rows of horizontal or diagonal bridging of material, size, and type required by SJI's "Specifications" for type of joist, chord size, spacing, and span. Furnish additional erection bridging if required for stability.
B. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy hex steel structural bolts; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.
   1. Finish: Hot-dip zinc coating, ASTM A 153/A 153M, Class C.
C. Furnish miscellaneous accessories including splice plates and bolts required by joist manufacturer to complete joist assembly.

2.6 CLEANING AND SHOP PAINTING

A. Clean and remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories.
B. Apply one coat of shop primer to joists and joist accessories.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Do not install joists until supporting construction is in place and secured.
B. Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Specifications," joist manufacturer's written instructions, and requirements in this Section.
   1. Before installation, splice joists delivered to Project site in more than one piece.
   2. Space, adjust, and align joists accurately in location before permanently fastening.
   3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
C. Field weld joists to supporting steel bearing plates and framework. Coordinate welding sequence and procedure with placement of joists. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
D. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

3.2 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
B. Visually inspect field welds according to AWS D1.1/D1.1M.
C. Visually inspect bolted connections.
D. Prepare test and inspection reports.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Roof deck.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of deck, accessory, and product indicated.
B. Shop Drawings:
   1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.
B. Product Certificates: For each type of steel deck.
C. Evaluation reports.
D. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."

2.2 ROOF DECK

A. Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:
   1. Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33, G90 zinc coating.
   2. Deck Profile: As indicated.
   3. Profile Depth: As indicated.
   4. Design Uncoated-Steel Thickness: As indicated.

2.3 ACCESSORIES

A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.
B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.
C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.
D. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.
E. Galvanizing Repair Paint: ASTM A 780/A 780M.

F. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.
B. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
C. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.
D. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.
E. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.
F. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld or mechanically fasten to substrate to provide a complete deck installation.
    1. Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.

3.2 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
B. Field welds will be subject to inspection.
C. Prepare test and inspection reports.

3.3 PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780/A 780M and manufacturer's written instructions.
B. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation, and apply repair paint.

END OF SECTION

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. Wood furring, grounds, nailers, and blocking.

1.3 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data for the following products:
   1. Metal framing anchors.
   2. Construction adhesives.

C. Retain below where applicable; normally delete if species and grade are indicated for each use.

D. Material certificates for dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the American Lumber Standards Committee's (ALSC) Board of Review.

E. Material test reports from a qualified independent testing agency indicating and interpreting test results relative to compliance of fire-retardant-treated wood products with requirements indicated.

F. Insert specific model code organization below or revise if report must be from another source.

G. Research or evaluation reports of the model code organization acceptable to authorities having jurisdiction that evidence the following products' compliance with building code in effect for Project.
   1. Metal framing anchors.
   2. Power-driven fasteners.
   3. Fire-retardant-treated wood.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Keep materials under cover and dry. Protect from weather and contact with damp or wet surfaces. Stack lumber, plywood, and other panels. Provide for air circulation within and around stacks and under temporary coverings.
   1. For lumber and plywood pressure treated with waterborne chemicals, place spacers between each bundle to provide air circulation.

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:
   1. Metal Framing Anchors:
      a. Cleveland Steel Specialty Co.
      b. Harlen Metal Products, Inc.
      c. Silver Metal Products, Inc.
      d. Simpson Strong-Tie Company, Inc.
      e. Southeastern Metals Manufacturing Co., Inc.

2.2 LUMBER, GENERAL

A. Lumber Standards: Comply with DOC PS 20, "American Softwood Lumber Standard," and with applicable grading rules of inspection agencies certified by ALSC's Board of Review.

B. Grade Stamps: Provide lumber with each piece factory marked with grade stamp of inspection agency evidencing compliance with grading rule requirements and identifying grading agency, grade, species, moisture content at time of surfacing, and mill.

C. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
   1. Provide dressed lumber, S4S, unless otherwise indicated.
   2. Provide lumber with 15 percent maximum moisture content at time of dressing for 2-inch nominal (38-mm actual) thickness or less, unless otherwise indicated.

2.3 FIRE-RETARDANT-TREATED LUMBER

A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.
   1. Use treatment that does not promote corrosion of metal fasteners.
   2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.

C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use matrial that is warped or that does not comply with requirements for untreated material.

D. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

E. Application: Treat all rough carpentry unless otherwise indicated, specifically including:
   1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.

2.4 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
   1. All fasteners and hardware shall be Type 316 stainless steel.

B. Nails, Wire, Brads, and Staples: FS FF-N-105.

C. Below covers power-driven staples, nails, P-nails, and allied fasteners.

D. Power-Driven Fasteners: CABO NER-272.

E. Wood Screws: ASME B18.6.1.

F. Lag Bolts: ASME B18.2.1. (ASME B18.2.3.8M)

G. High-Strength Bolts, Nuts & Washers: ASTM A325 (ASTM A325M), Type 1, heavy hex steel structural bolts, heavy hex carbon-steel nuts, and hardened carbon-steel washers.

2.5 METAL FRAMING ANCHORS

A. General: Provide galvanized steel hangers and framing anchors of structural capacity, type, and size indicated and as recommended by the manufacturer for each use.

B. Galvanized Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653, G60 (ASTM A 653M, Z180) coating designation; structural, commercial, or lock-forming quality, as standard with manufacturer for type of anchor indicated.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Discard units of material with defects that impair quality of carpentry and that are too small to use with minimum number of joints or optimum joint arrangement.

B. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted.

C. Fit carpentry to other construction; scribe and cope as required for accurate fit. Correlate location of furring, nailers, blocking, grounds, and similar supports to allow attachment of other construction.

D. Apply field treatment complying with AWPA M4 to cut surfaces of preservative-treated lumber and plywood.

E. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
   1. NES NER-272 for power-driven fasteners.
   2. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.

F. Revise below to include other kinds of nails if required.

G. Use common wire nails, unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood; predrill as required.

H. Use hot-dip galvanized or stainless-steel nails.

3.2 WOOD FRAMING, GENERAL

A. Framing Standard: Comply with UBC standards for structural framing unless otherwise indicated.

B. Install framing members of size and at spacing indicated.

C. Do not splice structural members between supports.

3.3 PROTECTION

A. Protect rough carpentry from weather.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES:

A. Rigid board type wall insulation(s) for thermal protection in wall assemblies.

1.2 REFERENCES

A. Refer to specific products for applicable standards and specifications of the following organiza-tions / agencies:
   1. American Society for Testing and Materials (ASTM).
   2. Federal Specifications (FS).
   3. Factory Mutual (FM).

1.3 SUBMITTALS

A. Comply with submittal procedures specified in Section 01300.

B. Product data: Manufacturer's specifications and installation instructions for polyiso foam core insulation board and fasteners.

C. Samples:
   1. Submit 5 inch x 9 inch sample(s) of each board type required.
   2. Submit sample(s) of each fastener type required.

D. Certificates: Manufacturer's certification that materials meet specification requirements.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. American Society for Testing and Materials (ASTM).
   2. Federal Specifications (FS).
   3. Factory Mutual (FM).

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver insulation in packages labeled with material name, thermal value and product code.

B. When stored outdoors, stack insulation on pallets above ground and cover with tarpaulin or other suitable waterproof coverings. Slit or remove manufacturer´s packaging before covering with the jobsite waterproof covering, to prevent condensation accumulation.

1.6 PROJECT CONDITIONS

A. Comply with building code and/or insurance underwriter's requirements applicable for products of this Section.

B. Do not install insulation when insulation and / or framing is wet.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Provide foil-faced polyiso insulating sheathing products as manufactured by Atlas Roofing Cor-poration, 2000 River Edge Parkway, Ste. 800, Atlanta, GA 30328. Ph. (770) 952-1442, Fax (770) 952-3170.

2.2 MATERIALS

A. Basis of Design
   1. Closed-cell polyisocyanurate foam core manufactured using patented, non-ozone depleting hydrocarbon blowing technology; ASTM C1289, Type I, Class 1

B. Insulation Long-Term “R” Value: Determined in accordance with CAN/ULC-S770/LTTR.

2.3 FASTENERS

A. Basis of Design
   1. Secure all rigid wall insulation with thermal wing-nut anchors equal to Type 304 Stainless Steel Hohmann & Barnard Thermal 2-Seal Adjustable Veneer Anchors.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Start of installation indicates installer accepts conditions of existing framing surfaces.

3.2 APPLICATION / INSTALLATION

A. Install specified wall insulation panels using approved mechanical fasteners in accordance with manufacturer’s latest written instructions and building codes.

B. Install with tight board to board joints to assure proper edge contact and thermal performance.

C. Install approved peel and stick, min. 4” wide tape at all junctures of the foam panels and at all penetrations.

3.3 CLEANING / PROTECTION

A. Remove trash and construction debris from insulation and / or framing surfaces prior to applica-tion.

B. Do not leave installed insulation exposed to weather for more than 60 days after installation
   1. Remove and replace installed insulation that has become damaged, with new insulation.
   2. Allow insulation surface to air dry prior to installing the wall cladding.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. HCFC Free Polyiso Rigid board type roof insulation(s) for thermal protection as part of roofing as-semblies.

1.2 RELATED SECTIONS

A. Section 05310 – Steel Deck.

B. Section 06100 – Rough Carpentry: Roof blocking and nailers.

1.3 REFERENCES

A. ASTM C 1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Insulation Board.

B. ASTM E 108 - Standard Test Methods for Fire Tests of Roof Coverings.

C. ASTM E 119 - Standard Test Methods for Fire Tests of Building Construction and Materials.

D. FM 4450 - Approval Standard - Class I Insulated Steel Roof Decks.

E. FM 4470 - Approval Standard - Class I Roof Covers.

F. LTTR – Long Term Thermal Resistance Predicted by CAN/ULC-S770-03.

G. UL 263 - Fire Tests of Building Construction and Materials.

H. UL 790 - Standard Test Methods for Fire Tests of Roof Coverings.

I. UL 1256 - Fire Test of Roof Deck Constructions.

1.4 DEFINITIONS

A. LTTR (Long Term Thermal Resistance) is defined as using techniques from ASTM C1303 or CAN/ULC-S770, the predicted R-Value that has been shown to be equivalent to the average performance of a permeably faced foam insulation product over 15 years. LTTR applies to ALL foam insulation prod-ucts with blowing agents other than air, such as polyiso, extruded polystyrene and polyurethane. The new method is based on consensus standards in the US and Canada.

1.5 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Product Data:
   1. Manufacturer´s specifications
   2. Installation instructions for insulation board and fasteners
   3. Product Data as per ASTM 2129 – 01 Standard for Data Collection for Sustainability Assess-ment of Building Products

C. Samples:
   1. Submit 6 by 6 inch (152 by 152 mm) samples of each board type required.
   2. Submit samples of each fastener type required.

D. Shop Drawings: Roof plan showing layout of boards and fastening patterns.

E. Certificates: System Manufacturer´s or insulation manufacturer's certification that the insulation meets Zero ODP (Ozone Depletion Potential) and Zero GWP (Global Warming Potential) specification require-ments.

F. Thermal Warranty: Submit sample warranty indicating conditions and limitations.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. American Society for Testing and Materials (ASTM).
   2. Factory Mutual (FM).
   3. Underwriters Laboratories Inc. (UL) Classification.
   4. IBC, BOCA, ICBO and SBCCI Sections on Foam Plastic Insulation.

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver insulation in packages labeled with material name, thermal value and product code.

B. When stored outdoors, stack insulation on pallets above ground or roof deck and cover with tarpaulin or other suitable waterproof coverings. Slit or remove manufacturer´s packaging before covering with water-proof covering.

1.8 PROJECT CONDITIONS

A. Comply with insurance underwriter´s requirements applicable for products of this Section.

B. Do not install insulation on roof deck when water of any type is present. Do not apply roofing materials when substrate is damp or wet.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Atlas Roofing Corporation or equal.

B. Provide polyiso roof board insulation from a single manufacturer.

2.2 MATERIALS

A. Polyiso Roof Board Insulation: Provide products that comply with the following:
   1. ASTM standards specified.
   2. Underwriters Laboratories Inc. (UL) classifications specified.
   3. ICBO Uniform Building Code Section on Foam Plastic Insulation.

B. Polyiso Roof Board Insulation: Closed-cell HCFC FREE “Green” polyisocyanurate foam core integrally laminated to heavy non- asphaltic fiber-reinforced felt facers; FM 1-90 wind uplift classification; com-pressive strength - 20 psi.

C. Nailable Polyiso Roof Board Insulation: Closed-cell HCFC FREE “Green” polyisocyanurate foam board bonded to 7/16 inch thick APA/TECO rated OSB on the top side and a fiber-reinforced felt facer on the bottom; for use with metal roofing, FM 1-90 wind rating; compressive strength - 20 psi.

D. LTTR - Insulation "R" Value:* Long-term thermal resistance values of the foam were determined in ac-cordance with CAN/ULC-S770. All test samples were third-party selected and tested by an accredited ma-terials testing laboratory.

E. Related Materials:
   1. Fasteners: Factory Mutual approved.
   2. Fasteners: For nailable insulation: per insulation manufacturers standards.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roof deck for suitability to receive insulation. Verify that substrate is dry, clean and free of foreign material that will damage insulation or impede installation.

B. Verify that roof drains, scuppers, roof curbs, nailers, equipment supports, vents and other roof accesso-ries are secured properly and installed in conformance with Contract Drawings and submittals.

C. Verify that deck is structurally sound to support installers, materials and equipment without damaging or deforming work.
   1. Start of installation indicates installer accepts conditions of existing deck surfaces.

3.2 APPLICATION / INSTALLATION

A. Install specified insulation using approved mechanical fasteners in accordance with manufacturer´s lat-est written instructions and as required by governing codes and Owner´s insurance carrier.

B. Install with end joints staggered to avoid having insulation joints coinciding with joints in deck. In multi-layer installations, stagger joints in top and bottom layers.

3.3 CLEANING / PROTECTION

A. Remove trash and construction debris from insulation surface prior to application of roofing membrane.

B. Do not leave installed insulation exposed to weather. Cover and waterproof with completed roof system immediately after installation.
   1. Temporarily seal exposed insulation edges at the end of each day.
   2. Remove and replace installed insulation that has become wet or damaged with new insulation.

C. Protect installed insulation and roof cover from traffic by use of protective covering materials during and after installation.

END OF SECTION

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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

B. Section includes standing-seam metal roof panels.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Meet with Owner, Architect, Owner's insurer if applicable, metal panel Installer, metal panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal panels, including installers of roof accessories and roof-mounted equipment.
   2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
   3. Review methods and procedures related to metal panel installation, including manufacturer's written instructions.
   4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
   5. Review structural loading limitations of deck during and after roofing.
   6. Review flashings, special details, drainage, penetrations, equipment curbs, and condition of other construction that affect metal panels.
   7. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
   8. Review temporary protection requirements for metal panel systems during and after installation.
   9. Review procedures for repair of metal panels damaged after installation.
   10. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

B. Sustainable Design Submittals:
   1. Product Test Reports: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirements.
   1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

C. Shop Drawings:
   1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.

2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 3 inches per 12 inches (1:5).

D. Calculations:
   1. Include calculations with registered engineer seal, verifying roof panel and attachment method resist wind pressures imposed on it pursuant to applicable building codes.

E. Samples for Initial Selection: For each type of metal panel indicated with factory-applied color finishes.
   1. Include similar Samples of trim and accessories involving color selection.

F. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
   1. Metal Panels: 12 inches (305 mm) long by actual panel width. Include clips, fasteners, closures, and other metal panel accessories.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Manufacturer and Installer.

B. Product Test Reports: For each product, for tests performed by a qualified testing agency.

C. Field quality-control reports.

D. Sample Warranties: For special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal panels to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in architectural sheet metal products.

B. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Retain strippable protective covering on metal panels until installation. Remove as panels are being installed. Verify film is not left on installed panels.

1.9 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.10 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

B. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.11 WARRANTY

A. Special Galvalume Substrate Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including rupturing, or perforating.
      b. Deterioration of metals and other materials beyond normal weathering.
   1. Warranty Period: 20 years and 6 months from date of Substantial Completion.

B. Special Installer Warranty: Furnish a written warranty signed by the Panel Applicator guaranteeing materials and workmanship for watertightness of the roofing system, flashings, penetrations, and against all leaks.
   1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 29 percent.

B. Energy Performance: Provide roof panels according to one of the following when tested according to CRRC-1:
   1. Three-year, aged solar reflectance of not less than 0.35.
   2. Three-year, aged Solar Reflectance Index of not less than 29 when calculated according to ASTM E 1980.

C. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) when tested according to ASTM E 1680 and ASTM E 283 at the following test-pressure difference:
   1. Test-Pressure Difference: 6.24 lbf/sq. ft. (300 Pa).

D. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 1646 and ASTM E 331 at the following test-pressure difference:
   1. Test-Pressure Difference: 15 lbf/sq. ft. (718.2 Pa).

E. Hydrostatic Head Resistance: No water penetration when tested according to ASTM E2140.

F. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.

1. Uplift Rating: UL 90.

G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

2.2 STANDING-SEAM METAL ROOF PANELS

A. General: Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.
   1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E 1514.
   2. Aluminum Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E 1637.

B. Vertical-Rib, Seamed-Joint, Standing-Seam Metal Roof Panels: Formed with vertical ribs at panel edges and panel striations between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and mechanically seaming panels together.
   1. Basis-of-Design Products include, but are not limited to: Berridge Manufacturing Company; Zee-lock (90^{o} seam).
   2. Metallic-Coated Steel Sheet: Aluminum-zinc alloy-coated steel sheet complying with ASTM A 792/A 792M, Class AZ50 (Class AZM150) coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
      a. Nominal Thickness: 0.024 inch (0.61 mm).
      b. Exterior Finish: Galvalume.
      c. Painted materials shall have a removable plastic film to protect the paint during roll forming, shipping and handling.
   1. Clips: Continuous Zee-rib with Vinyl Weatherseal insert to accommodate thermal movement.
      a. All clips, hardware and fasteners utilized for this installation shall be non-ferrous (aluminum or Type 316 stainless steel) to the extent practicable.
   2. Joint Type: Single folded.
   3. Panel Coverage: 16 inches (406 mm).
   4. Panel Height: 2.0 inches (51 mm).

2.3 UNDERLAYMENT MATERIALS

A. Self-Adhering, High-Temperature Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of 40 mils (1.02 mm) thick, consisting of slip-resistant, polyethylene-film top surface laminated to a layer of butyl or SBS-modified asphalt adhesive, with release-paper backing. Provide primer when recommended by underlayment manufacturer.
   1. Thermal Stability: Stable after testing at 240 deg F (116 deg C); ASTM D 1970.
   2. Low-Temperature Flexibility: Passes after testing at minus 20 deg F (29 deg C); ASTM D 1970.
   3. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Mid-States Asphalt Quick Stick HT Pro
b. Polyglass Polystick MTS
c. Soprema Lastobond Shield HT
d. Tamko TW Underlayment or TW Metal & Tile Underlayment

B. Felt Underlayment: ASTM D 226/D 22M, Type II (No. 30), asphalt-saturated organic felts.

2.4 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Subframing and Furring: ASTM C 645; cold-formed, metallic-coated steel sheet, ASTM A 653/A 653M, G90 (Z275 hot-dip galvanized) coating designation or ASTM A 792/A 792M, Class AZ50 (Class AZM150) coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal panels.
2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.

C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.

D. Gutters: Formed from same material as roof panels, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch (2400-mm) long sections, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual." Furnish gutter supports spaced a maximum of 36 inches (914 mm) o.c., fabricated from same metal as gutters. Provide wire ball strainers of compatible metal at outlets. Finish gutters to match metal roof panels. All clips, hardware and fasteners utilized for gutter installations shall be non-ferrous (aluminum or Type 316 stainless steel) to the extent practicable.

E. Downspouts: Formed from same material as roof panels. Fabricate in 10-foot (3-m) long sections, complete with formed elbows and offsets, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual." Finish downspouts to match gutters. All clips, hardware and fasteners utilized for downspout installations shall be non-ferrous (aluminum or Type 316 stainless steel) to the extent practicable.

F. Panel Fasteners: Type 316 stainless steel (preferred), zinc-coated steel, corrosion resisting steel, zinc cast head, or nylon capped steel, type and size as approved for the applicable loading requirements.

G. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
1. Joint Sealant: Silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.

2.5 FABRICATION

A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using factory set, non-adjustable, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.

C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

D. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
   1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
   2. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
   3. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.
      a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal panel manufacturer for application, but not less than thickness of metal being secured.

2.6 FINISHES

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Steel Panels and Accessories:
   1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat applied by panel manufacturer on a continuous coil coating line, with a top side dry film thickness of 0.75± 0.05 mil (0.0013 mm) over 0.2± 0.05 mil (0.0013 mm) primer coat, to provide a total dry film thickness of 0.95± 0.10 mil (0.024 mm). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

2. Mica Fluoropolymer: AAMA 621. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat applied by panel manufacturer on a continuous coil coating line, with a top side dry film thickness of 0.75± 0.05 mil (0.0013 mm) over 0.2± 0.05 mil (0.0013 mm) primer coat, to provide a total dry film thickness of 0.95± 0.10 mil (0.024 mm). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
3. Metallic Fluoropolymer: AAMA 621. Two-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat applied by panel manufacturer on a continuous coil coating line, with a top side dry film thickness of 0.75± 0.05 mil (0.0013 mm) over 0.2± 0.05 mil (0.0013 mm) primer coat, to provide a total dry film thickness of 0.95± 0.10 mil (0.024 mm). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
5. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.35 mil (0.009 mm).

B. Aluminum Panels and Accessories:
1. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat applied by panel manufacturer on a continuous coil coating line, with a top side dry film thickness of 0.75± 0.05 mil (0.0013 mm) over 0.2± 0.05 mil (0.0013 mm) primer coat, to provide a total dry film thickness of 0.95± 0.10 mil (0.024 mm). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. Mica Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat applied by panel manufacturer on a continuous coil coating line, with a top side dry film thickness of 0.75± 0.05 mil (0.0013 mm) over 0.2± 0.05 mil (0.0013 mm) primer coat, to provide a total dry film thickness of 0.95± 0.10 mil (0.024 mm). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
3. Metallic Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat applied by panel manufacturer on a continuous coil coating line, with a top side dry film thickness of 0.75± 0.05 mil (0.0013 mm) over 0.2± 0.05 mil (0.0013 mm) primer coat, to provide a total dry film thickness of 0.95± 0.10 mil (0.024 mm). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.
1. Examine primary and secondary roof framing to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by metal roof panel manufacturer.

2. Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal roof panel manufacturer.
    a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal panel manufacturer's written recommendations.

3.3 UNDERLAYMENT INSTALLATION

PART 21 - Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply at locations indicated below, wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches (152 mm) staggered 24 inches (610 mm) between courses. Overlap side edges not less than 36 inches (914.4 mm Roll laps with roller. Cover underlayment within 14 days or as directed by the underlayment product manufacturer.

1. Apply over the entire roof surface.

B. Flashings: Install flashings to cover underlayment to comply with requirements specified in Section 07620 "Sheet Metal Flashing and Trim."

3.4 METAL PANEL INSTALLATION

A. General: Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
    1. Shim or otherwise plumb substrates receiving metal panels to be level to 1/4 inch in 20 ft. (6 mm in 6.1 m).
    2. Flash and seal metal panels at perimeter of all openings. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
    3. Locate and space fastenings in uniform vertical and horizontal alignment.
    4. Install flashing and trim as metal panel work proceeds.
    5. Panels should be continuous without end laps.
    6. Align bottoms of metal panels and fasten.
    7. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

B. Fasteners:
    1. Steel Panels: All clips, hardware and fasteners utilized for this installation shall be non-ferrous (aluminum or Type 316 stainless steel) to the extent practicable (i.e. except only where such non-ferrous are not available as components of the roof manufacturer’s standard warranted system).

C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.

D. Standing-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.
   1. Install clips to supports with self-tapping fasteners.
   2. Install pressure plates, if required, at locations indicated in manufacturer's written installation instructions.
   3. Seamed Joint: Crimp standing seams with manufacturer-approved, motorized seamer tool so clip, metal roof panel, and factory-applied vinyl weatherseal are completely engaged.

E. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
   1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, and similar items. Provide types indicated by metal roof panel manufacturers; or, if not indicated, types recommended by metal roof panel manufacturer.

F. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
   1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and achieve waterproof and weather-resistant performance.
   2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.

G. Gutters: Join sections with riveted and soldered or lapped and sealed joints. Attach gutters to eave with gutter hangers spaced not more than 36 inches (914 mm) o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.

H. Downspouts: Join sections with telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch (25 mm) away from walls; locate fasteners at top and bottom and at approximately 60 inches (1524 mm) o.c. in between.
   1. Provide elbows at base of downspouts to direct water away from building.
   2. Connect downspouts to underground drainage system indicated.

I. Roof Curbs: Install flashing around bases where they meet metal roof panels.

J. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to metal roof panels as recommended by manufacturer.

3.5 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align metal panel units within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines as indicated and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect metal roof panel installation, including accessories. Report results in writing.

B. Remove and replace applications of metal roof panels where tests and inspections indicate that they do not comply with specified requirements.

C. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.

3.7 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

B. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

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 sheet metal flashing and trim in the following categories:
   1. Roof-drainage systems.
   2. Metal flashing.

B. Related Sections: The following Sections contain requirements that relate to this Section:
   1. Division 4 Sections for through-wall flashing and other integral masonry flashings specified as part of masonry work.
   2. Division 7 Section "Joint Sealants" for elastomeric sealants.

1.3 PERFORMANCE REQUIREMENTS

A. General: Install sheet metal flashing and trim to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failing.

B. Fabricate and install flashings at roof edges to comply with recommendations of FM Loss Prevention Data Sheet 1-49 for the following wind zone:
   1. Wind Zone 1: Wind pressures of 21 to 30 psf (1.00 to 1.44 kPa).

1.4 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data including manufacturer's material and finish data, installation instructions, and general recommendations for each specified flashing material and fabricated product.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experience Installer who has completed sheet metal flashing and trim work similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

1.6 PROJECT CONDITIONS

A. Coordinate Work of this Section with interfacing and adjoining Work for proper sequencing of each installation. Ensure best possible weather resistance, durability of Work, and protection of materials and finishes.

PART 2 - PRODUCTS

2.1 METALS

A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 coating designation; structural quality.

2.2 MISCELLANEOUS MATERIALS AND ACCESSORIES

A. Fasteners: All fasteners and hardware shall be non-ferrous to the maximum extent feasible, ideally 316 stainless steel. At a minimum fasteners and hardware shall be same metal as sheet metal flashing or other noncorrosive metal as recommended by sheet metal manufacturer. Match finish of exposed heads with material being fastened.

B. Asphalt Mastic: SSPC-Paint 12, solvent-type asphalt mastic, nominally free of sulfur and containing no asbestos fibers, compounded for 15-mil (0.4-mm) dry film thickness per coat.

C. Mastic Sealant: Polyisobutylene; nonhardening, nonskinning, nondrying, nonmigrating sealant.

D. Elastomeric Sealant: Generic type recommended by sheet metal manufacturer and fabricator of components being sealed and complying with requirements for joint sealants as specified in Division 7 Section "Joint Sealants."

E. Adhesives: Type recommended by flashing sheet metal manufacturer for waterproof and weather-resistant seaming and adhesive application of flashing sheet metal.

F. Paper Slip Sheet: 5-lb/square (0.244 kg/sq. m) red rosin, sized building paper conforming to FS UU-B-790, Type I, Style 1b.

G. Metal Accessories: Provide sheet metal clips, straps, anchoring devices, and similar accessory units as required for installation of Work, matching or compatible with material being installed; noncorrosive; size and thickness required for performance.

H. Roofing Cement: ASTM D 4586, Type I, asbestos free, asphalt based.

2.3 FABRICATION, GENERAL

A. Sheet Metal Fabrication Standard: Fabricate sheet metal flashing and trim to comply with recommendations of SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of the item indicated.

B. Comply with details shown to fabricate sheet metal flashing and trim that fit substrates and result in waterproof and weather-resistant performance once installed. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.

C. Form exposed sheet metal Work that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems.

D. Seams: Fabricate nonmoving seams in sheet metal with flat-lock seams. Tin edges to be seamed, form seams, and solder.

E. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.

F. Separate metal from noncompatible metal or corrosive substrates by coating concealed surfaces at locations of contact with asphalt mastic or other permanent separation as recommended by manufacturer.

G. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of sheet metal exposed to public view.

H. Fabricate cleats and attachment devices from same material as sheet metal component being anchored or from compatible, noncorrosive metal recommended by sheet metal manufacturer.

1. Size: As recommended by SMACNA manual or sheet metal manufacturer for application but never less than thickness of metal being secured.

2.4 SHEET METAL FABRICATIONS

A. General: Fabricate sheet metal items in thickness or weight needed to comply with performance requirements but not less than that listed below for each application and metal.

B. Gutters with Girth up to 15 Inches (380 mm): Fabricate from the following material:
   1. Galvanized Steel: 0.0217 inch (0.55 mm) thick.

C. Downspouts: Fabricate from the following material:
   1. Galvanized Steel: 0.0217 inch (0.55 mm) thick.

D. Flashing (not otherwise specified), Exposed Trim, Roof Penetration Flashing: Fabricate from the following material:
   1. Galvanized Steel: 0.0276 inch (0.7 mm) thick.

E. Flashing Receivers, Drip Edges, Eave Flashing: Fabricate from the following material:
   1. Galvanized Steel: 0.0217 inch (0.55 mm) thick.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions under which sheet metal flashing and trim are to be installed and verify that Work may properly commence. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Unless otherwise indicated, install sheet metal flashing and trim to comply with performance requirements, manufacturer's installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Anchor units of Work securely in place by methods indicated, providing for thermal expansion of metal units; conceal fasteners where possible, and set units true to line and level as indicated. Install Work with laps, joints, and seams that will be permanently watertight and weatherproof.

B. Install exposed sheet metal Work that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.

C. Expansion Provisions: Provide for thermal expansion of exposed sheet metal Work. Space movement joints at maximum of 10 feet (3 m) with no joints allowed within 24 inches (610 mm) of corner or intersection. Where lapped or bayonet-type expansion provisions in Work cannot be used or would not be sufficiently weatherproof and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

D. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pretin edges of sheets to be soldered to a width of 1-1/2 inches (38 mm), except where pretinned surface would show in finished Work.
   1. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.

E. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate elastomeric sealant to comply with SMACNA standards. Fill joint with sealant and form metal to completely conceal sealant.
   1. Use joint adhesive for nonmoving joints specified not to be soldered.

F. Seams: Fabricate nonmoving seams in sheet metal with flat-lock seams. Tin edges to be seamed, form seams, and solder.

G. Separations: Separate metal from noncompatible metal or corrosive substrates by coating concealed surfaces, at locations of contact, with asphalt mastic or other permanent separation as recommended by manufacturer.

H. Roof-Drainage Accessories: Install drainage items fabricated from sheet metal, with straps, adhesives, and anchors recommended by SMACNA's Manual or the item manufacturer, to drain roof in the most efficient manner. Coordinate flashing and sheet metal items for steep-sloped roofs with roofing installation.

I. Roof-Penetration Flashing: Coordinate roof-penetration flashing installation with roofing and installation of items penetrating roof. Install flashing as follows:
   1. Turn lead flashing down inside vent piping, being careful not to block vent piping with flashing.
   2. Seal and clamp flashing to pipes penetrating roof, other than lead flashing on vent piping.

3.3 CLEANING AND PROTECTION

A. Clean exposed metal surfaces, removing substances that might cause corrosion of metal or deterioration of finishes.

B. Provide final protection and maintain conditions that ensure sheet metal flashing and trim Work during construction is without damage or deterioration other than natural weathering at the time of Substantial Completion.

END OF SECTION

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 sealants for the following applications, including those specified by reference to this Section:
   1. Exterior joints in the following vertical surfaces and nontraffic horizontal surfaces:
      a. Control and expansion joints.
      b. Joints between different materials.
      c. Perimeter joints at frames of doors and windows.
      d. Other joints as indicated.
   2. Interior joints in the following vertical surfaces and horizontal nontraffic surfaces:
      a. Perimeter joints between interior wall surfaces and frames of interior doors and windows.
      b. Joints between plumbing fixtures and adjoining walls, floors, and counters.
      c. Other joints as indicated.

1.3 PERFORMANCE REQUIREMENTS

A. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.

1.4 SUBMITTALS

A. Product Data: For each joint-sealant product indicated, provide data indicating sealant chemical characteristics, performance criteria and limitations.

B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multicomponent materials.

B. Store and handle materials in compliance with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not proceed with installation of joint sealants under the following conditions:
   1. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer.
   2. When joint substrates are wet.

B. Joint-Width Conditions: Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.

C. Joint-Substrate Conditions: Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.

PART 2 - PRODUCTS

2.1 PRODUCTS AND MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the products specified in the sealant schedules at the end of Part 3.

2.2 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.

B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range for this characteristic.

2.3 ELASTOMERIC JOINT SEALANTS

A. Elastomeric Sealant Standard: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant in the Elastomeric Joint-Sealant Schedule at the end of Part 3, including those referencing ASTM C 920 classifications for type, grade, class, and uses.

B. Stain-Test-Response Characteristics: Where elastomeric sealants are specified in the Elastomeric Joint-Sealant Schedule to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

2.4 SOLVENT-RELEASE JOINT SEALANTS

A. Butyl-Rubber-Based Solvent-Release Joint-Sealant Standard: Comply with ASTM C 1085 for each product of this description indicated in the Solvent-Release Joint-Sealant Schedule at the end of Part 3.

2.5 LATEX JOINT SEALANTS

A. Latex Sealant Standard: Comply with ASTM C 834 for each product of this description indicated in the Latex Joint-Sealant Schedule at the end of Part 3.

2.6 JOINT-SEALANT BACKING

A. General: Provide sealant backings of material and type that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C 1330, of type indicated below and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:
   1. Type C: Closed-cell material with a surface skin.

C. Elastomeric Tubing Sealant Backings: Neoprene, butyl, EPDM, or silicone tubing complying with ASTM D 1056, nonabsorbent to water and gas, and capable of remaining resilient at temperatures down to minus 26 deg F (minus 32 deg C).Provide products with low compression set and of size and shape to provide a secondary seal, to control sealant depth, and otherwise contribute to optimum sealant performance.

D. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

2.7 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants with joint substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint sealant manufacturer's written instructions and the following requirements:
   1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
   2. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air. Porous joint surfaces include the following:
      a. Concrete.
      b. Masonry.
   3. Remove laitance and form-release agents from concrete.
   4. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.

B. Joint Priming: Prime joint substrates where recommended in writing by joint sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use nonstaining masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations of ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
   1. Do not leave gaps between ends of sealant backings.
   2. Do not stretch, twist, puncture, or tear sealant backings.
   3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and back of joints.

E. Install sealants by proven techniques to comply with the following and at the same time backings are installed:
   1. Place sealants so they directly contact and fully wet joint substrates.
   2. Completely fill recesses provided for each joint configuration.
   3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
   1. Remove excess sealants from surfaces adjacent to joint.
   2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
   3. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.
      a. Use masking tape to protect adjacent surfaces of recessed tooled joints.

3.4 CLEANING

A. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from the original work.

3.6 ELASTOMERIC JOINT-SEALANT SCHEDULE

A. Multicomponent Nonsag Urethane Sealant: Where joint sealants of this type are indicated, provide products complying with the following:
   1. Products: Available products include the following:
      a. Chem-Calk 500; Bostik Inc.
      b. Dynatrol; Pecora Corporation.
      c. Sikaflex - 2c NS; Sika Corporation.
      d. Sonolastic NP 2; Sonneborn Building Products Div., ChemRex Inc.
   2. Type and Grade: M (multicomponent) and NS (nonsag).
   3. Class: 25.
   4. Use Related to Exposure: NT (nontraffic).
   5. Uses Related to Joint Substrates: M, G, A, and, as applicable to joint substrates indicated, O.
   6. Applications: Door perimeters, expansion and control joints in concrete and masonry.

3.7 SOLVENT-RELEASE JOINT-SEALANT SCHEDULE

A. Butyl-Rubber-Based Solvent-Release Sealant: Where joint sealants of this type are indicated, provide products complying with the following:
   1. Products: Available products include the following:
      a. BC-158; Pecora Corporation.
      b. Sonneborn Multi-Purpose Sealant; Sonneborn Building Products Div., ChemRex, Inc.
      c. Tremco Butyl Sealant; Tremco.
   2. Applications: General sealing between similar or dissimilar materials including masonry, steel, aluminum, glass, wood and stone.

B. Latex Sealant: Where joint sealants of this type are indicated, provide products complying with the following:
   1. Products: Available products include the following:
      a. AC-20; Pecora Corporation.
      b. Sonolac; Sonneborn Building Products Div., ChemRex, Inc.
      c. Tremco Acrylic Latex Caulk; Tremco.
   2. Applications: General purpose caulking including metal siding and plumbing fixtures.

END OF SECTION

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PART 1 - GENERAL

1.1 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

1.2 QUALITY ASSURANCE.

A. Provide doors complying with ANSI/SDI 100 "Recommended Specifications for Standard Steel Doors and Frames" and as specified.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Deliver doors cardboard-wrapped or crated to provide protection during transit and job storage. Provide additional protection to prevent damage to finish of factory-finished doors. Inspect doors on delivery for damage. Minor damages may be repaired provided refinished items match new work and are acceptable to Architect; otherwise, remove and replace damaged items as directed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
   1. Steel Doors:
      a. Republic Builders Products.
      b. Steelcraft.
      c. Tex-Steel Corporation.

2.2 MATERIALS

A. Hot-Rolled Steel Sheets and Strip: Commercial-quality carbon steel, pickled and oiled, complying with ASTM A 569 (ASTM A 569M).

B. Cold-Rolled Steel Sheets: Carbon steel complying with ASTM A 366 (ASTM A 366M), commercial quality, or ASTM A 620 (ASTM A 620M), drawing quality, special killed.

2.3 DOORS

A. Steel Doors: Provide 1-3/4-inch- (44-mm-) thick doors of materials and ANSI/SDI 100 grades and models as indicated on Drawings or schedules.

B. Doors shall have hall be deep drawn embossed raised panels, both inside and out as indicated on Drawings or schedules.

C. Doors shall be reinforced by laminating face skins to a foam core slab of expanded polystyrene. Core shall have 1 lb to 1.25 lb per cubic foot density.

2.4 FABRICATION

A. Fabricate steel door units to be rigid, neat in appearance, and free from defects, warp, or buckle. Where practical, fit and assemble units in manufacturer's plant. Clearly identify work that cannot be permanently factory assembled before shipment, to assure proper assembly at Project site. Comply with ANSI/SDI 100 requirements.

B. Clearances: Not more than 1/8 inch (3.2 mm) at jambs and heads. Not more than 3/4 inch (19 mm) at bottom.

C. Fabricate exposed faces of doors and panels from only cold-rolled steel sheet, 18 Gauge (minimum).

D. Tolerances: Comply with SDI 117 "Manufacturing Tolerances Standard Steel Doors and Frames."

E. Exposed Fasteners: Unless otherwise indicated, provide countersunk flat or oval heads for exposed screws and bolts.

F. Hardware Preparation: Comply with applicable requirements of SDI 107 and ANSI A115 Series specifications for door and frame preparation for hardware.

G. Locate hardware as indicated on Shop Drawings or, if not indicated, according to the Door and Hardware Institute's (DHI) "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."

2.5 FINISHES, GENERAL

A. Prime Finish: Manufacturer's standard, factory-applied coat of rust-inhibiting primer complying with ANSI A250.10 for acceptance criteria.

B. Factory-Applied Paint Finish: Manufacturer's standard, factory-applied paint finish complying with ANSI A250.3 for performance and acceptance criteria.
   1. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install steel doors and accessories according to Shop Drawings, manufacturer's data, and as specified. Fit hollow-metal doors accurately in frames, within clearances specified in ANSI/SDI 100.

3.2 ADJUSTING AND CLEANING

A. Prime Coat Touchup: Immediately after erection, sand smooth any rusted or damaged areas of prime coat and apply touchup of compatible air-drying primer.

B. Protection Removal: Immediately before final inspection, remove protective wrappings from doors and frames.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Manual overhead insulated rolling doors. Principal components of door system shall be aluminum (or stainless steel).

1.2 SYSTEM DESCRIPTION

A. Design Requirements:
   1. Wind Loading: Supply doors to withstand up design wind loads as required by 2015 IBC.
   2. Cycle Life:
      a. Design doors of standard construction for normal use of up to 20 cycle per day maximum.
   3. Insulated Door Slat Material Requirements:
      a. Flame Spread Index of 0 and a Smoke Developed Index of 10 as tested per ASTM E84.
      b. Minimum Sound Transmission Class (STC) rating of 26 as tested per ASTM E90.
      c. Minimum R-value of 8.0 (U-factor of 0.125) as calculated using the ASHRAE Handbook of Fundamentals.
      d. Insulation to be CFC Free with an Ozone Depletion Potential (ODP) rating of zero.

1.3 SUBMITTALS

A. Reference Section 01 Submittal Procedures; submit the following items:
   1. Product Data.
   2. Shop Drawings: Include special conditions not detailed in Product Data. Show interface with adjacent work.
   3. Quality Assurance/Control Submittals:
      a. Provide proof of manufacturer ISO 9001:2008 registration.
      b. Provide proof of manufacturer and installer qualifications - see 1.4 below.
      c. Provide manufacturer's installation instructions.
   4. Closeout Submittals:
      a. Operation and Maintenance Manual.
      b. Certificate stating that installed materials comply with this specification.

1.4 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer Qualifications: ISO 9001:2008 registered and a minimum of five years experience in producing doors of the type specified.
   2. Installer Qualifications: Manufacturer's approval.

1.5 DELIVERY STORAGE AND HANDLING

A. Follow manufacturer's instructions.

1.6 WARRANTY

A. Standard Warranty: Two years from date of shipment against defects in material and workmanship.

B. Maintenance: Submit for owner’s consideration and acceptance of a maintenance service agreement for installed products.

PART 2 - PART 2 PRODUCTS

2.1 MANUFACTURER

A. Approved manufacturers include, but are not necessarily limited to: Cornell Iron Works, Inc..

2.2 MATERIALS

A. Curtain:
   1. Slat Material: No. 6F, (Listed Exterior/Interior): Aluminum
      a. Insulation: 7/8 inch (22 mm) foamed-in-place, closed cell urethane.
      b. Total Slat Thickness: 15/16 inch (24 mm).
      c. Slats have a Flame Spread Index of 0 and a Smoke Developed Index of 10 as tested per ASTM E84.
      d. Slat has an R-value of 8.0 and an STC rating of 26.
   2. Bottom Bar: Reinforced extruded aluminum interior face with full depth insulation and exterior skin slat to match curtain material and gauge.
   3. Fabricate interlocking sections with high strength [nylon] [cast iron] endlocks on alternate slats each secured with two ¼" (6.35 mm) rivets. Provide windlocks as required to meet specified wind load.
   4. Exterior Slat Finish: Clear anodized.
   5. Interior Slat Finish: Clear anodized.
   6. Curtain Configuration
      a. Standard Curtain configuration.
   7. Bottom Bar Finish:
      a. Exterior Face: Match slats.
      b. Interior Face: Clear anodized.
   8. Bottom Bar Configuration:
      a. Standard Bottom Bar Configuration.

B. Guides: Fabricate with minimum 3/16 inch (4.76 mm) aluminum angles. Provide windlock bars of same material when windlocks are required to meet specified wind load. Top of inner and outer guide angles to be flared outwards to form bellmouth for smooth entry of curtain into guides. Provide removable guide stoppers to prevent over travel of curtain and bottom bar.
   1. Finish: Clear anodized.
   2. Configuration:
      a. Standard Guide Configuration.

C. Counterbalance Shaft Assembly:
   1. Barrel: Steel pipe capable of supporting curtain load with maximum deflection of 0.03 inches per foot (2.5 mm per meter) of width.
   2. Spring Balance: Oil-tempered, heat-treated steel helical torsion spring assembly designed for proper balance of door to ensure that maximum effort to operate will not exceed 25 lbs (110 N). Provide wheel for applying and adjusting spring torque.

D. Brackets: Fabricate from minimum 3/16 inch (5 mm) steel plate with permanently lubricated ball or roller bearings at rotating support points to support counterbalance shaft assembly and form end closures.
   1. Finish:
      a. Steel: ASTM A 123, Grade 85 zinc coating, hot-dip galvanized after fabrication.

E. Hood: 0.040 inch (1.016 mm) aluminum with reinforced top and bottom edges. Provide minimum 1/4 inch (6.35 mm) steel intermediate support brackets as required to prevent excessive sag.

F. Weatherstripping:
   1. Bottom Bar: Replaceable, bulb-style, compressible EDPM gasket extending into guides.
   2. Guides: Replaceable vinyl strip on guides sealing against fascia side of curtain.
   3. Lintel Seal: Nylon brush seal fitted at door header to impede air flow.

2.3 ACCESSORIES

A. Locking:
   1. Manual Chain Hoist: Padlockable chain keeper on guide.

2.4 OPERATION

A. Manual Chain Hoist: Provide chain hoist operator with endless steel chain, chain pocket wheel and guard, geared reduction unit, and chain keeper secured to guide.

PART 3 - EXECUTION

3.1 EXAMINATION

A. substrates upon which work will be installed and verify conditions are in accordance with approved shop drawings.

B. Coordinate with responsible entity to perform corrective work on unsatisfactory substrates.

C. Commencement of work by installer is acceptance of substrate.

3.2 INSTALLATION

A. General: Install door and operating equipment with necessary hardware, anchors, inserts, hangers and supports.

B. Follow manufacturer's installation instructions.

3.3 ADJUSTING

A. Following completion of installation, including related work by others, lubricate, test, and adjust doors for ease of operation, free from warp, twist, or distortion.

3.4 CLEANING

A. Clean surfaces soiled by work as recommended by manufacturer.

B. Remove surplus materials and debris from the site.

3.5 DEMONSTRATION

A. Demonstrate proper operation to Owner's Representative.

B. Instruct Owner's Representative in maintenance procedures.

END OF SECTION

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PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish and install aluminum architectural windows complete with hardware and related components as shown on drawings and specified in this section.

B. All windows shall be equal to Peerless Products, Inc. Series 4170 Thermal F-AW80 Fixed windows (Basis of Design).

C. Glass and Glazing
   1. All units shall be factory glazed.

1.2 TESTING AND PERFORMANCE REQUIREMENTS

A. Units shall comply with air, water and structural requirements as specified in ASTM E 330-02 for type and classification of window units required.

B. Test Procedures and Performance Requirements
   1. Windows shall conform to all ASTM E 330-02 requirements for the type and classification of window units required. In addition, the following performance criteria must be met:
   2. Air Infiltration Test
      a. Test unit in accordance with ASTM E 283 at a static air pressure difference of 6.24 psf.
      b. Air infiltration shall not to exceed 0.1 cfm per square foot of crack.
   3. Water Resistance Test
      a. Test unit in accordance with ASTM E 331 & ASTM E 547 at a static air pressure difference of 15 psf.
      b. There shall be no uncontrolled water leakage.
   4. Uniform Load Structural Test
      a. Test unit in accordance with ASTM E 330 at a positive and negative static air pressure difference of 120 psf.
      b. There shall be no glass breakage or permanent damage.

1.3 QUALITY ASSURANCE

A. test reports from an AAMA certified laboratory verifying performance as specified in section 1.02.

B. Provide test reports and window manufacturers letter of certification showing compliance with ASTM E 330-02 for the appropriate window type.

C. Test reports shall be no more than four years old.

1.4 SUBMITTALS

A. Submit shop drawings, finish samples, test reports and warranties.
   1. Shop drawings shall indicate type of glazing, screen and window finish to be supplied.
   2. Additional samples may be requested if so directed by the architect.

1.5 DELIVERY AND STORAGE

A. Protect units adequately against damage from the elements, construction activities, theft and other hazards before, during and after installation.

1.6 WARRANTIES

A. Manufacturers Warranties
   1. Submit written warranties from window manufacturer for the following:
      a. Windows: Windows furnished are certified as fully warranted against any defects in material or workmanship under normal use and service for a period of one (1) year from date of fabrication.
      b. Finish: The pigmented organic finishes on windows and component parts (such as panning, trim, mullions, and the like) are certified as complying fully with the requirements of the AAMA 260X specification and fully warranted against chipping, peeling, cracking or blistering for a period of five (5) years from date of installation.
      c. Glass: The insulating glass units shall be warranted from visual obstruction due to internal moisture for a period of ten (10) years. The manufacturer shall furnish a test report and notice of product certification from an independent laboratory showing compliance per ASTM E 2190-02 as pass/fail.

PART 2 - PART 2 PRODUCTS

2.1 MATERIALS

A. Aluminum
   1. Extruded aluminum shall be 6063-T5 or T6 alloy and tempered.

B. Fasteners
   1. Fasteners shall be aluminum, non-magnetic stainless steel or other materials warranted by the manufacturer to be non-corrosive and compatible with aluminum window members, trim, hardware, anchors and other components of the window units.
   2. Exposed fasteners shall not be permitted on exterior except where unavoidable for the application of hardware.

C. Thermal Barrier
   1. All exterior aluminum shall be separated from the interior aluminum by an integrally concealed, low-conductance structural thermal barrier in a manner that eliminates direct metal-to-metal contact.
   2. Thermal barrier de-bridge space shall not be less than 3/16”.
   3. Thermal barrier shall be poured-in-place two-part polyurethane that has been in use on similar units for a period of not less than two years and has been tested to demonstrate:
      a. Resistance to thermal conductance and condensation.
      b. Adequate strength and security of glass retention.

D. Hot Melt Silicone and Glazing Beads
   1. Hot Melt Silicone shall conform to AAMA 800 specification.
   2. Glazing beads shall be extruded aluminum and shall be of sufficient strength to retain the glass.

E. Sealant
   1. Sealant shall be non-shrinking, non-migrating elastomeric type conforming to AAMA 803 and AAMA 808.

F. Glass
   1. Glazing shall comply with Section 08800 Glazing.

2.2 FABRICATION

A. General
   1. Units shall be able to be re-glazed without dismantling the master frame.
   2. All aluminum frame and sash extrusions shall have a minimum wall thickness of 0.062”.

B. Frame
   1. Master frame shall be no less than 4”.
   2. Frame components shall be mechanically fastened.

C. Finish
   1. Organic
      a. Finish all exposed areas of aluminum windows and components with organic coating of type and color as selected by the architect.
      b. Finish shall be certified by the manufacturer to meet or exceed AAMA 2603, 2604 or 2605 specification.

PART 3 - PART 3 EXECUTION

3.1 INSPECTION

A. Job Conditions
   1. Verify that openings are dimensionally within allowable tolerances, plumb, level, clean, provide a solid anchoring surface and are in accordance with the approved shop drawings.

3.2 INSTALLATION

A. Work to be completed in accordance with the approved shop drawings and specifications by skilled tradesmen.

B. Set units plumb and level in a single plane for each wall plane without warp or rack of frames or sash. Adequately anchor units in place separating aluminum and other corrodible surfaces from sources of corrosion or electrolytic action.

C. Adjust window units for proper operation after installation.

D. Furnish and apply sealants to provide a weather tight installation.

E. Leave all exposed surfaces clean, smooth and free of debris.

3.3 ANCHORAGE

A. Adequately anchor to maintain permanent position when subjected to normal movement and loading.

3.4 CLEANING AND PROTECTION

A. After completion of installation, units shall be inspected, adjust and promptly cleaned to prevent damage to finish or glazing.

B. Remove excess sealant, labels, dirt and other substances.

C. Initiate all protection and other precautions required to insure that units will be without damage or deterioration at time of acceptance.

END OF SECTION

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PART 1 - GENERAL

1.1 SCOPE

A. Work under this section is comprised of furnishing and installing finish hardware specified herein and noted on the drawings, for a complete and operational system, including any electrified hardware components, systems and controls.

B. Product, and hardware schedule submittals.

C. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work

1.2 RELATED DOCUMENTS

A. Drawings and general conditions of contract, including general and supplementary conditions, and Division 1-specification sections, apply to this section.

1.3 RELATED WORK

A. Specified elsewhere that should be examined for its effect upon this section:
   1. Section 08110 – Steel Doors and Frames

1.4 HARDWARE COMPLIANCE

A. Provide only hardware that has been tested and listed by UL for types and sizes of doors required and complies with requirements of door and door frame. All hardware used on fire labeled openings will be listed for those types of openings and bear the identifying label indicating UL (Underwriter's Laboratories) approved for use on fire doors.

B. All hardware specified herein will be in compliance (to the extent required) with:
   1. NFPA-80 - Standard for Fire Doors and Windows
   2. NFPA-101- Life Safety Code
   3. ADA, the Americans with Disabilities Act – title III – Public Accommodations
   4. ANSI-A 117.1 – American National Standards Institute – Accessible and Usable Buildings and Facilities
   5. UL – Underwriter's Laboratories
   6. WHI – Warnock Hersey International, Division of INCHAPE Testing Services
   7. TAS - Texas Accessibility Standards
   8. State and local codes including authority having jurisdiction

1.5 GENERAL

A. Finish hardware must be neatly and properly installed in accordance with the best practices as approved by the Owner's Representative.

B. No extra cost will be allowed because of changes or corrections necessary to facilitate the proper installation of any hardware. The General Contractor will be responsible for the proper fabrication of all work or materials to receive the hardware.

C. Any specified hardware not specifically mentioned herein will be called to the attention of the Architect during the bidding period so that an addendum may be prepared to cover such items. It will be the responsibility of the successful bidder to furnish all required finish hardware, whether or not herein mentioned, unless excluded from this section of the specifications.

1.6 QUALIFICATIONS

A. The finish hardware supplier will be a person or firm technically proficient and experienced in this trade, who has been furnishing “Institutional Grade” hardware in the Austin area for not less than five years, and will be responsible for properly detailing and fitting material to the conditions required by the Drawings.

B. Hardware supplier to be a qualified “direct distributor” of the products to be furnished. In addition, the supplier is to have, in their employment, an A.H.C. representative, certified by the “Door and Hardware Institute”, who will be made available at reasonable times to consult with the Architect, Contractor and Owner’s Representative, regarding any matters affecting the finish hardware.

C. Installer for mechanical hardware shall have a minimum of 2 years of experience of installing architectural finish hardware and attend a pre-installation meeting with the manufacturer’s representative of locks, exit devices and closers.

1.7 SUBMITTALS

A. Hardware Schedule: in a prudent and timely manner, submit copies of schedule in accordance with Division 1, General Requirements. Schedule will be in “vertical format”, listing each door opening, including handing of opening, all hardware scheduled for opening or otherwise required to allow for proper function of door opening as intended, and finish of hardware.

B. Submit manufacturer’s cut sheets on all hardware items.

C. The General Contractor will deliver finish hardware templates to and coordinate with related door and frame suppliers.

D. The General Contractor will furnish to Owner’s Representative one complete copy of installation instructions and maintenance guides on all hardware, both electrical and mechanical.

1.8 DELIVERY, HANDLING, AND PACKAGING

A. Furnish all hardware to the jobsite securely boxed, bagged, wrapped or packaged with each unit clearly marked and numbered in accordance with the hardware schedule. Include door and item number for each.

B. Pack each item complete with all necessary parts and fasteners. Include whatever information may be necessary to show compliance with requirements, and include instructions for installation and for maintenance of operating parts and finish. Transmit copy of applicable data to Installer.

C. Hardware supplier is responsible for setting-up the hardware on the site, in a suitable, dry and secure room, provided by the General Contractor.

1.9 WARRANTY

A. Provide warranty that all items furnished under this section of the specification will be free of defects in material and workmanship and will perform the services for which it was intended for a period of one (1) year for door closers, and ten (10) years for exit devices. Replace, repair or adjust any items not fulfilling this warranty at no further expense to Owner.

1.10 TEMPLATES

A. The General Contractor will furnish, in a timely manner, finish hardware templates to each supplier or fabricator of doors, frames, and other work to be factory-prepared for the installation of hardware. Contractor will check the shop drawings of such other work, to confirm that adequate provisions are made for the proper installation of hardware, with all specified operating characteristics and clearances.

1.11 OPERATION AND MAINTENANCE DATA

A. Provide Owner with manufacturer's parts list and maintenance instructions under provisions of the General Conditions, for each type of hardware supplied and necessary wrenches and tools required for proper maintenance of hardware

PART 2 - PRODUCTS

2.1 HARDWARE

A. Manufacturers as follows. All products used on this project must be equal to in quality, and fully compatible in terms of functionality and interchangeability of components, with the products of the following manufacturers.

Manufacturer	Abbreviation	Website
Best Access	BES	www.bestaccess.com
Bommer industries, *i*nc.	BOM	www.bommer.com
Falcon	FAL	www.falconlock.com
Glynn Johnson	GLY	www.glynn-johnson.com
Hager Hinge Company	HAG	www.hagerhinge.com
Ives	IVE	www.ives.ingersollrand.com
LCN	LCN	www.lcnclosers.com
National Guard	NGP	www.ngpinc.com
Rockwood	ROC	www.rockwoodmfg.com
Schlage	SCH	www.schlage.com
Trimco/BBW/Quality	TRI	www.trimcobbw.com
Von Duprin	VON	www.vonduprin.com
Zero	ZER	www.zerointernational.com

2.2 FINISHES

A. All exposed hardware will be dull chrome (US 26 D) finish unless otherwise noted. Closers will be powder coated epoxy enamel to match adjacent hardware finish

2.3 FASTENINGS

A. As required for finished installation

B. Hardware furnished under this section of the specifications will be complete with all necessary screws, bolts, anchors, adapter brackets or other fastenings for proper application. Such fastenings will be of suitable size and type, and will harmonize with hardware as to material and finish and as the manufacturer supplies with their products. Stops, thresholds and holders will be fastened to concrete with steel drop-in anchors and to doors with sex bolts. All closers and exit devices will be thru-bolted.

C. Utilize screws and installation tools provided with the hardware. No other screws or attachments are acceptable. Self-taping screws will not be accepted unless provided by the manufacturer.

2.4 LEVERS AND TRIM

A. Levers will be cast or forged solid brass (dull chrome US 26 D or 626), or stainless steel (US 32 D or 630). Zinc alloys or pot metal material will not be acceptable.

B. Roses for use with levers will be wrought brass or stainless steel, and will have built-in deadstops with concealed springs to keep lever from sagging.

2.5 LOCKS AND LATCHES

A. Will be of the mortise type only. All locksets, latchsets, electrified locksets, cylinders, and trim to be of one manufacturer as hereafter listed for continuity of design and consideration of warranty.

B. Case will be of .090 gauge Cold formed steel, zinc dichromate plated: 6” high by 4-1/4” wide by 1” wide with post indexed trim.

C. Front will be armored, wrought brass, bronze or stainless steel, adjustable for door bevel, reinforced by heavy gauge steel with stabilizing ribs, fastened by machine screws. Fronts will be 8” x 1-1/4” in size.

D. Strikes will be ASA size of brass or bronze with lips of length to protect all jamb trim but will be no longer than so required. Provide and install stamped box strikes at all locations.

E. Latch bolts will be three-piece anti-friction type 5/8” wide, 1” high and with no less than ¾” protection, with no delarin or plastic parts.

F. Deadbolts will be solid brass or bronze, chrome plated, with two hardened free-floating steel pins to prevent sawing. Size to be 5/8” wide, 1-3/8” high and no less than 1” projection. Hardened steel rollers are required with the deadbolt.

G. Backset will be 2-3/4”.

H. Hubs will be forged brass or hardened steel. Lever action will be balanced mechanically to provide equal pressure on knob in either direction to actuate the latchbolt.

I. Springs will be a coiled spring for latchbolt return and a coiled torsion spring for hub return.

J. Spring will be 3-5/8” x 2-7/8” plus or minus 3/16”.

K. Cases may provide apertures for post-indexed trim.

2.6 DOOR CLOSERS

A. LCN 4041 (representative product) or approved equal.

B. All door closers, unless otherwise specified or shown on the Drawings, will be heavy duty, surface mounted, full rack and pinion liquid (hydraulic) type, with cast iron cylinders, capable of controlling door through 180 degrees of swing. Provide full covers of non-ferrous, non-corrosive material painted to match the adjacent hardware finish

C. Surface closers will be adjusted by key valves. Furnish six (6) adjusting keys. Spring power of each closer will be adjustable, and will be capable of meeting handicapped accessibility code requirements.

D. No closer will be installed on the outside of any exterior door or on the corridor side of any room door. Wherever it is necessary to install a closer on the side of a door away from the butts, a parallel arm will be used. Corner or soffit brackets will not be permitted. Corridor installation is acceptable where abutting walls prevent normal installation. All fastenings to the door will be by sex bolts.

E. Closers to have adjustable spring power, which allows for closer sizing. Closers to have separate tamper resistant, non-critical regulating hydraulic screw valves for closing speed, latching speed, and backcheck control as a standard feature.

F. All parallel arms will be extra heavy-duty solid forged steel (EDA Extra Duty Arm). All closers, without exception, will be installed to 180º door swing specifications. Closers shall not have soffit stops.

G. All door closers must be covered by a ten-year factory guarantee against defective material or workmanship.

H. The successful bidder is required to keep in touch with the progress of the job and have a factory trained representative visit the job prior to installation to train the General Contractor's installer on proper techniques and once again insure that all closers are properly adjusted at completion of the installation.

2.7 HINGES

A. (BUTTS) BB1168 Series Hager (representative product) or approved equal.

B. Hinges will be five-knuckle, standard or heavy-duty, ball bearing, button-tip, full mortise template type hinges.

C. At labeled doors, or doors with closers, provide steel (painted) bearing-type hinges.

D. Exterior door hinges will be of steel (painted) with non-removable pins, or will have pins held in place by a set screw which can only be removed while the door is open.

E. Provide heavyweight hinges on all openings with high frequency usage as indicated in the hardware schedule.

F. Hinges (butts) will be of the class as indicated by manufacturer's number in the hardware sets. All hinges will have sufficient throw to clear the door trim, plinth, or cove base, but will have no more throw than is necessary.

G. Hinges will be sized as follows:
   1. Doors 3'-0" wide or less: 4-1/2" x 4-1/2" (1-1/2 pair hinges)

H. Quantity of hinges per door will be as follows:

1. Door up to 90” in height 1-1/2 pair (3)

2.8 EXIT DEVICES

A. Falcon 24/25 Series or Von Duprin 33/99 Series (representative products) or approved equal. NOTE: ALL EGRESS DOORS SHALL BE PROVIDED WITH EXIT DEVICES (PANIC HARDWARE).

B. Vertical rod exit devices will not be accepted.

C. Exit devices to be UL listed for life safety. All exit devices for labeled doors will bear the UL label for “fire exit hardware”. All devices will comply with NFPA 80 and NFPA 101 requirements.

2.9 DOOR STOPS

A. Wall Mounted: Trimco #1209W (representative product) or approved equal.

B. place door stops in such a position that they permit maximum door swing, but do not present a hazard or obstruction. All floor mounted door stops will be installed using flush bolts and steel drop-in anchors manufactured by Ramset or Red Head: Anchors will be set at least one inch into the concrete. Lead anchors will not be allowed. Floor stops shall be placed as far from the hinge edge of the door so as to not allow a trip hazard.

C. Exterior door stops, when possible, should be wall mounted on a wing wall or recess that acts to stop the door from swinging more than 90 degrees from the closed position. If wing walls are not possible to construct, the alternative floor mounted stop is to be provided, with appropriate railing to prevent a tripping hazard.

2.10 GASKETING

A. Provide materials and finishes as listed in the hardware schedule or as shown on the Drawings. All thresholds must be in accordance with the requirements of ANSI A117.1 and the ADA. If no thresholds or gasketing is specified, provide thresholds and complete gasketing at all exterior doors, and smoke seals at all interior fire rated doors as follows:

PART 3 - EXECUTION

3.1 INSTALLATION

A. Hardware installers shall be professional hardware installers with ten years of documented hardware installation experience. Contractor shall submit hardware installer’s names and experience qualifications to Architect and Owner for review and approval prior to start of hardware installation.

B. Check hardware against the reviewed hardware schedule upon delivery. Do not install hardware when it is apparent that the scheduled hardware will not function properly for the application for which it was intended. Contact the Architect immediately for clarification, and correction of the application – prior to installation of the incorrect hardware.

C. Finish hardware installed prior to the building being “dried in” and “climate conditioned”, which shows any signs of rusting, wear or abuse, will be subject to rejection by the Architect or Owner’s Representative. Any such rejected hardware will be replaced, at no cost to Owner, by the General Contractor.

D. Mount hardware units at heights recommended in “Recommended Location for Builders’ Hardware” by BHMA, except as otherwise specifically indicated or required to comply with governing regulations, including ADA and the Accessibility Standards of the Architectural Barriers Act Article 9102, of the Texas Civil Statutes, except as may be otherwise directed by the Architect. Use only the fasteners supplied by the manufacturer. All fastening points will be used.

E. Install each hardware item in compliance with the manufacturer’s instructions and recommendations. Wherever cutting and fitting is required to install hardware onto or into surfaces which are later to be painted or finished in another way, install each item completely and then remove and store in a secure place during the finish application. After completion of the finishes, re-install each item. Do not install surface-mounted items until finishes have been completed on the substrate. The use of cardboard shim stock is prohibited.

F. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation. Mortise and cutting to be done neatly, and evidence of cutting to be concealed in the finished work.

G. Drill and countersink units that are not factory-prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.

H. Mount door stops using plated, flathead screws and steel drop-in anchors.

I. Take care when using cleaning chemicals around finish hardware so as not to damage the finish.

J. Architect, Owner’s Representative and Finish Hardware Supplier shall inspect completed hardware installation and operation upon completion of hardware installation. Hardware installer shall correct any installation deficiencies noted during this inspection.

3.2 FINAL ADJUSTMENT

A. Wherever hardware installation is made more than one month prior to acceptance or occupancy of a space or area, return to the work during the week prior to acceptance or occupancy, and make a final check and adjustment of all hardware items in such space or area. Clean and re-lubricate operating items as necessary to restore proper function and finish of hardware and doors.

B. Instruct Owner’s personnel in proper adjustment and maintenance of hardware during the final adjustment of hardware.

C. Door closers will be adjusted by a carpenter trained by the hardware supplier trained personnel at completion of installation and again one month prior to expiration of the Contractor’s one-year anniversary of substantial completion.

3.3 FIELD QUALITY CONTROL

A. After installation has been completed, obtain the services of a qualified hardware consultant to check for proper application of finish hardware, according to the finish hardware schedule, keying schedule and specifications. In addition, check all hardware for adjustments and proper operation.

END OF SECTION

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 glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:
   1. Windows.

1.3 DEFINITIONS

A. Manufacturer: A firm that produces primary glass or fabricated glass as defined in referenced glazing publications.

1.4 PERFORMANCE REQUIREMENTS

A. General: Provide glazing systems capable of withstanding normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Glass Design: Glass thicknesses indicated are minimums and are for detailing only. Confirm glass thicknesses by analyzing Project loads and in-service conditions. Provide glass lites for various size openings in nominal thicknesses indicated, but not less than thicknesses and in strengths (annealed or heat treated) required to meet or exceed the following requirements of the current edition of the International Building Code.

C. Thermal Movements: Provide glazing that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures acting on glass framing members and glazing components. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

1.5 SUBMITTALS

A. Product Data: For each glass product and glazing material indicated.

B. Glazing Schedule: Use same designations indicated on Drawings for glazed openings in preparing a schedule listing glass types and thicknesses for each size opening and location.

C. Product Certificates: Signed by manufacturers of glass and glazing products certifying that products furnished comply with requirements.

D. Preconstruction Adhesion and Compatibility Test Report: From glazing sealant manufacturer indicating glazing sealants were tested for adhesion to glass and glazing channel substrates and for compatibility with glass and other glazing materials.

E. Product Test Reports: From a qualified testing agency indicating the following products comply with requirements, based on comprehensive testing of current products:

1. Glazing sealants.
2. Glazing gaskets.

F. Warranties: Special warranties specified in this Section.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed glazing similar in material, design, and extent to that indicated for Project and whose work has resulted in construction with a record of successful in-service performance.

B. Source Limitations for Glazing Accessories: Obtain glazing accessories from one source for each product and installation method indicated.

C. Elastomeric Glazing Sealant Product Testing: Obtain sealant test results for product test reports in "Submittals" Article from a qualified testing agency based on testing current sealant formulations within a 36-month period.
   1. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated, as documented according to ASTM E 548.
   2. Test elastomeric glazing sealants for compliance with requirements specified by reference to ASTM C 920, and where applicable, to other standard test methods.

D. Safety Glass: Category II materials complying with testing requirements in 16 CFR 1201 and ANSI Z97.1.
   1. Subject to compliance with requirements, permanently mark safety glass with certification label of Safety Glazing Certification Council or another certification agency acceptable to authorities having jurisdiction.

E. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.
   1. GANA Publications: GANA'S "Glazing Manual".

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials according to manufacturer's written instructions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

PART 2 - PRODUCTS

2.1 INSULATED GLASS

A. Glazing: Insulated glazing unit, consisting of two panes of 3/16” separated by a hermetically sealed void. Inner surface of the outer pane of glass (surface 2) shall be provided with a Low E coating. Unit shall maintain a Solar Heat Gain Coefficient of not more than 0.50 and a U Factor of not more than 0.50.

2.2 ELASTOMERIC GLAZING SEALANTS

A. General: Provide products of type indicated, complying with the following requirements:
   1. Compatibility: Select glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
   2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
   3. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range for this characteristic.

B. Elastomeric Glazing Sealant Standard: Comply with ASTM C 920 and other requirements indicated for each liquid-applied, chemically curing sealant in the Glazing Sealant Schedule at the end of Part 3, including those referencing ASTM C 920 classifications for type, grade, class, and uses.

2.3 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tape: Preformed, butyl-based elastomeric tape with a solids content of 100 percent; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; packaged on rolls with a release paper backing; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
   1. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
   2. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

B. Expanded Cellular Glazing Tape: Closed-cell, PVC foam tape; factory coated with adhesive on both surfaces; packaged on rolls with release liner protecting adhesive; and complying with AAMA 800 for the following types:
   1. Type 1, for glazing applications in which tape acts as the primary sealant.
   2. Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.4 GLAZING GASKETS

A. Lock-Strip Gaskets: Neoprene extrusions in size and shape indicated, fabricated into frames with molded corner units and zipper lock strips, complying with ASTM C 542, black.

B. Dense Compression Gaskets: Molded or extruded gaskets complying with standards referenced with name of elastomer utilized, and of profile and hardness required to maintain watertight seal.

C. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned gaskets complying with ASTM C 509, Type II, black; and of profile and hardness required to maintain watertight seal.

2.5 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks: Elastomeric material with a Shore A durometer hardness of 85, plus or minus 5.

D. Spacers: Elastomeric blocks or continuous extrusions with a Shore A durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.

E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

2.6 FABRICATION OF GLASS AND OTHER GLAZING PRODUCTS

A. Fabricate glass and other glazing products in sizes required to glaze openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing standard, to comply with system performance requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine framing glazing, with Installer present, for compliance with the following:
   1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
   2. Presence and functioning of weep system.
   3. Minimum required face or edge clearances.
   4. Effective sealing between joints of glass-framing members.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

3.3 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of framing systems, glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Glazing channel dimensions, provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by Project conditions during installation.

C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.

D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction sealant-substrate testing.

E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

G. Provide spacers for glass lites where the length plus width is larger than 50 inches (1270 mm).:

H. Provide edge blocking where needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 PROTECTION AND CLEANING

A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations, including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove them immediately as recommended by glass manufacturer.

C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for build-up of dirt, scum, alkaline deposits, or stains; remove as recommended by glass manufacturer.

D. Remove and replace glass that is broken, chipped, cracked, abraded, or damaged in any way, including natural causes, accidents, and vandalism, during construction period.

E. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended by glass manufacturer.

END OF SECTION

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 surface preparation and field painting of the following:
   1. Exposed exterior items and surfaces.
   2. Exposed interior items and surfaces.
   3. Surface preparation, priming, and finish coats specified in this Section are in addition to shop priming and surface treatment specified in other Sections.

B. Paint exposed surfaces, except where the paint schedules indicate that a surface or material is not to be painted or is to remain natural. If the paint schedules do not specifically mention an item or a surface, paint the item or surface the same as similar adjacent materials or surfaces whether or not schedules indicate colors. If the schedules do not indicate color or finish, the Architect will select from standard colors and finishes available.

C. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.
   1. Prefinished items include the following factory-finished components:
      a. Finished mechanical and electrical equipment.
      b. Light fixtures.
      c. Distribution cabinets.
   2. Finished metal surfaces include the following:
      a. Anodized aluminum.
      b. Stainless steel.
      c. Galvanized roof and wall panels, trim, and accessories.
      d. Galvanized framing members.
      e. Structural members provided with protective coatings in accordance with other specification sections, and not specifically noted to be painted.
   3. Labels: Do not paint over Underwriters Laboratories (UL), Factory Mutual (FM), or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.

1.3 DEFINITIONS

A. General: Standard coating terms defined in ASTM D 16 apply to this Section.
   1. Flat refers to a lusterless or matte finish with a gloss range below 15 when measured at an 85-degree meter.
   2. Eggshell refers to low-sheen finish with a gloss range between 5 and 20 when measured at a 60-degree meter.
   3. Satin refers to low-sheen finish with a gloss range between 15 and 35 when measured at a 60-degree meter.
   4. Semigloss refers to medium-sheen finish with a gloss range between 30 and 65 when measured at a 60-degree meter.
   5. Full gloss refers to high-sheen finish with a gloss range more than 65 when measured at a 60-degree meter.

1.4 SUBMITTALS

A. Product Data: For each paint system specified. Include block fillers and primers.

B. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for each type of finish-coat material indicated.

1.5 QUALITY ASSURANCE

A. Applicator Qualifications: Engage an experienced applicator who has completed painting system applications similar in material and extent to that indicated for this Project with a record of successful in-service performance.

B. Source Limitations: Obtain block fillers, primers, and undercoat materials for each coating system from the same manufacturer as the finish coats.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the Project Site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label, and the following information:
   1. Product name or title of material.
   2. Product description (generic classification or binder type).
   3. Manufacturer's stock number and date of manufacture.
   4. Contents by volume, for pigment and vehicle constituents.
   5. Thinning instructions.
   6. Application instructions.
   7. Color name and number.
   8. VOC content.

B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 deg F (7 deg C). Maintain containers used in storage in a clean condition, free of foreign materials and residue.
   1. Protect from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and application.

1.7 PROJECT CONDITIONS

A. Apply water-based paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 50 and 90 deg F (10 and 32 deg C).

B. Apply solvent-thinned paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 45 and 95 deg F (7.2 and 35 deg C).

C. Do not apply paint in snow, rain, fog, or mist; or when the relative humidity exceeds 85 percent; or at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.
   1. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by manufacturer during application and drying periods.

1.8 EXTRA MATERIALS

A. Furnish extra paint materials from the same production run as the materials applied in the quantities described below. Package paint materials in unopened, factory-sealed containers for storage and identify with labels describing contents. Deliver extra materials to the Owner.

1. Quantity: Furnish the Owner with 1 gallon of each color and each type of paint used on the project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products listed in the paint schedules. For all paint classifications, Sherwin Williams Co. (S-W) products are listed as representative examples. Products from other manufacturers that can be demonstrated to be equal in composition and material properties will also be acceptable upon approval by the Architect.

2.2 PAINT MATERIALS, GENERAL

A. Material Compatibility: Provide primers, undercoats, and finish-coat materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

B. Material Quality: Provide manufacturer's best-quality paint material of the various coating types specified. Paint-material containers not displaying manufacturer's product identification will not be acceptable.
   1. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. Furnish manufacturer's material data and certificates of performance for proposed substitutions.

C. Colors: Provide color selections made by the Architect.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with the Applicator present, under which painting will be performed for compliance with paint application requirements.
   1. Do not begin to apply paint until unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.
   2. Start of painting will be construed as the Applicator's acceptance of surfaces and conditions within a particular area.

B. Coordination of Work: Review other Sections in which primers are provided to ensure compatibility of the total system for various substrates.

3.2 PREPARATION

A. General: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of the size or weight of the item, provide surface-applied protection before surface preparation and painting.
   1. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.

B. Cleaning: Before applying paint or other surface treatments, clean the substrates of substances that could impair the bond of the various coatings. Remove oil and grease before cleaning.
   1. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

C. Surface Preparation: Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and as specified.
   1. Provide barrier coats over incompatible primers or remove and reprime.
   2. Ferrous Metals: Clean ungalvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with the Steel Structures Painting Council's (SSPC) recommendations.
      a. Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.
      b. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents recommended by paint manufacturer, and touch up with the same primer as the shop coat.
   3. Galvanized Surfaces: Clean galvanized surfaces with nonpetroleum-based solvents so surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.

D. Materials Preparation: Mix and prepare paint materials according to manufacturer's written instructions.
   1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
   2. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.
   3. Use only thinners approved by paint manufacturer and only within recommended limits.

3.3 APPLICATION

A. General: Apply paint according to manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied.
   1. Paint colors, surface treatments, and finishes are indicated in the schedules.
   2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
   3. Provide finish coats that are compatible with primers used.
   4. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures are in place. Extend coatings in these areas, as required.
   5. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before the final installation of equipment, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
   6. Paint interior surfaces of ducts with a flat, nonspecular black paint where visible through registers or grilles.
   7. Finish exterior doors on tops, bottoms, and side edges the same as exterior faces.

B. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.

1. The number of coats and the film thickness required are the same regardless of application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.
2. Omit primer on metal surfaces that have been shop primed and touchup painted.
3. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
4. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and where application of another coat of paint does not cause the undercoat to lift or lose adhesion.

C. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.
   1. Brushes: Use brushes best suited for the type of material applied. Use brush of appropriate size for the surface or item being painted.
   2. Rollers: Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by the manufacturer for the material and texture required.
   3. Spray Equipment: Use airless spray equipment with orifice size as recommended by the manufacturer for the material and texture required.

D. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate. Provide the total dry film thickness of the entire system as recommended by the manufacturer.

E. Prime Coats: Before applying finish coats, apply a prime coat of material, as recommended by the manufacturer, to material that is required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn through or other defects due to insufficient sealing.

F. Pigmented (Opaque) Finishes: Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.

G. Transparent (Clear) Finishes: Use multiple coats to produce a glass-smooth surface film of even luster. Provide a finish free of laps, runs, cloudiness, color irregularity, brush marks, orange peel, nail holes, or other surface imperfections.
   1. Provide satin finish for final coats.

H. Stipple Enamel Finish: Roll and redistribute paint to an even and fine texture. Leave no evidence of rolling, such as laps, irregularity in texture, skid marks, or other surface imperfections.

I. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.

3.4 CLEANING

A. Cleanup: At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from the site.

1. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping. Be careful not to scratch or damage adjacent finished surfaces.

3.5 PROTECTION

A. Protect work of other trades, whether being painted or not, against damage by painting. Correct damage by cleaning, repairing or replacing, and repainting, as approved by Architect.

3.6 EXTERIOR PAINT SCHEDULE

A. Ferrous Metal: Provide the following finish systems over exterior ferrous metal. Primer is not required on shop-primed items.
   1. Full-Gloss, Alkyd-Enamel Finish: 2 finish coats over a rust-inhibitive primer.
      a. Primer: Rust-inhibitive metal primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.3 mils (0.033 mm).
         1) S-W: Kem Kromik Metal Primer B50N2/B50W1.
      b. First and Second Coats: Full-gloss, exterior, alkyd enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 3.0 mils (0.076 mm).
         1) S-W: Industrial Enamel B-54 Series.
   2. Deep-Color, Full-Gloss, Alkyd-Enamel Finish: 2 finish coats over a rust-inhibitive primer.
      a. Primer: Rust-inhibitive metal primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.4 mils (0.036 mm).
         1) S-W: Kem Kromik Metal Primer B50N2/B50W1.
      b. First and Second Coats: Deep-color, full-gloss, exterior, alkyd enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 3.7 mils (0.094 mm).
         1) S-W: SWP Exterior Gloss Paint A-2 Series.

B. Zinc-Coated Metal: Provide the following finish systems over exterior zinc-coated (galvanized) metal surfaces:
   1. Full-Gloss, Alkyd-Enamel Finish: 2 finish coats over a galvanized metal primer.
      a. Primer: Galvanized metal primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils (0.031 mm).
         1) S-W: Galvite Paint B50W3.
      b. First and Second Coats: Full-gloss, exterior, alkyd enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.6 mils (0.066 mm).
         1) S-W: Industrial Enamel B-54 Series.

3.7 INTERIOR PAINT SCHEDULE

A. Ferrous Metal: Provide the following finish systems over ferrous metal:
   1. Full-Gloss, Alkyd-Enamel Finish: 2 finish coats over an enamel undercoater and a primer.

a. Primer: Quick-drying, rust-inhibitive, alkyd-based or epoxy-metal primer, as recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.5 mils (0.038 mm).
   1) S-W: Kem Kromik Metal Primer B50N2/B50W1.
b. Undercoat: Alkyd, interior enamel undercoat or full-gloss, interior, alkyd-enamel finish coat, as recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils (0.031 mm).
   1) S-W: Industrial Enamel B-54 Series.
c. Finish Coat: Full-gloss, alkyd, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils (0.031 mm).
   1) S-W: Industrial Enamel B-54 Series.

B. Zinc-Coated Metal: Provide the following finish systems over exterior zinc-coated (galvanized) metal surfaces:
   1. Full-Gloss, Alkyd-Enamel Finish: 2 finish coats over a galvanized metal primer.
      a. Primer: Galvanized metal primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils (0.031 mm).
         1) S-W: Galvite Paint B50W3.
      b. First and Second Coats: Full-gloss, exterior, alkyd enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.6 mils (0.066 mm).
         1) S-W: Industrial Enamel B-54 Series.

END OF SECTION

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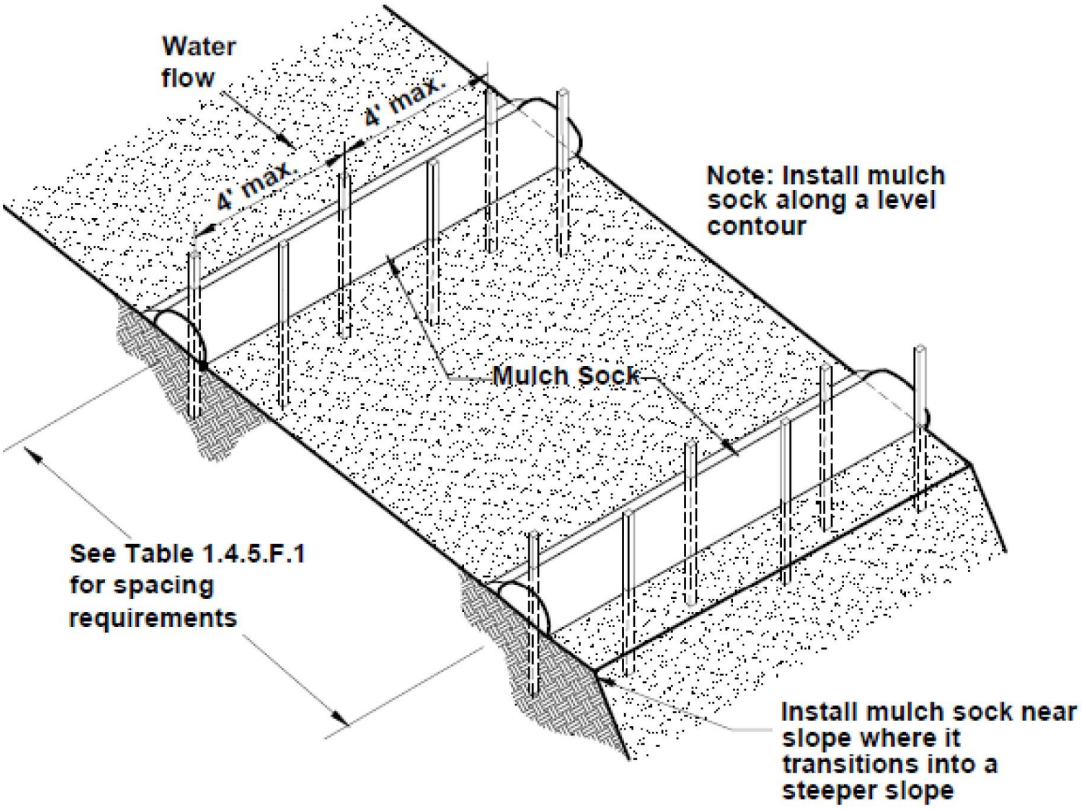
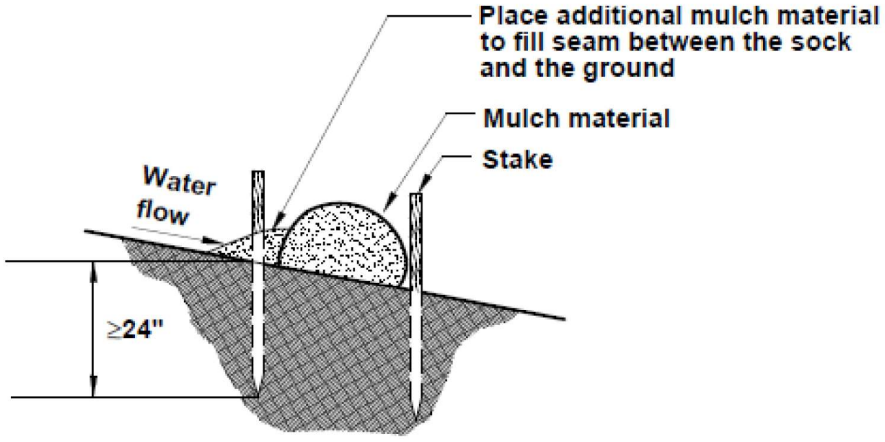
Slope	Max. Slope Length Between 18 in. Dia. Sock (ft)	Max. Drainage Area (sf) per 100 ft of Sock
100:1-50:1	100	10000
50:1-30:1	75	7500
30:1-25:1	65	6500
25:1-20:1	50	4800
20:1-10:1	25	2600
10:1-5:1	15	1300
5:1-2:1	10	1000

Slope	Max. Slope Length Between 12 in. Dia. Sock (ft)	Max. Drainage Area (sf) per 100 ft of Sock
100:1-50:1	100	6000
50:1-30:1	40	4000
30:1-25:1	30	3000
25:1-20:1	25	2600
20-1:10-1	15	1300
10:1-5:1	10	1000
5:1-2:1	5	500

Figure 1.4.5.F Typical Mulch Sock Detail



TYPICAL MULCH SOCK INSTALLATION
N.T.S.



MULCH SOCK
N.T.S.

G. **Silt Fence.** (See Standard Specifications manual item 642S and Standards manual 642S-1 for details)

1. **Description.**

Silt Fence is a temporary barrier made of non-woven polypropylene, polyethylene, or polyamide material that is trenched or sliced into the ground and supported by posts on the downstream side of the fabric. Silt fence works by intercepting sheet flow from slopes, causing the runoff to pond behind the fence, thereby promoting deposition of sediment on the uphill side of the fence. They are most effective when designed to provide comprehensive water and sediment control throughout a construction site and if used in conjunction with erosion control practices.

A common misconception among many designers is that the silt fence actually "filters" suspended particles from runoff. The effectiveness of silt fence is primarily derived from its ability to pond water behind the fence. This ponding action allows suspended particles to settle out on the uphill side of the fence. Particles are not removed by filtering the runoff through the fabric.

2. **Purpose.**

Used to control sheet flow runoff from disturbed land, silt fencing may also be used to create a sediment trap for removal of suspended particles from low volume concentrated flows. The removal efficiency of silt fencing depends mainly on the detention time of the runoff behind the control. The detention time is controlled by the geometry of the upstream pond, hydraulic properties of the fabric, and maintenance of the control (Barrett et al., 1998).

3. **Conditions Where Practice Applies.**

Silt fence is used during the period of construction near the perimeter of a disturbed area to intercept sediment. This fence shall remain in place until the disturbed area is permanently stabilized. Silt fence should not be used where there is a concentration of water in a channel or drainage way or where soil conditions prevent a minimum toe-in depth of six (6) inches or installation of support post to a minimum depth of 12 inches. If concentrated flow occurs after installation, corrective action must be taken such as placing rock berms in the areas of concentrated flow.

4. **Design Criteria.**

Silt fence is typically constructed near the perimeter of a disturbed site within the developing area. It is not to be constructed outside the property lines without obtaining a legal easement from the affected adjacent property owners.

The following criteria shall be observed:

• Drainage Area - Consult Table 1.4.5.G.1 for maximum drainage area allowed for a specific slope category. If the drainage area to the silt fence exceeds this value, additional silt fence should be installed to break up the runoff into multiple storage areas.

• Height - 24 inch minimum height measured from the existing or graded ground.

For Design purposes use the following criteria:

• Assume a construction Total Suspended Solids (TSS) concentration = 3000 mg/L.

• Use a target removal of sediment particle equal to or greater than diameter (d) = 20 microns.

• Use the Influent Particle size distribution of the solids suspended in runoff shown in Figure 1.4.5.G (Barrett et al., 1998).

A. Overland flow:

1. General guidelines. Silt fence for sediment and slope control should be installed along the contour of the slope (i.e. the entire length should be at the same elevation). The maximum drainage area to the silt fence should not exceed those shown on Table 1.4.5.G.1. The spacing criterion is based on the maximum drainage area, in square feet, above a 100 feet wide section of silt fencing. At each end of the silt fence, a minimum 20-foot segment shall be turned uphill to create a "J" hook (see "J"-hook detail) to prevent ponded water from flowing around the ends of the silt fence. Individual sections of silt fence should be limited to 200-foot lengths. This limits the impact if a failure occurs, and prevents large volumes of water from accumulating and flowing to one end of the installation, which may cause damage to the fence.

2. Sediment control. When used for sediment control, silt fence should be located to provide the storage volume behind the fence that will contain the runoff from the 2 year storm. Table 1.4.5.G.1 provides the spacing on uniform slopes necessary to achieve this storage volume. If the designer proposed an alternative configuration, it must be demonstrated that 2 year storm runoff volume is contained and released in a manner such that the effluent concentration does not exceed effluent standards of City of Austin Code Title 6, Article 5 as well as the baseline TSS conditions in ECM 1.6.9.3 Table 1-10. The design presumptions are stated above.

   Larger storage volumes increase the sediment removal efficiency of the silt fence, and decrease the required replacement/clean-out intervals.

   A common location to place silt fence for sediment control is at the toe of a slope. When used for this application, the silt fence should be located at least five (5) feet from the toe of the slope to ensure that a large storage volume is available for runoff and sediment.

   For sediment control applications, the maximum drainage area to the silt fence should not exceed those shown on Table 1.4.5.G.1. If the contributing area exceeds this value, additional silt fence should be installed to break up the runoff into multiple storage areas. When used as a velocity control measure for sheet flow on long slopes of disturbed ground, silt fence should be placed at the spacing interval and not exceed the drainage area to the fence stated in the table below:

3. Slope control. Silt fence can be installed on a slope to reduce the effective slope length and limit the velocity of runoff flowing down the slope (see Table 1.4.5.G.1). Silt fence also helps prevent concentrated flows from developing, which can cause rill and gully erosion. As a secondary benefit, silt fence installed on slopes can remove suspended sediment from runoff that results from any erosion that has occurred. For slopes that receive runoff from above, a silt fence should be placed at the top of the slope to control the velocity of the flow running onto the slope, and to spread the runoff out into sheet flow.

Table 1.4.5.G.1: Maximum spacing between silt fences on slopes		
Slope	**Spacing Interval (ft)**	**Max. Drainage Area (sf)**
100:1 to 50:1 (1-2%)	500	25,000
50:1 to 30:1 (2-3.3%)	250	15,000
30:1 to 25:1 (3.3-4%)	150	12,000
25:1 to 20:1 (4-5%)	120	10,000
20:1 to 10:1 (5-10%)	100	5,000
10:1 to 5:1 (10-20%)	50	2,500
5:1 to 2:1 (20-50%)	10	1,000

4. Perimeter control. Silt fence is commonly used as a perimeter control along streets or adjacent to water bodies to prevent polluted water from leaving the site. When a diversion or perimeter control silt fence is installed in the direction of a slope, a 20-foot length of fence should be turned in, across the slope, at regular intervals (100 feet) to create a "J"-hook (see "J" hook detail).

   These "J"-hooks act as check dams, controlling the velocity of the diverted runoff as it travels along the fence.

B. Concentrated flow. Not allowed

C. Diversion. Silt fence can also be utilized as a synthetic diversion structure to redirect clean water around a site and intercept sediment-laden runoff and transport it to a sediment removal practice. Must demonstrate additional BMPs designed to prevent rill/gully erosion due to concentrated flow along the perimeter of the silt fence.

5. Materials Specifications.

   See City of Austin Standard Specifications 642Sfor material specification and installation details.

6. Troubleshooting

• Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.

• Repair undercut silt fences.

• Repair or replace split, torn, slumping, or weathered fabric. The lifespan of silt fence fabric is generally 5 to 8 months.

• Silt fences that are damaged and become unsuitable for the intended purpose should be removed from the site of work, disposed of, and replaced with new silt fence barriers.

• Sediment that accumulates in the silt fence must be periodically removed in order to maintain silt fence effectiveness. Sediment should be removed when the sediment accumulation reaches approximately one-half of the fence height (one foot) on the silt fence. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed at an appropriate location. Upon removal of silt fence, accumulated sediment must also be removed and disposed of properly.

• Silt fences should be left in place until the upstream area is permanently stabilized. Until then, the silt fence must be inspected and maintained.

• Holes, depressions, or other ground disturbance caused by the removal of the silt fences should be backfilled and repaired.

Figure 1.4.5.G Influent Particle Size Distribution of the Suspended Solids in Runoff.

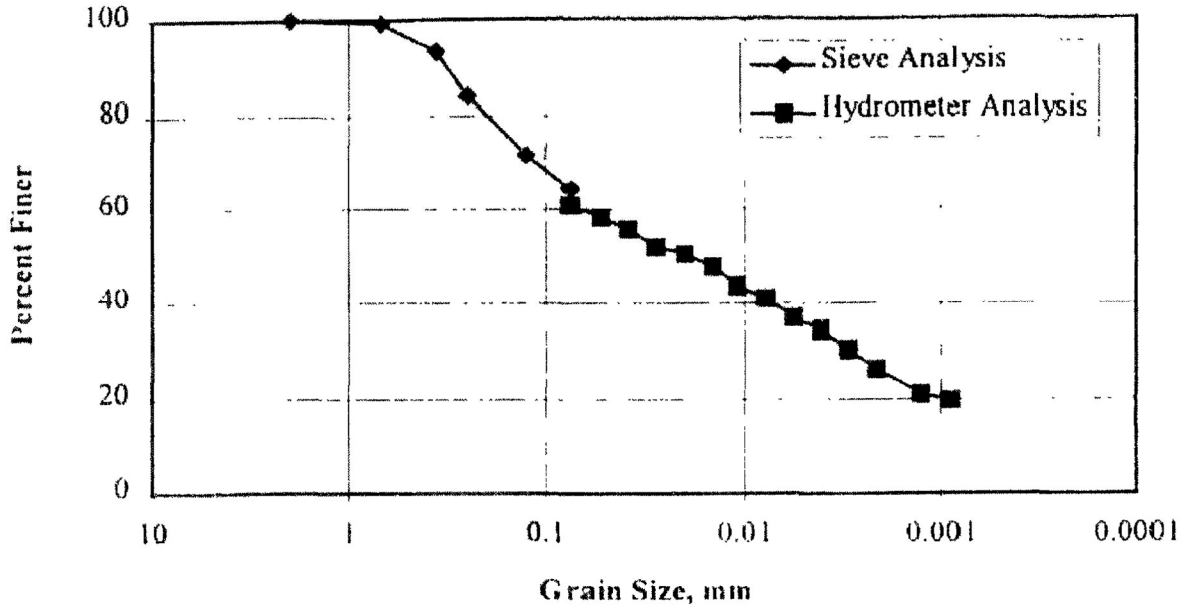


Figure 1.4.5.G.1 Silt Fence Installation

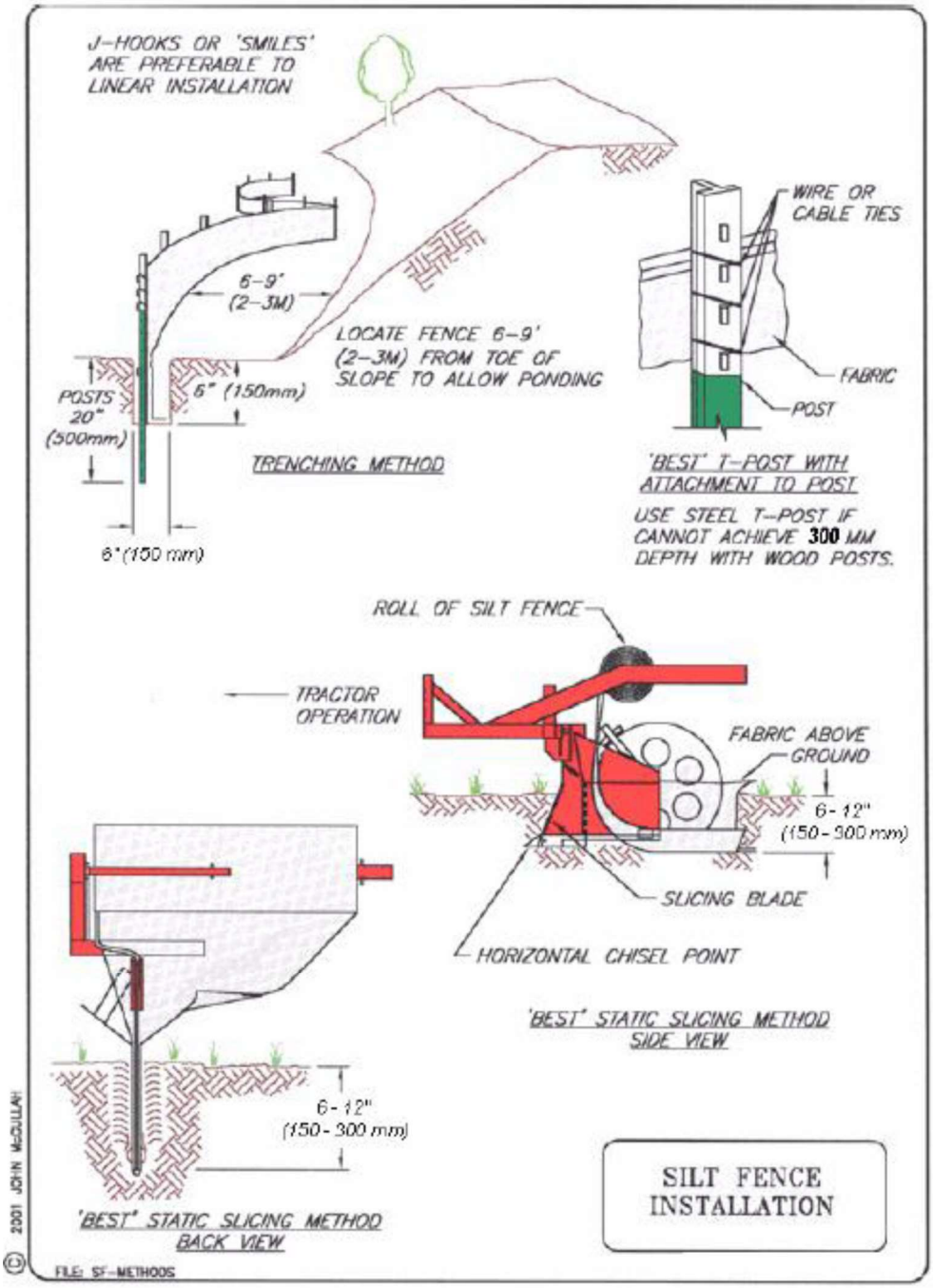


Figure 1.4.5.G.2 Silt Fence Placement — One Slope

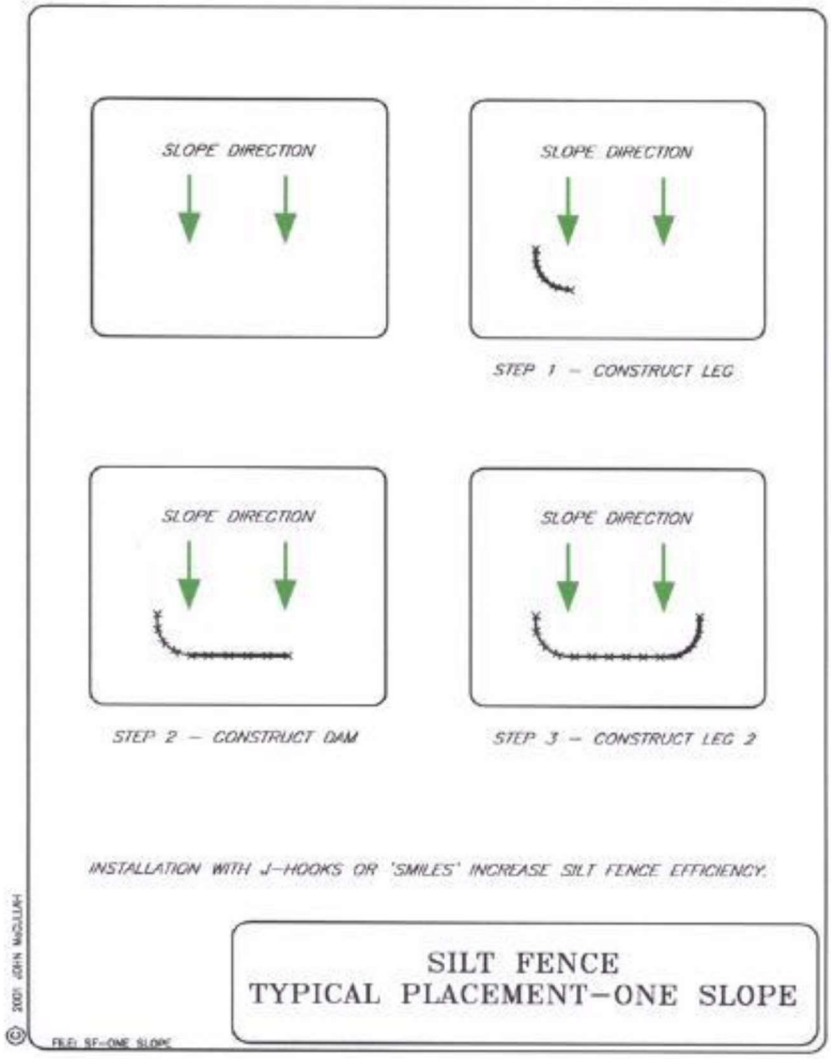


Figure 1.4.5.G.3 Silt Fence Placement for Perimeter Control

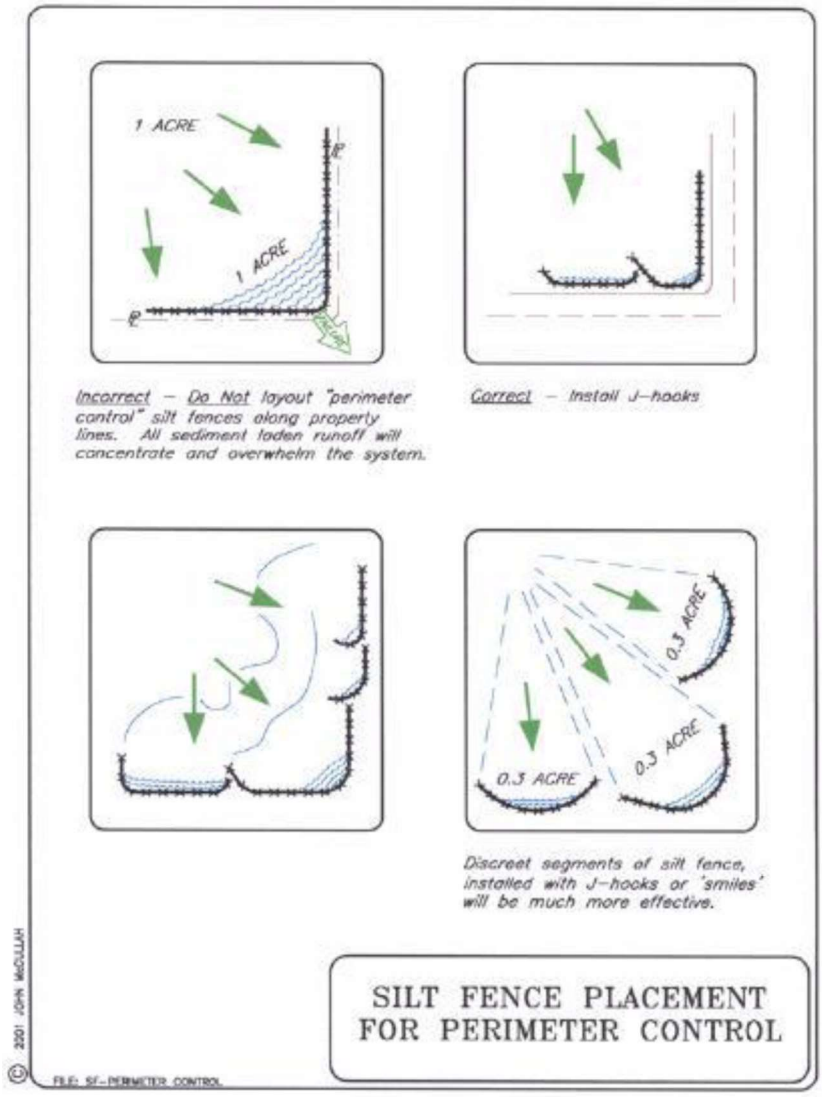
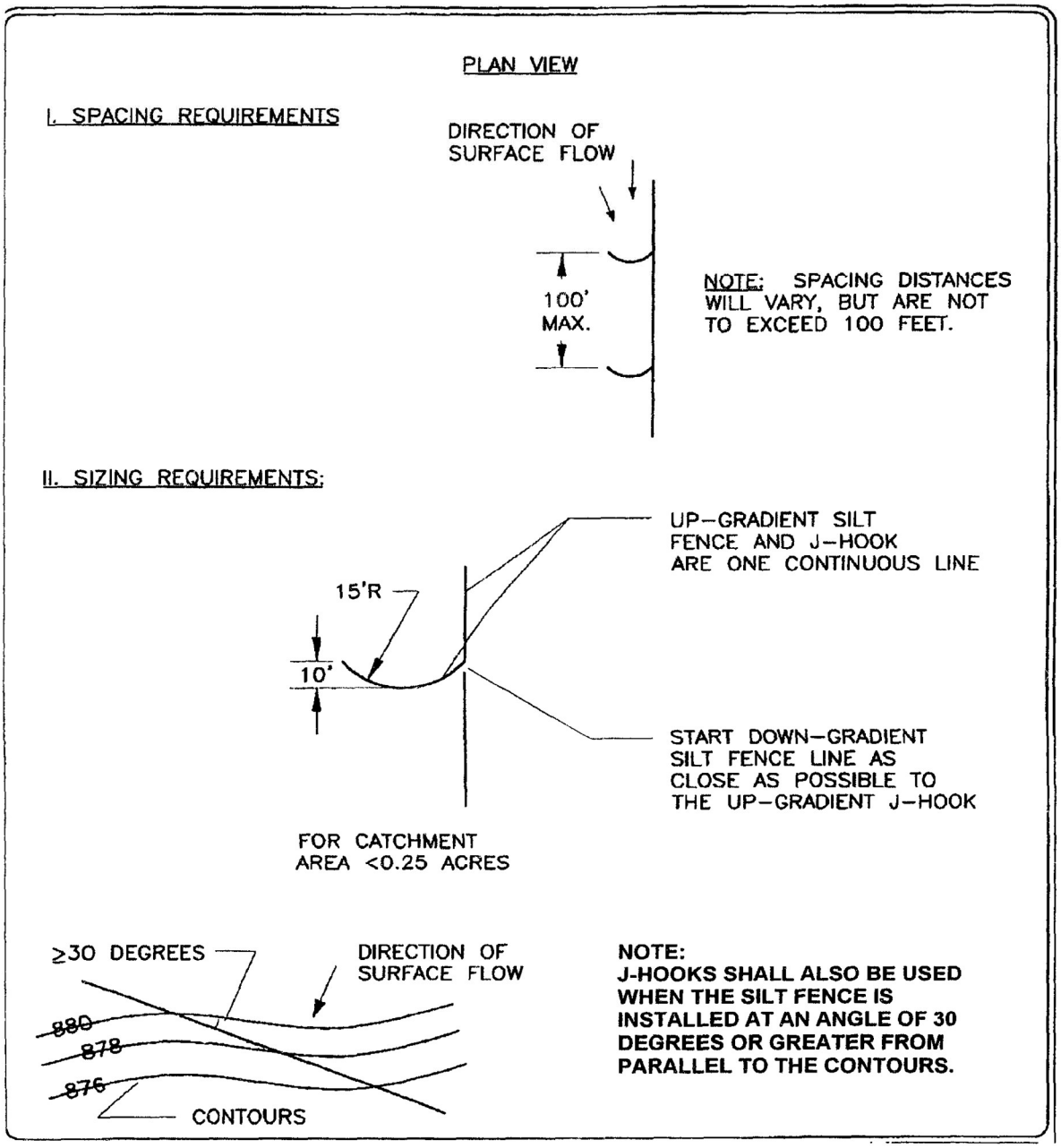


Figure 1.4.5.G.4 Silt Fence J - Hook Detail



H. **Triangular Sediment Filter Dikes.** (See Standard Specifications manual item 648S and Standards manual item 648S for detail)

1. Description.

   A temporary barrier constructed of wire mesh and geotextile fabric, installed along a flat area.

2. Purpose.

The purpose of a triangular sediment filter dike is to intercept and detain water-borne sediment from a stabilized construction entrance, roadway utility work, small utility repairs, underground storage tank removals, or minor redevelopment projects.

3. Conditions Where Practice Applies.

The triangle sediment filter dike is used where:

- There is no concentration of water in a channel or other drainage way above the barrier, and

- If concentrated flow occurs after installation, corrective action must be taken such as placing rock berms in the areas of concentrated flow.

- Contributing drainage area is limited to sheetflow from the stabilized construction entrance. Additionally, the triangle sediment filter dike should be placed across the construction entrance(s) at the end of the day to form a continuous perimeter sedimentation control in conjunction with other approved perimeter controls.

- There is work within a parking lot covered with asphalt, the dike should be placed on the asphalt and the skirt weighed down with rock or a continuous wood strip nailed to the asphalt.

- There is roadway or small utility work. The dike should be placed to intercept stormwater prior to entering the inlet.

- There is underground storage tank removal or installation.

- There is minor redevelopment on a site and no other types of sediment control are feasible.

4. Design Criteria.

- See City of Austin Standard Specification 628S.

l. **Hay Bale Dikes.** (See Standard Specifications manual item 628S and Standards manual item 628S-1 for detail)

1. Description.

A temporary barrier constructed with hay bales with a life expectancy of two (2) months or less.

2. Purpose.

The purpose of a hay bale dike is to intercept and detain small amounts of sediment from unprotected areas of limited extent. The use of this type of sediment control is only acceptable for above ground and underground storage tank construction or removal projects.

3. Conditions Where Practice Applies. The hay bale dike is used where:

- No other practice is feasible, and

- There is no concentration of water in a channel or other drainage way above the barrier and

• If concentrated flow occurs after installation, corrective action must be taken such as placing rock berms in the areas of concentrated flow.

• Construction activities and revegetation will be completed in three (3) months or less.

• Contributing drainage area is less than 2,500 square feet.

4. Design Criteria.

A design is not required. The following criteria shall be observed:

All bale dikes shall be placed on the contour. Bales shall be embedded a minimum of four (4) inches and securely anchored using 3/8 inch diameter rebar stakes driven through the bales. Bales that are not able to be imbedded and are place on impervious cover should be placed level with the concrete and have all bales butted end to end with no voids or gaps between them. Bales shall be bound by either wire or nylon string. Jute or cotton binding is unacceptable. Bales shall be replaced every two (2) months or more often during wet weather when loss of structural integrity is accelerated.

J. **Mulch Berm** (See Standard Specifications manual item 647S and Standards manual 647S-1 for details)

1. Description.

Mulch Berm is a temporary sedimentation control made of wood mulch, wood chips, or other organic material used to intercept sheet flow and pond runoff. Mulch berms provide a three-dimensional filter that retains sediment and other pollutants (e.g., suspended solids) while allowing the cleaned water to flow through the berm. Mulch berms can be used in place of traditional sediment controls such as a silt fence or in conjunction with other approved controls.

The effectiveness of using Mulch berm as a sediment control technique depends on:

• The type of mulch used

• Mulch morphology

• Drainage area to section of berm

• Method of application: the mulch berm material can be placed mechanically or by hand.

• Soil type

• Slope

• Climatic characteristics

• Proper preparation of application area (uniform application surface to ensure optimal mulch to soil contact)

2. Materials.

Mulch berm material can be manufactured on or off the project site. It consists primarily of organic material, separated at the point of generation, and may include: shredded bark, stump grindings, or composted bark

The mulch berm shall have the following composition:

• Use untreated wood chips less than or equal to 5 inches in length with 95% passing a 2-inch screen and less than 30% passing a 1-inch screen (TXDOT Special Specification 1011, Mulch Filter Berm).

• Large portions of silts, clays, or fine sands are not acceptable in the mix.

Mulch berm material is composed of a mixture of particle sizes and may contain rocks less than 2 inches in diameter. Mulch berm material must be free of refuse, physical contaminants, and material toxic to plant growth. It is not acceptable for the mulch berm material to contain ground construction debris, biosolids, or manure.

Prior to placement a representative sample of the mulch berm material must be accepted by the project engineer or his/her designee and by the city inspector.

3. Installation.

• A Mulch Berm is not allowed on 2:1 slopes or steeper.

• Mulch Berm maximum slope spacing criteria must be followed (see Table 1.4.5.J.1) The spacing criterion is based on the maximum drainage area, in square feet, above a 100 feet wide section of mulch berm.

• Mulch Berms should be a minimum 24 inches high and 36 inches wide. (Figure 1.4.5.J).

• Mulch Berms should be installed parallel to the base of the slope or the other affected area. For best filtration, a mulch berm should be placed on the level contour of a slope so that flows are dissipated into uniform sheet flow which has little energy for transporting sediment (see section 1.4.5.G., Silt Fence for proper placement).

• The mulch may be placed with a hydraulic bucket, a pneumatic blower, or by hand.

• When a diversion or perimeter control mulch berm is installed in the direction of a slope, a 20-foot length of berm should be turned in, across the slope, at regular intervals (See Table 1.4.5.J.1 spacing criteria) to create a "J"-hook (see ECM 1.4.5.G, Silt Fence "J" hook detail). These "J"-hooks act as check dams, controlling the velocity of the diverted runoff as it travels along the berm.

4. Where a mulch berm is not allowed as a sediment control:

• On slopes with groundwater seepage;

• In concentrated flow situations or in runoff channels;

• On slopes equal to or steeper than 2:1;

• At the bottom of steep perimeter slopes exceeding 100 feet in length (large up-gradient watershed);

• Below culvert outlet aprons, and

• Around catch basins and closed storm system outlets.

• Within a stormwater control structure.

5. Inspection and Maintenance.

• Inspect every 7-days and within 24-hours of a rainfall event of 0.5-inches or greater event and replace or repair if necessary.

• Sediments collected at the base shall be removed when they reach 1/3 of the exposed height of the mulch berm.

• Vegetation adds stability and should be promoted.

• If the mulch is not removed prior to revegetation, it should be spread out into the landscape to a depth that will not prevent seed germination and encourage effective revegetation of the site.

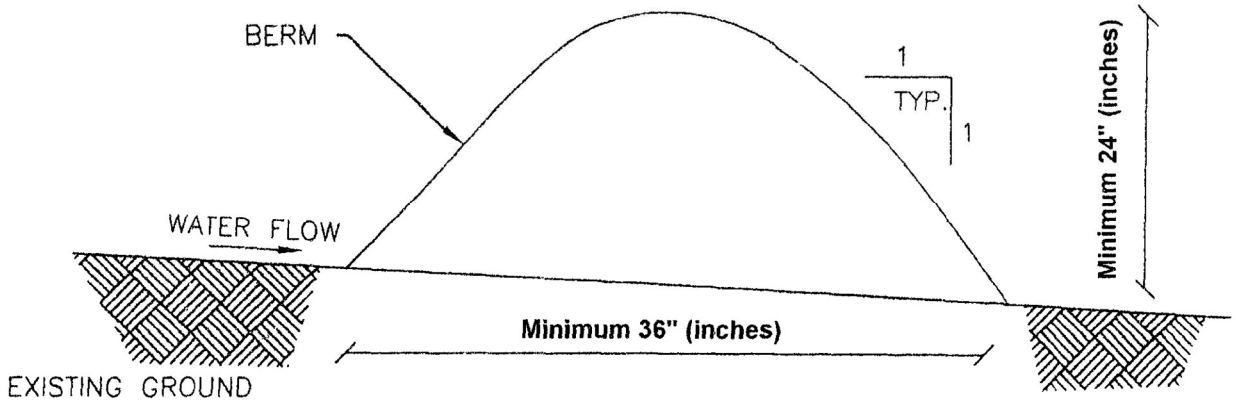
References:

1. City of Austin, Mabel Davis Park Site Remediation, Standard Technical Specifications, Compost/Mulch Filter Berm - Section 02273 (2004), Volume 2
2. Storey, et al. (2006), Water Quality Characteristics and Performance of Compost Filter Berms, Report 0-4572-1, Texas Department of Transportation
3. Demars, and Long (2001), Performance Specifications for Wood Waste Materials as an Erosion Control Mulch and as a Filter Berm, NETCR 25

Table 1.4.5.J.1. Maximum Spacing between Mulch Berms on Slopes

Slope	Spacing Interval (ft)	Max. Drainage Area (sf) per 100 ft of Berm
100:1 to 50:1 (1-2%)	100	10,000
50:1 to 30:1 (2-3.3%)	75	7,500
30:1 to 25:1 (3.3-4%)	65	6,500
25:1 to 20:1 (4-5%)	50	4,800
20:1 to 10:1 (5-10%)	25	2,600
10:1 to 5:1 (10-20%)	15	1,300
5:1 to 2:1 (20-50%)	10	1,000

Figure 1.4.5.J TYPICAL MULCH BERM



K. Sediment Basin.

1. Definition

   An earthen embankment suitably located to capture runoff, with a trapezoidal spillway lined with an impermeable geotextile or laminated plastic membrane, and equipped with a floating skimmer for dewatering.

2. Purpose

   Sediment basins are designed to provide an area for runoff to pool and settle out a portion of the sediment carried down gradient. Past designs used a perforated riser for dewatering, which allowed water to leave the basin from all depths. One way to improve the sediment capture rate is to have an outlet which dewaters the basin from the top of the water column

where the water is cleanest. A skimmer is probably the most common method to dewater a sediment basin from the surface. The basic concept is that the skimmer does not dewater the basin as fast as runoff enters it, but instead allows the basin to fill and then slowly drain over hours or days. This process has two effects. First, the sediment in the runoff has more time to settle out prior to discharge. Second, a pool of water forms early in a storm event and this further increases sedimentation rates in the basin. Many of the storms will produce more volume than the typical sediment basin capacity and flow rates in excess of the skimmer capability, resulting in flow over the emergency spillway. This water is also coming from the top of the water column and has thereby been "treated" to remove sediment as much as possible. (Adapted from SoilFacts: Dewatering Sediment Basins Using Surface Outlets. N. C. State University, Soil Science Department.)

3. Conditions Where Practice Applies

   Skimmer sediment basins are needed where drainage areas are too large for temporary sediment traps. Do not locate the skimmer sediment basin in intermittent or perennial streams.

4. Planning Considerations

   Select locations for skimmer basins during initial site evaluation. Install skimmer sediment basins before any site grading takes place within the drainage area.

   Select skimmer sediment basin sites to capture sediment from all areas that are not treated adequately by other sediment control measures. Always consider access for cleanout and disposal of the trapped sediment. Locations where a pond can be formed by constructing a low dam across a natural swale are generally preferred to sites that require excavation. Where practical, divert sediment-free runoff away from the basin.

   A skimmer is a sedimentation basin dewatering control device that withdraws water from the basin's water surface, thus removing the highest quality water for delivery to the uncontrolled environment. A skimmer is shown in Figure 6.64a. By properly sizing the skimmer's control orifice, the skimmer can be made to dewater a design hydrologic event in a prescribed period. Because the spillway is actually used relatively frequently, it should be carefully stabilized using geotextiles, or rock if necessary, that can withstand the expected flows. The spillway should be placed as far from the inlet of the basin as possible to maximize sedimentation before discharge. The spillway should be located in natural groundcover to the greatest extent possible

The costs of using a skimmer system are similar, or occasionally less, than a conventional rock outlet or perforated riser. However, the basin is more efficient in removing sediment. Another advantage of the skimmer is that it can be reused on future projects. The main disadvantage of the skimmer is that it does require frequent maintenance, primarily in removing debris from the inlet.

A skimmer must dewater the basin from the top of the water surface. The rate of dewatering must be controlled. A dewatering time of 24 to 72 hours is required. Any skimmer design that dewaters from the surface at a controlled rate is acceptable.

Figure 1.4.5.K.1

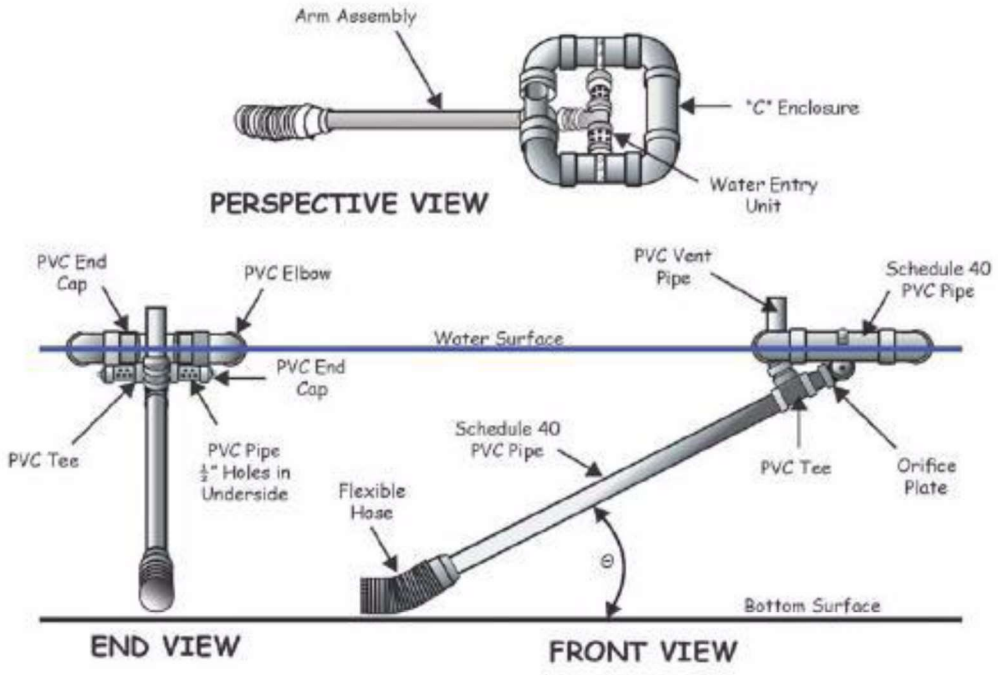


Figure 6.64a Schematic of a skimmer, from Pennsylvania Erosion and Sediment Pollution Control Manual, March, 2000.

5. Skimmer Orifice Diameter

   In order to streamline the orifice sizing procedure, Figure 6.64b, may be used. This design chart assumes the designer knows or has determined the sedimentation basin's water storage volume in cubic feet and the desired dewatering time (in days) for the basin under consideration. The skimmer orifice size (in inches) can be read by entering Figure 6.64b from the x-axis with the basin's water storage volume (in cubic feet), moving vertically to the line that represents the basin's desired dewatering time (in days), then moving to the left to the y-axis.

6. Design Example

Example: The design professional in charge of designing the sedimentation basin for a 10-acre construction site desires to use a skimmer to control dewatering of a sedimentation basin. The sedimentation basin for a 10-acre disturbed area requires a water storage volume of 18,000 cubic feet. The desired dewatering time is 1-3 days.

Solution: Using the water storage volume of 18,000 cubic feet and the 1-3 day dewatering time on Figure 6.64b, a 2-inch orifice diameter is required. (Adapted from Proper Sizing of the Control Orifice for the Faircloth Skimmer. Pennsylvania State University Department of Agricultural and Biological Engineering Fact Sheet #252.)

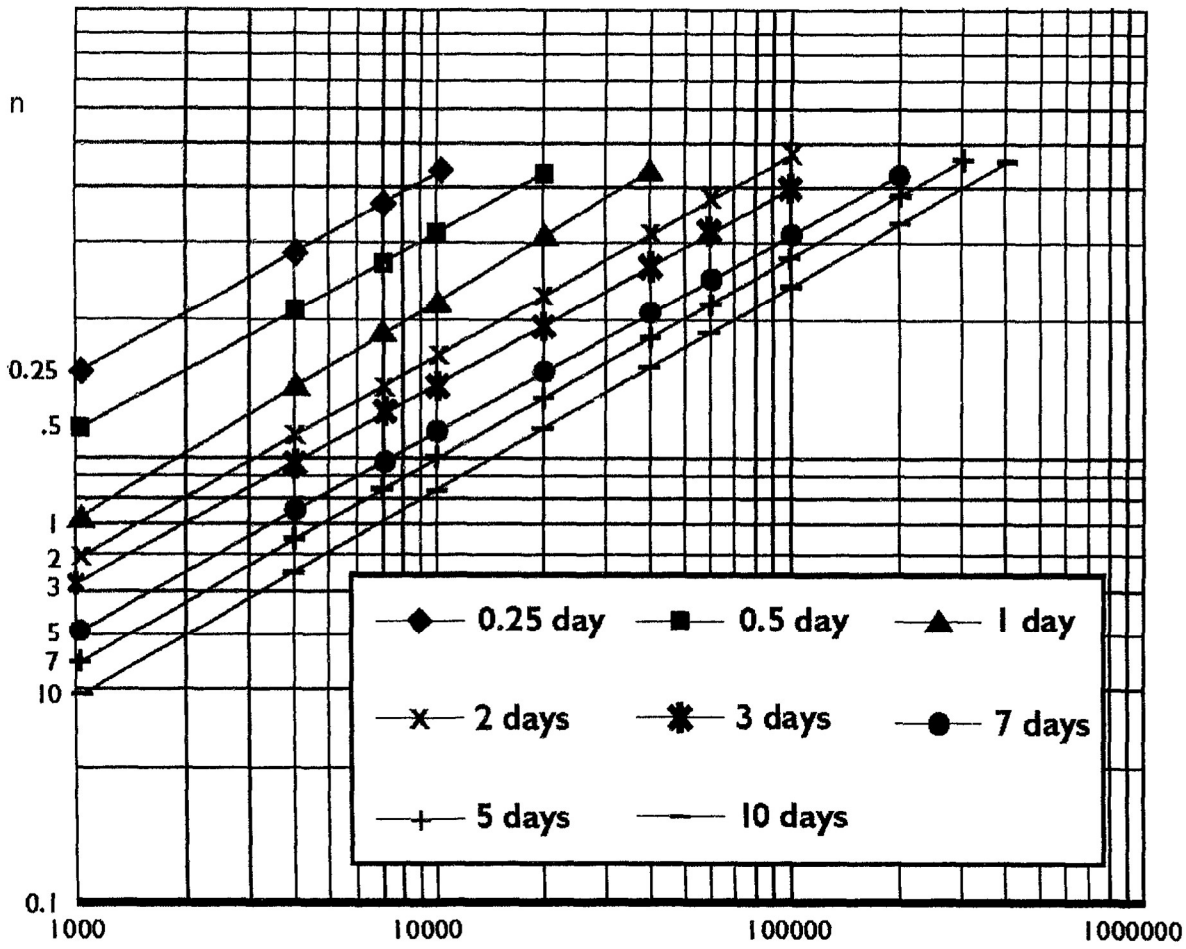


Figure 6.64b Skimmer orifice diameter as a function of the basin volume and basin dewatering time. Rev. 6/06 6.64.3

Table 1.4-D Skimmer Design Criteria.

Summary:	Skimmer Sediment Basin
Primary Spillway:	Trapezoidal spillway with impermeable membrane
Maximum Drainage Area:	10 Acres
Minimum Volume:	1,800 cubic feet per acre of disturbed area
Minimum Surface Area:	325 square feet per cfs of Q10 peak inflow
Minimum L/W Ratio	2:1
Maximum L/W Ratio:	6:1
Minimum Depth:	2 feet
Dewatering Mechanism	Skimmer
Minimum Dewatering Time:	24 hours
Baffles Required:	3 baffles

7. Design Considerations

Drainage areas—Limit drainage areas to 10 acres.

Design basin life—Ensure a design basin life of 3 years or less.

Dam height—Limit dam height to 5 feet.

Basin locations—Select areas that:

- Provide capacity for storage of sediment from as much of the planned disturbed area as practical;
- Exclude runoff from undisturbed areas where practical;
- Provide access for sediment removal throughout the life of the project;
- Interfere minimally with construction activities.

Basin shape—Ensure that the flow length to basin width ratio is at least 2:1 to improve trapping efficiency. Length is measured at the elevation of the principal spillway.

Storage volume—Ensure that the sediment storage volume of the basin, as measured to the elevation of the crest of the principal spillway, is at least 1,800 cubic feet per acre for the disturbed area draining into the basin (1,800 cubic feet is equivalent to half an inch of sediment per acre of basin disturbed area).

Remove sediment from the basin when approximately one-half of the storage volume has been filled.

Spillway capacity—The spillway system must carry the peak runoff from the 10-year storm with a minimum 1 foot of freeboard in the spillway. Base runoff computations on the disturbed soil cover conditions expected during the effective life of the structure.

Sediment cleanout elevation—Determine the elevation at which the invert of the basin would be half-full. This elevation should also be marked in the field with a permanent stake set at this ground elevation (not the top of the stake).

Basin dewatering—The basin should be provided with a surface outlet. A floating skimmer should be attached to a Schedule 40 PVC barrel pipe of the same diameter as the skimmer arm. The orifice in the skimmer will control the rate of dewatering. The skimmer should be sized to dewater the basin in 24-72 hours (1-3 days).

Outlet Protection—Discharge velocities must be within allowable limits for the receiving stream (References: Outlet Protection).

Basin spillway—Construct the entire flow area of the spillway in undisturbed soil if possible. Make the cross section trapezoidal with side slopes of 3:1 or flatter.

• Capacity—The minimum design capacity of the spillway must be the peak rate of runoff from the 10-year storm. Maximum depth of flow during the peak runoff should be 6 inches. In no case should the freeboard of the spillway be less than 1 foot above the design depth of flow.

• Velocity—Ensure that the velocity of flow discharged from the basin is nonerosive for the existing conditions. When velocities exceed that allowable for the receiving areas, provide outlet protection (References: Outlet Protection).

Embankment—Ensure that embankments for skimmer sediment basins do not exceed 5 feet in height (measured at the center line from the original ground surface to the top of the embankment). Keep the crest of the spillway outlet a minimum of 1.5 feet below the top of the embankment. Additional freeboard may be added to the embankment height which allows flow through a designated bypass location. Construct embankments with a minimum top width of 5 feet and side slopes of 2:1 or flatter. Machine compact the embankments.

Excavation—Where sediment pools are formed or enlarged by excavation, keep side slopes at 2:1 or flatter for safety.

Erosion protection—Stabilize all areas disturbed by construction (except the lower half of the sediment pool) by suitable means immediately after completing the basin (References: Surface Stabilization).

Trap efficiency—Improve sediment basin trapping efficiency by employing the following considerations in the basin design:

• Surface area—In the design of the settling pond, allow the largest surface area possible.

• Length—Maximize the length-to-width ratio of the basin to prevent short circuiting, and ensure use of the entire design settling area.

• Baffles—Provide a minimum of three porous baffles to evenly distribute flow across the basin and reduce turbulence.

• Inlets—Area between the sediment inlets and the basin should be stabilized by geotextile material, with or without rocks (Figure 6.64c shows the area with rocks). The inlet to basin should be located the greatest distance possible from the principal spillway.

• Dewatering—Allow the maximum reasonable detention period before the basin is completely dewatered (at least 24 hours).

• Inflow rate—Reduce the inflow velocity and divert all sediment-free runoff.

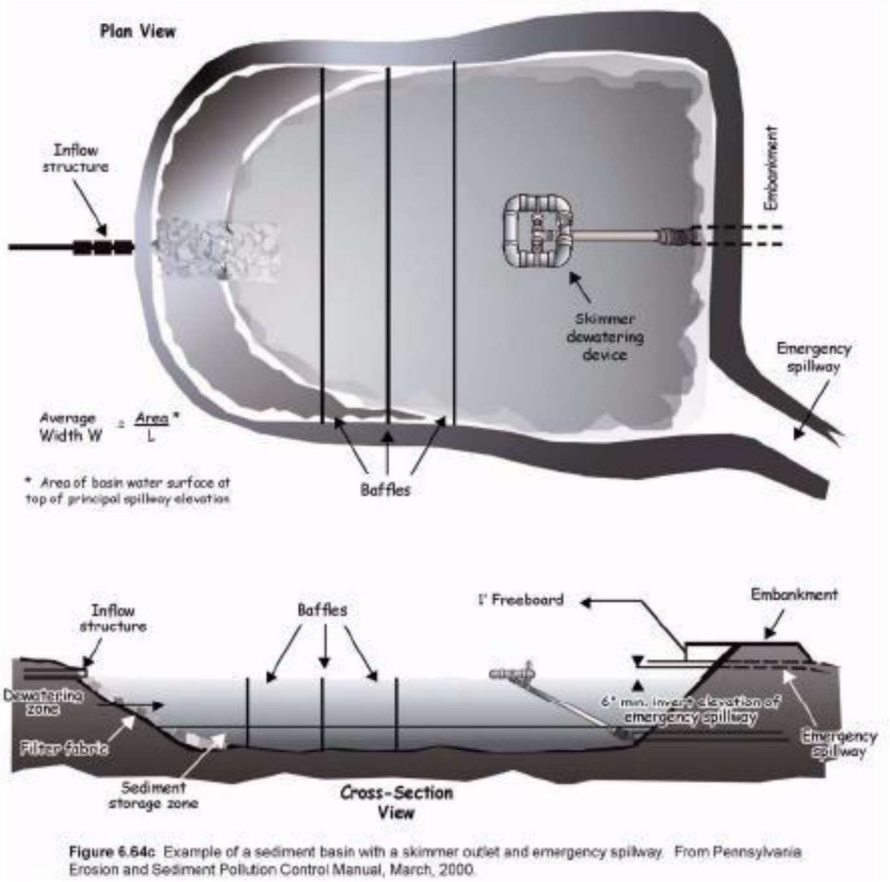


Figure 6.64c Example of a sediment basin with a skimmer outlet and emergency spillway. From Pennsylvania Erosion and Sediment Pollution Control Manual, March, 2000.

Figure 6.64c Example of a sediment basin with a skimmer outlet and emergency spillway. From Pennsylvania Erosion and Sediment Pollution Control Manual, March, 2000.

8. Construction Specifications

    1. Clear, grub, and strip the area under the embankment of all vegetation and root mat. Remove all surface soil containing high amounts of organic matter and stockpile or

dispose of it properly. Haul all objectionable material to the designated disposal area. Place temporary sediment control measures below basin as needed

2. Ensure that fill material for the embankment is free of roots, woody vegetation, organic matter, and other objectionable material. Place the fill in lifts not to exceed 9 inches, and machine compact it. Over fill the embankment 6 inches to allow for settlement.

3. Shape the basin to the specified dimensions. Prevent the skimming device from settling into the mud by excavating a shallow pit under the skimmer or providing a low support under the skimmer of stone or timber.

4. Place the barrel (typically 4-inch Schedule 40 PVC pipe) on a firm, smooth foundation of impervious soil. Do not use pervious material such as sand, gravel, or crushed stone as backfill around the pipe. Place the fill material around the pipe spillway in 4-inch layers and compact it under and around the pipe to at least the same density as the adjacent embankment. Care must be taken not to raise the pipe from the firm contact with its foundation when compacting under the pipe haunches.

   Place a minimum depth of 2 feet of compacted backfill over the pipe spillway before crossing it with construction equipment. In no case should the pipe conduit be installed by cutting a trench through the dam after the embankment is complete.

5. Assemble the skimmer following the manufacturer's instructions, or as designed.

6. Lay the assembled skimmer on the bottom of the basin with the flexible joint at the inlet of the barrel pipe. Attach the flexible joint to the barrel pipe and position the skimmer over the excavated pit or support. Be sure to attach a rope to the skimmer and anchor it to the side of the basin. This will be used to pull the skimmer to the side for maintenance.

7. Earthen spillways—Install the spillway in undisturbed soil to the greatest extent possible. The achievement of planned elevations, grade, design width, and entrance and exit channel slopes are critical to the successful operation of the spillway. The spillway should be lined with laminated plastic or impermeable geotextile fabric. The fabric must be wide and long enough to cover the bottom and sides and extend onto the top of the dam for anchoring in a trench. The edges may be secured with 8-inch staples or pins. The fabric must be long enough to extend down the slope and exit onto stable ground. The width of the fabric must be one piece, not joined or spliced; otherwise water can get under the fabric. If the length of the fabric is insufficient for the entire length of the spillway, multiple sections, spanning the complete width, may be used. The upper section(s) should overlap the lower section(s) so that water cannot flow under the fabric. Secure the upper edge and sides of the fabric in a trench with staples or pins. (Adapted from "A Manual for Designing, Installing and Maintaining Skimmer Sediment Basins." February, 1999. J. W. Faircloth & Son.).

8. Inlets—Discharge water into the basin in a manner to prevent erosion. Use temporary slope drains or diversions with outlet protection to divert sediment-laden water to the upper end of the pool area to improve basin trap efficiency (References: Runoff Control Measures and Outlet Protection).

9. Erosion control—Construct the structure so that the disturbed area is minimized. Divert surface water away from bare areas. Complete the embankment before the area is cleared. Stabilize the emergency spillway embankment and all other disturbed areas above the crest of the principal spillway immediately after construction (References: Surface Stabilization).

10. Install porous baffles as specified in Practice 6.65, Porous Baffles.

11. After all the sediment-producing areas have been permanently stabilized, remove the structure and all the unstable sediment. Smooth the area to blend with the adjoining areas and stabilize properly (References: Surface Stabilization).

Reference

Jarrett, A. R. Proper Sizing of the Control Orifice for the Faircloth Skimmer. Pennsylvania State University Department of Agricultural and Biological Engineering Fact Sheet #252. http://www.age.psu.edu/extension/factsheets/f/F252.pdf

Jarrett, A. R. Controlling the Dewatering of Sedimentation Basins. Pennsylvania State University Department of Agricultural and Biological Engineering Fact Sheet #253.

http://www.age.psu.edu/extension/factsheets/f/F253.pdf

Erosion and Sediment Pollution Control Manual, March, 2000. Commonwealth of Pennsylvania Dept. of Environmental Protection, Office of Water Management, Document #363-2134-008.

http://www.co.centre.pa.us/conservation/esmanual.pdf

McLaughlin, Richard. SoilFacts: Dewatering Sediment Basins Using Surface Outlets. N. C. State University, Soil Science Department.

A Manual for Designing, Installing and Maintaining Skimmer Sediment Basins. February, 1999. J. W. Faircloth & Son.

9. Maintenance

   Inspect skimmer sediment basins at least weekly and after each significant (one-half inch or greater) rainfall event and repair immediately. Remove sediment and restore the basin to its original dimensions when sediment accumulates to one-half the height of the first baffle. Pull the skimmer to one side so that the sediment underneath it can be excavated. Excavate the sediment from the entire basin, not just around the skimmer or the first cell. Make sure vegetation growing in the bottom of the basin does not hold down the skimmer.

   Repair the baffles if they are damaged. Re-anchor the baffles if water is flowing underneath or around them.

   If the skimmer is clogged with trash and there is water in the basin, usually jerking on the rope will make the skimmer bob up and down and dislodge the debris and restore flow. If this does not work, pull the skimmer over to the side of the basin and remove the debris. Also check the orifice inside the skimmer to see if it is clogged; if so remove the debris.

   If the skimmer arm or barrel pipe is clogged, the orifice can be removed and the obstruction cleared with a plumber's snake or by flushing with water. Be sure and replace the orifice before repositioning the skimmer.

   Check the fabric lined spillway for damage and make any required repairs with fabric that spans the full width of the spillway. Check the embankment, spillways, and outlet for erosion damage, and inspect the embankment for piping and settlement. Make all necessary repairs immediately. Remove all trash and other debris from the skimmer and pool areas.

   Freezing weather can result in ice forming in the basin. Some special precautions should be taken in the winter to prevent the skimmer from plugging with ice.

   Sedimentation basins shall not be allowed as stand alone BMPs. Applicant must demonstrate appropriate site management practices, temporary stabilization measures, perimeter and internal controls instead of just relying on a sediment basin at the outlet of the project. Temporary sediment basins and traps are not allowed to be constructed in concentrated flow paths, draws, creeks or other drainage features exist that have contributing drainage areas greater than 40 acres.

Detention/sedimentation structures must be designed to withstand the force and velocity from a 10-year frequency storm without failing. Larger storms shall be bypassed via stabilized conveyances. Those devices that employ sedimentation must provide the storage volume for the runoff from a 2-year, 24 hour storm under compacted site conditions. The sedimentation basins must be designed such that drawdown time is 72 hours via surface skimmers. The design must include considerations for overflows to ensure that the device and its detention pool remain intact. Detention/sedimentation structures shall not be sited in natural drainage channels, draws or ravines that are directly connected to off-site drainage features like creeks, rivers, ponds or recharge features. In particular, this means that silt fences shall not be used to control concentrated or channelized flow and sedimentation basins shall not be constructed in natural draws because failures of the earthen retaining system are often catastrophic to the downstream receiving waters.

- Antiseep - antiseep collars will be required when the soil conditions or length of service make piping through the backfill a possibility.

- The number of collars shall be determined from the backfill conditions and the length of pipe installed.

- Cutoff collars will be spaced at not more than 25 foot centers. If only one (1) is used, it should be placed not more than 25 feet from the riser. Collars and their connections to the pipe shall be watertight and located no closer than two (2) feet to a pipe joint.

• Emergency spillway - Emergency spillways shall be constructed so as to handle the 25 year frequency storm without damage to the structure from erosion. The emergency spillway cross section shall be trapezoidal with a minimum bottom width of ten (10) feet.

- The minimum capacity of the emergency spillway shall be that required to pass the peak rate of runoff from the 25 year frequency storm, less any reduction due to flow in the riser.

- Velocities - The velocity of flow in the exit channel shall not exceed maximum permissible velocities for vegetated channels. For channels with erosion protection other than vegetation, velocities shall be within the nonerosive range for the type of protection used.

- Erosion protection - Erosion protection shall be provided by vegetation as prescribed in this manual.

- Freeboard - Freeboard is the difference between the design high water elevation in the emergency spillway and the top of the compacted embankment. If there is no emergency spillway, it is the difference between the water surface elevation required to pass the design flow through the discharge piping and the top of the compacted embankment. The freeboard shall be at least one (1) foot.

10. Embankment Cross Section.

The minimum top width shall be three (3) feet. The side slopes shall not be steeper than 3:1.

11. Entrance of Runoff into Basin.

Points of entrance of surface runoff into excavated sediment basins shall be protected to prevent erosion. Diversions, grade stabilization structures or other water control devices shall be installed as necessary to insure direction of runoff and protect points of entry into the basin.

12. Disposal.

The sediment shall be placed in an approved spoils disposal site.

13. Safety.

Sediment basins are attractive to children and can be very dangerous. Therefore, they shall be fenced or otherwise made inaccessible to people or animals, unless this is deemed unnecessary due to the remoteness of the site or other circumstances.

14. Information to be Submitted with Design.

Sediment basin design and construction plans submitted for review to the City of Austin shall include all relevant information as required by the Administrative Criteria Manual.

The following outlines this relevant information:

- Specific location of basin.
- Plan view of dam, storage basin and emergency spillway.
- Cross section of dams, low-flow riser and emergency spillway; profile of emergency spillway.
- Details of pipe connections, riser to pipe connection, riserbase, trash rack, antivortex device and when required, antiseep collars.
- Runoff calculations for the two (2) year and 25 year frequency storms.
- Storage Computation:

  - Total required.

  - Total available.

  - Level of sediment at which cleanout shall be required; to be stated as a distance from the riser crest to the sediment surface.

  - Calculations showing design of piping and emergency spillway.

  - Other information deemed necessary by the Watershed Protection and Development Review Department.

L. **Sediment Trap.** (See Standard Specifications manual item 644S and Specifications manual item 644S-1 for detail)

1. Description.

A small temporary basin formed by excavation and/or an embankment to intercept sediment-laden runoff and to trap and retain the sediment.

2. Purpose.

The purpose of a sediment trap is to intercept sediment-laden runoff and trap the sediment in order to protect drainageways, properties and rights of way below the sediment trap from sedimentation.

3. Conditions Where Practice Applies.

A sediment trap is usually installed at points of discharge from disturbed areas.

4. Design Criteria.

   If any of the design criteria presented here cannot be met, see Section 1.4.5 K "Sediment Basin".

5. Drainage Area.

   The drainage area for a sediment trap is recommended to be less than five (5) acres.

6. Location.

   The sediment trap should be located to obtain the maximum storage benefit from the terrain, for ease of cleanout and disposal of the trapped sediment and to minimize interference with construction activities.

7. Trap Size.

   The volume of a sediment trap as measured at the elevation of the crest of the outlet shall be at least 1800 cubic feet per acre of drainage area. The volume of the trap shall be calculated using standard mathematical procedures.

8. Trap Cleanout.

   Sediment shall be removed and the trap restored to its original dimensions when the sediment has accumulated to ½ of the design depth of the trap or one (1) foot, whichever is less. Sediment removed from the trap shall be deposited in an approved spoils area and in such a manner that it will not cause additional siltation.

9. Embankment.

   The embankment shall be mechanically compacted.

10. Excavation.

    All excavation operations shall be carried out in such a manner that erosion and water pollution shall be minimal. Any excavated portion of sediment trap shall have 2:1 or flatter slopes.

11. Outlet.

    There are two (2) types of outlets for sediment traps. Sediment traps are named according to the type of outlet. Each type has different design criteria and will be discussed separately. The outlets shall be designed, constructed and maintained in such a manner that sediment does not leave the trap and that erosion of the outlet does not occur. A trap may have several different outlets with each outlet conveying part of the flow based on the criteria below and the combined outlet capacity shall meet that criteria.

    A pipe outlet sediment trap consists of a basin formed by an embankment or excavation along with an embankment. The outlet for the trap is through a perforated riser and a pipe through the embankment. The outlet pipe and riser shall be made of corrugated metal or polyvinyl chloride. The riser diameter shall be of the same or larger diameter than the pipe. The top of the embankment shall be at least 1-½ feet above the crest of the riser. The length of the riser shall be perforated to achieve a 40 hour or longer draw-down time. All pipe connections shall be watertight. The capacity of the riser shall be sufficient to handle the peak flow from the 25 year storm.

    A stone outlet sediment trap consists of a basin formed by an embankment or excavation and an embankment. The outlet for the trap is over a level stone section. The stone outlet for a sediment trap differs from that for a stone outlet structure because of the intentional

ponding of water behind the stone. To provide for a ponding area, a triple layer geotextile fabric wrapped stone core having a nominal diameter of one (1) foot shall be placed in the outlet structure. The core shall be covered by a minimum of six (6) inches of stone.

The minimum length (feet) of the outlet shall be equal to six (6) times the drainage area (acres). The crest of the outlet (top of stone) shall be at least one (1) foot below the top of the embankment. Unless otherwise specified, all aggregate used shall be at least three (3) inches thick and shall not exceed ½ cubic foot in volume.

Geotextile fabric specification shall be woven polypropylene, polyethylene or polyamide geotextile, minimum unit weight 4.5 ounce per square yard, mullen burst strength greater than 250 pounds per square inch, ultraviolet stability exceeding 70 percent and equivalent opening size exceeding 40.

12. Sediment Plan Details.

There is no standard symbol for a sediment trap. Each trap shall be delineated on the plans in such a manner that it will not be confused with any other features. Each trap on a plan shall have a number and the numbers shall be consecutive. The following information shall be shown for each trap in a summary table form on the same sheet that the trap is on:

- Type of trap;
- Size of outlet;
- Trap dimensions
- Embankment height and excavation depth;
- Drainage area.

M. **Sediment Trapping Devices for Excavation Pumpage.**

1. Description.

A sediment tank or a temporary pit which is constructed to trap and filter sediment from water pumped from excavated areas.

2. Purpose.

Sediment Tank - traps and retains sediment from water being pumped from excavated areas.

Sump Pit - collects water retained in excavated areas and removes sediment before the water is pumped from the site.

3. Conditions Where Practice Applies.

Sediment tanks are generally used for the period of deep excavation where space is limited.

Sump pits are constructed for collecting water during construction; particularly useful during excavation for building foundations.

4. Design Criteria.

- Sediment Tank.

The location of sediment tank shall be convenient for clean out and disposal of the trapped sediment and shall minimize the interference with construction activities. The size of the tank can be estimated from the following formula:

Storage (cubic foot) = 16 x pump discharge (gallons per minute).

- Sump Pit.

A perforated standpipe shall be placed in the center of the pit to collect filtered water. A base of two (2) inch aggregate shall be placed in the pit to a depth of 12 inches. The pit surrounding the standpipe shall be backfilled with two (2) inch aggregate after installing the standpipe. Discharge of water pumped from the standpipe shall be conveyed to a sediment trapping device such as a rock berm, brush berm, stone outlet structure, sediment trap or sediment basin or to an area protected by any of these devices. The number of sump pits and their locations shall be determined by an engineer.

N. Stabilized Construction Entrance. (See Standard Specifications manual item 641S and Specifications manual item 641S-1 for detail)

1. Description.

   A stabilized pad of crushed stone located at any point where traffic will be entering or leaving a construction site to or from a public right of way, street, alley, sidewalk or parking area.

2. Purpose.

   The purpose of a stabilized construction entrance is to reduce or eliminate the tracking or flowing of sediment onto public rights of way.

3. Conditions Where Practice Applies.

   A stabilized construction entrance applies to all points of construction ingress and egress.

4. Design Criteria.

   The following design criteria shall be observed:

- Stone Size - Stone size shall be four (4) to eight (8) inch or larger open graded rock.

- Drainage - Entrance must be properly graded or incorporate a drainage swale to prevent runoff from leaving the construction site.

- Thickness - Not less than eight (8) inches.

- Width - Not less than full width of all points of ingress or egress.

- Length - As required, but not less than 50 feet.

5. Maintenance.

   The entrance shall be maintained in a condition which will prevent tracking or flowing of sediment onto public rights of way. This may require periodic top dressing with additional stone as conditions demand and repair and/or clean out of any measures used to trap

sediment. All sediment spilled, dropped, washed or tracked onto public rights of way must be removed immediately by contractor.

When necessary, wheels must be cleaned to remove sediment prior to entrance onto public right of way. When washing is required, it shall be done on an area stabilized with crushed stone which drains into an approved sediment trap or sediment basin. All sediment shall be prevented from entering any storm drain, ditch or watercourse using approved methods.

O. Pipe Slope Drain. (See Standard Specifications manual item 637S and Specifications manual item 637S-1 and 637S-2 for detail)

1. Description.

   A flexible tubing and/or rigid pipe with prefabricated entrance section temporarily placed to extend from the top of a slope to the bottom of a slope.

2. Purpose.

   The purpose of the pipe slope drain is to convey surface runoff safely down slopes without causing erosion.

3. Conditions Where Practice Applies.

   Pipe slope drains are to be used where concentrated flow of surface runoff must be conveyed down a slope in order to prevent erosion. Recommended maximum drainage area is five (5) acres.

4. Design Criteria.

   Unless otherwise specified, pipe slope drains are to be sized as follows:

Table 1.4-E Pipe Slope Drain Sizes

SIZE	PIPE/TUBING DIAMETER (D) (INCH)	MAXIMUM DRAINAGE AREA (ACRES)
PSD-12	12	.5
PSD-18	18	1.5
PSD-21	21	2.5
PSD-24	24	3.5
PSD-30	30	5.0

5. Inlet.

   The height of the earth dike at the entrance to the pipe slope drain shall be equal to or greater than the diameter of the pipe (D), plus 12 inches and shall be adequate to prohibit overtopping by the 100 year storm.

6. Outlet.

   Pipe slope drain shall outlet onto a riprap apron and then into a stabilized area or stable watercourse. A sediment trapping device shall be used to trap sediment from any sediment-laden water conveyed by the pipe slope drain.

P. Turbidity Curtain.

1. Definition

   A turbidity curtain is a temporary fabric curtain with very low permeability, installed in a waterway or waterbody to minimize sediment transport. Turbidity curtain is installed at an angle not greater than 45 degrees parallel to the direction to flow.

2. Purpose

   The purpose of this practice is to provide sediment containment while construction activities are occurring in or directly adjacent to a waterway or waterbody. Higher turbidity increases water temperatures because suspended particles absorb more heat. This, in turn, reduces the concentration of dissolved oxygen (DO) because warm water holds less DO than cold. Higher turbidity also reduces the amount of light penetrating the water, which reduces photosynthesis and the production of DO. Suspended materials can clog fish gills, reducing resistance to disease in fish, lowering growth rates, and affecting egg and larval development. As the particles settle, they can blanket the stream bottom, especially in slower waters, and smother fish eggs and benthic macroinvertebrates. http://water.epa.gov/type/rsl/monitoring/vms55.cfm

3. Conditions Where Practice Applies

   This practice applies where construction activities are located within or adjacent to a perennial waterbody. This includes but is not limited to bridge construction, utility work, stream bank restoration, shoreline modification and dredging.

   DOT Type II—"Moving Water" Floating Turbidity Curtains Permeable & Impermeable, are most commonly used for water conditions typical to Austin area lakes. This is slow to medium current applications, with currents in one direction & up to 5 feet/second, such as in rivers, and large lakes with moderate to strong winds and waves.

   If the current exceeds 5 feet per second, other methods to divert flow away from the turbidity curtain such as temporary concrete traffic curtains, coffer dams, pumping, or sheet piling should be considered.

4. Design Criteria

   This section establishes the minimum standards for design, installation and performance requirements.

   A. Installation — Details of construction not listed in the text shall conform to the pertinent requirements of Figure 1.4.5.P.1 and Figure 1.4.5.P.2.

      1) The curtain shall be installed before construction activities are initiated. Contractor will provide notice to the Environmental inspector 48 hours prior to installation and will include in the sequence of construction when the turbidity curtain will be installed.

      2) The curtain shall remain in place and be maintained until the construction activity is completed and the disturbed area has stabilized.

      3) The ends of the curtain shall be securely anchored and keyed into the shoreline to fully enclose the area where sediment may enter the water.

4) A turbidity curtain shall not be installed perpendicular to the direction of flow in a waterway or waterbody. Turbidity curtain shall be installed at an angle not greater than 45 degrees parallel to the direction to flow.

5) Driven posts shall be used to hold the curtain in position. The maximum spacing between posts shall be 10 feet. When curtain height exceeds 8 feet, post spacing may need to be decreased.

6) When bedrock prevents the installation of posts, float devices may be used. Flotation devices shall be flexible, buoyant units contained in an individual flotation sleeve or collar attached to the turbidity curtain. Use solid expanded polystyrene logs or equivalent having a 49 square inch minimum end area. Polystyrene beads or chips shall not be used as a flotation device. Buoyancy provided by the flotation devices shall be sufficient to support the weight of the turbidity curtain and maintain a freeboard of at least one-third of the flotation device cross section above the water surface. Refer to Figure 1.4.5.P.2.

7) The curtain shall extend to the bottom of the water body when depth of water is eight feet or less. For application in waters exceeding eight feet in depth, the curtain may extend to the desired depth, however the curtain shall not be required to exceed eight feet below the water surface unless special conditions warrant otherwise. The curtain shall be weighted at the bottom (as shown in USACE Standard Detail EP 1110-01-16) to maintain the desired depth.

8) Ballast or anchors shall be used to hold the curtain in a vertical position. Bottom load lines may consist of a chain incorporated into the bottom hem of the screen, of sufficient weight to serve as ballast to hold the screen in a vertical position. Additional anchorage shall be provided if necessary.

9) Danger buoys shall be used as required by Coast Guard regulations for navigable waterways or City of Austin permit when working in navigable waters.

B. Plans and Specifications — Plans and specifications for installing a turbidity curtain shall be in keeping with this standard and attached detail drawing and shall describe the requirements for applying the practice to achieve its intended purpose:

1) Location of turbidity curtain.

2) Material specification conforming to standard C. Plans, standard detail drawings, and specifications shall include schedule sequence or notes for installation, inspection, and maintenance. The responsible party shall be identified.

C. Material

1) Components of the turbidity curtain system shall be clean and free of exotic species.

2) Top load lines shall consist of steel cable sufficient to support the load of the turbidity curtain system.

3) Fabric shall be selected according to the specifications in Table 1.

Table 1. Fabric Specifications for Turbidity Curtain

Requirement	Method	Value
Min. grab tensile strength	ASTM D 4632	200 lb (890 N)
Min. puncture strength	ASTM D 4833	90 lb (400 N)
Maximum permeability	ASTM D 4491	$\leq 1 \times 10^{-7}$ cm/s
Min. ultraviolet stability	ASTM D 4355	70%

Source: WisDOT Spec 628.2.10.

D. Operation and Maintenance

1) Turbidity curtains shall be inspected daily by Contractor and repaired/adjusted as necessary to maintain proper installation practice, compliance with site plan, and as directed by the City. Third party inspection shall be performed weekly and maintain inspection log.

2) Turbidity curtains shall not be removed until the water contained within the curtain has equal or lower turbidity than the waterway or waterbody, or if a flood event is imminent.

3) Care shall be taken when removing the curtain to minimize the release or re-suspension of sediment.

4) Turbidity curtains that have been previously used in other water bodies must be properly cleaned to prevent the spread of invasive exotic species from other sites. If any materials (including turbidity curtains, bouys and chains) have been previously used, they shall be disinfected with vinegar or cleaned with hot water greater than 104 deg. F then allowed to completely dry for a minimum period of five days. If there are any questions about the occurrence of zebra mussels (Dreissena polymorpha), Giant salvinia (Salvinia molesta), or other aquatic invasive species in a waterbody that you have worked in, are working in, or intend to work in, contact the Texas Parks and Wildlife Department.

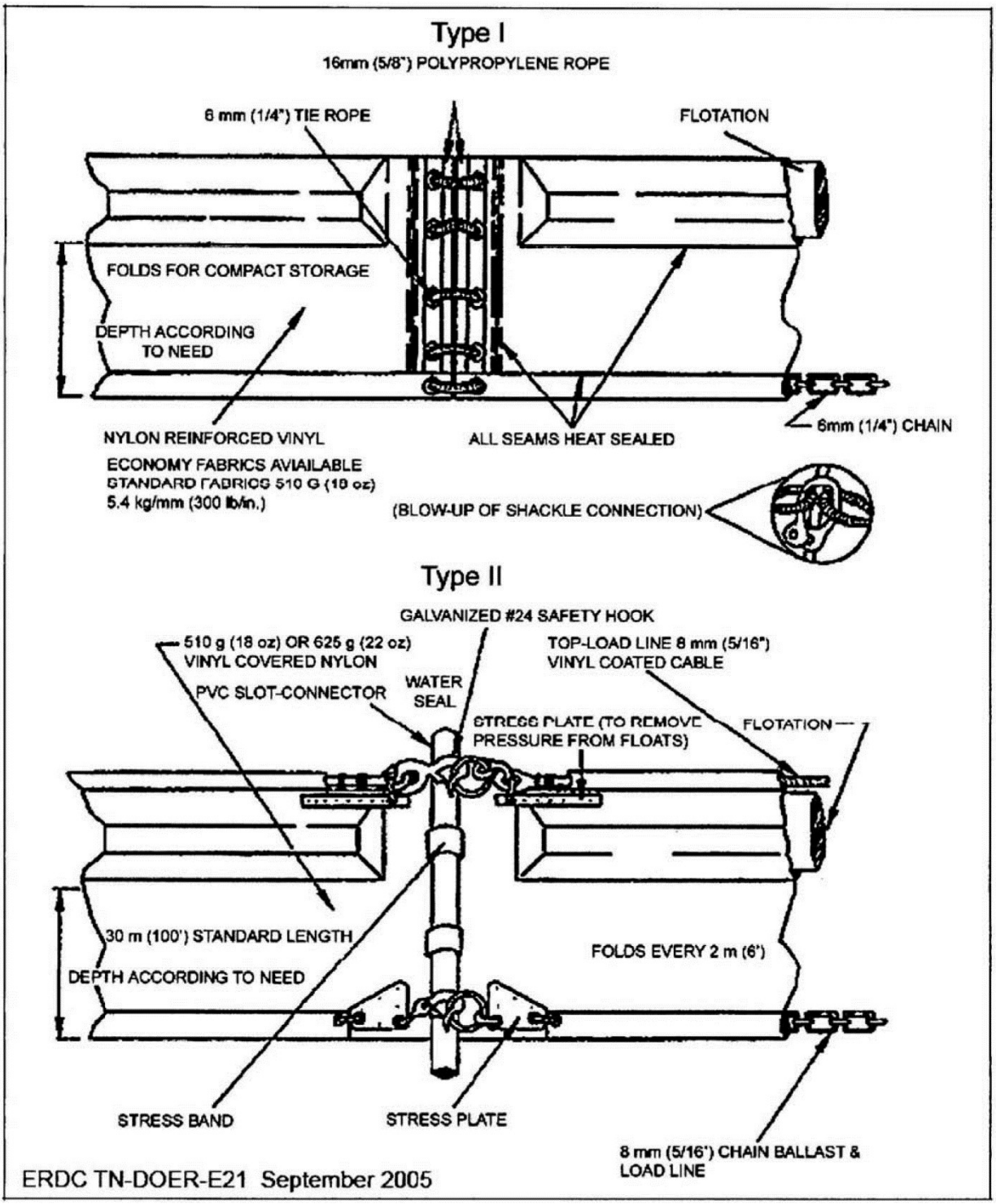


Figure 1.4.5.P.1. Type I and II Turbidity Curtain

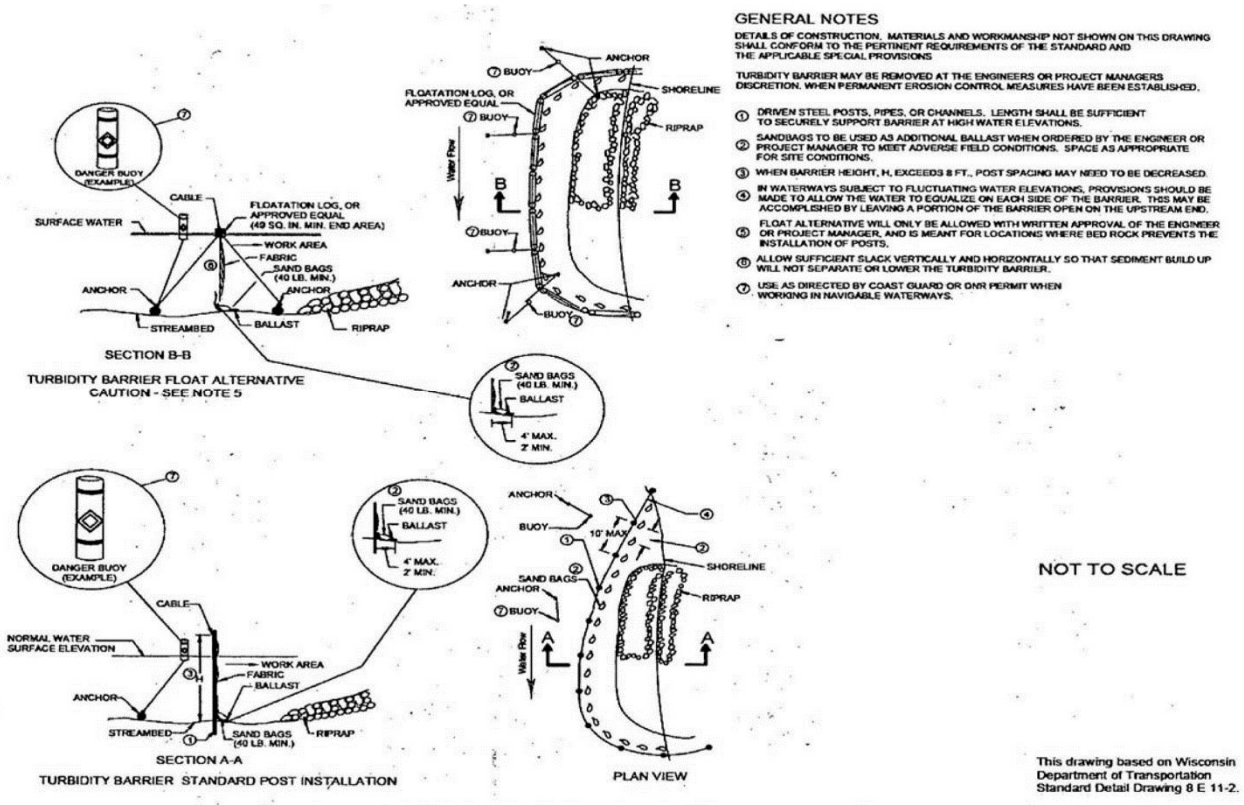


Figure 1.4.5.P.2 Turbidity Curtain Placement Details

Q. **Dust Control.**

1. Description.

   Controlling dust movement on construction sites and roads.

2. Purpose.

   To prevent blowing and movement of dust from exposed soil surfaces, reduce on and off-site damage, health hazards and improve traffic safety.

3. Conditions Where Practice Applies.

   This practice is applicable to areas subject to dust blowing and movement where on and off-site damage is likely without treatment.

4. Procedures.

   a. Temporary Methods.

      i. Mulching - See Section 1.4.5.A.

      ii. Vegetative Stabilization - See Section 1.4.7.

      iii. Tillage - To roughen surface and bring clods to the surface. This is an emergency measure which should be used before soil blowing starts. Begin plowing on windward side of site. Chisel-type plows spaced about 12 inches apart, spring-toothed harrows and similar plows are examples of equipment which may produce the desired effect.

iv. Irrigation - Site is sprinkled with water until the surface is moist. Repeat as needed.

v. Barriers - Solid board fences, snow fences, burlap fences, crate walls, bales of hay, and similar materials can be used to control air currents and soil blowing. Barriers placed at right angles to prevailing currents at intervals of about 15 times their height are effective in controlling soil blowing.

vi. Alternative dust control methods must be approved by the Environmental Inspector prior to use.

Source: Rule No. R161-14.34, 12-15-2014 ; Rule No. R161-14.26, 12-30-2014 ; Rule No. R161-17.12 , 6-13-17.

1.4.6 - Permanent Structural Practices

A. **Diversion.**

1. Description.

A drainageway of parabolic or trapezoidal cross section, with a supporting ridge on the lower side that is constructed across the slope.

2. Purpose.

The purpose of a diversion is to intercept and convey runoff to stable outlets at nonerosive velocities.

3. Conditions Where Practice Applies.

Diversions are used where:

• Runoff from higher areas is or has potential for damaging property, causing erosion or interfering with or preventing the establishment of vegetation on lower areas.

• The length of slopes need to be reduced so that soil loss will be reduced to a minimum.

• Diversions are only applicable below stabilized or protected areas. Avoid establishment on slopes greater than 15 percent.

4. Design Criteria.

The design procedures for parabolic and trapezoidal channels shall conform to the Drainage Criteria Manual.

5. Location.

Diversion location shall be determined by considering outlet conditions, topography, land use, soil type, length of slope and the layout of the proposed development.

6. Capacity.

The constructed diversion shall have capacity to carry, as a minimum, the peak discharge from a ten (10) year frequency rainfall event with freeboard of not less than one (1) foot.

Diversions designed to protect homes, schools, industrial buildings, roads, parking lots and comparable high-risk areas and those designed to function in connection with other structures, shall have sufficient capacity to carry peak runoff expected from the 25 year storm.

7. Velocity and Grade.

   The maximum permissible velocities of flow for the native grasses and soil conditions in Travis County have not been determined. Research of this type is planned, but until it is completed, design velocities should be held to below six (6) feet per second on grades up to five (5) percent, five (5) feet per second on slopes from five (5) to ten (10) percent and four (4) feet per second on slopes over ten (10) percent.

8. Cross Section.

   The diversion channel shall be parabolic or trapezoidal in shape.

   The diversion shall be designed to have stable side slopes. The side slopes shall not be steeper than 2:1 and shall be flat enough to insure ease of maintenance of the structure and its protective vegetative cover.

   The ridge shall have a minimum width of four (4) feet at the design water elevation; a minimum of one (1) foot freeboard.

9. Outlets.

   Each diversion shall have a stable outlet. The outlet may be a constructed or natural waterway, a stabilized open channel, grade stabilization structure, etc. In all cases, the outlet must discharge in such a manner as not to cause erosion. Outlets shall be constructed and stabilized prior to the operation of the diversion.

B. **Standards for Grass-Lined Swales.**

1. Description.

   A natural or manmade drainageway of parabolic or trapezoidal cross section that is below adjacent ground level and is stabilized by suitable vegetation. The flow is normally wide and shallow and conveys the runoff down the slope.

2. Purpose.

   The purpose of a grass-lined swale is to convey runoff without causing damage by erosion.

3. Conditions Where Practice Applies.

   Grass-lined swales are used where added channel capacity and/or stabilization is required to control erosion resulting from concentrated runoff and where such control can be achieved by this practice alone or in combination with others.

4. Design Criteria.

5. Capacity.

   The minimum capacity shall be that required to confine the peak rate of runoff expected from a ten (10) year frequency rainfall event or a higher frequency corresponding to the hazard involved. This requirement for confinement may be waived on slopes of less than one (1) percent where out-of-bank flow will not cause erosion or property damage.

   Where there is base flow, it shall be handled by a subsurface drain or a stone or gabion mattress lined low flow channel. The capacity of the subsurface drain or low flow channel shall be five (5) percent of the design peak flow or as determined by actual measurement of the maximum base flow.

   The design procedure for parabolic and trapezoidal channels is contained in the Drainage Criteria Manual.

6. Velocity and Grade.

The maximum permissible velocities of flow for the native grasses and soil conditions in Travis County have not been determined. Research of this type is planned, but until it is completed, design velocities should be held to below six (6) feet per second on grades up to five (5) percent, five (5) feet per second on slopes from five (5) to ten (10) percent and four (4) feet per second on slopes over ten (10) percent.

7. Cross Section.

   The design water surface elevation of a waterway receiving water from diversions or other tributary channels shall be equal to or less than the design water surface elevation in the diversion or other tributary channels (see Figures 1-19 and 1-20 in Appendix V of this manual for "Grass-Lined Swales" for details).

8. Outlets.

   Each waterway shall have a stable outlet. The outlet may be another waterway, a stabilized open channel, grade stabilization structure, etc. In all cases, the outlet must discharge in such a manner as not to cause erosion. Outlets shall be constructed and stabilized prior to the operation of the waterway.

9. Drainage.

   Subsurface drainage measures shall be provided for sites having high water tables or seepage problems, except where water-tolerant vegetation, such as Switch grass or Indian grass can be used.

   Where there is base flow, a subsurface drain or concrete low flow channel shall be required.

10. Stabilization.

    Waterways shall be stabilized immediately after final grading in accordance with the appropriate standards for critical area stabilization.

C. **Level Spreader.** (See 1.6.7.B.1 for Rock Level Spreader specifications and refer to 1.6.7.B Vegetative Filter Strips for design criteria)

1. Description.

   An outlet constructed at zero (0) percent grade across the slope whereby concentrated runoff may be discharged at nonerosive velocities into undisturbed area stabilized by existing vegetation.

2. Purpose.

   The purpose of the level spreader is to convert a concentrated flow of sediment-free runoff (e.g., diversion outlets) into sheet flow and to outlet it onto areas stabilized by existing vegetation without causing erosion.

3. Conditions Where Practice Applies.

   The level spreader is used only in those situations where the spreader can be constructed on undisturbed soil, where the area directly below the level lip is stabilized by existing vegetation, where the drainage area above the spreader is stabilized by existing vegetation and where the water will not be reconcentrated immediately below the point of discharge.

4. Design Criteria.

   The design criteria for level spreader shall be a maximum of one (1) cubic foot per second per foot of length, based on the peak rate of flow from a ten (10) year frequency rainfall event. The minimum length shall be five (5) feet. An alternate such as grade stabilization

structure, grassed waterway, etc., should be considered where the length of the level spreader exceeds 20 feet.

5. Outlets.

   Final discharge will be over the level lip protected with fiber glass matting erosion stops and jute or excelsior protective material onto an existing stabilized area. The stabilized area shall have a complete vegetative cover sufficiently established to be erosion resistant.

D. **Rock Riprap.**

1. Description.

   A layer of loose rock or aggregate placed over an erodible soil surface.

2. Purpose.

   The purpose of rock riprap is to protect the soil surface from the erosive forces of water.

3. Condition Where Practice Applies.

   This practice applies to soil-water interfaces where the soil conditions, water turbulence and velocity, expected vegetative cover and ground water conditions are such that the soil may erode under the design flow conditions. Rock riprap may be used, as appropriate, at such places as storm drain outlets, channel banks and/or bottoms, roadside ditches, drop structures and shorelines.

4. Design Criteria.

   The design of rock riprap for erosion control includes determination of a rock size and gradation to resist movement for the design hydraulic conditions. In addition an underlying filter layer that prevents migration of soils through the armor is often required. Rock size selection is based on the water forces acting on the rock matrix during the design discharge. The design discharge for sizing rock riprap for the portion of channels and ditches protected with stone riprap shall be the peak discharge from a one hundred (100) year frequency rainfall event. The roughness coefficient, "n", of riprap is highly dependent on the size of the rock used in the gradation and the depth of flow over the armor surface. At low flow depths the relative effect of rock riprap size on roughness is greater than that at higher flow depths. Significant guidance regarding roughness estimation exists in the literature, however the equation adapted for the Federal Highway Administration Hydraulic Engineering Circular No. 15, "Design of Roadside Channels with Flexible Linings" (2005) is recommended for determining the roughness value for the constructed riprap surface:

$$n = \frac{0.262\, d^{\frac{1}{6}}}{2.25 + 5.23 \log (d/D_{50})}$$

   where:

   d = the average channel flow depth (ft)

   D_{50} = median rock diameter for which 50% of the gradation is comprised of rocks of equal or smaller size (feet)

5. Rock Riprap Size and Gradation.

Rock riprap should be of sufficient size and properly graded that the stone weight and interlocking characteristics of the rock mixture resists movement when exposed to hydraulic stresses. The curve in Figure 1-22 in Appendix V of this manual provides an estimate of individual minimum rock sizes (diameter and weight of a spherical specimen) for a range of channel velocities that may be stable up to 17 feet per second. The chart was adapted from the United States Bureau of Reclamation, "Hydraulic Design of Stilling Basins and Energy Dissipators, Engineering Monograph No. 25", (1983). The rock size rating curve was based on laboratory flume tests and prototype stilling basins observed by the Bureau of Reclamation. The rock riprap sizing criteria is most applicable to high energy environments. The curve can be represented with the following expression:

$$D_{50} = 0.0105V^{2.06}$$

where:

D50 = median rock diameter (feet)

V = average water velocity (ft/sec)

Stone weight can be estimated assuming a shape midway between a sphere and a cube using the following expression (adapted from ASTM D5519).

$$W_{50} = 47.54D_{50}^{3} S_g$$

where:

W_{50} = median stone weight for which 50% of the gradation is comprised of rocks of equal or lesser weight (lbs)

Sg = specific gravity of the stone

Stone weight varies with the source of the material. For quartz the specific gravity is approximately 2.65, where many types of native Texas limestone can vary from 2.3 to 2.5. For placed rock riprap the minimum recommended specific gravity is 2.4.

Rock riprap gradation, as used herein, is defined as an allowable particle size distribution based on the median particle diameter, or D50. The rock riprap gradation shall conform to the gradation table below. Neither the width nor the thickness of a single stone shall be less than one third of its length.

Rock Riprap Gradation Table								
Rock Riprap Class by Median Particle Diameter (D50)		D15 (in)		D50 (in)		D85 (in)		D100 (in)
Class	Diameter (in)	Min	Max	Min	Max	Min	Max	Max
I	6	3.7	5.2	5.7	6.9	7.8	9.2	12.0
II	9	5.5	7.8	8.5	10.5	11.5	14.0	18.0
III	12	7.3	10.5	11.5	14.0	15.5	18.5	24.0
IV	15	9.2	13.0	14.5	17.5	19.5	23.0	30.0
V	18	11.0	15.5	17.0	20.5	23.5	27.5	36.0
VI	21	13.0	18.5	20.0	24.0	27.5	32.5	42.0
VII	24	14.5	21.0	23.0	27.5	31.0	37.0	48.0
VIII	30	18.5	26.0	28.5	34.5	39.0	46.0	60.0
IX	36	22.0	31.5	34.0	41.5	47.0	55.5	72.0
X	42	25.5	36.5	40.0	48.5	54.5	64.5	84.0

Reference: National Cooperative Highway Research Program, "NCHRP Report 568 - Riprap Design Criteria, Recommended Specifications, and Quality Control."

The rock riprap layer thickness shall be no less than the maximum stone size (D100) or 1.5 times the D50, whichever produces the greater thickness. For applications in drainage channels the riprap layer should be a minimum of 2.0 times as thick as the median stone size specified.

6. Rock Riprap Gradation Field Verification.

   Rock gradations larger than Class I may require field testing as traditional test methods such as sieves or mechanical sorting machines may be impractical. Where projects require field verification of the rock riprap size class and gradation, the test methods described in City of Austin Standard Specification 591S Riprap for Slope Stabilization may be used.

7. Filter.

A filter is a transitional layer of material placed between the riprap and the underlying soil surface intended to prevent soil movement through the riprap and permit relief of hydrostatic pressure within the soils. Filters can prevent loss of the underlying soil through piping or from surface water causing erosion beneath the riprap. A filter is recommended especially when the riprap is placed on noncohesive material that is subject to significant subsurface drainage. Areas where water surface levels fluctuate frequently and areas of high groundwater levels should include filters in the design of riprap revetment.

A filter can be of two (2) general forms. A fabric filter is one or more layers layer of geotextile filter fabric manufactured for that express purpose and a granular filter is one or more graded layers of sand, gravel or stone.

The proper design of filters is critical to the stability of riprap installations on channel banks. If openings in the filter are too large, excessive flow piping through the filter can cause erosion and failure of the bank material below the filter. On the other hand, if the openings in the filter are too small, the build-up of hydrostatic pressures behind the filter can cause a slip plane to form along the filter resulting in massive translational slide failure.

To determine the need for a filter and to properly design granular filters the gradation of the armor layer, filter layers and adjacent strata to meet the following criteria:

$$\frac{D_{15(Upper)}}{D_{85(Lower)}} < 5 < \frac{D_{15(Upper)}}{D_{15(Lower)}} < 40$$

In the above relationships, "upper" refers to the overlying material and "lower" refers to the underlying material. The relationships must hold between the filter and base material and between the riprap and the filter. A filter ratio of 5 or less between layers will usually result in a stable condition. The filter ratio is defined as the ratio of the 15 percent particle size (D15) of the upper/coarser layer to the 85 percent particle size (D85) of the lower/finer layer. An additional requirement for stability is that the ratio of the 15 percent particle size of the upper/coarser material to the 15 percent particle size of the lower/finer material should exceed 5 but not be less than 40. When determining the need for a filter the upper layer represents the rock armor and the lower layer represents the finer underlying substrate. In design, the filter material will be evaluated relative to the rock armor and the underlying material. In cases where the requirements cannot be met with a single gradation multiple layers of granular filter material of varying gradations may be required to meet the criteria. The thickness of a granular filter layer should be no less than 1.5 times the maximum size in the filter gradation. The minimum allowable thickness for a filter blanket shall be 102 mm (4 in).

In design of an appropriate geotextile as a riprap filter, soil retention , permeability, clogging survivability should be considered. Detailed design guidance for selection of geotextiles as a riprap filter can be found in the Federal Highway Administration "Geosynthetic Design and Construction Guidelines" (FHWA-HI-95-038). With the exception of problematic soils or high velocity conditions associated with steep channels and rundowns, geotextile filters may usually be selected based on the apparent opening size (AOS) of the geotextile and the soil type as shown in the following table from FHWA-HI-95-038.

Maximum AOS for Geotextile Filters

Soil Type	Maximum AOS (mm)
Non cohesive, less than 15 percent passing the US #200	0.43
Non cohesive, 15 to 50 percent passing the US #200 sieve	0.25
Non cohesive, more than 50 percent passing the US #200 sieve	0.22
Cohesive, plasticity index greater than 7	0.30

Although they are usually more economical than granular filters, geotextile filters are difficult to install in underwater, ultimately degrade and can create a failure slip plane when placed against non-cohesive bank material and on steep slopes. Geotextile filter fabric shall be installed with sufficient anchoring and overlap between seams according to the manufacturer's recommendations to ensure full filter barrier protection of the subgrade after riprap installation.

Riprap should not be dumped directly onto the geotextile filter fabric, because it may tear or displace the fabric. A four (4) inch minimum thickness granular cushion layer of gravel or sand may be specified over the filter fabric when the riprap stones cannot be placed as to not damage the fabric. Side slopes shall be 2:1 or flatter in order for the gravel or sand not to slide down the filter cloth before placing the riprap.

E. **Gabions.** (See Standard Specifications manual item 594S and Specifications manual item 594S-1 and 594S-2 for detail)

1. Description.

   Compartmented rectangular containers made of heavily galvanized and plastic-coated steel wire woven in a uniform hexagonal pattern, with an opening of approximately three (3) x four (4) inches, then filled with stone.

2. Purpose.

   The purpose of gabions is to protect the soil surface from the erosive forces of water or to retain unstable soil in a more vertical condition.

3. Condition Where Practice Applies.

   This practice applies to soil faces where the soil conditions, erosive forces, expected vegetative cover and ground water conditions are such that the soil may erode under the design conditions. Gabions may be used, as appropriate, at such places as storm drain outlets, weirs, channel banks and/or bottoms, roadside ditches, drop structures, shorelines and earth retaining structures.

4. Design Criteria.

   The minimum design discharge for that portion of channels and ditches protected with gabions shall be peak discharge from a ten (10) year frequency rainfall event. The roughness coefficient, "n", to be used for determining flow in the gabion protected channel shall be:

TABLE 1-3 ROUGHNESS COEFFICIENT FOR GABIONS	
n	Stone Size
0.028	4 inches
0.029	5 inches
0.030	6 inches
0.031	7 inches
0.0315	8 inches
Source: City of Austin	

Gabion weirs should be founded on a gabion apron which extends downstream. The length of the apron will vary with the hydraulic and soil conditions.

In no case will the apron extend downstream less than the minimum length shown in Table 1-4 below:

TABLE 1-4 APRON LENGTH	
Gravel	6 feet
Coarse or Medium Sand	9 feet
Fine or Silty Sand	12 feet
Clay	9 feet
Source: City of Austin	

Gabion earth retaining structures will be designed in conformance with the manufacturer's recommendations.

5. Materials.

The wire mesh shall consist of plastic-coated (polyvinyl chloride) galvanized wire with a diameter of 0.0842 inches for revet mattress and 0.155 inch for all other applications. The wire for salvages and corners shall be plastic-coated galvanized wire with a diameter of 0.1305 inch. Tie and connecting wire shall be plastic-coated wire with a diameter of 0.084.

The stone fill material shall consist of hard, durable, clean stone, four (4) to eight (8) inches in size.

F. **Subsurface Drain.**

1. Description.

A conduit, such as pipe or tubing, installed beneath the ground surface which intercepts, collects and/or conveys drainage water.

2. Purpose.

A subsurface drain may serve one (1) or more of the following purposes:

• Improve the soil environment for vegetable growth by regulating the water table and ground water flow.

• Intercept and prevent ground water movement into a wet area and to handle base flow for grassed waterways.

• Relieve artesian pressures.

• Remove surface runoff.

• Provide internal drainage of slopes to improve their stability and reduce erosion.

• Provide internal drainage behind bulkheads, retaining walls, etc.

• Replace existing subsurface drains that are interrupted or destroyed by construction operations.

• Provide subsurface drainage to dewater stormwater management structures.

• Improve dewatering of sediment in sediment basins (see Section 1.4.5 K "Sediment Basins" for additional information).

3. Conditions Where Practice Applies.

Subsurface drains are used where lowering or controlling ground water or surface runoff is required. The soil shall have enough depth and permeability to permit installation of an effective system. This standard does not apply to storm drainage systems or foundation drains.

An outlet for the drainage systems shall be available, either by gravity flow or by pumping. The outlet shall be adequate for the quantity of water to be discharged without damage above or below the point of discharge.

4. Design Criteria.

The required capacity shall be determined by one (1) or more of the following:

• Where subsurface drainage is to be uniform over an area through a systematic pattern of drains, a drainage coefficient of one (1) inch to be removed in 24 hours shall be used.

• Where subsurface drainage is to be by random system, a minimum inflow rate of 1.5 cubic feet per second per 1,000 feet of line shall be used to determine the required capacity.

For interceptor subsurface drains on sloping land, increase the inflow rate as follows:

Land Slopes	Increase Inflow Rate By
2 - 5 percent	10 percent
5 - 12 percent	20 percent
over 12 percent	30 percent

• Additional design capacity must be provided if surface water is allowed to enter the system.

5. Size of Subsurface Drain.

   The size of the subsurface drains shall be determined in accordance with the Drainage Criteria Manual.

6. Depth and Spacing.

   The minimum depth of cover of subsurface drains shall be 24 inches, where possible. The minimum depth of cover may be reduced to a minimum of 12 inches where it is not possible to attain the 24 inch depth and where the drain is not subject to damage by equipment loading. Roots from some types of vegetation can plug drains as the drains get closer to the surface.

   The spacing of drain laterals will be dependent on the permeability of the soil, the depth of installation of the drains and degree of drainage required. Generally, drains installed 36 inches deep and spaced 50 feet center to center will be adequate.

7. Minimum Velocity and Grade.

   The minimum grade for subsurface drains shall be 0.10 percent. Where surface water enters the system, a velocity of not less than two (2) feet per second shall be used to establish the minimum grades. Provisions shall be made for preventing debris or sediment from entering the system by means of filters or collection and periodic removal of sediment from installed traps.

8. Materials for Subsurface Drains.

   Acceptable subsurface drain materials include perforated, continuous closed joint conduits of polyethylene plastic, concrete, corrugated metal, asbestos-cement, bituminized fiber and polyvinyl chloride.

The conduit shall meet strength and durability requirements of the site.

9. Loading.

   The allowable loads on subsurface drain conduits shall be based on the trench and bedding conditions specified for the job. A safety factor of not less than 1.5 shall be used in computing the maximum allowable depth of cover for a particular type of conduit.

10. Envelopes and Envelope Material.

    Envelopes shall be used around subsurface drains for proper bedding of the conduit. Not less than ten (10) inches of envelope material shall be used for sand-gravel envelopes. Where necessary to improve the characteristics of flow of ground water into the conduit, more envelope material may be required.

    Envelope material shall be placed to the height of the uppermost seepage strata. Behind bulkhead and retaining walls, it shall go to within 12 inches of the top of the structure. This does not cover the design of filter materials where needed.

    Materials used for envelopes shall not contain materials which will cause an accumulation of sediment in the conduit or render the envelope unsuitable for building of the conduit. Envelope materials shall consist of sand-gravel material, all of which shall pass a 1½ inch sieve, 90 to 100 percent shall pass a ¾ inch sieve and not more than ten (10) percent shall pass a Number 40 sieve.

    The conduit shall be placed and bedded in a sand-gravel envelope. A minimum of three (3) inches depth of envelope material shall be placed on the bottom of a conventional trench. The conduit shall be placed on this and the trench completely filled with envelope material to a minimum depth of three (3) inches above the conduit.

    Envelope Material.

    Soft or yielding soil under the drain shall be stabilized where required and lines protected from settlement by adding gravel or other suitable material to the trench, by placing the conduit on plank or other rigid support or by using long sections of perforated or watertight pipe with adequate strength to insure satisfactory subsurface drain performance.

    The envelope shall be interrupted every ten (10) feet by an impervious cutoff wall. This wall shall fit tightly around the pipe and prohibit the continued flow of water through the envelope, thus forcing it into the conduit.

11. Auxiliary Structure and Subsurface Drain Protection.

    The outlet shall be protected against erosion and undermining of the conduit, against damaging periods of submergence and against entry of rodents or other animals into the subsurface drain.

    A continuous ten (10) foot section of corrugated metal, cast iron, polyvinyl chloride or steel pipe without perforations shall be used at the outlet end of the line and shall outlet above the normal elevation of low flow in the outlet ditch. No envelope material shall be used around the ten (10) foot section of pipe. Two-thirds (2/3) of the pipe shall extend to a point above the toe of the ditch side slope or the side slope shall be protected from erosion.

    Conduits under roadways and embankments shall be watertight and designed to withstand the expected loads.

    Where surface water is to be admitted to subsurface drains, inlets shall be designed to exclude debris and prevent sediment from entering the conduit. Lines flowing under

pressure shall be designed to withstand the resulting pressures and velocity of flow. Surface waterways shall be used where feasible.

The upper end of each subsurface drain line shall be capped with a tight fitting cap of the same material as the conduit or other durable material, unless connected to a structure.

G. **Land Grading.**

1. Description.

   Reshaping of the existing topography in accordance with a plan as determined by engineering survey and layout.

2. Purpose.

   The purpose of land grading is to provide for erosion control and vegetative establishment on those areas where the existing topography is to be reshaped by grading according to plan.

3. Design Criteria.

   The grading plan should be based upon the incorporation of building designs and street layouts that fit and utilize existing topography and desirable natural surroundings to avoid extreme grade modifications. Information submitted will provide sufficient topographic surveys and soil investigations to determine limitations that must be imposed on the grading operation related to slope stability, effect on adjacent properties and drainage patterns, measures for drainage and water removal and vegetative treatment, etc.

   The plan must show existing and proposed contours of the area(s) to be graded. The plan shall also include practices for erosion control, slope stabilization, safe disposal of runoff water and drainage, such as waterways, lined ditches, reverse slope benches (include grade and cross section), grade stabilization structures, retaining walls and surface and subsurface drains. The plan shall also include scheduling and phasing of these practices; the following shall be incorporated into the plan:

• Provisions shall be made to safely conduct surface runoff to storm drains, protected outlets or to stable water courses to insure that surface runoff will not damage slopes or other graded areas (see Section 1.4.6 "Permanent Structural Practices").

• Cut and fill slopes shall be designed to the natural angle of repose for the material. Without approval of the Director of Transportation and Public Services, they will be no steeper than 2:1, except for cut slopes in solid limestone. Where the slope is to be mowed, the maximum slope shall be no steeper than 3:1 (4:1 is preferred because of safety factors related to mowing steep slopes).

• Reverse slope benches or diversions shall be provided whenever the vertical interval (height) of any 2:1 through 5:1 slope exceeds 15 feet. Benches shall be located so as to divide the slope face as equally as possible and shall convey the water to a stable outlet. Soils, seeps, rock outcrops, etc., shall also be taken into consideration when designing benches.

- Benches shall be wide enough to accommodate the construction equipment in use and provide for ease of maintenance.

- Benches shall be designed with a reverse slope of 5:1 or flatter to the toe of the upper slope and with a minimum of one (1) foot in depth. Bench gradient to the outlet shall be between one (1) and two (2) percent.

- The flow length within a bench shall not exceed 800 feet unless accompanied by appropriate design and computations (see Section 1.4.5 "Temporary Structural Practices").

• Surface water shall be diverted from the face of all cut and/or fill slopes by the use of diversions, ditches and swales or conveyed down slope by the use of designed structure, except where:

- The length of overland flow (in feet) to the crest of the slope shall not exceed the distance "A" given in the following diagram and example for any combination of side slopes and vertical intervals and;

- The face of slope is or shall be stabilized and the face of all graded slopes shall be protected from surface runoff until they are stabilized and;

- The face of the slope shall not be subjected to any concentrated flows of surface water from natural drainageways, graded swales, downspouts, etc.

The maximum total horizontal overland flow distance "B" shall not exceed 15 times the side slope "X" of the cut or fill slope. Maximum allowable overland flow distance (in feet) to the top of the slope with no diversion of surface water will be determined by use of the formulas found in Section 2 "Determination of Storm Runoff" of the Drainage Criteria Manual.

H. **Grade Stabilization Structure (Paved Chute or Flume).**

1. Definition.

   A channel lined with bituminous concrete, Portland cement concrete or comparable nonerodible material placed to extend from the top of a slope to the bottom of a slope.

2. Purpose.

   The purpose of the paved chute or flume is to convey surface runoff safely down slopes without causing erosion.

3. Conditions Where Practice Applies.

   A paved chute or flume is to be used where concentrated flow of surface runoff must be conveyed down a slope in order to prevent erosion. The maximum allowable drainage area shall be 36 acres.

4. Design Criteria.

• Size Group A.

- The height (H) of the dike at the entrance is at least 1.5 feet.

- The depth (d) of the chute down the slope is at least eight (8) inches.

- The length (L) of the inlet and outlet sections is five (5) feet.

• Size Group B.

- The height (H) of the dike at the entrance is at least two (2) feet.

- The depth (d) of the chute down the slope is at least ten (10) inches.

- The length (L) of the inlet and the outlet sections is six (6) feet.

• Each size group has various bottom widths and allowable drainage areas as shown below:

Size 1/	Bottom Width, b, Ft.	Maximum Drainage Area Acres
A-2	2	5
A-4	4	8
A-6	6	11
A-8	8	14
A-10	10	18
B-4	4	14
B-6	6	20
B-8	8	25
B-10	10	31
B-12	12	36

Note: 1/ The size is designated with a letter and a number, such as A-6, which means a chute or flume in Size Group A with a six (6) foot bottom width. The selected size shall be shown on the plans.

If a minimum of 75 percent of the drainage area will have a good grass or woodland cover throughout the life of the structure, the drainage areas listed above may be increased by 50 percent. If a minimum of 75 percent of the drainage area will have a good mulch cover throughout the life of the structure, the drainage areas listed above may be increased by 25 percent.

5. Outlet.

When a paved chute or flume is used, the velocity at its outfall shall be checked for erosion potential downstream and when required, energy dissipation structures shall be installed.

Source: Rule No. R161-15.12, 1-4-16 .

1.4.7 - Vegetative Practices

A. **Temporary Vegetative Stabilization of Disturbed Areas.**

1. Description.

   Stabilize soil in disturbed areas with temporary vegetation. Refer to Section 1.4.5.A. - Mulching for other temporary stabilization options.

2. Purpose.

   To stabilize the soil; to reduce damages from sediment and runoff to downstream areas; improve wildlife habitat; enhance natural beauty.

3. Conditions Where Practice Applies.

   Use vegetation to temporarily stabilize the soil on disturbed, graded or cleared areas prior to establishment of permanent vegetation.

4. Design Criteria.

   Prior to vegetative establishment, install needed erosion control practices, such as diversions, grade stabilization structures, berms, dikes, level spreaders, and sediment basins. Final grading and shaping has usually not been completed for temporary stabilization.

5. Fertilizer.

   For temporary vegetative establishment, fertilizer may be applied if a soil test indicates the need for additional nutrients. For more information, refer to Standard Specification 606S, Fertilizer. In order to avoid the conveyance of nutrients off-site, the timing of fertilization shall not occur when rainfall is expected or during slow plant growth or dormancy (i.e., during the cool season for warm-season plants). Chemical fertilizer may not be applied in the Critical Water Quality Zone.

6. Seed Bed Preparation.

   Prepare a suitable seed bed which allows good seed-to-soil contact and soil conditions that are conducive to vegetative growth. Do not disturb the soil within the critical root zone of existing trees. See Section 1.4.8.B. or information regarding the protection of trees in construction areas. Areas of compacted soil shall be loosened to minimum depths between six (6) and twelve (12) inches, or deeper, depending on the extent of compaction, the location of compaction, and the type and nature of soils affected by compaction (e.g., shallow vs deep, wet vs dry). In cases where minimum depths of six (6) to twelve (12) inches is not attainable (i.e., shallow soil above bedrock) apply decompaction to the depth of soil present. Decompaction can be achieved by tilling, plowing, discing, raking, ripping or other acceptable means before seeding. After seed bed preparation, heavy equipment must not be driven over soils. In areas where no topsoil exists, or where imported topsoil is needed for vegetative establishment, the subgrade shall be loosened by discing or by scarifying to a depth of at least two (2) inches prior to placement to permit bonding of the topsoil to the subsoil. Placement of topsoil shall not occur in such a manner or location such that stormwater runoff is likely to transport the material downstream (e.g. over bedrock in an area of concentrated flow). All disturbed areas to be revegetated are required to have a minimum of six (6) inches of topsoil. Topsoil, when used, shall meet the definition of topsoil as defined in Standard Specification 601S.3.A Salvaging and Placing Topsoil. Topsoil salvaged from the existing site may often be used, but it should meet the same standards as set forth in these standards.

The following are general threshold levels of compaction as determined by three compaction testing methods, including bulk density method, standard proctor method, and penetration resistance method. Compaction levels that are detrimental to root growth are dependent on soil type which typically varies from site to site and must be determined by an Engineer, Landscape Architect, Soil Scientist, or their designated representative before compaction testing occurs.

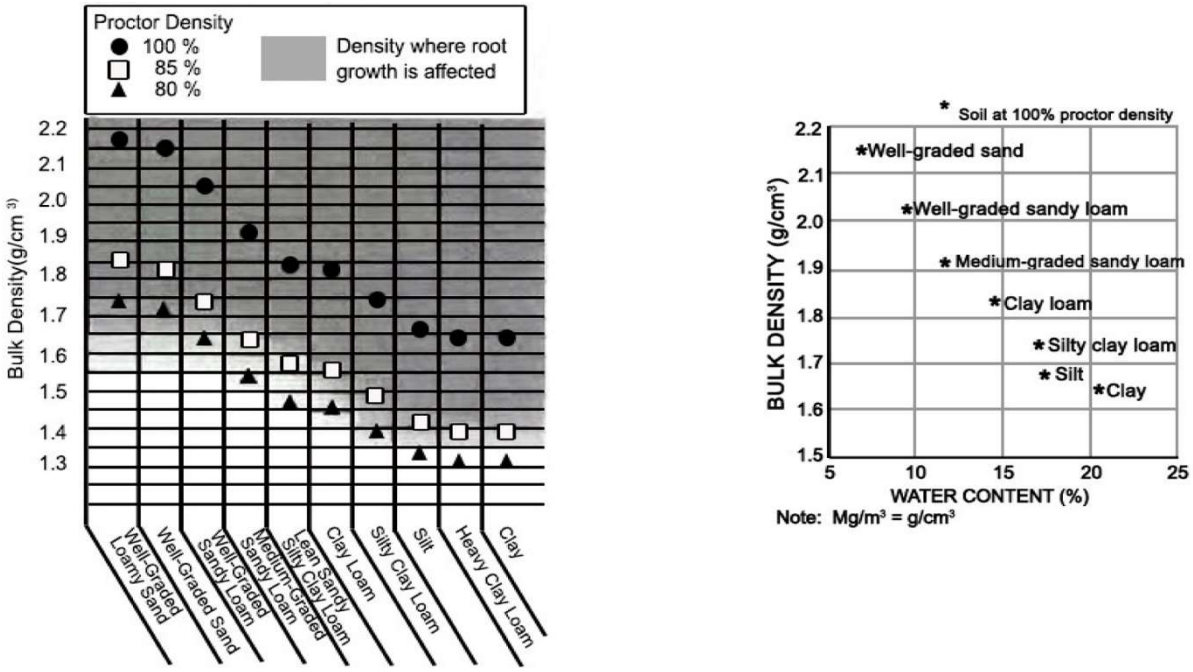
Acceptable Compaction: Good rooting anticipated, but increasing settlement expected as compaction is reduced and/or in soil with a high organic matter content.

a. Bulk Density Method: Varies by soil type (see Figure 1.4.7-1).

b. Standard Proctor Method: 75 - 85 percent; soil below 75 percent is unstable and will settle excessively.

c. Penetration Resistance Method: 75 to 250 p.s.i.; soil below 75 p.s.i. becomes increasingly unstable and will settle excessively.

Figure 1.4.7-1: The relationships of soil types to bulk density and Proctor Values. Source: Urban (2008) Up by Roots.



7. Seeding.

If seeding is to be conducted during the cool season (September 15 to March 1) plant species noted as "cool season cover crop" from the Tables in Standard Specification 604S and/or 609S. Warm season seeding (March 2 to September 14) shall follow standard specification 604S (seeding for erosion control) and 609S (native grassland seeding and planting for restoration). Apply seed uniformly with broadcast method, a seed spreader, drill, cultipacker seeder or hydroseeder (slurry includes seed, fertilizer and binder - see item 8[next]).

Length of seed germination is dependent on weather, soil moisture, species type and other variables. For native seed it can range from two to five weeks. If inadequate germination is evidenced, reseeding shall be required.

8. Protection of Seed Bed with Hydromulch or Soil Retention Blanket.

   Newly-installed temporary vegetation must be protected by hydromulch or soil retention blanket (refer to Standard Specification 605S Soil Retention Blanket) immediately after seeding. Protection of the seed bed shall occur in a manner that will allow seed germination and that encourages effective vegetative growth. Hydromulching, when used, shall comply with the requirements of Table 1.4.7-A: Hydromulching for Temporary Vegetative Stabilization. The following hydromulch requirements are in accordance with the Erosion Control Technology Council (ECTC). The ECTC has set its mission to be the recognized industry authority in the development of standards, testing, and installation techniques for rolled erosion control products (RECPs), hydraulic erosion control products (HECPs) and sediment retention fiber rolls (SRFRs).

Table 1.4.7-A: Hydromulching for Temporary Vegetative Stabilization

Material	Description	Longevity	Typical Applications	Application Rates
100% or any blend of wood, cellulose, straw, and/or cotton plant material (except no mulch shall exceed 30% paper)	70% or greater Wood/Straw 30% or less Paper or Natural Fibers	0—3 months	Moderate slopes; from flat to 3:1	1,500 to 2,000 lbs per acre

a. Hydraulic Mulch. Hydraulically-applied material(s) containing defibrated paper, wood and/or natural fibers that may or may not contain tackifiers used to facilitate revegetation establishment on mild slopes and designed to be functional for up to 3 months. Refer to Table 1.4.7-B for mulch properties and to Standard Specification 604S - Seeding for additional mulch requirements.

Table 1.4.7-B: Properties of Hydraulic Mulch

Property (Test Method)	Required Value
Moisture content %	12.0% ±3.0% (max.)
Organic matter %	90% ±1% Oven Dry Basis (min.)
Tacking Agent	0% or greater
Water holding capacity	500% or greater

9. Watering

Supplemental watering may be required to germinate seed and maintain growth. Depending on the weather and constituents of a seed mix, new plantings may require daily watering for the first week or longer after sowing to ensure germination, with reduced irrigation post-germination to ensure growth, plant health and vigor. Irrigation shall occur at rates and frequencies determined by a licensed irrigator or other qualified professional, and as allowed by the Austin Water Utility and the current water restrictions and water conservation initiatives. Significant rainfall (on-site rainfall of half-inch or greater) may allow the postponement of watering until the next scheduled irrigation.

B. **Permanent Vegetative Stabilization of Disturbed Areas.**

1. Description.

Permanent vegetative stabilization may comprise the installation of vegetation such as sod and bunch grasses, forbs, shrubs, and/or trees on critical disturbed areas. When seeded, newly-installed permanent vegetation must be protected by hydromulch or soil retention blanket (refer to Standard Specification 605S Soil Retention Blanket).

2. Purpose.

To stabilize the soil, to reduce damages from sediment and runoff to downstream areas, improve wildlife habitat, enhance natural beauty.

3. Conditions Where Practice Applies.

Disturbed, graded or cleared areas which are subject to erosion and where a permanent, long-lived vegetative cover is needed.

4. Design Criteria.

- Standard Specifications

For areas that are seeded refer to Standard Specification 604S - Seeding for Erosion Control or 609S - Native Grassland Seeding and Planting for Restoration (whichever is applicable). For areas that are sodded refer to Standard Specification 602S - Sodding for Erosion Control.

- Site Preparation.

- Install needed erosion control practices, such as interceptor dikes, berms and spreaders, contour ripping, erosion stops, channel liners and sediment basins.

- Grade as needed and feasible to permit the use of conventional equipment for seed bed preparation, seeding, mulch applications, anchoring and maintenance.

5. Bed Preparation.

Prepare a suitable bed which allows good contact between the soil and the seed or sod (whichever is used).

Areas of compacted soil shall be loosened by plowing, discing, raking or other acceptable means to a depth of six (6) inches or greater prior to seeding or sodding.

In areas where no topsoil exists, or where topsoil is needed for vegetative establishment, the subgrade shall be loosened by discing or by scarifying to a depth of at least two (2)

inches prior to placement of six (6) inches of topsoil to permit bonding of the topsoil to the subsoil.

All disturbed areas to be revegetated are required to place a minimum of six (6) inches of topsoil. Topsoil, when used, shall meet the definition of topsoil as defined in standard specification 601S.3.A Salvaging and Placing Topsoil.

Topsoil salvaged from the existing site may often be used, but it should meet the same standards as set forth in these standards. Placement of topsoil shall not occur in such a manner or location such that stormwater runoff is likely to transport the material downstream (e.g. over bedrock in an area of concentrated flow).

6. Fertilizer.

   For permanent vegetative establishment, fertilizer may be applied if a soil test indicates the need for additional nutrients. For more information, refer to Standard Specification 606S, Fertilizer. In order to avoid the conveyance of nutrients off-site, the timing shall not occur when rainfall is imminent, or during slow plant growth or dormancy (i.e., during the cool season for warm-season plants). Chemical fertilizer may not be applied in the Critical Water Quality Zone.

7. Seeding.

   Select the appropriate species in the tables provided in Standard Specification 604S and/or 609S. All seeding work must conform to these specifications.

8. Protection of Seed Bed with Hydromulch or Soil Retention Blanket.

   When seeded, newly-installed permanent vegetation must be protected by hydromulch or soil retention blanket (refer to Standard Specification 605S Soil Retention Blanket) immediately after seeding. Protection of the seed bed shall occur in a manner that will allow seed germination and that encourages effective vegetative growth. Hydromulching, when used, shall comply with the requirements of Table 1.4.7-C: Hydromulching for Permanent Vegetative Stabilization. The following hydromulch requirements are in accordance with the Erosion Control Technology Council (ECTC). The ECTC has set its mission to be the recognized industry authority in the development of standards, testing, and installation techniques for rolled erosion control products (RECPs), hydraulic erosion control products (HECPs) and sediment retention fiber rolls (SRFRs).

Table 1.4.7-C: Hydromulching for Permanent Vegetative Stabilization

Material	Description	Longevity	Typical Applications	Application Rates
Bonded Fiber Matrix (BFM)	80% Organic defibrated fibers 10% Tackifier	6 months	On slopes up to 2:1 and erosive soil conditions	2,500 to 4,000 lbs per acre (see manufacturers recommendations)
Fiber Reinforced Matrix (FRM)	65% Organic defibrated fibers 25% Reinforcing Fibers or less 10% Tackifier	Up to 12 months	On slopes up to 1:1 and erosive soil conditions	3,000 to 4,500 lbs per acre (see manufacturers recommendations)

a. Bonded Fiber Matrix (BFM): Bonded Fiber Matrix shall consist of organic defibrated fibers and cross-linked hydro-colloidal tackifiers. Refer to Table 1.4.7-D for mulch properties and to Standard Specification 604S - Seeding for additional mulch requirements.

Table 1.4.7-D: Properties of Bonded Fiber Matrix

Property (Test Method)	Required Value
Moisture content %	12% ±3.0% (max.)
Organic matter %	75% ±3% Oven Dry Basis (min.)
Cross-linked Hydro-colloidal Tackifiers	10.0% ±1%
Water holding capacity	500% or greater
Mass per unit area (ASTM D6566)	10.0 oz/square yard (min.)
Thickness (ASTM D6525)	0.12 inch (min.)
Ground Cover (ASTM D6567)	97% (min.)
Functional Longevity	6 months (min.)
% Effectiveness	90% (min.)
Cure time	24 hours
Vegetative Establishment (ASTM D7322)	400%

b. Fiber Reinforced Matrix (FRM). Fiber Reinforced Matrix shall consist of organic defibrated fibers produced from grinding clean, whole wood chips, crimped interlocking fibers, cross-linked insoluble hydro-colloidal tackifiers and reinforcing natural and/or synthetic fibers. Refer to Table 1.4.7-E for mulch properties and to Standard Specification 604S - Seeding for additional mulch requirements.

Table 1.4.7-E: Properties of Fiber Reinforced Matrix

Property (Test Method)	Required Value
Moisture content %	12% ±3.0% (max.)
Organic matter % - organic fiber	65% ±3.5% Oven Dry Basis (min.)
Organic matter % - reinforcing fibers	25% or less
Cross-linked Hydro-colloidal Tackifiers	10.0% ±1%
Water holding capacity	500% or greater
Mass per unit area (ASTM D6566)	11.0 oz/square yard (min.)
Thickness (ASTM D6525)	0.16 inch (min.)
Ground Cover (ASTM D6567)	97% (min.)
Functional Longevity	12 months (min.)
% Effectiveness	99% (min.)
Cure time	24 hours
Vegetative Establishment (ASTM D7322)	500%

9. Sodding.

   Sodding is an acceptable practice for permanent vegetative stabilization. Installation of sod shall comply with practices described in Standard Specification 602S - Sodding. Sod placed on slopes greater than 3:1 must be staked using biodegradable landscape staples.

10. Rooted Plants.

    Installation of rooted plants - including bare root, live root, and container-grown plants - in conjunction with other methods, is an acceptable means of achieving permanent vegetative stabilization. Installation of rooted plants shall comply with practices described in Standard Specification 608S - Planting.

11. Irrigation.

    Supplemental watering may be required to germinate seed and maintain growth of rooted plants. Depending on the weather and constituents of a seed mix, new plantings may require daily watering for the first week or longer after sowing to ensure germination, with

reduced irrigation post-germination to ensure growth, plant health and vigor. Irrigation shall occur at rates and frequencies determined by a licensed irrigator or other qualified professional, and as allowed by the Austin Water Utility and the current water restrictions and water conservation initiatives. Significant rainfall (on-site rainfall of half-inch or greater) may allow the postponement of watering until the next scheduled irrigation.

12. Maintenance.

Maintenance is a vital factor in providing an adequate vegetative erosion control cover. Monitoring, watering, mulching and weeding shall be required during the period of establishment to ensure planting success. Maintenance practices shall comply with construction methods and plant establishment requirements described in Standard Specifications 604S, 608S, and 609S.

a. Reseeding - Inspect all seeded areas for failures and reseed as necessary per 609S.

b. Replanting - Failure of rooted plant requires replacement per Standard Specification 608S.

c. Weeding - Anticipate weed problems prior to planting desired plants and control weeds as necessary to curb competition and enable proposed vegetation to thrive. Weed types and amounts are dependent on weather, season, soil quality, and site conditions. Refer to Standard Specifications 604 and 609 for weed lists. Treatment methods shall be tailored for each situation, and should follow current City of Austin Integrated Pest Management (IPM) guidelines and Invasive Species Management Plan.

Source: Rule No. R161-14.26, 12-30-2014 ; Rule No. R161-15.12, 1-4-16 .

1.4.8 - Special Practices

A. **Minimizing Stripped Areas.** (See Figure 1-29 in Appendix V of this manual for detail)

1. Description.

Minimizing soil disturbance by exposing only the areas for active construction.

2. Purpose.

To expose the smallest practical area of land for the shortest possible time, thereby reducing the potential for erosion.

3. Conditions Where Practice Applies.

Where improved surfaces or vegetative cover cannot be established within 12 months of the disturbance.

Where disturbance of the natural vegetative cover may cause serious erosion and flooding problems.

Along site perimeters to help control erosion and act as a buffer zone to protect neighboring properties.

4. Procedures.

• Extent of disturbed areas shall be determined on the basis of the amount of critical areas such as steep slopes and areas of high erodibility. The proposed sequence of stripping shall be indicated on the erosion and sediment control plan.

• Watershed, subwatersheds or construction stages should be used as the basis to define specified areas.

• Stabilization operations shall be completed in a specified stripping area before disturbing the next specified area.

• Grading of particularly critical areas should be avoided during the season of maximum erosion potential (May 1—September 30).

• Equipment and vehicles shall be prohibited from maneuvering on areas designated to be undisturbed. Areas to be left undisturbed to discourage vehicular traffic should be fenced, according to City of Austin Standards.

B. **Protection of Trees in Construction Areas.**

1. Description.

   Protection of desirable trees from mechanical and other injury while the land is being converted to urban use.

2. Purpose.

   To employ the necessary protective measures to insure the survival of desirable trees for shade, beautification and vegetative cover.

3. Conditions Where Practice Applies.

   On areas now occupied by single specimen trees or groups of trees.

• Criteria for deciding upon the trees to leave:

- Aesthetic values: Consideration should be given to autumn foliage, flowering habits, bark and crown characteristics and type of fruit.

- Freedom from disease and rot.

- Life span of trees: Some are considered short-lived trees.

- Wildlife values: Oaks, hickories, dogwoods, etc., have a high food value.

- Comfort index: Summer temperatures are generally ten (10) degrees cooler under stands of hardwoods than cedars.

- Sudden exposure: To direct sunlight and ability to withstand radiated heat from proposed buildings and pavement.

- Space needed: For future growth and relationship to structures, electric and telephone lines, water and sewer lines, driveways and streets. Mark trees with bright paint or ribbon so there is no doubt as to which trees are to be left and protected from damage during construction.

NOTE: A more detailed discussion on the preservation of trees and the specific requirements relative to the Land Development Code is found in Section 3.00 of this manual and in the City of Austin Standards and City of Austin Standard Specifications.

C. **Dust Control.**

1. Description.

   Controlling dust movement on construction-sites and roads.

2. Purpose.

   To prevent blowing and movement of dust from exposed soil surfaces, reduce on and off-site damage, health hazards and improve traffic safety.

3. Conditions Where Practice Applies.

   This practice is applicable to areas subject to dust blowing and movement where on and off-site damage is likely without treatment.

4. Procedures

- Temporary Methods.

  - Mulches - See Section 1.4.5.

  - Vegetative Cover - See Section 1.4.7.

  - Spray-on Adhesives - On mineral soils (not effective on muck soils). Keep traffic off these areas.

TABLE 1-5
SPRAY-ON ADHESIVES

	Water Dilution	Type of Nozzle	Apply-Gallons/Acre
Anionic asphalt emulsion	7:1	Fine Spray	1,200
Latex emulsion	12½ :1	Fine Spray	235
Resin-in-water emulsion	4:1	Fine Spray	300

Source: City of Austin

  - Tillage - To roughen surface and bring clods to the surface. This is an emergency measure which should be used before soil blowing starts. Begin plowing on windward side of site. Chisel-type plows spaced about 12 inches apart, spring-toothed harrows and similar plows are examples of equipment which may produce the desired effect.

  - Irrigation - This is generally done as an emergency treatment. Site is sprinkled with water until the surface is moist. Repeat as needed.

  - Barriers - Solid board fences, snow fences, burlap fences, crate walls, bales of hay and similar materials can be used to control air currents and soil blowing. Barriers

placed at right angles to prevailing currents at intervals of about 15 times their height are effective in controlling soil blowing.

- Permanent Methods.

  - Permanent Vegetation - See Section 1.4.7.

  - Stone - Cover surface with crushed stone or coarse gravel.

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Attachment C – COA Oak Wilt Policy

CITY OF AUSTIN, TEXAS

OAK WILT PREVENTION POLICY

1.0 Purpose and Scope

The purpose of this Oak Wilt Prevention Policy is to identify measures that city staff and city-hired contractors and their sub-contractors, who perform the services of removing or trimming trees, will take to prevent the spread of oak wilt.

2.0 Definitions

Oak Wilt Disease: A tree disease caused by the fungus, *Ceratocystis fagacearum*. The fungus infects the vascular system of a tree. The vascular system contains vessels which transport moisture throughout the tree. The vessels of an infected tree effectively become blocked by the infection of the fungus, and cannot transport adequate moisture to sustain a healthy or living tree. In most cases, the end result is tree mortality.

3.0 Prevention Policy

3.1 Prior to beginning field work, all city staff associated with projects involving potential contact with oak trees shall be made aware of the city's official Oak Wilt Policy by receiving and reading a written copy of this policy. Staff receiving a written copy of the policy shall include, but not limited to, project managers, equipment operators responsible for removing or trimming trees, or operators using heavy equipment which could cause wounding of susceptible oaks in the use of the equipment. In addition, individual city departments will provide a written copy of the Oak Wilt Policy to contractors participating in city projects in areas where oak trees are present before initiating field work.

3.2 When possible, city staff and contractors should avoid trimming or pruning Live oaks and Red oaks (Spanish, Shumard, Texas Red, and Blackjack oaks) from March 1 to June 1.

3.3 At all times and irrespective of limb size, all cuts and wounds to oak trees shall be dressed immediately using a non-phytotoxic tree wound dressing. Stump cuts and damaged roots (both above and below ground) shall also be dressed.

3.4 Disinfection of pruning tools, saws, and related equipment is mandatory during the trimming or pruning of oak trees. Disinfection of tree removal and trimming equipment shall occur before work begins in a project area, between work in individual oak trees, and again prior to leaving a project area. Acceptable disinfectants include either aerosol disinfectant or a 10 percent bleach-water solution.

*NOTE: Although this policy would require the disinfection of pruning equipment before and between oak trees as a precaution, research does not substantiate disinfection as a means of preventing the transmission of the oak wilt disease.

4.0 Disposal Policy

4.1 Chipping or shredding the wood from infected trees to use as mulch is an acceptable means of recycling the wood. Chipping or shredding allows the wood to dry out quickly, thereby killing the fungus.

4.2 Burning diseased wood is an acceptable means of disposal. Burning diseased logs will kill the fungus, and the fungus will not spread with the smoke.

Created by Chris Dolan, Oak Wilt Arborist
Watershed Protection & Development Review Department
Revision 11/30/06

4.3 Logs from diseased Red Oaks, that are not chipped, shredded, or burned shall be disposed of at a landfill.

4.4 Firewood from diseased Red oak trees shall *not* be stored near healthy trees where fungal spores or insects that carry the spores have the potential to spread the fungus to healthy trees. It is recommended to store oak firewood under a sheet of clear plastic, tightly sealing the edges of plastic with soil or bricks. Doing so will prevent any spore carrying beetles from escaping and will solarize and heat the stored firewood to speed the drying process. It is also recommended to use clear plastic, as black plastic will reveal any escape holes to the beetles.

4.5 In situations where diseased Red oak trees are identified and are not accessible for chipping, shredding, or removal, the trunk of the diseased tree should be girdled, and the stem treated with an appropriate herbicide to deaden the tree and hasten the desiccation and drying of the wood below the minimum moisture content that could support the development of fungal spores.

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PART I - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Tag, tape and stenciling systems for equipment, piping, valves, pumps, ductwork and similar items.

2. Hazard and safety signs.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 1 - General Requirements.

1.02 QUALITY ASSURANCE

A. Referenced Standards:

1. American Society of Mechanical Engineers (ASME):

a. A13.1, Scheme for the Identification of Piping Systems.

2. The International Society of Automation (ISA).

3. National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI):

a. Z535.1, Safety Color Code.

b. Z535.2, Environmental and Facility Safety Signs.

c. Z535.3, Criteria for Safety Symbols.

d. Z535.4, Product Safety Signs and Labels.

4. National Fire Protection Association (NFPA):

a. 70, National Electrical Code (NEC).

b. 704, Standard System for the Identification of Hazards of Materials for Emergency Response.

5. Occupational Safety and Health Administration (OSHA):

a. 29 CFR 1910.145, Specification for Accident Prevention Signs and Tags.

1.03 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01300 for requirements for the mechanics and administration of the submittal process.

2. Product technical data including:

   a. Catalog information for all identification systems.

   b. Acknowledgement that products submitted meet requirements of standards referenced.

3. Identification register, listing all items in PART 3 of this Specification Section to be identified, type of identification system to be used, lettering, location and color.

4. Schedule of Hazard and Safety Signage indicating text and graphics.

PART II - PRODUCTS

2.01 MANUFACTURES

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

   1. W.H. Brady Co.

   2. Panduit.

   3. Seton.

   4. National Band and Tag Co.

   5. Carlton Industries, Inc.

B. Submit request for substitution in accordance with Specification Section 01640.

2.02 MANUFACTURED UNITS

A. Type A1 - Round Metal Tags:

   1. Materials:

      a. Aluminum or stainless steel.

      b. Stainless steel shall be used in corrosive environments.

   2. Size:

      a. Diameter: 1-1/2 IN minimum.

      b. Thickness: 0.035 IN (20 GA) minimum.

   3. Fabrication:

      a. 3/16 IN minimum mounting hole.

b. Legend: Stamped and filled with black coloring.

4. Color: Natural.

B. Type A2 - Rectangle Metal Tags:

1. Materials: Stainless steel.

2. Size:

a. 3-1/2 IN x 1-1/2 IN minimum.

b. Thickness: 0.036 IN (20 GA) minimum.

3. Fabrication:

a. 3/16 IN minimum mounting hole.

b. Legend: Stamped and filled with black coloring.

4. Color: Natural.

C. Type A3 - Metal Tape Tags:

1. Materials: Aluminum or stainless steel.

2. Size:

a. Width 1/2 IN minimum.

b. Length as required by text.

3. Fabrication:

a. 3/16 IN minimum mounting hole.

b. Legend: Embossed.

4. Color: Natural.

D. Type B1- Square Nonmetallic Tags:

1. Materials: Fiberglass reinforced plastic.

2. Size:

a. Surface: 2 x 2 IN minimum.

b. Thickness: 100 MILS.

3. Fabrication:

a. 3/16 IN mounting hole with metal eyelet.

b. Legend: Preprinted and permanently embedded and fade resistant.

4. Color:

a. Background: Manufacturer standard or as specified.

b. Lettering: Black.

E. Type B2 - Nonmetallic Signs:

1. Materials: Fiberglass reinforced or durable plastic.

2. Size:

a. Surface: As required by text.

b. Thickness: 60 MILS minimum.

3. Fabrication:

a. Rounded corners.

b. Drilled holes in corners with grommets.

c. Legend: Preprinted, permanently embedded and fade resistant for a 10 year minimum outdoor durability.

4. Color:

a. Background: Manufacturer standard or as specified.

b. Lettering: Black.

5. Standards for OSHA signs: NEMA/ANSI Z535.1, NEMA/ANSI Z535.2, NEMA/ANSI Z535.3, NEMA/ANSI Z535.4, OSHA 29 CFR 1910.145.

F. Type C - Laminated Name Plates:

1. Materials: Phenolic or DR (high impact) acrylic.

2. Size:

a. Surface: As required by text.

b. Thickness: 1/16 IN.

3. Fabrication:

a. Outdoor rated and UV resistant when installed outdoors.

b. Two layers laminated.

c. Legend: Engraved through top lamination into bottom lamination.

d. Two drilled side holes, for screw mounting.

4. Color: Black top surface, white core, unless otherwise indicated.

G. Type D - Self-Adhesive Tape Tags and Signs:

1. Materials: Vinyl tape or vinyl cloth.

2. Size:

a. Surface: As required by text.

b. Thickness: 5 MILS minimum.

3. Fabrication:

a. Indoor/Outdoor grade.

b. Weather and UV resistant inks.

c. Permanent adhesive.

d. Legend: Preprinted.

e. Wire markers to be self-laminating.

4. Color: White with black lettering or as specified.

5. Standards for OSHA signs: NEMA/ANSI Z535.1, NEMA/ANSI Z535.2, NEMA/ANSI Z535.3, NEMA/ANSI Z535.4, OSHA 29 CFR 1910.145.

H. Type E - Heat Shrinkable Tape Tags:

1. Materials: Polyolefin.

2. Size: As required by text.

3. Fabrication:

a. Legend: Preprinted.

4. Color: White background, black printing.

I. Type F - Underground Warning Tape:

1. Materials: Polyethylene.

2. Size:

a. 6 IN wide (minimum).

b. Thickness: 3.5 MILS.

3. Fabrication:

a. Legend: Preprinted and permanently imbedded.

b. Message continuous printed.

c. Tensile strength: 1750 PSI.

4. Color: As specified.

J. Type G - Stenciling System:

1. Materials:

a. Exterior type stenciling enamel.

b. Either brushing grade or pressurized spray can form and grade.

2. Size: As required.

3. Fabrication:

a. Legend: As required.

4. Color: Black or white for best contrast.

K. Underground Tracer Wire:

1. Materials:

a. Wire:

1) 12 GA AWG.

2) Solid.

b. Wire nuts: Waterproof type.

c. Split bolts: Brass.

2.03 ACCESSORIES

A. Fasteners:

1. Bead chain: #6 brass, aluminum or stainless steel.

2. Plastic strap: Nylon, urethane or polypropylene.

3. Screws: Self-tapping, stainless steel.

4. Adhesive, solvent activated.

2.04 MAINTENANCE MATERIALS

A. Where stenciled markers are provided, clean and retain stencils after completion and include in extra stock, along with required stock of paints and applicators.

PART III - EXECUTION

3.01 GENERAL INSTALLATION

A. Install identification devices at specified locations.

B. All identification devices to be printed by mechanical process, hand printing is not acceptable.

C. Attach tags to equipment with sufficient surface or body area with solvent activated adhesive applied to back of each tag.

D. Attach tags with 1/8 IN round or flat head screws to equipment without sufficient surface or body area, or porous surfaces.

1. Where attachment with screws should not or cannot penetrate substrate, attach with plastic strap.

E. Single items of equipment enclosed in a housing or compartment to be tagged on outside of housing.

1. Several items of equipment mounted in housing to be individually tagged inside the compartment.

F. Tracer Wire:

1. Attach to pipe at a maximum of 10 FT intervals with tape or tie-wraps.

2. Continuous pass from each valve box and above grade at each structure.

3. Coil enough wire at each valve box to extend wire a foot above the ground surface.

4. 1,000 FT maximum spacing between valve boxes.

5. If split bolts are used for splicing, wrap with electrical tape.

6. If wire nuts are used for splicing, knot wire at each splice point leaving 6 IN of wire for splicing.

7. Use continuous strand of wire between valve box where possible.

a. Continuous length shall be no shorter than 100 FT.

3.02 SCHEDULES

A. Process Systems:

1. General:

a. Provide arrows and markers on piping.

1) At 20 FT maximum centers along continuous lines.

2) At changes in direction (route) or obstructions.

3) At valves, risers, "T" joints, machinery or equipment.

4) Where pipes pass through floors, walls, ceilings, cladding assemblies and like obstructions provide markers on both sides.

b. Position markers on both sides of pipe with arrow markers pointing in flow direction.

1) If flow is in both directions use double headed arrow markers.

c. Apply tapes and stenciling in uniform manner parallel to piping.

2. Trenches with piping:

a. Tag type: Type F - Underground Warning Tape

b. Location: Halfway between top of piping and finished grade.

c. Letter height: 1-1/4 IN minimum.

d. Natural gas or digester gas:

1) Color: Yellow with black letters.

2) Legend:

a) First line: “CAUTION CAUTION CAUTION”

b) Second line: “BURIED GAS LINE BELOW”

e. Potable water:

1) Color: Blue with black letters.

2) Legend:

a) First line: “CAUTION CAUTION CAUTION”

b) Second line: “BURIED WATER LINE BELOW”

f. Storm and sanitary sewer lines:

1) Color: Green with black letters.

2) Legend:

a) First line: “CAUTION CAUTION CAUTION”

b) Second line: “BURIED SEWER LINE BELOW”

g. (Nonpotable) water piping, except 3 IN and smaller irrigation pipe:

1) Color: Green with black letters.

2) Legend:

a) First line: "CAUTION CAUTION CAUTION"

b) Second line: "BURIED NONPOTABLE WATER LINE BELOW"

h. Chemical feed piping (e.g., chlorine solution, polymer solution, caustic solution, etc.):

1) Color: Yellow with black letters.

2) Legend:

a) First line: "CAUTION CAUTION CAUTION"

b) Second line: "BURIED CHEMICAL LINE BELOW"

i. Other piping (e.g., compressed air, irrigation, refrigerant, heating water, etc.):

1) Color: Yellow with black letters.

2) Legend:

a) First line: "CAUTION CAUTION CAUTION"

b) Second line: "BURIED PIPE LINE BELOW"

3. Yard valves, buried, with valve box and concrete pad:

a. Tag type: Type A2 - Rectangle Metal Tags.

b. Fastener: 3/16 IN x 7/8 IN plastic screw anchor with 1 IN #6 stainless steel pan head screw.

c. Legend:

1) Letter height: 1/4 IN minimum.

2) Valve designation as indicated on the Drawings (e.g., "V-xxx").

4. Valves and slide gates:

a. Tag type:

1) Outdoor locations: Type B1 - Square Nonmetallic Tags.

2) Indoor noncorrosive:

a) Type A1 - Round Metal Tags.

b) Type B1 - Square Nonmetallic Tags.

3) Indoor corrosive:

a) Stainless steel Type A1 - Round Metal Tags.

b) Type B1 - Square Nonmetallic Tags.

b. Fastener:

1) Type A1: Chain of the same material.

2) Type B1: Stainless steel chain.

c. Color: Per ASME A13.1 corresponding to the piping system.

d. Legend:

1) Letter height: 1/4 IN minimum.

2) Valve designation as indicated on the Drawings (e.g., "V-xxx").

5. Process equipment (e.g., pumps, pump motors, blowers, air compressors, bar screens, clarifier drive mechanism, etc.):

a. Tag type:

1) Type B2 - Nonmetallic Signs.

2) Type D - Self-Adhesive Tape Tags and Signs.

3) Type G - Stenciling System.

b. Fastener:

1) Self.

2) Screws.

3) Adhesive.

c. Legend:

1) Letter height: 1/2 IN minimum.

2) Equipment designation as indicated on the Drawings (e.g., "Primary Sludge Pump P-xxx").

6. Piping systems:

a. Tag type:

1) Outdoor locations: Type G - Stenciling System.

2) Indoor locations:

a) Type D - Self-Adhesive Tape Tags and Signs.

b) Type G - Stenciling System.

b. Fastener: Self.

c. Color: Per ASME A13.1.

d. Legend:

1) Letter height: Manufacturers standard for the pipe diameter.

2) Mark piping in accordance with ASME A13.1.

3) Use piping designation as indicated on the Drawings.

4) Arrow: Single arrow.

7. Process tanks (over 1000 GAL) and basins, (e.g., chemical storage, clarifiers, trickling filters, digesters, etc.):

a. Tag type:

1) Type B2 - Nonmetallic Signs.

2) Type G - Stenciling System.

b. Fastener:

1) Screw.

2) Self.

c. Location as directed by Owner.

d. Legend:

1) Letter height: 4 IN minimum.

2) Equipment designation as indicated on the Drawings (e.g., “Clarifier CL-xxx”).

8. Tanks (less than 1000 GAL) (e.g., break tanks, chemical tanks, hydro-pneumatic tanks, air receivers, etc.):

a. Tag type:

1) Type D - Self-Adhesive Tape Tags and Signs.

2) Type G - Stenciling System.

b. Fastener: Self.

c. Legend:

1) Letter height: 2 IN minimum.

2) Equipment designation as indicated on the Drawings (e.g., “Polymer Storage Tank Txxx”)

B. Instrumentation Systems:

1. Instrumentation Equipment (e.g., flow control valves, primary elements, etc.):

a. Tag type:

1) Outdoor locations: Type B1 - Square Nonmetallic Tags.

2) Indoor noncorrosive:

a) Type A1 - Round Metal Tags.

b) Type B1 - Square Nonmetallic Tags.

3) Indoor corrosive:

a) Stainless steel Type A1 - Round Metal Tags.

b) Type B1 - Square Nonmetallic Tags.

b. Fastener:

1) Type A1: Chain of the same material.

2) Type B1: Stainless steel chain.

c. Legend:

1) Letter height: 1/4 IN minimum.

2) Equipment ISA designation as indicated on the Drawings (e.g., “FIT-xxx”).

2. Enclosure for instrumentation and control equipment, (e.g., PLC control panels, etc.):

a. Tag type: Type C - Phenolic Name Plates.

b. Fastener: Screws.

c. Legend:

1) Letter height: 1/2 IN minimum.

2) Equipment name (e.g., "PLC CONTROL PANEL PCP-xxx").

3. Components inside equipment enclosure, (e.g., PLC's, control relays, contactors, and timers):

    a. Tag type: Type D - Self-Adhesive Tape Tags.

    b. Fastener: Self.

    c. Legend:

        1) Letter height: 3/16 IN minimum.

        2) Description or function of component (e.g., "PLC-xxx" or "CR-xxx").

4. Through enclosure door mounted components (e.g., selector switches, controller digital displays, etc.):

    a. Tag type: Type C - Phenolic Name Plates.

    b. Fastener: Screws.

    c. Legend:

        1) Letter height: 1/4 IN minimum.

        2) Component ISA tag number as indicated on the Drawings (e.g., "HS-xxx").

C. HVAC Systems:

1. General:

    a. Provide arrows and markers on ducts.

        1) At 20 FT maximum centers along continuous lines.

        2) At changes in direction (route) or obstructions.

        3) At dampers, risers, branches, machinery or equipment.

        4) Where ducts pass through floors, walls, ceilings, cladding assemblies and like obstructions provide markers on both sides.

    b. Position markers on both sides of duct with arrow markers pointing in flow direction.

        1) If flow is in both directions use double headed arrow markers.

    c. Apply tapes and stenciling in uniform manner parallel to ducts.

2. HVAC Equipment (e.g., unit heaters, exhaust fans, air handlers, etc.):

    a. Tag type:

        1) Type B2 - Nonmetallic Signs.

2) Type C - Phenolic Name Plates.

b. Fastener: Screws.

c. Legend:

1) Letter height: 1 IN minimum.

2) Equipment designation as indicated on the Drawings (e.g., "EF-xxx").

3. Ductwork:

a. Tag type:

1) Type D - Self-Adhesive Tape Tags and Signs.

2) Type G - Stenciling System.

b. Fastener: Self.

c. Legend:

1) Letter height: 1 IN minimum.

2) Description of ductwork, (e.g., “AIR SUPPLY”).

3) Arrows: Single arrow.

4. Enclosure for instrumentation and control equipment, (e.g., fan control panels, etc.):

a. Tag type: Type C - Phenolic Name Plates.

b. Fastener: Screws.

c. Legend:

1) Letter height: 1/2 IN minimum.

2) Equipment designation as indicated on the Drawings (e.g., "FAN CONTROL PANEL FCP-xxx").

5. Wall mounted thermostats:

a. Tag type: Type D - Self-Adhesive Tape Tags and Signs.

b. Fastener: Self.

c. Legend:

1) Letter height: 3/16 IN minimum.

2) Description of equipment controlled (e.g., "UH-xxx" or AHU-xxx").

6. Components inside equipment enclosure, (e.g., controller's, control relays, contactors, and timers):

    a. Tag type: Type D - Self-Adhesive Tape Tags and Signs.

    b. Fastener: Self.

    c. Legend:

        1) Letter height: 3/16 IN minimum.

        2) Description or function of component (e.g., "CR-xxx").

7. Through enclosure door mounted equipment (e.g., selector switches, controller digital displays, etc.):

    a. Tag type: Type C - Phenolic Name Plates.

    b. Fastener: Screws.

    c. Legend:

        1) Letter height: 1/4 IN minimum.

        2) Component tag number as indicated on the Drawings or as defined by contractor (e.g., "HS-xxx").

D. Electrical Systems:

1. Trenches with ductbanks, direct-buried conduit, or direct-buried wire and cable.

    a. Tag type: Type F - Underground Warning Tape.

    b. Letter height: 1-1/4 IN minimum.

    c. Location:

        1) Where trench is 12 IN or more below finished grade: In trench 6 IN below finished grade.

        2) Where trench is less than 12 IN below finished grade: In trench 3 IN below finished grade.

    d. Electrical power (e.g., low and medium voltage):

        1) Color: Red with black letters.

        2) Legend:

            a) First line: "CAUTION CAUTION CAUTION".

            b) Second line: "BURIED ELECTRIC LINE BELOW".

e. Communications (e.g., telephone, instrumentation, LAN, SCADA):

1) Color: Orange with black letters.

2) Legend:

a) First line: “CAUTION CAUTION CAUTION”.

b) Second line: “BURIED COMMUNICATION LINE BELOW”.

2. Switchgear, switchboards and motor control centers:

a. Tag type: Type C - Phenolic Name Plates.

b. Fastener: Screws.

c. Main equipment legend:

1) Letter height:

a) First line: 1 IN minimum.

b) Subsequent lines: 3/8 IN minimum.

2) First line: Equipment name (e.g., "MAIN SWITCHBOARD MSBxxx").

3) Second line:

a) Source of power (e.g., "FED FROM MCCxxx LOCATED IN ROOM xxx").

b) Include the building name or number if the source is in another building.

4) Third line: System voltage and phase (e.g., “480/277 V, 3PH”).

5) Fourth line: Date installed (e.g., “INSTALLED JULY 20xx”).

d. Main and feeder device legend:

1) Letter height: 3/8 IN minimum.

2) Description of load (e.g., “MAIN DISCONNECT”, "PUMP Pxxx" or "PANELBOARD HPxxx").

3. Panelboards and transformers:

a. Tag type: Type C - Phenolic Name Plates.

b. Fastener: Screws.

c. Legend:

1) Letter height:

a) First line: 3/8 IN minimum.

b) Subsequent lines: 3/16 IN minimum.

2) First line: Equipment name (e.g., "PANELBOARD LPxxx" or "TRANSFORMER Txxx").

3) Second line (panelboards only): System voltage and phase (e.g., “208/120V, 3PH”).

4) Third line:

a) Source of power (e.g., "FED FROM MCCxxx LOCATED IN ROOM xxx").

b) Include the building name or number if the source is in another building.

5) Fourth line: Date installed (e.g., “INSTALLED JULY 20xx”).

4. Transfer switches:

a. Tag type: Type C - Phenolic Name Plates.

b. Fastener: Screws.

c. Legend:

1) Letter height:

a) First line: 3/8 IN minimum.

b) Subsequent lines: 3/16 IN minimum.

2) First line: Equipment name (e.g., "AUTOMATIC TRANSFER SWITCH ATSxxx").

3) Second line: Normal source of power (e.g., "NORMAL SOURCE FED FROM MCCxxx").

4) Third line: Emergency source of power (e.g., "EMERGENCY SOURCE FED FROM SGENxxx").

5) Fourth line: Date installed (e.g., “INSTALLED JULY 20xx”).

5. Safety switches, separately mounted circuit breakers and motor starters, VFD’s, etc.:

a. Tag type: Type C - Phenolic Name Plates.

b. Fastener: Screws.

c. Legend:

1) Letter height: 1/4 IN minimum.

2) First line: Description of load equipment is connected to (e.g., "PUMP Pxxx").

6. Enclosure for instrumentation and control equipment, (e.g., lighting control panels, etc.):

   a. Tag type: Type C - Phenolic Name Plates.

   b. Fastener: Screws.

   c. Legend:

      1) Letter height: 1/2 IN minimum.

      2) Equipment name (e.g., "LIGHTING CONTROL PANEL LCPxxx").

7. Components inside equipment enclosures (e.g., circuit breakers, fuses, control power transformers, control relays, contactors, timers, etc.):

   a. Tag type: Type D - Self-Adhesive Tape Tags and Signs.

   b. Fastener: Self.

   c. Legend:

      1) Letter height: 3/16 IN minimum.

      2) Description or function of component (e.g., "M-xxx", "CR-xxx" or "TR-xxx").

8. Through enclosure door mounted equipment (e.g., selector switches, controller digital displays, etc.):

   a. Tag type: Type C - Phenolic Name Plates.

   b. Fastener: Screws.

   c. Legend:

      1) Letter height: 1/4 IN minimum.

      2) Component tag number as indicated on the Drawings or as defined by contractor (e.g., "HS-xxx").

9. Conductors in control panels and in pull or junction boxes where multiple circuits exist.

   a. Tag type: Type D - Self-Adhesive Tape Tags.

   b. Fastener: Self.

   c. Tag conductor at both ends.

   d. Legend:

1) Letter height: 1/8 IN minimum.

2) Circuit number or wire number as scheduled on the Drawings or as furnished with the equipment.

10. Conductors in handholes and manholes.

    a. Tag type: Type A3 - Metal Tape Tags.

    b. Fastener: Nylon strap.

    c. Tag conductor at both ends.

    d. Legend:

        1) Letter height: 1/8 IN minimum.

        2) Circuit number or wire number as scheduled on the Drawings.

11. Grounding conductors associated with grounding electrode system in accordance with the following:

    a. Tag type: Type D - Self-Adhesive Tape Tags.

    b. Fastener: Self.

    c. Legend:

        1) Letter height: 1/8 IN minimum.

        2) Function of conductor (e.g., "MAIN BONDING JUMPER", "TO GROUND RING", "TO MAIN WATER PIPE").

12. Flash protection for switchboards, panelboards, industrial control panels and motor control centers:

    a. Tag type: Type D - Self-Adhesive Tape Signs.

    b. Fastener: Self.

    c. Legend: Per NFPA 70.

13. Entrances to electrical rooms:

    a. Tag type: Type B2 - Nonmetallic Signs.

    b. Fastener: Screw or adhesive.

    c. Size: 5 IN x 7 IN.

    d. Location: Each door to room.

    e. Legend:

1) OSHA Danger Sign.

2) Description of Danger: "HIGH VOLTAGE, AUTHORIZED PERSONNEL ONLY".

14. Equipment where more than one voltage source is present:

a. Tag type:

1) Type B2 - Nonmetallic Signs.

2) Type D - Self-Adhesive Tape Signs.

b. Fastener:

1) Screw or adhesive.

2) Self.

c. Size: 1-3/4 IN x 2-1/2 IN.

d. Location: Exterior face of enclosure or cubical.

e. Legend:

1) OSHA Danger Sign.

2) Description of Danger: "MULTIPLE VOLTAGE SOURCES".

END

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 portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.

B. Warranty: Sample of special warranty.

C. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Failure of hydrostatic test according to NFPA 10.
      b. Faulty operation of valves or release levers.

B. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each mounting bracket indicated.
   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:
      a. Amerex Corporation.
      b. Ansul Incorporated; Tyco International Ltd.
      c. Badger Fire Protection.
      d. J. L. Industries, Inc.; a division of Activar Construction Products Group.
      e. Kidde Residential and Commercial Division; Subsidiary of Kidde plc.
      f. Larsen's Manufacturing Company.

2. Valves: Manufacturer's standard.
3. Handles and Levers: Manufacturer's standard.
4. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B.

B. Purple-K Dry-Chemical Type in Steel Container: UL-rated 80-B:C, 10-lb (4.5-kg) nominal capacity, with potassium bicarbonate-based dry chemical in steel container.

2.2 MOUNTING BRACKETS

A. Mounting Brackets: Manufacturer's standard galvanized steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or red baked-enamel finish.
   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:
      a. Amerex Corporation.
      b. Ansul Incorporated; Tyco International Ltd.
      c. J. L. Industries, Inc.; a division of Activar Construction Products Group.
      d. Larsen's Manufacturing Company.

B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.
   1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fire extinguishers for proper charging and tagging.
   1. Remove and replace damaged, defective, or undercharged fire extinguishers.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.
   1. Mounting Brackets: 54 inches (1372 mm) above finished floor to top of fire extinguisher.

END OF SECTION

PART I - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Requirements of this Specification Section apply to all equipment provided on the Project including those found in other Divisions even if not specifically referenced in individual "Equipment" Articles of those Specification Sections.

B. Related Sections include but are not necessarily limited to:

1. Division 0 - Procurement and Contracting Requirements.

2. Division 1 - General Requirements.

3. Division 16 – Electrical.

4. Division 17 – Instrumentation and Control.

5. Section 03300 – Cast-In-Place Concrete.

6. Section 07920 - Joint Sealants.

7. Section 09900 - High Performance Industrial Coatings.

8. Section 10400 - Identification Devices.

1.02 QUALITY ASSURANCE

A. Referenced Standards:

1. American Bearing Manufacturers Association (ABMA).

2. American Gear Manufacturers Association (AGMA).

3. ASTM International (ASTM):

a. E1934, Standard Guide for Examining Electrical and Mechanical Equipment with Infrared Thermography.

b. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.

4. Hydraulic Institute (HI):

a. 9.6.4, Centrifugal and Vertical Pumps for Vibration Measurements and Allowable Valves.

5. International Electrotechnical Commission (IEC).

6. Institute of Electrical and Electronics Engineers, Inc. (IEEE).

7. International Organization for Standardization (ISO):

    a. 1940, Mechanical Vibration - Balance Quality Requirements for Rotors in a Constant (Rigid) State - Part 1: Specification and Verification of Balance Tolerances.

    b. 21940-11, Mechanical Vibration - Rotor Balancing - Part 11: Procedures and Tolerances for Rotors with Rigid Behavior.

8. National Electrical Manufacturers Association (NEMA):

    a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

    b. ICS 6, Enclosures for Industrial Control and System.

9. InterNational Electrical Testing Association (NETA):

    a. ATS, Acceptance Testing Specification for Electrical Power Distribution Equipment and Systems.

10. National Fire Protection Association (NFPA):

    a. 70, National Electrical Code (NEC):

11. National Institute for Certification in Engineering Technologies (NICET).

12. National Institute of Standards and Technology (NIST).

13. Occupational Safety and Health Administration (OSHA):

    a. 29 CFR 1910, Occupational Safety and Health Standards, referred to herein as OSHA Standards.

14. Underwriters Laboratories, Inc. (UL).

    a. 508, Standard for Safety Industrial Control Equipment.

    b. 508A, Standard for Safety Industrial Control Panels.

    c. 698A, Standard for Industrial Control Panels Relating to Hazardous (Classified) Locations.

15. Vibration Institute.

B. Natural frequency analysis firm:

1. An independent firm, whose sole or principal part of its business is the calculation of and analysis of natural frequencies of rotating equipment.

2. Minimum of 10 years experience.

3. Employs a registered professional engineer who has experience in finite element analysis, rotordynamic analysis and experimental modal analysis.

a. Minimum five years combined field testing and data analysis experience.

b. Qualified Vibration Category III certification from the Vibration Institute.

C. Vibration Testing Program:

1. Testing firm:

a. An independent firm performing, as the sole or principal part of its business for a minimum of 10 years, the inspection, testing, calibration, and adjusting of systems.

b. Must have an established monitoring and testing equipment calibration program with accuracy traceable in an unbroken chain, according to NIST.

2. Field personnel:

a. Minimum of three years field experience covering all phases of field vibration testing and data gathering.

b. Qualified Vibration Category II certification from the Vibration Institute.

3. Analysis personnel:

a. Minimum five years combined field testing and data analysis experience.

b. Qualified Vibration Category III certification from the Vibration Institute.

D. Infrared Thermography Testing Program:

1. Testing firm:

a. An independent firm performing, as the sole or principal part of its business for a minimum of 10 years, the inspection, testing, calibration, and adjusting of systems.

b. Must have an established monitoring and testing equipment calibration program with accuracy traceable in an unbroken chain, according to NIST.

2. Field personnel:

a. Minimum of one year field experience covering all phases of field thermography testing and data gathering.

b. Supervisor certified by NETA or NICET.

3. Analysis personnel:

a. Minimum three years combined field testing and data analysis experience.

b. Supervisor certified by NETA or NICET.

E. Electrical Equipment and Connections Testing Program:

1. Refer to the testing requirements and qualifications outlined in the Division 16 and Division 17 Specifications:

F. Miscellaneous:

1. A single manufacturer of a "product" shall be selected and utilized uniformly throughout Project even if:

a. More than one manufacturer is listed for a given "product" in Specifications.

b. No manufacturer is listed.

2. Equipment, electrical assemblies, related electrical wiring, instrumentation, controls, and system components shall fully comply with specific NEC requirements related to area classification and to NEMA 250 and NEMA ICS 6 designations shown on Electrical Power Drawings and defined in the Electrical specifications.

1.03 DEFINITIONS

A. Product: Manufactured materials and equipment.

B. Major Equipment Supports - Supports for Equipment:

1. Located on or suspended from elevated slabs with supported equipment weighing 2000 LBS or greater, or;

2. Located on or suspended from roofs with supported equipment weighing 500 LBS or greater, or;

3. Located on slab-on-grade or earth with supported equipment weighing 5000 LBS or more.

C. Equipment:

1. One or more assemblies capable of performing a complete function.

2. Mechanical, electrical, instrumentation or other devices requiring an electrical, pneumatic, electronic or hydraulic connection.

3. Not limited to items specifically referenced in "Equipment" articles within individual Specifications.

D. Installer or Applicator:

1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.

2. Installer and applicator are synonymous.

1.04 SUBMITTALS

A. Shop Drawings:

1. General for all equipment:

    a. See Section 01300 for requirements for the mechanics and administration of the submittal process.

    b. Data sheets that include manufacturer's name and complete product model number.

        1) Clearly identify all optional accessories that are included.

    c. Acknowledgement that products submitted comply with the requirements of the standards referenced.

    d. Manufacturer's delivery, storage, handling, and installation instructions.

    e. Equipment identification utilizing numbering system and name utilized in Drawings.

    f. Equipment installation details:

        1) Location of anchorage.

        2) Type, size, and materials of construction of anchorage.

        3) Anchorage setting templates.

        4) Manufacturer's installation instructions.

    g. Equipment area classification rating.

    h. Shipping and operating weight.

    i. Equipment physical characteristics:

        1) Dimensions (both horizontal and vertical).

        2) Materials of construction and construction details.

    j. Equipment factory primer and paint data.

    k. Manufacturer's recommended spare parts list.

    l. Equipment lining and coatings.

    m. Equipment utility requirements include air, natural gas, electricity, and water.

    n. Ladders and platforms provided with equipment:

        1) Certification that all components comply fully with OSHA requirements.

        2) Full details of construction/fabrication.

        3) Scaled plan and sections showing relationship to equipment.

2. Mechanical and process equipment:

    a. Operating characteristics:

        1) Technical information including applicable performance curves showing specified equipment capacity, rangeability, and efficiencies.

        2) Brake horsepower requirements.

        3) Copies of equipment data plates.

    b. Piping and duct connection size, type and location.

    c. Equipment bearing life certification.

    d. Equipment foundation data:

        1) Equipment center of gravity.

        2) Criteria for designing vibration, special or unbalanced forces resulting from equipment operation.

        3) Control panels:

            a) Panel construction.

            b) Point-to-point ladder diagrams.

            c) Scaled panel face and subpanel layout.

            d) Technical product data on panel components.

            e) Panel and subpanel dimensions and weights.

            f) Nameplate schedule.

3. Systems schematics and data:

    a. Provide system schematics where required in system specifications.

        1) Acknowledge all system components being supplied as part of the system.

        2) Utilize equipment, instrument and valving tag numbers defined in the Contract Documents for all components.

        3) Provide technical data for each system component showing compliance with the Contract Document requirements.

        4) For piping components, identify all utility connections, vents and drains which will be included as part of the system.

4. For factory painted equipment, provide paint submittals in accordance with Section 09900.

5. Qualifications for:

    a. Natural frequency analysis firm and personnel.

    b. Vibration testing firm and personnel.

    c. Infrared thermography testing firm and personnel.

    d. Electrical equipment and connections testing firm and personnel.

6. Equipment Monitoring and Testing plans, in accordance with PART 3 of this Specification Section:

    a. Natural frequency analysis and calculations.

    b. Vibration testing.

    c. Thermography testing.

B. Factory Test Reports:

1. Natural frequency bump test reports where required for rotating equipment.

    a. Minimum characteristics of impact hammer.

        1) Frequency Range 1 kHz.

        2) Range (5v output) 5,000 LBF (22,200 N).

        3) Hammer Sensitivity (7pprox.) 1 mV/lbf (0.23 mV/N).

        4) Resonant Frequency 12 kHz

C. Contract Closeout Information:

1. Operation and Maintenance Data:

    a. See Section 01730 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

D. Informational Submittals:

1. Notification, at least one week in advance, that testing will be conducted at factory.

2. Certification from equipment manufacturer that all manufacturer-supplied control panels that interface in any way with other controls or panels have been submitted to and coordinated with the supplier/installer of those interfacing systems.

3. Submit sample Manufacturer's Field Service Report (MFSR), see Exihibit A. Report shall use manufacturer’s standard report or use the form in the Exhibits and have at least the following information:

a. Certification that equipment has been installed properly, has been initially started up, has been calibrated and/or adjusted as required, and is ready for operation.

b. Certification for major equipment supports that equipment foundation design loads shown on the Drawings or specified have been compared to actual loads exhibited by equipment provided for this Project and that said design loadings are equal to or greater than the loads produced by the equipment provided.

c. Motor test reports.

d. Field noise testing reports if such testing is specified.

e. Preliminary field quality control testing format to be used as a basis for final field quality control reporting.

f. Provide three bound final written reports documenting natural frequency testing, vibration monitoring and testing for specified equipment.
   1) Include the acceptance criteria of all equipment tested.
   2) Provide individual tabbed sections for information associated with each piece of tested equipment.

g. Certification prior to Project closeout that electrical panel drawings for manufacturer-supplied control panels truly represent panel wiring including any field-made modifications.

h. Testing and monitoring reports in accordance with PART 3 of this Specification Section.

i. Certification that driven equipment and VFD are compatible.

4. Submit completed Manufacturer's Field Service Report (MFSR) for each piece of equipment supplied, see Exhibit A.

PART II - PRODUCTS

2.01 ACCESSORIES

A. Guards:

1. Provide each piece of equipment having exposed moving parts with full length, easily removable guards, meeting OSHA requirements.

2. Interior applications:

   a. Construct from expanded galvanized steel rolled to conform to shaft or coupling surface.

   b. Utilize non-flattened type 16 GA galvanized steel with nominal 1/2 IN spacing.

   c. Connect to equipment frame with hot-dip galvanized bolts and wing nuts.

3. Exterior applications:

a. Construct from 16 GA stainless steel or aluminum.

b. Construct to preclude entrance of rain, snow, or moisture.

c. Roll to conform to shaft or coupling surface.

d. Connect to equipment frame with stainless steel bolts and wing nuts.

B. Data Plate:

1. Attach a stainless steel data plate to each piece of rotary or reciprocating equipment.

2. Permanently stamp information on data plate including manufacturer's name, equipment operating parameters, serial number and speed.

C. Lifting Eye Bolts or Lugs:

1. Provide on all equipment 50 LBS or greater.

2. Provide on other equipment or products as specified in the narrow-scope Specification Sections.

2.02 FABRICATION

A. Design, fabricate, and assemble equipment in accordance with modern engineering and shop practices.

B. Manufacture individual parts to standard sizes and gages so that repair parts, furnished at any time, can be installed in field.

C. Furnish like parts of duplicate units to be interchangeable.

D. Ensure that equipment has not been in service at any time prior to delivery, except as required by tests.

E. Furnish equipment which requires periodic internal inspection or adjustment with access panels which will not require disassembly of guards, dismantling of piping or equipment or similar major efforts.

1. Quick opening but sound, securable access ports or windows shall be provided for inspection of chains, belts, or similar items.

F. Provide common, lipped base plate mounting for equipment and equipment motor where said mounting is a manufacturer's standard option.

1. Provide drain connection for 3/4 IN PVC tubing.

G. Machine the mounting feet of rotating equipment.

H. Fabricate equipment which will be subject to Corrosive Environment in such a way as to avoid back to back placement of surfaces that cannot be properly prepared and painted.

1. When such back to back fabrication cannot be avoided, provide continuous welds to seal such surfaces from contact with corrosive environment.

2. Where continuous welds are not practical, after painting seal the back to back surfaces from the environment in accordance with Section 07920.

I. Natural frequency/critical Speed:

1. All rotating parts accurately machined and in as near perfect rotational balance as practicable.

2. Excessive vibration is sufficient cause for equipment rejection.

3. Ratio of all rotative speeds to natural frequency/critical speed of a unit or components: Greater than 1.2.

J. Control Panels Engineered and Provided with the Equipment by the Manufacturer:

1. Manufacturer's standard design for components and control logic unless specific requirements are specified in the specific equipment Specification Section.

2. NEMA rated components are acceptable in the manufacturer's standard engineered design, IEC rated components are not acceptable unless specific requirements are required in the specific equipment Specification Section.

3. Affix entire assembly with a UL 508A or UL 698A label "Listed Enclosed Industrial Control Panel" prior to delivery.

   a. Control panels without an affixed UL 508A or UL 698A label shall be rejected.

4. Provide equipment or control panels with Short Circuit Current Rating (SCCR) labeling as required by NFPA 70 and other applicable codes.

   a. Determine the SCCR rating by one of the following methods:

      1) Method 1: SCCR rating meets or exceeds the available fault current of the source equipment when indicated on the Drawings.

      2) Method 2: SCCR rating meets or exceeds the source equipment's Amp Interrupting Current (AIC) rating as indicated on the Drawings.

      3) Method 3: SCCR rating meets or exceeds the calculated available short circuit current at the control panel.

   b. The source equipment is the switchboard, panelboard, motor control center or similar equipment where the control panel circuit originates.

   c. For Method 3, provide calculations justifying the SCCR rating. Utilize source equipment available fault current or AIC rating as indicated on the Drawings.

2.03 SHOP OR FACTORY PAINT FINISHES

A. Electrical Equipment:

1. Provide factory-applied paint coating system(s) for all electrical equipment components except those specified in Section 09900 to receive field painting.

    a. Field painted equipment: See Section 09900 for factory applied primer/field paint compatibility requirements.

B. Field paint other equipment in accordance with Section 09900.

1. See Section 09900 for factory applied primer/field paint compatibility requirements.

PART III - EXECUTION

3.01 INSTALLATION

A. Install equipment as shown on Drawings and in accordance with manufacturer's directions.

B. Utilize templates for anchorage placement for slab-mounted equipment.

C. For equipment having drainage requirements such as seal water, provide 3/4 IN PVC or clear plastic tubing from equipment base to nearest floor or equipment drain.

1. Route clear of major traffic areas and as approved by Engineer.

D. DO NOT construct foundations until major equipment supports are approved.

E. Extend all non-accessible grease fittings using stainless steel tubing to a location which allows easy access of fittings from closest operating floor level.

F. Equipment Base:

1. Construct level in both directions.

2. Take particular care at anchor bolt locations so these areas are flat and level.

G. Machine Base:

1. Mount machine base of rotating equipment on equipment base.

    a. Level in both directions, using a machinist level, according to machined surfaces on base.

2. Level machine base on equipment base and align couplings between driver and driven unit using stainless steel blocks and shims.

    a. Blocks and shims milled flat and coplanar of both faces.

    b. Maximum of 3 shims under each foot.

    c. Size blocks and shims to provide solid support at each mounting bolt location.

1) Provide area size of blocks and shims approximately 1-1/2 times area support surface at each mounting bolt point.

d. Provide blocks and shims at each mounting bolt.

1) Furnish blocks and shims that are square shape with "U" cut out to allow blocks and shims to be centered on mounting bolts.

e. After all leveling and alignment has been completed and before grouting, tighten mounting bolts to proper torque value.

H. Rotating equipment Couplings:

1. Align in the annular and parallel positions.

a. For equipment rotating at 1200 RPM or less, align both annular and parallel within 0.001 IN tolerance for couplings 4 IN size and smaller.

b. Couplings larger than 4 IN size: Increase tolerance 0.0005 IN per inches of coupling diameter, i.e., allow 6 IN coupling 0.002 IN tolerance, and allow a 10 IN coupling 0.004 IN tolerance.

c. For equipment rotating at speeds greater than 1200 RPM allow both annular and parallel positions within a tolerance rate of 0.00025 IN per inch coupling diameter.

2. If equipment is delivered as a mounted unit from factory, verify factory alignment on site after installation and realigned if necessary.

3. Check surfaces for runout before attempting to trim or align units.

I. Grouting:

1. After machine base has been shimmed, leveled onto equipment base, couplings aligned and mounting bolts tightened to correct torque value, place a dam or formwork around base to contain grouting between equipment base and equipment support pad.

a. Extend dam or formwork to cover leveling shims and blocks.

b. Do not use nuts below the machine base to level the unit.

2. Saturate top of roughened concrete subbase with water before grouting.

a. Add grout until entire space under machine base is filled to the top of the base underside.

b. Puddle grout by working a stiff wire through the grout and vent holes to work grout in place and release any entrained air in the grout or base cavity.

3. When the grout has sufficiently hardened, remove dam or formwork and finish the exposed grout surface to fine, smooth surface.

a. Cover exposed grout surfaces with wet burlap and keep covering sufficiently wet to prevent too rapid evaporation of water from the grout.

b. When the grout has fully hardened (after a minimum of seven days) tighten all anchor bolts to engage equipment base to grout, shims, and equipment support pad.

c. Recheck driver-driven unit for proper alignment.

3.02 INSTALLATION CHECKS

A. For all equipment specifically required in detailed specifications, secure services of experienced, competent, and authorized representative(s) of equipment manufacturer to visit site of work and inspect, check, adjust and approve equipment installation.

1. In each case, representative(s) shall be present during placement and start-up of equipment and as often as necessary to resolve any operational issues which may arise.

B. Secure from equipment manufacturer's representative(s) a written report certifying that equipment:

1. Has been properly installed and lubricated.

2. Is in accurate alignment.

3. Is free from any undue stress imposed by connecting piping or anchor bolts.

4. Has been operated under full load conditions and that it operated satisfactorily.

a. Secure and deliver a field written report to Owner immediately prior to leaving jobsite.

C. No separate payment shall be made for installation checks.

1. All or any time expended during installation check does not qualify as Operation and Maintenance training or instruction time when specified.

3.03 IDENTIFICATION OF EQUIPMENT AND HAZARD WARNING SIGNS

A. Identify equipment and install hazard warning signs in accordance with Section 10400.

3.04 FIELD PAINTING AND PROTECTIVE COATINGS

A. For required field painting and protective coatings, comply with Section 09900, High Performance Industrial Coatings.

3.05 FIELD QUALITY CONTROL

A. General:

1. Furnish equipment manufacturer’s field quality control services and testing as specified in the individual equipment Specification Sections.

2. Execute pre-demonstration requirements in accordance with Section SS01700.

3. Perform and report on all tests required by the equipment manufacturer's Operation and Maintenance Manual.

4. Provide testing of electrical equipment and connections in accordance with the Division 16 specifications.

5. Equip testing and analysis personnel with all appropriate project related reference material required to perform tests, analyze results, and provide documentation including, but not limited to:

    a. Contract Drawings and Specifications.

    b. Related construction change documentation.

    c. Approved Shop Drawings.

    d. Approved Operation and Maintenance Manuals.

    e. Other pertinent information as required.

B. Equipment Monitoring and Testing Plans:

1. Approved in accordance with Shop Drawing submittal schedule.

2. Included as a minimum:

    a. Qualifications of firm, field personnel, and analysis personnel doing the Work.

    b. List and description of testing and analysis equipment to be utilized.

    c. List of all equipment to be testing, including:

        1) Name and tag numbers identified in the Contract Documents.

        2) Manufacturer's serial numbers.

        3) Other pertinent manufacturer identification,

C. Instruments Used in Equipment and Connections Quality Control Testing:

1. Provide testing of instruments and connections in accordance with the Division 17 specifications.:

D. Testing and Monitoring Program Documentation:

1. Provide reports with tabbed sections for each piece of equipment tested.

2. Include all testing results associated with each piece of equipment under that equipment's tabbed section.

    a. Include legible copies of all forms used to record field test information.

3. Prior to start of testing, submit one copy of preliminary report format for Engineer review and comment

    a. Include data gathering and sample test report forms that will be utilized.

4. In the final report, include as a minimum, the following information for all equipment tested:

    a. Equipment identification, including:

        1) Name and tag numbers identified in the Contract Documents.

        2) Manufacturer's serial numbers.

        3) Other pertinent manufacturer identification,

    b. Date and time of each test.

    c. Ambient conditions including temperature, humidity, and precipitation.

    d. Visual inspection report.

    e. Description of test and referenced standards, if any, followed while conducting tests.

    f. Results of initial and all retesting.

    g. Acceptance criteria.

    h. "As found" and "as left" conditions.

    i. Corrective action, if required, taken to meet acceptance.

    j. Verification of corrective action signed by the Contractor, equipment supplier, and Owner's representative.

    k. Instrument calibration dates of all instruments used in testing.

5. Provide three (3) bound final reports prior to Project final completion.

6. Also refer to the requirements for reports specified in Division 16 and Division 17 of these Specifications.

E. Electrical Equipment and Connections Testing Program:

1. Perform testing on Electrical equipment and connections in accordance with the Division 16 specification requirements.

2. Repair or replace equipment shown to be out of range of the acceptable tolerance until the equipment meets or exceeds acceptability standards.

F. Other Testing:

1. Perform tests and inspections not specifically listed but required to assure equipment is safe to energize and operate.

2. Subbase that supports the equipment base and that is made in the form of a cast iron or steel structure that has supporting beams, legs, and cross members that are cast, welded, or bolted shall be tested for a natural frequency of vibration after equipment is mounted.

    a. The ratio of the natural frequency of the structure to the frequency of the disturbing force shall not be between 0.5 and 1.5.

3.06 DEMONSTRATION

A. Demonstrate equipment in accordance with Section SS01700.

3.07 ABBREVIATION TABLE

A. As indicated on the Drawings.

END

EXHIBIT A

MANUFACTURER FIELD SERVICE REPORT

This field service report is generic in nature. An electronic copy of this form will be furnished upon request from the Engineer. This report is to reflect that all requirements of the Operations and Maintenance Manual and the individual equipment specification requirements have been performed for the installation and operation and also to provide a baseline for amperage draw for each phase, vibration readings, rotation, alignment and all other applicable tests required to insure that the equipment has been installed properly. A MFSR will be required for each individual piece of equipment requiring a MFSR.

Definitions of Reports:

Initial service report: Required for construction preparations. Equipment delivered to site is in good condition and conforms to specification requirements. Anchor bolts, hardware and ancillary items (piping, flanges, conduits, fuel/power supply) are compatible with equipment.

Interim service report: Required for equipment installation onto base or foundation. Piping connections, electrical and control connections or structural attachment are complete. For equipment stored on site over four weeks, interim service report will document that manufacturer's long-term storage procedures have been incorporated and equipment has not been damaged, nor coatings deteriorated.

Final service report is to be completed when equipment can be started, electrical amperage and voltage draw measured, cold and hot alignments performed, vibration testing and monitoring performed and the equipment is found to be in compliance with Manufacturer's operating parameters and the requirements of the individual equipment specifications.

PROJECT: _____

Report Status:

Initial Service Report completed and submitted on _____

Interim Service Report completed and submitted on _____

Final Service Report completed and submitted on _____

Commencement of Warranty _____

I Description

A. Equipment Name and Identification: _____

_____

B. Serial Number: _____

C. Specification Section Number: _____

D. Manufacturer: _____

E. Representative: _____

F. Type of Service: Initial _____ Interim _____ Final _____

II General Review

A. The above referenced equipment/material/supplies have been inspected, checked, and adjusted. Yes _____ No _____

Summary: _____

_____

B. The above referenced equipment/material/supplies were placed upon properly prepared or suitable substrate. N/A _____ Yes _____ No _____

Summary: _____

_____

C. The above referenced equipment/material/supplies are free from any undue stress imposed by any connected piping, anchor bolts or any other load. N/A _____ Yes _____ No _____

Summary: _____

_____

D. The above referenced equipment/material/supplies have operated under design conditions. N/A _____ Yes _____ No _____

Summary: _____

_____

E. The above referenced equipment/material/supplies have been installed in accordance with the manufacturer's recommendations and the Procurement Documents, require no corrective work, and are hereby approved. Yes _____ No _____

Summary: _____

_____

F. The above referenced equipment/material/supplies are acceptable to the manufacturer as installed providing the following corrective action(s) are performed:

1. _____
2. _____
3. _____
4. _____
5. _____

III Inspection Checklist

Item	Acceptable (Yes/No)	Readings/Comments
Bearings (1)		
Belts (tension reading)		
Lubrication Levels		
Vibration (1) (2) (MILS/SEC)		
Infrared Thermography (1) (2)		
Starting AMPS		
Full Load AMPS		
Volts		
Rotation		
Jacket Temperature (DEGF)		
Seal Water Flow Rate (GPH or GPM)		
Seal Water Pressure (PSI)		
O-rings/Packing		
Alignment (1)		
Anchor Bolts		
Grout		

Item	Acceptable (Yes/No)	Readings/Comments
Substrate Approval		
Sound level (4 FT from unit) (1) (dB)		
Other		

(1) Inspection or testing reports must be attached.
(2) Provide vibration testing and monitoring procedures for Engineer's review and approval prior to testing.

IV O&M Manuals

A. The O&M manual as presented contains all information required for proper operation, maintenance, and instruction of this system. N/A _____ Yes _____ No _____

Summary: _____

_____

V Preventive Maintenance

A. The preventive maintenance summary outlined in the O&M manual is acceptable for operation of the system throughout the warranty period. N/A _____ Yes _____ No _____

Summary: _____

_____

VI Operator Training/Classroom Instruction

A. Training and instruction have been performed in accordance with the requirements of the Procurement Documents. N/A _____ Yes _____ No _____

B. Final Training/Classroom Instruction Completed on: _____

Summary: _____

_____

VII Remarks

_____

_____

_____

VIII Certification

I hereby certify, that I, _____, am a duly authorized representative of the manufacturer, that I am empowered by the manufacturer to inspect, approve, and operate his equipment, and that I am authorized to make recommendations required to assure that the equipment furnished by the manufacturer is complete and operational, except as modified herein. I also certify that all information contained herein is true and accurate.

By: _____
(Authorized Representative)

For: _____

Date: _____

IX Acknowledgments

By: _____

For: _____
(Contractor)

Date: _____

By: _____

For: _____
(Engineer)

Date: _____

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PART 1 - GENERAL

1.01 SUMMARY

A. Scope of Work

1. A single Fire Alarm System Contractor (FASC) shall furnish all services and equipment as defined herein and in other Specification sections as listed below under Related Requirements. The FASC shall have the qualifications as described in subsection 1.02 "Related Requirements", this Section of the Specifications.

2. Furnishing a complete system design responsibility for the fire alarm system design for the Substation No. 4 Building accompanied by a complete set of PLANS that shall be designed by a Texas State Fire Marshal's Office Fire Alarm Planning Superintendent certified designer who is licensed in the State of Texas and all submitted PLANS must be stamped by the licensed designer in accordance to the requirements of the Texas State Fire Marshal's Office. The system design shall be in accordance with UL, NFPA, NEC, ANSI, and IEEE standards.

3. Furnishing a complete system installation responsibility which shall include the furnishing of all labor, materials, and items of service required for the completion of a functional fire alarm system for the Substation No. 4 Building as reviewed by the Owner in strict accordance with this section of the specifications and the applicable contract drawings. At minimum, all aspects of the fire alarm system installation shall be directly performed by or under the direct supervision of a State of Texas Fire Marshall's Office Fire Alarm Technician certified technician that is licensed in the State of Texas.

4. Furnish and install a complete and fully functional fire alarm system as shown on the PLANS and as Specified herein for the Substation No. 4 Building. The fire alarm system shall utilize a complete, electrically supervised digital addressable, multiplexed signal transmission, intelligent type fire alarm control system.

5. Fire alarm control panel, remote annunciator panels, monitor panels, fire alarm pull stations, smoke and heat detectors, audible and visual notification appliances, addressable interface devices, device enclosures/back boxes, coverplates, interconnect conduit/wiring, mounting hardware, and all related incidentals for a complete and fully functional fire alarm system shall be furnished and installed. Boxes, conduit/wire shall be sized, furnished, and installed per the requirements of the PLANS and Division 16 Specifications unless specified otherwise herein.

6. All major elements of work are believed to be adequately described herein. The FASC is expected to anticipate and include in the cost of the work any incidentals which may be required, but not specifically expressed herein, in order to provide a complete and fully functional fire alarm system for the Substation No. 4 Building.

7. The FASC shall provide a fire alarm system that meets all of the requirements stated herein. The FASC is expected to make allowances for all necessary adjustments for the actual installation and to examine physical conditions which may affect the performance of their work, and coordinate the actual pipe routing and equipment locations as necessary to accommodate the existing conditions, obstructions, and the work of other trades. No extra payment will be allowed for FASC's failure to make such allowances. The cost associated with this task shall be included in the FASC's base bid.

8. The omission by the Engineer of any necessary system component, as required by the Authorities Having Jurisdiction, in the Drawings, or Specifications shall not relieve the FASC of the responsibility for verifying and providing such necessity, without additional cost to the Owner.

9. The fire alarm system shall meet all current NFPA code requirements, including but not limited to NFPA 13, 13R, 13D, 14, and 72 and per the edition as required by the City of Austin. The fire alarm system shall meet all requirements of the City of Austin Fire Department, ADA guidelines, all applicable Texas Accessibility Standards, and currently adopted edition of the International Fire Code (IFC) as amended by the City of Austin.

10. The FASC shall be responsible for coordinating with AT&T and the Owner for the installation of telephone services to the Substation No. 4 Building. The Owner shall furnish and install the telephone cables up to the Substation No. 4 Building, the FASC shall be responsible for routing the telephone cables within the Substation No. 4 Building and for the termination of the telephone cables to the Fire Alarm Control Panel.

B. System Description:

1. The fire alarm system shall monitor the smoke detectors and heat detectors for trouble and activation with audible and visual indication at the fire alarm control panel.

2. The fire alarm system shall be an addressable digital supervised system.

3. As part of the fire alarm control panel, furnish and install a digital alarm communicator transmitter to seize telephone line(s), dial preselected telephone number(s), transmit fire alarm, supervisory, and trouble signals to a remotely located digital alarm communicator receiver central alarm station (operated by the Authority Having Jurisdiction) over a telephone line(s).

4. The fire alarm control panel shall include interface capability with the fire suppression systems.

5. The fire alarm control panel shall provide signals as required to the security system to release all electrically locked exit doors on general alarm, where applicable.

6. The fire alarm control panel shall provide interface capability to smoke dampers, fans, air conditioning equipment, and other equipment as required for a fully functional and complete fire alarm system.

7. Provide a total coverage smoke-detection system in accordance with the fire code and interconnect the total coverage smoke-detection system with all air-moving equipment, as required per the Authority Having Jurisdiction, to accomplish the required shutoff of air-moving equipment without the need of duct-mounted smoke detectors.

1.02 RELATED REQUIREMENTS

A. Drawings and other Technical Specification Sections show and/or specify additional features required to describe and illustrate functional requirements of the fire alarm system.

B. FASC Qualifications:

1. The fire alarm system design/installation entity shall have a minimum of five (5) years experience designing, furnishing, and installing complete fire alarm systems for buildings/facilities that are similar in scope and value as required for this project.

2. FASC shall have current firm alarm certificate of registration issued by the State of Texas Fire Marshal's office and employ the licensed Fire Alarm Planning Superintendent and Fire Alarm Technician(s) who are performing the work on this project.

C. Manufacturer Qualifications: A firm experienced in manufacturing systems similar to those required for this project and with a record of successful in-service performance.

D. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system components from a single manufacturer where possible.

E. Comply with the applicable requirements of Division 16 Specifications.

F. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

G. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.

1.03 COORDINATION.

A. Coordinate as required with all necessary utility service providers such as telephone (AT&T), Authorities Having Jurisdiction such as the City of Austin Fire Department, etc. as required to establish the complete functional fire alarm system required for the project as shown on the Drawings and as specified herein.

B. Coordinate layout and installation of fire alarm system subcomponents with other trades. Coordination with the overall construction sequencing of facility is required to meet the raceway routing and device mounting requirements of the Drawings and Specifications.

1.04 SUBMITTALS

A. Submit shop drawings in accordance with the requirements of Section 01300 of the Contract Specifications. Include:

1. Riser diagram of fire alarm system, initiating devices, notification appliances and interface connections.
2. Layout drawings showing locations of devices and appliances, junction boxes, wire and conduit routing, auxiliary power supplies for visuals and connections to fire suppression system supervisory and ancillary devices.
3. Dimensioned/scaled top and bottom enclosure views, front enclosure elevations, and internal component/device layouts, as applicable
4. Wiring diagrams, as applicable,
5. Catalog cut sheets. Include all system sub-components, annunciator panel, as applicable.
6. Calculations: Include notification circuit voltage drop, control panel battery-sizing, and other calculations.
7. Certifications: Include the Alarm Planning Superintendent, Alarm Installation Technician, and Firm certifications/registrations with the State of Texas Fire Marshall's Office.

B. Field test reports: Indicate and interpret test results for compliance with performance requirements.

C. Submissions to Authorities Having Jurisdiction: In addition to distribution requirements for Submittals previously specified, make an identical submission to the City of Austin Fire Department. Include copies of annotated contract Drawings as needed to depict component locations to facilitate review. Resubmit as required to make clarifications or revisions to obtain approval. Upon receipt of comments from the Authorities Having Jurisdiction, submit to Engineer for review.

D. Certificate of Completion: Comply with NFPA.

1.05 OPERATION AND MAINTENANCE MANUALS

A. Furnish Operation and Maintenance Manuals in accordance with the requirements of Section 01730 of the Contract Specifications. Include:

1. Installation and operation manuals.
2. Renewal parts bulletin.
3. As built drawings, including approved shop drawings.
4. Test data
5. Record copy of site specific software on CD ROM, complete with all necessary files
6. Software licenses registered in the name of the Owner

7. Software and Firmware Operational Documentation:
   a. Software operating and upgrade manuals.
   b. Device address list.
   c. Printout of software application and graphic screens.

1.06 CODE REQUIREMENTS AND PERMITS

A. Code Requirements:

1. All aspects of the electrical construction shall comply with all National Electrical Code (NEC), NFPA, IEEE, OSHA requirements, local ordinances, the Authorities Having Jurisdiction, and all other pertinent codes and standards, latest revision.

1.07 SPECIAL SERVICES

A. Provide service and maintenance of fire alarm equipment for two years from date of Substantial Completion.

B. Software Service Agreement:

1. Comply with UL 864
2. Technical Support:
   a. Provide software support for two years from the date of Substantial Completion
3. Upgrade Service:
   a. Update software to latest version at Project completion. Furnish, install, configure, and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software. Provide 30 day advance written notice to the Owner to allow for scheduling and access to the system. All upgrades shall also be provided to the Owner on CD-ROM, and a full backup of the existing (prior to the upgrade) system software and settings shall be made on CD-ROM and provided to the Owner prior to upgrade.

1.08 SPARE PARTS

A. Furnish ten percent spare parts or a minimum quantity of three, which ever is greater, for the following:

1. Audio / visual signal units
2. Smoke and heat detectors
3. Manual pull stations
4. Lamps for audio/visual signal units of each type

5. Detector bases of each type
6. Printer ribbons/cartridges
7. Fuses of each type
8. Keys and tools (minimum one set)

B. Furnish the above spare parts packaged with protective covering for storage and identified with labels describing the package contents.

PART 2 - PRODUCTS

2.01 GENERAL

A. All products shall be U. L. Certified, at minimum.

B. Manufacturers:

1. Grinnell Simplex
2. Silent Knight,
3. Federal Signal Corporation,
4. Fire Control Instruments, Inc.
5. Siemens Cerberus
6. General Electric
7. or approved equal

2.02 SYSTEM OPERATIONAL DESCRIPTION

A. Furnish and install fire alarm signal initiation by the following:

1. Manual stations
2. Heat detectors
3. Smoke detectors
4. Duct smoke detectors
5. Verified automatic operation of smoke detectors
6. Automatic suppression system flow, as applicable
7. Fire-extinguishing system operation
8. Fire standpipe system
9. other alarm inputs as provided by the Fire Suppression Systems, as applicable

B. Fire alarm signal shall initiate the following actions:

1. Continuously operate alarm notification appliances
2. Identify alarm at fire alarm control panel and applicable remote annunciator panels.
3. Initiate digital alarm communicator transmitter and transmit an alarm signal to the remotely located digital alarm communicator receiver central alarm station operated by the Authority Having Jurisdiction.
4. Unlock electric door locks in designated egress paths
5. Release fire and smoke doors held open by magnetic door holders.
6. Shutdown of fans and other air-handling equipment serving zone when alarm was initiated and as required per the requirements of the Authority Having Jurisdiction and at no additional cost to the Owner.
   a. Mechanical air-handling equipment, including, but not limited to, mechanical ventilation equipment, shall be supervised by the Fire Alarm System as required per the Authority Having Jurisdiction.
   b. Coordinate all final requirements with the Authority Having Jurisdiction prior to and at the time of shop drawing review/approval by the Authority Having Jurisdiction.
7. Close smoke dampers in air ducts of designated air-conditioning duct systems serving zone where alarm was initiated.
8. Record events in the system memory.
9. Record events by the system printer.

C. Furnish and install fire alarm system supervisory signal initiation by the following:

1. Valve supervisory switch
2. Low air pressure switch for dry pipe or pre-action sprinkler system
3. Other supervisory signals available from the fire suppression systems specified, if any
4. Record events in the system memory.
5. Record events by the system printer.
6. Initiate the digital alarm communicator transmitter and transmit supervisory signals to a remote digital alarm communicator receiver central alarm station operated by the Authority Having Jurisdiction.

D. Furnish and install fire alarm system trouble signal initiation by the following:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at fire-alarm control panel
4. Ground or a single break in fire-alarm control panel internal circuits.

5. Abnormal ac voltage at fire-alarm control panel.
6. Failure in standby battery circuitry or battery charging.
7. Abnormal position of any switch at fire-alarm control panel or annunciator.
8. Low-air-pressure switch operation on a dry-pipe or pre-action sprinkler system
9. Other trouble signals available from the fire suppression systems specified, if any.
10. Record events in the system memory.
11. Record events by the system printer.
12. Initiate the digital alarm communicator transmitter and transmit trouble signals to a remote digital alarm communicator receiver central alarm station operated by the Authority Having Jurisdiction.

2.03 FIRE ALARM CONTROL PANEL

A. Construction: Enclosed panel, NEMA 12 rated at minimum, suitable for wall surface mounting and the application environment in which the panel is located. Also refer to the Drawings. Provide multiple enclosures as required to contain the components as specified.

B. Power Supply:

1. Primary Power Input: 120 volts, AC, 60 Hertz, single phase, single point feed.
2. Derive the necessary power for all fire alarm system sub-component loads from the single point feed inclusive of all needed power supplies, voltage transformation, and all necessary short circuit and overload protection for a fully functional system.
3. Secondary Power Input: 24 volts DC supply system with batteries, automatic battery charger, and automatic transfer switch, complete with all accessories, furnished and installed integral to the panel. Batteries shall be sealed valve regulated recombinant lead acid type. Batteries shall be sized to operate the complete system under the following operating scenario: 24 hours with the complete system operating in normal or supervisory (non-alarm) operating mode followed by an additional 10 minutes with the complete system operating in alarm or supervisory mode (including all notification appliances).
4. Fire alarm system loads shall automatically transfer to the secondary power input upon loss of the primary power input.
5. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

C. General Requirements:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.

2. System software and programs shall be stored in non-volatile programmable memory, retaining the information through failure of primary and secondary power supplies.
3. Include a real-time clock for time annotation of events on the event recorder and printer.
4. The System shall provide a means to recall alarms and trouble conditions in chronological order for the purpose of recreating an event history. Separate alarm, supervisory, and trouble logs shall be provided.
5. Provisions for addressable initiation devices that communicate device identity and status with the following:
   a. Smoke sensors shall additionally communicate sensitivity setting
   b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device
   c. Addressable control circuits for operation of mechanical equipment
   d. other devices as required
6. All wiring and terminal blocks shall be tagged.
7. Provide overall three ply phenolic red-white-red nameplate with lettering not less than 1 inch high for control panel. Secure to enclosure with stainless steel screws.

D. Indication and System Controls:

1. Alpha-numeric Indication:
   a. Arranged for interface between human operator at fire-alarm control panel and addressable system components including annunciation, supervision, and control. Display alarm, supervisory, and component status messages and the programming and control menu
   b. Type: Liquid-crystal type, 80 character minimum
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands
3. Discrete Indicating Lights and System Controls:
   a. At a minimum, provide individual LEDs identifying alarm and trouble conditions within each zone and the type of device originating the signal.
   b. At a minimum, provide system reset, alarm acknowledge, alarm silence, system test, and lamp test pushbuttons. These may be integrated into the keypad at the manufacturer's discretion.

E. Serial Interfaces: Minimum of two RS-232 or Universal Serial Bus (USB) ports to provide connections to printers, laptop computers, and miscellaneous peripheral devices. USB ports are preferred if available.

F. Input/Output Signals: Furnish and install the quantity and rating of input/output signals as required to interface with the Fire Suppression Systems, Smoke Dampers, door locks, air conditioners, fans, and other equipment as specified elsewhere and as shown on the Drawings for a complete and functional system at no additional cost to the Owner.

G. Digital Alarm Communicator Transmitter:

1. Furnish and install a digital alarm communicator transmitter to automatically transmit alarm, supervisory, and trouble signals to a remote digital alarm communicator receiver central alarm station operated by the Authority Having Jurisdiction.

2. Digital alarm communicator transmitter shall be acceptable to the remote digital alarm communicator receiver central alarm station and shall comply with UL 632. Coordinate requirements with the Authority Having Jurisdiction.

3. Digital alarm communicator transmitter shall be mounted integral to the Fire Alarm Control Panel.

4. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control panel and automatically captures one or two telephone line(s) and dials a preset number for a remote digital alarm communicator receiver central alarm station(s). When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote digital alarm communicator receiver central alarm station over the remaining line. Transmitter shall automatically report telephone service restoration to the remote digital alarm communicator receiver central alarm station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal. Transmitter shall be field programmable for use with one or two telephone lines.

5. Self-Test: Conducted automatically every 24 hours with report transmitted to remote digital alarm communicator receiver central alarm station.

6. Digital alarm communicator transmitter shall also provide
   a. LED display
   b. Field programmable selection of signals to be transmitted to the remote digital alarm communicator receiver central alarm station
   c. Programming device.

H. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events. Printer shall be furnished and installed integral with the fire alarm control panel.

I. 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.

J. The Fire Alarm Control Panel shall be manufactured by Tyco SimplexGrinnell, and no equal.

K. The Fire Alarm Control Panel shall Comply with UL 864, "Control Units and Accessories for Fire Alarm Systems".

L. The following Fire Alarm Control Panel hardware shall be provided:

1. Power Limited base panel with platinum cabinet and door, 120 VAC input power.
2. Minimum 2,500 point capacity where (1) point equals (1) monitor (input) or (1) control (output).
3. Minimum 2000 points of annunciation where one (1) point of annunciation equals:
   a. 1 LED driver output on a graphic driver or 1 switch input on a graphic switch input module.
   b. 1 LED on panel or 1 switch on panel.
4. 9 Amp Power Supply minimum with temperature compensated, dual-rate battery charger capable of charging up to 110 Ah batteries without a separate external battery charger. Battery charger voltage and amperage values shall be accessible on the Fire Alarm Control Panel LCD display.
5. Minimum One Auxiliary electronically resettable fused 2A @24VDC Output, with programmable disconnect operation for 4-wire detector reset.
6. Minimum One Auxiliary Relay, SPDT 2A @32VDC, programmable as a trouble relay, either as normally energized or de-energized, or as an auxiliary control.
7. Minimum Three (3) Class B Addressable Notification Appliance Signaling Line Circuits (SLCs).
   a. Each Addressable Notification Appliance SLC shall be rated at 3A and capable of supporting up to 127 Notification Appliances per channel.
   b. Wiring shall be 16 AWG to 12 AWG unshielded twisted pair wire. Systems that require shielded wire for Notification Appliances shall not be accepted.
   c. A constant voltage under both primary and secondary power conditions shall be maintained at the notification appliance field wiring terminal connections in the Fire Alarm Control Panel to ensure the voltage drop on the circuit is consistent under both primary and secondary power conditions.
   d. For systems that do not provide a constant voltage source at the Fire Alarm Control Panel notification appliance field wiring terminal connections, the fire alarm contractor shall:

1) Provide separate point-to-point voltage drop calculations for all notification appliances under worst case secondary power specifications, and

2) Perform a complete functional test of all notification appliances under worst case secondary power conditions.

8. Minimum Three (3) Class B Notification Appliance Circuits (NAC; rated 3A@24VDC, resistive).
   a. NAC's shall be conventional reverse polarity operation and shall be for synchronized strobes and independent horn/strobe operation over two wires.
   b. NACs shall be selectable as auxiliary power outputs derated to 2 A for continuous duty.
   c. Strobe synchronization and audible cadence synchronization shall be across all panel NAC circuits. Systems that cannot provide listed synchronization across all panel NAC's shall not be acceptable.

9. Where required provide Intelligent Remote Battery Charger for charging up to 110Ah batteries.

10. Expansion Power Supplies with minimum three (3) Class B integral Intelligent Addressable Notification Appliance Signaling Line Circuits (SLCs) for system expansion. Expansion power supplys shall provide complete capability as the primary power supply.

11. Power Supplies with integral conventional reverse polarity Notification Appliance Circuit Class B for system expansion. Expansion power supplys shall provide complete capability as the primary power supply.

12. Minimum Four (4) form "C" Auxiliary Relay Circuits (Form C contacts rated 10A @ 250VAC, resistive), operation shall be programmable for other fire response functions. Relays shall be capable of switching up to 10 A @ 250VAC, inductive.

13. The Fire Alarm Control Panel shall support up to (5) RS-232-C ports and one service port. All (5) RS-232 Ports shall be capable of two-way communications.

14. Remote Unit Interface: supervised serial communication channel for control and monitoring of remotely located annunciators and I/O panels.

15. Municipal City Circuit Connection with Disconnect switch, 24VDC Remote Station (reverse polarity), local energy, shunt master box, or a form "C" contact output.

16. Programmable DACT for either Common Event Reporting or per Point Reporting.

17. Fire Panel Internet Interface to provide supplemental notification and remote user access to the Fire Alarm Control Panel using Ethernet and TCP/IP communications protocol compatible with IEEE Standard 802.3.

18. Modular Network Communications Card.

M. Cabinet: Lockable steel enclosure. Arrange unit so all operations required for testing or for normal care and maintenance of the system are performed from the front of the enclosure. If more than a single unit is required to form a complete control unit, provide exactly matching modular unit enclosures.

N. Alphanumeric Display and System Controls: Panel shall include an 80 character LCD display to indicate alarm, supervisory, and component status messages and shall include a keypad for use in entering and executing control commands.

1. The system shall have the capability to provide expanded content, multi-line, operator interface displays as indicated on the drawings and specifications. The expanded content multi-line displays shall be Quarter-VGA (QVGA) or larger and be capable of supporting a minimum of 854 standard ASCII characters to minimize or eliminate the levels of navigation required for access to information when responding to critical emergencies and abnormal system conditions. The QVGA operator interface shall provide operator prompts and six context sensitive soft-keys for intuitive operation.
   a. Expanded content, multi-line operator interfaces shall be capable of providing the following functions:
      1) Dual language operation with Instant-Switch language selection during runtime.
      2) Activity display choices for:
         a) First 8 Events.
         b) First 5 Events and Most Recent Event (with first and most recent event time and date stamps).
         c) First Event and Most Recent Event (with first and most recent event time and date stamps).
         d) Scrollable List Display displays a scrollable list of active points for the event category (alarm, priority 2, supervisory, or trouble) selected. The position in this list will be the last acknowledged point (not flashing) at the top followed by the next 7 unacknowledged points (flashing).
         e) General Event Status (alarm, priority 2, supervisory, or trouble in system)
         f) Site Plan
      3) Equal or hierarchal priority assignment. In systems with two or more operator interfaces, each operator interface shall be programmable to allow multiple operator interfaces to have equal operation priority or to allow hierarchal priority control to be assigned to individual operator interfaces (locations).
      4) Up to 50 custom point detail messages for providing additional point specific information in detailed point status screens.

5) Bitmap file import for operator interface display of site plan and background watermark images.

2. Expanded content, multi-line displays shall have the capability to provide Dual-Language operation.
   a. Language selection shall be via a switch on the operator interface panel. Operator interface panels shall support instant-language-switchover during runtime to allow the operator to toggle between languages each time the language selection switch is operated, without requiring complicated multi-step processes.
   b. Both one-byte and two-byte characters shall be supported.

O. Distributed Module Operation: File Alarm Control Panel shall be capable of allowing remote location of the following modules; interface of such modules shall be through a Style 4 (Class B) supervised serial communications channel (SLC):

1. Addressable Signaling Line Circuits
2. Initiating Device Circuits
3. Notification Appliance Circuits
4. Auxiliary Control Circuits
5. Graphic Annunciator LED/Switch Control Modules
   a. In systems with two or more Annunciators and/or Command Centers, each Annunciator/Command Center shall be programmable to allow multiple Annunciators/Command Centers to have equal operation priority or to allow hierarchal priority control to be assigned to individual Annunciator/Command Center locations.
6. Amplifiers, voice and telephone control circuits

2.04 MANUAL PULL STATIONS

A. General:

1. Fabricated of metal or plastic and finished in red with molded, raised-letter operating instructions in contrasting color.
2. The Manual Pull Station shall be surface mounted. Furnish and install manufacturer's surface back box. Furnish and install coverplate.
3. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type.
4. Integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control panel.

2.05 SMOKE DETECTORS

A. General:

1. Operating voltage: 24 volts DC
2. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control panel.
4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
5. Integral Visual-Indicating Light: LED type indicating detector has operated
6. Field adjustable: Detector can be adjusted and tested after installation

B. Photoelectric Smoke Detector:

1. Detector address shall be accessible from fire-alarm control panel and shall be able to identify the detector's location within the system and its sensitivity setting.
2. LED or infrared light source suitable for use as a smoke detector and tested per UL 268A.

C. Ionization Smoke Detector:

1. Shall respond to both visible and invisible combustion products.

2.06 HEAT DETECTORS

A. Heat Detector, Combination Type

1. Actuated by either a fixed temperature of 135 degrees F or rate of rise that exceeds 15 degrees F per minute
2. Mounting: Adapter plate for outlet box mounting
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control panel.

B. Heat Detector, Fixed Temperature Type:

1. Actuated by either a fixed temperature of 135 degrees F or rate of rise that exceeds 15 degrees F per minute
2. Mounting: Adapter plate for outlet box mounting
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control panel.

2.07 NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances:

1. Individually addressed, connected to a signaling line circuit, equipped for mounting as indicated and with screw terminals for system connections.
2. Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated and with screw terminals for system connections.
3. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections.
4. Mounted on recessed outlet box. Where surface mounted, furnish and install manufacturer's surface back box. Furnish and install coverplate.

B. Horns: Electric-vibrating-polarized type, 24 volts DC; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 85 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol.

C. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch high letters on the lens. Provide rated light output in accordance with the requirements of the Authority Having Jurisdiction.

2.08 REMOTE ANNUNCIATOR PANEL

A. General: Provide annunciator panel where required by the Drawings or by the Authorities Having Jurisdiction.

B. Description: Annunciator functions shall match those of fire-alarm control panel for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control panel, including acknowledging, silencing, resetting, and testing.

C. Construction: Enclosed panel, NEMA 3R rated at minimum, suitable for wall surface mounting and the application environment in which the panel is located. Also refer to the Drawings.

D. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control panel. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

E. Provide overall three ply phenolic red-white-red nameplate with lettering not less than 1 inch high for each annunciator panel. Secure to enclosure with stainless steel screws.

2.09 ADDRESSABLE INTERFACE DEVICE

A. Description: Microelectronic monitor module for use in providing a system address for alarm-initiating devices with normally open contacts.

B. Integral Relay: Capable of providing a direct signal to/from equipment as required by the Drawings and Specifications for a complete functional system.

2.10 MISCELLANEOUS

A. Wiring:

1. Non-Power-Limited Circuits: Furnish and install wiring per Section 16200 "Wiring (600 Volts and Below)". Exception: The following minimum wire sizes apply:
   a. Low voltage circuits: No. 16 AWG, minimum
   b. Line-Voltage circuits: No. 12 AWG minimum.

2. Power-Limited Circuits: Furnish and install NFPA 70, Types FPL, FPLR, or FPLP as recommended by the manufacturer. Minimum wire size is No. 16 AWG

B. Building Maps and Signage:

1. Building map shall be provided adjacent to the Fire Alarm Control Panel and each annunciator panel. Map shall consist of floor plans with all room numbers and zones identified. Maps shall be properly oriented and mounted in a durable frame. Handwritten or hand-drawn maps shall not be accepted.

2. Provide additional signage as required by NFPA and Authorities Having Jurisdiction at no additional cost to the Owner.

PART 3 - EXECUTION

3.01 EQUIPMENT INSTALLATION

A. Equipment Mounting: Install fire-alarm control panel with tops of cabinets not more than 72 inches above the finished floor.

B. Manual Pull Stations: Mount in back boxes at 48 inches above finished floor.

C. Smoke- or Heat-Detector Spacing: Comply with NFPA

D. Visible/Audible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and not more than 80 inches above the floor or least 6 inches below the ceiling, whichever is lower.

E. Although it may not be shown on the Drawings, size, furnish, and install conduit/wire to interconnect the Fire Alarm Control Panel to the Building Telephone System.

3.02 GENERAL INSTALLATION

A. Furnish and install all wiring complete in a raceway system per all applicable requirements of the Division 16 specifications and the Contract Drawings, with the following supplementary requirements:

1. Color code all wiring differently from that used for normal building power wiring. Use different wiring colors for alarm and supervisory wiring
2. Paint fire alarm system junction/pull boxes red
3. Ground fire-alarm control panel and associated circuits and comply with IEEE 1100.

3.03 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by the Owner and the Authorities Having Jurisdiction.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections, for all tests.

C. Perform the following tests and inspections:

1. Pre-Test:
   a. After installation, align, adjust, calibrate, and balance the system and perform complete pre-testing.
   b. Test audible and visual appliances, smoke detectors, and heat detectors according to manufacturer's written instructions.
   c. Test for proper function of automatic transfer between primary and secondary power sources.
   d. Test battery charging and battery backup system.
   e. Test interlocks between the fire alarm system and:
      1) Fire suppression systems, as applicable
      2) elevators, as applicable
      3) door locks, as applicable,
      4) supervisory valves,
      5) annunciator panels,
      6) and other equipment
   f. Test for functional compliance with the Contract Requirements. Correct deficiencies observed, replace malfunctioning components as required, and perform all necessary adjustments re-testing until satisfactory performance is achieved.
   g. Maintain a log of testing and associated test results for the Owner’s review.

2. Final Test:

a. Provide minimum of 14 days written notice to the Owner when the system is ready for final acceptance testing.

b. Test system per the requirements of NFPA and the Authority Having Jurisdiction.

c. Correct all deficiencies and completely re-test work affected.

d. Provide a typewritten report of test results signed by the Technician and witnesses.

e. Provide Certificate of Completion per NFPA.

3. After installation and final testing, clean and vacuum all interior of the equipment. Touch-up and restore damaged surfaces to factory finish.

3.04 TRAINING

A. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain the fire alarm system. Include software related upgrades and maintenance.

3.05 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this Section. All costs are included in the Base Bid.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE

A. The work of Division 15 consists of providing labor, materials, products, and in performing all operations required for the complete operating installation of all mechanical systems in accordance with specifications, applicable drawings, terms, conditions of the contract and all applicable codes and ordinances governing the installation of the various mechanical systems. All work shall be fully correlated with the work of other crafts.

B. Each contractor shall study the contract documents to determine the extent of work provided under this contract, as well as to ascertain the difficulty to be encountered in performing the work on the drawings and outlined hereinafter and in making connections to existing utilities, installing new equipment and systems and coordinating the work with the other Trades.

C. EXAMINATION OF SITE: The Contractor shall thoroughly examine site as to the conditions under which the Work is to be performed. The Contractor shall verify, at the site, all measurements affecting their work and shall be responsible for the correctness of same. No extra compensation will be allowed to the Contractor for expenses due to his neglect to examine or failure to discover conditions which affect his work. No extra compensation will be allowed on account of differences between actual dimensions and those indicated on the drawings.

1.2 REGULATORY REQUIREMENTS

A. Codes and Ordinances/Permit and Fees: Perform all work in accordance with all state and local codes and ordinances, the current edition of NFPA, latest city recognized Building and Mechanical Codes and all current supplements, revisions, and addendums thereto. The current city recognized edition of the Accessibility Standards of the Architectural Barriers Act and any other authorities having jurisdiction (AHJ) over the Work. Procure and pay for all permits, licenses, fees and charges, and give all notices necessary.

B. In case of conflict between the Contract Documents and requirements of any Code or authorities having jurisdiction, the most stringent requirements of the aforementioned shall govern.

C. Should the contractor perform any work that does not comply with the requirements of the applicable Building Codes, State Laws, Local Ordinances and Industry Standards, the contractor shall bear all costs arising in correcting the deficiencies, as approved by the Architect.

1.3 INTENT

A. The drawings show general arrangements and the extent of the work. The drawings do not show, in minute detail, all features of the installation. Follow the drawings as closely as actual construction will permit. All material and labor necessary to complete the work in accordance with the intent of the specifications and drawings shall be furnished by the Contractor without additional charge.

1.4 COORDINATION OF WORK

A. Each contractor shall compare their drawings and specifications with those of other Trades. All work shall be installed in cooperation with other Trades installing interrelated work. Before installation, all Trades shall make proper provisions to avoid interferences.

B. Each contractor shall coordinate the location of their systems so that all outside air intakes are located in such a way as to prevent cross-contamination with the plumbing vents and exhaust fans. Such a distance shall be not less than 10'-0" ft.

C. Locations of conduit, ducts, piping and equipment shall be adjusted to accommodate the work with interferences anticipated and encountered. Exact routing and location of systems shall be determined prior to fabrication or installation.

D. Offsets and changes of direction in all conduit, ducts and piping systems shall be made as required to maintain proper headroom and pitch of sloping lines.

1.5 SERVICEABILITY OF PRODUCTS

A. Furnish all products to provide the proper orientation of serviceable components to access space provided.

B. Coordinate installation of piping, ductwork, equipment, system components, and other products to allow proper service of all items requiring periodic maintenance or replacement.

C. Replace or relocate all products incorrectly ordered or installed to provide proper serviceability.

D. Provide access doors in ceilings, walls, floors, etc., for access to all serviceable or operable equipment in concealed spaces, such as but not limited to traps, valves, dampers automatic devices, etc.

1.6 SUBMITTALS

A. Provide submittals for the equipment scheduled on the drawings. Mark submittal literature and shop drawings clearly and bind in folder for retention by Owner. Submittal review is for general design and arrangement only and does not relieve the Contractor from any of the requirements of the Contract Documents.

B. Where equipment of the acceptable manufacturers requires different arrangement or connections from those shown, it shall be the responsibility of the Contractor to install the equipment to operate properly and in harmony with the original intent of the drawings and specifications. The Contractor shall make all necessary changes in all affected related work provided under other Sections including location of rough-in connections by other Trades, conduit supports, insulation, etc. All changes shall be made at no increase in the Contract amount or additional cost to the other Trades and/or Owner.

1.7 RECORD AS-BUILT DRAWINGS

A. It will be the mechanical contractor’s responsibility to mark up a clear set of As-Built mechanical drawings as the work progresses to show the deviations from the sealed construction mechanical drawings, including but not limited to the following.
   1. Re-routing of the HVAC supply air, return air, exhaust air and outside air ductwork.
   2. Re-routing of HVAC piping.
   3. Re-sizing of HVAC ductwork and piping.
   4. Exact location of all branch line shut-off valves

B. Keep the marked-up As-Built drawings on site until completion of the project.

C. The General Contractor is to turn over the record As-Built drawings to the owner upon completion of the project.

1.8 MATERIALS

A. Install new materials and equipment, free from defects. Use materials and equipment which bear the Underwriters' Laboratories, Inc. label where a U.L. standard has been established.

1.9 GUARANTEE

A. All equipment and work shall be guaranteed for a period of 12 months after acceptance. Any defects in equipment or workmanship shall be promptly repaired or replaced by the Contractor without additional expense to the owner. The guarantee period of any part of the repaired item shall be extended for a period of one year from the date of such repair or replacement.

1.10 COMPLETION

A. Upon completion of the mechanical installation, demonstrate to the owner's satisfaction that the systems have been installed in a satisfactory manner in accordance with the plans and applicable codes. Show that all controls are operable and are properly adjusted in accordance with the requirements of the final systems balance, that all systems are properly balanced, that all equipment operates properly, that filters and strainers are clean, and that all components of all systems are installed and adjusted for proper operation. Provide at minimum one day of training for Owner’s personnel in operation and maintenance of equipment, as scheduled by the Owner.

1.11 OPERATION AND MAINTENANCE MANUALS

A. Provide Operation and Maintenance Manuals for the equipment stated as specification section as requiring Operation and Maintenance Manuals. Utilize the Operation and Maintenance Manuals for training of Owner's personnel in operation and maintenance of systems and related equipment.

1.12 SUPPORTING DEVICES, CUTTING, AND PATCHING

A. Securely fasten all mechanical work to the structure to prevent hazard human life and limb, and to prevent damage to products of construction under all conditions of operation.

B. Do all sleeving, cutting and patching of rough construction for piping. All cutting, repairing and required structural reinforcing for installation of this Work shall be done in conformance with Architect's directions and any damage caused by cutting shall be repaired equal to original conditions. No cutting without Architect's approval.

C. Place any sleeves, chases, concrete inserts, anchor bolts, etc., before concrete is poured, and be responsible for correct location and installation of these items.

1.13 EQUIPMENT IDENTIFICATION

A. Provide an identification tag for all scheduled HVAC equipment.
   1. Exception: Ceiling or wall mounted exhaust fans.

B. The identification tags lettering and number for the mechanical equipment to match the lettering and number as shown on the schedule for the mechanical equipment. Refer to the schedule sheet in the construction drawings.

1.14 PRODUCT HANDLING

A. Use all means necessary to protect materials of this Section before, during and after installation and to protect installed work and materials of all other trades.

B. Deliver all materials to the job site in their original unopened containers with all labels intact and legible at time of use. Store in strict accordance with the manufacturer's recommendations as approved by the Architect.

C. In the event of damage, immediately make all repairs and replacements necessary to the approval of the Architect and at no additional cost to the Owner.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.2 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
   1. Motor controllers.
   2. Torque, speed, and horsepower requirements of the load.
   3. Ratings and characteristics of supply circuit and required control sequence.
   4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.
B. Efficiency: Energy efficient, as defined in NEMA MG 1.
C. Service Factor: 1.15.
D. Multispeed Motors: Variable torque.
   1. For motors with 2:1 speed ratio, consequent pole, single winding.
   2. For motors with other than 2:1 speed ratio, separate winding for each speed.
E. Rotor: Random-wound, squirrel cage.
F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
G. Temperature Rise: Match insulation rating.
H. Insulation: Class F.
I. Code Letter Designation:
   1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
   2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
   1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
   2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
   3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
   4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
   1. Permanent-split capacitor.
   2. Split phase.
   3. Capacitor start, inductor run.
   4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Sleeves.
   2. Sleeve-seal systems.
   3. Grout.

1.2 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

2.2 SLEEVE-SEAL SYSTEMS

A. 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:
   1. Advance Products & Systems, Inc.
   2. Airex Manufacturing.
   3. CALPICO, Inc.
B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
   1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   2. Pressure Plates: Carbon steel.
   3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
B. Characteristics: Nonshrink; recommended for interior and exterior applications.
C. Design Mix: 5000-psi, 28-day compressive strength.
D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
   1. Sleeves are not required for core-drilled holes.
C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Cut sleeves to length for mounting flush with both surfaces.
   a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.
1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 07920 "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in NFPA.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:
1. Exterior Concrete Walls above Grade:
   a. Piping Smaller Than NPS 6: Galvanized-steel wall sleeves.
2. Concrete Slabs above Grade:
   a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
3. Interior Partitions:
   a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Escutcheons

B. Floor plates

1.2 SUBMITTALS

A. Not required.

PART 2 - PRODUCTS

2.1 One Piece Deep Pattern Escutcheon

A. Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

2.2 One Piece Cast Brass Type Escutcheon

A. Polished with chrome plated finish with setscrew fastener.

2.3 Floor Plates

A. Cast iron flange with holes for fasteners.

PART 3 - EXECUTION

3.1 ESCUTCHEON INSTALLATION

A. Install escutcheons for piping penetrations below ceiling interior walls, ceilings, and finished floors.

B. Install escutcheons with inner diameter to closely fit around pipe and piping insulation with an outer diameter to completely cover wall and ceiling openings.

C. Escutcheon Schedule
   1. One-Piece – Stamped-steel Type
      a. Insulated piping through wall.
      b. Uninsulated piping through wall, floor, or ceiling in a finished space.
      c. Uninsulated piping in equipment room, unfinished areas, and service areas.
   2. One-piece Deep-Pattern Type
      a. Piping with sleeve protruding from wall.

3.2 FLOOR PLATES

A. Install floor plates for piping penetrations of floors.

B. Install floor plates with inner diameter to closely fit around pipe and piping insulation with an outer diameter to completely cover floor opening.

END OF SECTION

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PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Metal pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Thermal-hanger shield inserts.
   4. Fastener systems.
   5. Equipment supports.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
   1. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
   2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:
   1. Trapeze pipe hangers.
   2. Equipment supports.
C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
   3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
   4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

2.2 TRAPEZE PIPE HANGERS

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

2.3 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.
B. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength.
C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.4 FASTENER SYSTEMS

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

2.5 EQUIPMENT SUPPORTS

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

2.6 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
   1. Properties: Nonstaining, noncorrosive, and nongaseous.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the enclosure structure.
B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

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

C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
D. Fastener System Installation:
1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
F. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
G. Install lateral bracing with pipe hangers and supports to prevent swaying.
H. Install enclosure attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
I. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
J. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
K. Insulated Piping:
1. Attach clamps and spacers to piping.
    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
    a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for equipment supports.
B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
    1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
    2. Obtain fusion without undercut or overlap.
    3. Remove welding flux immediately.
    4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
    1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting"
C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
E. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.
F. Use padded hangers for piping that is subject to scratching.

G. Use thermal-hanger shield inserts for insulated piping and tubing.
H. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
   2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
   3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
   4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
   5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
   6. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
   7. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
   8. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
   9. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
I. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
   2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
J. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
   2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
K. Enclosure Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
   2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
   3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
   4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
   5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
   6. C-Clamps (MSS Type 23): For structural shapes.
   7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
      a. Light (MSS Type 31): 750 lb.
      b. Medium (MSS Type 32): 1500 lb.

c. Heavy (MSS Type 33): 3000 lb.
8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

L. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

M. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
3. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.

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

O. Use powder-actuated fasteners or mechanical-expansion anchors instead of enclosure attachments where required in concrete construction.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fiberglass isolation pads.
   2. Open-spring isolators.
   3. Housed-spring isolators.
   4. Elastomeric hangers.
   5. Spring hangers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Delegated-Design Submittal: For each vibration isolation device.
   1. Include design calculations for selecting vibration isolators.

PART 2 - PRODUCTS

2.1 FIBERGLASS ISOLATION PADS

A. Fiberglass Isolation Pads:
   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:
      a. Ace Mountings Co., Inc.
      b. California Dynamics Corporation.
      c. Isolation Technology, Inc.
      d. Kinetics Noise Control, Inc.
      e. Vibration Eliminator Co., Inc.
   2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
   3. Size: Factory or field cut to match requirements of supported equipment.
   4. Pad Material: high-density matrix pre-compressed fiberglass with elastomeric coating.
   5. Surface Pattern: Smooth pattern.
   6. Retain subparagraph below if galvanized-steel baseplates are adhered to the isolation pad to facilitate load distribution.
   7. Load-bearing metal plates adhered to pads.

2.2 OPEN-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators:
   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:
      a. Ace Mountings Co., Inc.
      b. Isolation Technology, Inc.
      c. Kinetics Noise Control, Inc.
      d. Mason Industries, Inc.
      e. Vibration Eliminator Co., Inc.
      f. Vibration Isolation.
   2. Vibration Mountings & Controls, Inc

3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig.
8. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.3 HOUSED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing:
   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:
      a. Ace Mountings Co., Inc.
      b. Isolation Technology, Inc.
      c. Kinetics Noise Control, Inc.
      d. Mason Industries, Inc.
      e. Vibration Eliminator Co., Inc.
      f. Vibration Isolation.
      g. Vibration Mountings & Controls, Inc.
   2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   6. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.
      a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
      b. Top housing with attachment and leveling bolt or threaded mounting holes and internal leveling device.

2.4 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:
   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:
      a. Ace Mountings Co., Inc.
      b. Isolation Technology, Inc.
      c. Kinetics Noise Control, Inc.
      d. Mason Industries, Inc.
      e. Vibration Eliminator Co., Inc.
      f. Vibration Mountings & Controls, Inc.

2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
3. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.5 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:
   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:
      a. Ace Mountings Co., Inc.
      b. Kinetics Noise Control, Inc.
      c. Mason Industries, Inc.
      d. Novia; A Division of C&P.
      e. Vibration Eliminator Co., Inc.
      f. Vibration Isolation.
      g. Vibration Mountings & Controls, Inc.
   2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
   3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
   8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

PART 3 - EXECUTION

3.1 VIBRATION CONTROL DEVICE INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section "Cast-in-Place Concrete."
B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
C. Provide vibration isolation per schedule below for buildings with 20ft and less span. Isolator deflections and stiffness provided for most applications, however, the exact stiffness and deflection are outside of the natural resonating frequency range of the rotating system should be confirmed for the specific equipment installed.

EQUIPMENT TYPE	HORSE POWER / SP	ISOLATOR TYPE	DEFLECTION
Air Handling Unit	<10 HP	Open Spring or Spring Hanger Directly attached	1”
CU / VRF on Grade	All	Fiberglass (Kinetics KIP) or Rubber Neoprene Pads	1/4"
CU / VRF on Roof	All	House spring isolator	3/4"
Fans < 22 IN. Diam	Any	Spring Hanger Directly attached	3/4"
Fans < 22 IN. Diam	< 2 IN WC SP	Open Spring with spring base or Spring Hangers with rubber bushings	1.5"

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Equipment labels.
   2. Warning signs and labels.
   3. Pipe labels.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:
   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:
      a. Brady Corporation.
      b. Brimar Industries, Inc.
      c. Carlton Industries, LP.
      d. LEM Products Inc.
      e. Marking Services, Inc.
   2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
   3. Letter Color: Black.
   4. Background Color: White.
   5. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
   6. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
   7. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
   8. Fasteners: Stainless-steel rivets or self-tapping screws.
   9. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

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

2.2 WARNING SIGNS AND LABELS

A. 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:
   1. Brady Corporation.
   2. Brimar Industries, Inc.
   3. Champion America.
   4. Craftmark Pipe Markers.
   5. Marking Sevices Inc.
   6. National Marker Company.

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

C. Letter Color: White.

D. Background Color: Red.

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

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

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

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

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

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

2.3 PIPE LABELS

A. 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:
   1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
   2. Brimar Industries, Inc.
   3. Champion America.
   4. Craftmark Pipe Markers.
   5. LEM Products Inc.
   6. Marking Sevices Inc.

B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.

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

D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
   2. Lettering Size: Size letters according to ASME A13.1 for piping.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.
B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in mechanical rooms only as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
   7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
B. Pipe Label Color Schedule:
   1. Refrigerant Piping: Black letters on a safety-white background.

END OF SECTION

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PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following HVAC piping systems:
   1. Refrigerant suction and hot-gas piping, indoors and outdoors.
B. Related Sections:
   1. Section 15083 "Duct Insulation."

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail attachment and covering of heat tracing inside insulation.
   3. Detail insulation application at pipe expansion joints for each type of insulation.
   4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
   5. Detail removable insulation at piping specialties.
   6. Detail application of field-applied jackets.
   7. Detail application at linkages of control devices.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
E. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

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:
   a. Aeroflex USA, Inc.
   b. Airex Manufacturing.
   c. Armacell LLC.
   d. K-Flex USA.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
   1. 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:
      a. Aeroflex USA, Inc.
      b. Armacell LLC.
      c. Foster Brand; H. B. Fuller Construction Products.
      d. K-Flex USA.
   2. Adhesives shall have a VOC content of 50 g/L or less.
   3. Adhesive shall comply with the testing and product 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."
   4. Adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   5. Adhesive shall comply with the testing and product 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."

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
   1. VOC Content: 300 g/L or less.
   2. Low-Emitting Materials: Mastic coatings shall comply with the testing and product 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."
B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
   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:
      a. Childers Brand; H. B. Fuller Construction Products.
      b. Foster Brand; H. B. Fuller Construction Products.
      c. Knauf Insulation.
      d. Vimasco Corporation.
   2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.

3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
1. 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:
a. Childers Brand; H. B. Fuller Construction Products.
b. Eagle Bridges - Marathon Industries.
c. Foster Brand; H. B. Fuller Construction Products.
d. Knauf Insulation.
e. Mon-Eco Industries, Inc.
f. Vimasco Corporation.
2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

2.4 SEALANTS

A. Joint Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 100 to plus 300 deg F.
4. Color: White or gray.
5. Sealant shall have a VOC content of 420 g/L or less.
6. Sealant shall comply with the testing and product 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."

B. FSK and Metal Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.
5. Sealant shall have a VOC content of 420 g/L or less.
6. Sealant shall comply with the testing and product 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."

2.5 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
3. PVDC Jacket for Indoor Applications: 4-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm when tested according to ASTM E 96/E 96M and

with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

4. PVDC Jacket for Outdoor Applications: 6-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.

2.6 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.

2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
B. FSK Jacket: Aluminum-foil face, fiberglass-reinforced scrim with kraft-paper backing.

2.8 TAPES

A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
   1. Width: 3 inches.
   2. Thickness: 6.5 mils.
   3. Adhesion: 90 ounces force/inch in width.
   4. Elongation: 2 percent.
   5. Tensile Strength: 40 lbf/inch in width.
   6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
B. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
   1. Width: 2 inches.
   2. Thickness: 3.7 mils.
   3. Adhesion: 100 ounces force/inch in width.
   4. Elongation: 5 percent.
   5. Tensile Strength: 34 lbf/inch in width.

2.9 SECUREMENTS

A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.
B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.
C. Wire: 0.062-inch soft-annealed, galvanized steel.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
E. Install multiple layers of insulation with longitudinal and end seams staggered.
F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
G. Keep insulation materials dry during application and finishing.
H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
I. Install insulation with least number of joints practical.
J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
    1. Install insulation continuously through hangers and around anchor attachments.
    2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
    3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
    4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
L. Install insulation with factory-applied jackets as follows:
    1. Draw jacket tight and smooth.
    2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
    3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
        a. For below-ambient services, apply vapor-barrier mastic over staples.
    4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
    5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:
   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.
   4. Manholes.
   5. Handholes.
   6. Cleanouts.

3.3 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
   4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
   4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

F. Insulation Installation at Floor Penetrations:
   1. Pipe: Install insulation continuously through floor penetrations.

3.4 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
   2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent

pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:
   1. Install pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
   4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install mitered sections of pipe insulation.
   2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed valve covers manufactured of same material as pipe insulation when available.
   2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.
   4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.6 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:
   1. Draw jacket material smooth and tight.
   2. Install lap or joint strips with same material as jacket.
   3. Secure jacket to insulation with manufacturer's recommended adhesive.
   4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
   5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.7 FINISHES

A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
C. Do not field paint aluminum or stainless-steel jackets.

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.
B. Tests and Inspections:
   1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to two locations of straight pipe.
C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.9 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

3.10 INDOOR PIPING INSULATION SCHEDULE

A. Refrigerant Suction and Hot-Gas Piping: Flexible elastomeric, 1-1/2 inch thick.
B. Refrigerant Suction and Hot-Gas Flexible Tubing: Flexible elastomeric, 1-1/2 inch thick.
C. Condensate Piping: Flexible elastomeric, 1 inch thick.

3.11 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Refrigerant Suction and Hot-Gas Piping: Insulation shall be the following:
   1. Flexible Elastomeric: 2 inches thick.
B. Refrigerant Suction and Hot-Gas Flexible Tubing: Insulation shall be the following:
   1. Flexible Elastomeric: 2 inches thick.
C. Condensate: Insulation shall be the following:
   1. Flexible Elastomeric: 2 inches thick.

3.12 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
B. If more than one material is listed, selection from materials listed is Contractor's option.
C. Piping, Concealed:
   1. None.
D. Piping, Exposed:
   1. Aluminum: 20 mils thick.

3.13 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
B. If more than one material is listed, selection from materials listed is Contractor's option.
C. Piping, Concealed:
   1. Aluminum: 20 mils thick.
D. Piping, Exposed:

1. Aluminum: 20 mils thick.

3.14 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following duct services:
   1. Indoor, concealed supply and outdoor air.
   2. Indoor, exposed supply and outdoor air.
   3. Indoor, concealed return located in unconditioned space.
   4. Indoor, exposed return located in unconditioned space.

B. Related Sections:
   1. Section 23 31 13 "Metal Ducts" for duct liners.

1.2 ACTION SUBMITTALS

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

B. Sustainable Design Submittals:
   1. Provide documentation of VOC content showing compliance with low VOC requirements.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
   3. Detail application of field-applied jackets.
   4. Detail application at linkages of control devices.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
    1. 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:
        a. CertainTeed Corporation.
        b. Johns Manville; a Berkshire Hathaway company.
        c. Knauf Insulation.
        d. Owens Corning.

2.2 FIRE-RATED INSULATION SYSTEMS

A. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by an NRTL acceptable to authorities having jurisdiction.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
    1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
    2. Service Temperature Range: Minus 20 to plus 180° F.
    3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
    4. Color: White.
C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
    1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
    2. Service Temperature Range: Minus 20 to plus 180° F.
    3. Solids Content: 60 percent by volume and 66 percent by weight.
    4. Color: White.

2.5 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:
    1. Materials shall be compatible with insulation materials, jackets, and substrates.
    2. Fire- and water-resistant, flexible, elastomeric sealant.
    3. Service Temperature Range: Minus 40 to plus 250° F.
    4. Color: Aluminum.
    5. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:

6. Materials shall be compatible with insulation materials, jackets, and substrates.
7. Fire- and water-resistant, flexible, elastomeric sealant.
8. Service Temperature Range: Minus 40 to plus 250° F.
9. Color: White.

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
   2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
   3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
   4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
   5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for ducts.

2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
C. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
   1. Factory cut and rolled to size.
   2. Finish and thickness are indicated in field-applied jacket schedules.
   3. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper.
   4. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.

2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Width: 3 inches.
   2. Thickness: 11.5 mils.
   3. Adhesion: 90 ounces force/inch in width.
   4. Elongation: 2 percent.
   5. Tensile Strength: 40 lbf/inch in width.
   6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
   1. Width: 3 inches.
   2. Thickness: 6.5 mils.
   3. Adhesion: 90 ounces force/inch in width.
   4. Elongation: 2 percent.
   5. Tensile Strength: 40 lbf/inch in width.

6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Width: 2 inches.
2. Thickness: 3.7 mils.
3. Adhesion: 100 ounces force/inch in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch in width.

2.10 SECUREMENTS

A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020-inch-thick, 3/4-inch-wide with wing seal or closed seal.

B. Insulation Pins and Hangers:
1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that can hold insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030-inch-thick by 2 inches square.
   b. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
   c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
2. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that can hold insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Baseplate: Perforated, nylon sheet, 0.030-inch-thick by 1-1/2 inches in diameter.
   b. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
   c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
3. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that can hold insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Baseplate: Galvanized carbon-steel sheet, 0.030-inch-thick by 2 inches square.
   b. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
   c. Adhesive-backed base with a peel-off protective cover.
4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

D. Wire: 0.062-inch soft-annealed, stainless steel.

2.11 CORNER ANGLES

A. Aluminum Corner Angles: 0.040-inch-thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.
C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
E. Install multiple layers of insulation with longitudinal and end seams staggered.
F. Keep insulation materials dry during application and finishing.
G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
H. Install insulation with least number of joints practical.
I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
    1. Install insulation continuously through hangers and around anchor attachments.
    2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
    3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
K. Install insulation with factory-applied jackets as follows:
    1. Draw jacket tight and smooth.
    2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
    3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
        a. For below ambient services, apply vapor-barrier mastic over staples.
    4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
    5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches like butt joints.

3.3 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
   4. Seal jacket to roof flashing with flashing sealant.
B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
   4. Seal jacket to wall flashing with flashing sealant.
C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
   1. Comply with requirements in NFPA for firestopping and fire-resistive joint sealers.
E. Insulation Installation at Floor Penetrations:
   1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
   2. Seal penetrations through fire-rated assemblies.

3.4 INSTALLATION OF MINERAL-FIBER INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
   1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
   2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
   3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
d. Do not over compress insulation during installation.
e. Impale insulation over pins and attach speed washers.
f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1-inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   b. Install vapor stops for ductwork and plenums operating below 50° F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.5 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:
   1. Draw jacket material smooth and tight.
   2. Install lap or joint strips with same material as jacket.
   3. Secure jacket to insulation with manufacturer's recommended adhesive.
   4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
   5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with

weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.6 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.
B. Insulate duct access panels and doors to achieve same fire rating as duct.

3.7 FINISHES

A. Insulation with ASJ or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09900 "Painting".
   1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
      a. Finish Coat Material: Interior, flat, latex-emulsion size.
B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
C. Do not field paint aluminum or stainless-steel jackets.

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.
B. Tests and Inspections:
   1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.9 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:
   1. Indoor, concealed supply and outdoor air.
   2. Indoor, exposed supply and outdoor air.
   3. Indoor, concealed return located in unconditioned space.
   4. Indoor, exposed return located in unconditioned space.
   5. Outdoor, concealed supply and return.
   6. Outdoor, exposed supply and return.
B. Items Not Insulated:
   1. Fibrous-glass ducts.
   2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
   3. Factory-insulated flexible ducts.
   4. Factory-insulated plenums and casings.
   5. Flexible connectors.
   6. Vibration-control devices.
   7. Factory-insulated access panels and doors.

3.10 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, Supply-Air Duct and Plenum Insulation: Mineral-fiber blanket, 2 inches thick and 1.5-lb/cu. ft. nominal density.
B. Concealed, Return-Air Duct and Plenum Insulation: Mineral-fiber blanket, 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

C. Concealed, Outdoor-Air Duct and Plenum Insulation: Mineral-fiber blanket, 2 inches thick and 1.5-lb/cu. ft. nominal density.
D. Exposed, Supply-Air Duct and Plenum Insulation: Double wall, spiral, insulated ductwork. See Section 15815 – Metal Ducts.
E. Exposed, Return-Air Duct and Plenum Insulation: Double wall, spiral, insulated ductwork. See Section 15815 – Metal Ducts.
F. Exposed, Outdoor-Air Duct and Plenum Insulation: Double wall, spiral, insulated ductwork. See Section 15815 – Metal Ducts.

3.11 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
B. If more than one material is listed, selection from materials listed is Contractor's option.
C. Ducts and Plenums, Concealed:
   1. FSK
   2. ASJ
D. Ducts and Plenums, Exposed:
   1. Double wall spiral insulated type. See specification 15815 – Metal Ducts.

END OF SECTION

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PART 1 - GENERAL

1.1 SUMMARY

A. Section includes pipe and fitting materials and joining methods for the following:
   1. Steel pipe and fittings.
   2. Joining materials.
   3. Transition fittings.
   4. Dielectric fittings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of the following:
   1. Pipe.
   2. Fittings.
   3. Joining materials.
B. Delegated-Design Submittal:
   1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the enclosure structure.
   2. Locations of pipe anchors and alignment guides and expansion joints and loops.
   3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
   4. Locations of and details for penetration and firestopping for fire- and smoke-rated wall and floor and ceiling assemblies.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
   1. Condensate-Drain Piping: 150 deg F.

2.2 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L or Type M.
B. Wrought-Copper Unions: ASME B16.22.

2.3 PLASTIC PIPE AND FITTINGS

A. PVC Plastic Pipe: ASTM D 1785, with wall thickness as indicated in "Piping Applications" Article.
   1. PVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM D 2466 for Schedule 40 pipe; ASTM D 2467 for Schedule 80 pipe.

2.4 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless otherwise indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
B. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
C. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.
D. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.5 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Fittings:
   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:
      a. Charlotte Pipe and Foundry Company.
      b. IPEX USA LLC.
      c. Uponor.
      d. Viega LLC.
   2. One-piece fitting with one threaded brass or copper insert and one solvent-cement-joint end of material and wall thickness to match plastic pipe material.
B. Plastic-to-Metal Transition Unions:
   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:
      a. Charlotte Pipe and Foundry Company.
      b. IPEX USA LLC.
      c. NIBCO INC.
   2. Brass or copper end, solvent-cement-joint end of material and wall thickness to match plastic pipe material, rubber gasket, and threaded union.

2.6 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
B. Dielectric Unions:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Capitol Manufacturing Company.
      b. HART Industrial Unions, LLC.
      c. Matco-Norca.
      d. WATTS.
      e. Wilkins.

f. Zurn Industries, LLC.

2. Description:
   a. Standard: ASSE 1079.
   b. Pressure Rating: 125 psig minimum at 180 deg F.
   c. End Connections: Solder-joint copper alloy and threaded ferrous.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Above Ground Condensate-Drain Piping: Type M, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
B. Below Ground Condensate Drain Piping: Schedule 40 PVC plastic pipe and fittings and solvent-welded joints.

3.2 PIPING INSTALLATIONS

A. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
B. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to enclosure walls. Diagonal runs are prohibited unless specifically indicated otherwise.
C. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
D. Install piping at indicated slopes.
E. Install piping free of sags and bends.
F. Install fittings for changes in direction and branch connections.
G. Install piping to allow application of insulation.
H. Select system components with pressure rating equal to or greater than system operating pressure.
I. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
J. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
K. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
L. Install shutoff valve immediately upstream of each dielectric fitting.
M. Comply with requirements in Section 15077 "Identification for HVAC Piping and Equipment" for identifying piping.
N. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 15060 "Sleeves and Sleeve Seals for HVAC Piping."
O. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 15060 "Sleeves and Sleeve Seals for HVAC Piping."
P. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 15061 "Escutcheons for HVAC Piping."

3.3 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.

3.4 HANGERS AND SUPPORTS

A. Comply with requirements in Section 15050 " Hangers And Supports For Hvac Piping And Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.
B. Comply with requirements in Section 15074 "Vibration Controls for HVAC" for seismic restraints.
C. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
   2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
   3. Spring hangers to support vertical runs.
   4. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
   5. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.
D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
   1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
   2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
   3. NPS 1-1/4Maximum span, 7 feet; minimum rod size, 3/8 inch.
   4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
   5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
   6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
E. Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.
F. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.
E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
F. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.

2. PVC Pressure Piping: Join ASTM D 1785 schedule number, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule number PVC pipe and socket fittings according to ASTM D 2855.
3. PVC Nonpressure Piping: Join according to ASTM D 2855.

G. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.

3.6 FIELD QUALITY CONTROL

A. Prepare condensate piping according to ASME B31.9 and as follows:
1. Leave joints, including welds, uninsulated and exposed for examination during test.

END OF SECTION

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PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Refrigerant pipes and fittings.
   2. Refrigerant piping valves and specialties.
   3. Refrigerants.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of valve, refrigerant piping, and refrigerant piping specialty.
B. Shop Drawings:
   1. Show piping size and piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
   2. Show interface and spatial relationships between piping and equipment.
   3. Shop Drawing Scale: 1/4 inch equals 1 foot.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
B. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-410A:
   1. Suction Lines for Air-Conditioning Applications: 300 psig.
   2. Hot-Gas and Liquid Lines: 535 psig.

2.2 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 280, Type ACR.
B. Wrought-Copper Fittings: ASME B16.22.
C. Wrought-Copper Unions: ASME B16.22.
D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
E. Brazing Filler Metals: AWS A5.8/A5.8M.
F. Flexible Connectors:
   1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
   2. End Connections: Socket ends.

3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
4. Working Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 deg F.

2.3 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:
   1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
   2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
   3. Operator: Rising stem and hand wheel.
   4. Seat: Nylon.
   5. End Connections: Socket, union, or flanged.
   6. Working Pressure Rating: 500 psig.
   7. Maximum Operating Temperature: 275 deg F.

B. Packed-Angle Valves:
   1. Body and Bonnet: Forged brass or cast bronze.
   2. Packing: Molded stem, back seating, and replaceable under pressure.
   3. Operator: Rising stem.
   4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
   5. Seal Cap: Forged-brass or valox hex cap.
   6. End Connections: Socket, union, threaded, or flanged.
   7. Working Pressure Rating: 500 psig.
   8. Maximum Operating Temperature: 275 deg F.

C. Check Valves:
   1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
   2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
   3. Piston: Removable polytetrafluoroethylene seat.
   4. Closing Spring: Stainless steel.
   5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
   6. End Connections: Socket, union, threaded, or flanged.
   7. Maximum Opening Pressure: 0.50 psig.
   8. Working Pressure Rating: 500 psig.
   9. Maximum Operating Temperature: 275 deg F.

D. Service Valves:
   1. Body: Forged brass with brass cap including key end to remove core.
   2. Core: Removable ball-type check valve with stainless-steel spring.
   3. Seat: Polytetrafluoroethylene.
   4. End Connections: Copper spring.
   5. Working Pressure Rating: 500 psig.

E. Solenoid Valves: Comply with AHRI 760 and UL 429; listed and labeled by a National Recognized Testing Laboratory (NRTL).
   1. Body and Bonnet: Plated steel.
   2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
   3. Seat: Polytetrafluoroethylene.
   4. End Connections: Threaded.
   5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 115-V ac coil (if 24-V ac coil provided also provide means to transform voltage for connection).

6. Working Pressure Rating: 400 psig.
7. Maximum Operating Temperature: 240 deg F.

F. Safety Relief Valves: Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
2. Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Working Pressure Rating: 400 psig.
6. Maximum Operating Temperature: 240 deg F.

G. Thermostatic Expansion Valves: Comply with AHRI 750.
1. Body, Bonnet, and Seal Cap: Forged brass or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
5. Suction Temperature: 40 deg F.
6. Superheat: Adjustable.
7. Reverse-flow option (for heat-pump applications).
8. End Connections: Socket, flare, or threaded union.
9. Working Pressure Rating: 700 psig.

H. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.
1. Body, Bonnet, and Seal Cap: Ductile iron or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
5. Seat: Polytetrafluoroethylene.
6. Equalizer: External.
7. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter and 24, 115, or 208-V ac coil.
8. End Connections: Socket.
9. Throttling Range: Maximum 5 psig.
10. Working Pressure Rating: 500 psig.
11. Maximum Operating Temperature: 240 deg F.

I. Straight-Type Strainers:
1. Body: Welded steel with corrosion-resistant coating.
2. Screen: 100-mesh stainless steel.
3. End Connections: Socket or flare.
4. Working Pressure Rating: 500 psig.
5. Maximum Operating Temperature: 275 deg F.

J. Angle-Type Strainers:
1. Body: Forged brass or cast bronze.
2. Drain Plug: Brass hex plug.
3. Screen: 100-mesh monel.
4. End Connections: Socket or flare.
5. Working Pressure Rating: 500 psig.
6. Maximum Operating Temperature: 275 deg F.

K. Moisture/Liquid Indicators:
1. Body: Forged brass.

2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in parts per million (ppm).
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240 deg F.

L. Replaceable-Core Filter Dryers: Comply with AHRI 730.
1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 240 deg F.

M. Permanent Filter Dryers: Comply with AHRI 730.
1. Body and Cover: Painted-steel shell.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 240 deg F.

2.4 REFRIGERANTS

A. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

A. Suction Lines: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.
B. Hot-Gas and Liquid Lines[, and Suction Lines for Heat-Pump Applications]: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.
C. Safety-Relief-Valve Discharge Piping: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install diaphragm packless valves in suction and discharge lines of compressor.
B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
D. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.
E. Install a full-size, three-valve bypass around filter dryers.
F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.
G. Install thermostatic expansion valves as close as possible to distributors on evaporators.
    1. Install valve so diaphragm case is warmer than bulb.
    2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line. Confirm with manufacturer
    3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
H. Install safety relief valves where required by 2010 ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.
I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for the device being protected:
    1. Solenoid valves.
    2. Thermostatic expansion valves.
    3. Hot-gas bypass valves.
    4. Compressor.
K. Install filter dryers in liquid line between compressor and thermostatic expansion valve.
L. Install receivers sized to accommodate pump-down charge.
M. Install flexible connectors at compressors.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
B. Install refrigerant piping according to ASHRAE 15.
C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
F. Install piping adjacent to machines to allow service and maintenance.
G. Install piping free of sags and bends.
H. Install fittings for changes in direction and branch connections.
I. Select system components with pressure rating equal to or greater than system operating pressure.
J. Refer to sequence of operations on drawings for solenoid valve controllers, control wiring, and sequence of operation.
K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as per manufacturer requirements and mechanical code if valves or equipment requiring maintenance is concealed behind finished surfaces.
M. Install refrigerant piping in protective conduit where installed belowground.
N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
O. Slope refrigerant piping as follows:
    1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
    2. Install horizontal suction lines with a uniform slope downward to compressor.
    3. Install traps and double risers to entrain oil in vertical runs.
    4. Liquid lines may be installed level.
P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
Q. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
R. Identify refrigerant piping and valves according to Section 15077 "Identification for HVAC Piping and Equipment."
S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 15060 "Sleeves and Sleeve Seals for HVAC Piping."
T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 15060 "Sleeves and Sleeve Seals for HVAC Piping."
U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 15061 "Escutcheons for HVAC Piping."

3.4 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.
B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
C. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
    1. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.
    2. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze or steel.

3.5 HANGERS AND SUPPORTS

A. Comply with requirements for pipe hangers and supports specified in Section 15062 "Hangers and Supports for HVAC Piping and Equipment."
B. Install the following pipe attachments:
    1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
    2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
    3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.

4. Spring hangers to support vertical runs.
5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod diameters:
1. NPS 1/2: Maximum span, 60 inches; minimum rod, 1/4 inch.
2. NPS 5/8: Maximum span, 60 inches; minimum rod, 1/4 inch.
3. NPS 1: Maximum span, 72 inches; minimum rod, 1/4 inch.

D. Support multifloor vertical runs at least at each floor.

3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.
   a. Fill system with nitrogen to the required test pressure.
   b. System shall maintain test pressure at the manifold gage throughout duration of test.
   c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
   d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

B. Prepare test and inspection reports.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:
1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
1. Open shutoff valves in condenser water circuit.
2. Verify that compressor oil level is correct.
3. Open compressor suction and discharge valves.
4. Open refrigerant valves except bypass valves that are used for other purposes.

5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes split-system air-conditioning and heat pump units consisting of separate evaporator-fan and compressor-condenser components. Units are designed for exposed or concealed mounting and may be connected to ducts.

1.2 ACTION SUBMITTALS

A. Product Data: For each unit indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
B. Operation and maintenance data.

1.3 Quality Assurance

A. 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.
B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
D. Integral and standalone system Starters and Variable Frequency Drives (VFD's) shall comply with the requirements applicable ANSI standards for the application.

1.4 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace split-system air-conditioning units that fail in materials and workmanship within five years from date of Substantial Completion.

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:
   1. Daikin.
   2. Trane Co. (The); Unitary Products Group.
   3. York International Corp. / JCI

2.2 INDOOR EVAPORATOR UNIT (20 TONS OR MORE)

A. Evaporator-Fan Components:
   1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
   2. Insulation: Faced, glass-fiber duct liner.
   3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
   4. Fan: VFD or ECM controlled, invert duty, Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
   5. Fan Motors:

a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 15053 "Common Motor Requirements for HVAC Equipment."
b. Multi-tapped, multispeed with internal thermal protection and permanent lubrication.

6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
7. Filters:
   a. Disposable. Refer to manufacturer for 1-inch or 2-inch thick. Coordinate filter pull and size prior to order.
   b. Minimum Arrestance: According to ASHRAE 52.1 and MERV according to ASHRAE 52.2 (MERV 8 or as otherwise scheduled)
8. Condensate Drain Pans:
   a. Fabricated with two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
      1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
      2) Depth: A minimum of 2 inches deep.
   b. Single-wall, galvanized-steel sheet.
   c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
      1) Minimum Connection Size: NPS 1.
   d. Pan-Top Surface Coating: Asphaltic waterproofing compound.
   e. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

2.3 AIR-COOLED, VARIABLE SPEED COMPRESSOR-CONDSENSER UNIT (20 TONS OR MORE)

A. Outdoor/Condensing units: Air-cooled DX refrigeration units, designed specifically for use with indoor/evaporator units; factory assembled and wired with all necessary electronics and refrigerant controls; modular design for ganging multiple units.
   1. Refrigeration Circuit: Scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut-off valves, oil separators, service ports and refrigerant regulator.
   2. Refrigerant: Factory charged.
   3. Variable Flow Control: Modulate compressor capacity automatically to maintain constant suction and condensing pressure while varying refrigerant flow to suit heating/cooling loads.
   4. Capable of being installed with wiring and piping to the left, right, rear or bottom.
   5. Capable of heating operation at low end of operating range as specified, without additional low ambient controls or auxiliary heat source; during heating operation, reverse cycle (cooling mode) oil return or defrost is not permitted due to potential reduction in space temperature.
   6. Power Failure Mode: Automatically restart operation after power failure without loss of programmed settings.
   7. Provide refrigerant auto-charging and refrigerant charge check functions.
   8. Safety Devices: High pressure sensor and switch, low pressure sensor/switch, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload

protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-cycling timers.

9. Provide refrigerant sub-cooling to ensure the liquid refrigerant does not flash when supplying indoor units.
10. Oil Recovery Cycle: Automatic, occurring 2 hours after start of operation and then every 8 hours of operation; maintain continuous heating during oil return operation.
11. Controls: Provide contacts for electrical demand shedding.
12. Unit Cabinet: Weatherproof and corrosion resistant; rust-proofed mild steel panels coated with baked enamel finish.
    a. Designed to allow side-by-side installation with minimum spacing
13. Fans: One or more direct-drive propeller type, vertical discharge, with multiple speed operation via DC (Digitally Commutated) inverter.
    a. External Static Pressure: Factory set at .12" WG, minimum. Capable of up to .32" WG External Static Pressure
    b. Fan Airflow: As indicated for specific equipment.
    c. Fan Motors: Factory installed; permanently lubricated bearings; inherent protection; fan guard; output as indicated for specific equipment.
14. Condenser Coils: Copper tubes expanded into aluminum fins to form a mechanical bond; waffled louver fin and rifled bore tube design to ensure high efficiency performance.
15. Compressors: Scroll type, hermetically sealed, variable speed inverter-driven and fixed speed in combination to suit total capacity; minimum of one variable speed, inverter driven compressor per condenser unit; minimum of two compressors per condenser unit; capable of controlling capacity within range of 6 percent to 100 percent of total capacity.
    a. Variable Speed Control: Capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure; high/low pressure calculated by samplings of evaporators and condenser temperatures every 20 seconds, with compressor capacity adjusted to eliminate deviation from target value by changing inverter frequency or on/off setting of fixed speed compressors.
    b. Multiple Condenser Modules: Balance total operation hours of compressors by means of duty cycling function, providing for sequential starting of each module at each start/stop cycle, completion of oil return and completion of defrost, or every 8 hours.
    c. Failure Mode: In the event of compressor failure, operate remaining compressor(s) at proportionally reduced capacity; provide microprocessor and associated controls specifically designed to address this condition.
    d. Inverter Driven Compressors: PWM inverter driven, highly efficiency reluctance DC (Digitally Commutated), hermetically sealed scroll with maximum speed of 7,980 rpm.
    e. Rotors: Incorporating neodymium magnets for higher torque and efficiency; at complete stop of compressor, position rotor into optimum position for low torque start.
    f. Provide each compressor with crankcase heater, high pressure safety switch and internal thermal overload protector.
    g. Provide oil separators and intelligent oil management system.

B. Casing steel, finished with baked enamel, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
C. Heat Pump Components: Reversing valve and low-temperature air cut-off thermostat.
D. Low Ambient Kit: Permits operation down to 0 deg F.

2.4 ACCESSORIES

A. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.
   1. Minimum Insulation Thickness: 1 inch thick.
B. Automatic-reset timer to prevent rapid cycling of compressor.
C. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

2.5 CONTROLS

A. Each unit shall be supplied with a wall mounted thermostat controller. The controller shall have a backlit LCD display and be able to support the following display items and user input operations:
B. The controllers shall be capable of diagnostic use and provide malfunction codes to indicate the type of failure that has occurred. The user shall be able to read superheat temperatures, return air and discharge air temperature values directly from the wall mounted thermostats.
C. The controllers shall be capable of accepting independent set points for cooling and heating operation. The use of a common set point is not allowable.
D. The system shall provide automatic change-over from heating to cooling mode of operation. If, in heating mode, the space temperature rises 1 degree above the cooling set point, the system shall change from heating to cooling mode. If, in cooling mode, the space falls 1 degree below the heating set point, the system shall change from cooling to heating mode. Auto-change-over is required for all systems (heat pump and heat recovery). If not available in heat pump system, then manufacturer must provide system capable of meeting this requirement.
E. Adjustable setback temperature – The controllers shall allow for independent and adjustable setback temperature at each unit. The setback temperature (adjustable) shall determine the “override” temperature to start the system when in setback mode if the temperature rises or falls outside of the specified range.
F. Where VRF systems are specified with electric heaters (external), the wall mounted controllers shall directly control the external heater. The electric heat shall be considered the primary heating source unless the central controller is used to provide an alternate control strategy

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
B. Install ground-mounted, compressor-condenser components on 6-inch-thick, reinforced concrete base; 6 inches larger on each side than unit. Refer to Structural for concrete, reinforcement, and formwork specifications. Coordinate anchor installation with concrete base.

C. Install compressor-condenser components on vibration isolators with a minimum static deflection per specification Division 15 Section "Vibration Controls for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Connect pre-charged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.
B. Connect supply and return water coil with shut-off-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.
C. Connect supply and return condenser connections with shut-off-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.
D. Install piping adjacent to unit to allow service and maintenance.
E. Connect refrigerant piping to air-cooled compressor and condenser units; maintain required access to unit. Install furnished field-mounted accessories. Refrigerant piping and specialties are specified in Section 15183 "Refrigerant Piping.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
B. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.
   2. Leak Test: After installation, charge system with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor operation and unit operation, product capability, and compliance with requirements.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   5. Verify proper airflow over coils
C. Remove and replace malfunctioning units and retest as specified above.
D. Prepare test and inspection reports

END OF SECTION

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PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Single-wall rectangular ducts and fittings.
   2. Double-wall rectangular ducts and fittings
   3. Single-wall round ducts and fittings.
   4. Double-wall round ducts and fittings.
   5. Double-wall round exterior ducts and fittings.
   6. Sheet metal materials.
   7. Sealants and gaskets.
   8. Hangers and supports.

B. Related Sections:
   1. Section 15950 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
   2. Section 15820 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and ASCE/SEI 7.

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ANSI/ASHRAE 62.1.

1.3 ACTION SUBMITTALS

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

B. Sustainable Design Submittals:
   1. Product Data: For ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."
   2. Product Data: For adhesives, indicating VOC content.
   3. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
   4. Product Data: For sealants, indicating VOC content.
   5. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings:
   1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
   2. Factory- and shop-fabricated ducts and fittings.
   3. Duct layout indicating sizes, configuration, and static-pressure classes.
   4. Elevation of top of ducts.
   5. Dimensions of main duct runs from Enclosure grid lines.
   6. Fittings.
   7. Reinforcement and spacing.

8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and Enclosure attachment and vibration isolation.

D. Delegated-Design Submittal:
1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations for selecting hangers and supports.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:
    a. Luminaires.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.
    f. Perimeter moldings.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

D. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. Basis-of-Design Product: Subject to compliance with requirements, provide MKT Metal Manufacturing; MKT Double-Wall Rectangular Ducts and Fittings, or a comparable product by one of the following:
   1. McGill AirFlow LLC.
   2. Sheet Metal Connectors, Inc.
B. Rectangular Ducts: Fabricate ducts with indicated dimensions for the inner duct.
C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
D. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
E. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
F. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
   1. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
   2. Coat insulation with antimicrobial coating.
   3. Cover insulation with polyester film complying with UL 181, Class 1.
G. Inner Duct: Minimum 0.028-inch solid sheet steel.
H. Formed-on Transverse Joints (Flanges): Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Traverse Joints," for static-pressure class, applicable sealing

requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

I. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
   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:
      a. Ductmate Industries, Inc.
      b. Elgen Manufacturing.
      c. MKT Metal Manufacturing.
      d. Set Duct Manufacturing.
      e. Stamped Fittings Inc.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   1. Fabricate round ducts larger Than 90 inches in diameter with butt-welded longitudinal seams.

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.4 DOUBLE-WALL ROUND DUCTS AND FITTINGS

A. Basis-of-Design Product: Subject to compliance with requirements, provide MKT Metal Manufacturing; MKT Double-Wall Round Ducts and Fittings, or a comparable product by one of the following:
   1. McGill AirFlow LLC.
   2. SEMCO LLC.
   3. Sheet Metal Connectors, Inc.

B. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.
   1. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct

Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

a. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

2. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   a. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
   b. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
3. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Inner Duct: Minimum 0.028-inch solid sheet steel.

D. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
1. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
2. Coat insulation with antimicrobial coating.
3. Cover insulation with polyester film complying with UL 181, Class 1.

2.5 DOUBLE-WALL ROUND EXTERIOR DUCTS AND FITTINGS

A. Basis-of-Design Product: Subject to compliance with requirements, provide MKT Metal Manufacturing; MKT WEATHERGUARD™, or a comparable product by one of the following:
1. McGill AirFlow LLC.
2. SEMCO LLC.
3. Sheet Metal Connectors, Inc.

B. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.
1. Transverse Joints: Select Exterior duct systems require, for performance, an Accuflange or equal flange joining system utilizing a "barrel clamp" type of positive sealing device. Barrel clamps will have EPDM, closed cell foam gasket in the contact area with both flanges of adjoining pipe.
2. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   a. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
   b. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
3. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and

Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." Field "cut in" saddle type taps are not allowed with prefabricated systems unless written consent is provided by the manufacturer.

C. Inner Duct: Minimum 0.028-inch solid sheet steel.
D. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
E. Barrel Clamps: Barrel clamps with EPDM closed cell foam gaskets, and threaded locking bolt.
F. Outdoor Shell Cladding: 7-mil-smooth, 14-mil-embossed, pressure adhesive foil with ultraviolet and weather protection characteristics, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with stucco-embossed aluminum-foil facing.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. 3M VentureClad.
   2. Where the outer spiral shell butts to flange, apply a polyurethane sealer over the foil cladding, sealing the system.
   3. Extra Materials: Provide sufficient quantity for field touch up.

2.6 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G90.
   2. Finishes for Surfaces Exposed to View: Mill phosphatized.
C. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
D. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
   1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
E. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.7 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
B. Two-Part Tape Sealing System:
   1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
   2. Tape Width: 4 inches.
   3. Sealant: Modified styrene acrylic.
   4. Water resistant.

5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
11. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Water-Based Joint and Seam Sealant:
1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.
1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

F. Round Duct Joint O-Ring Seals:
1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.8 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
H. Trapeze and Riser Supports:
   1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
   2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
   3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
C. Install ducts in maximum practical lengths.
D. Install ducts with fewest possible joints.
E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to Enclosure lines.
G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of Enclosure. Install high as possible unless otherwise indicated on drawings.
H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 15820 "Air Duct Accessories" for fire and smoke dampers.
L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
B. Seal ducts at a minimum to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
   1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   2. All ductwork shall be seal class A.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
B. Enclosure Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Where practical, install concrete inserts before placing concrete.
   2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
   3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
   4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
D. Hangers Exposed to View: Threaded rod and angle or channel supports.
E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 15820 "Air Duct Accessories."
B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.
B. Use service openings for entry and inspection.
   1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 15820 "Air Duct Accessories" for access panels and doors.

2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:
1. When venting vacuuming system inside the Enclosure, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into Enclosure.

D. Clean the following components by removing surface contaminants and deposits:
1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:
1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from Enclosure.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.7 START UP

A. Air Balance: Comply with requirements in Section 15950 "Testing, Adjusting, and Balancing for HVAC."

3.8 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
B. Supply Ducts:
1. Ducts Connected to Constant-Volume Air-Handling Units:
a. Pressure Class: Positive 2-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 6.

d. SMACNA Leakage Class for Round: 6.
e. SMACNA Leakage Class for Round: 6.

C. Return Ducts:
1. Ducts Connected to Air-Handling Units:
a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 6.
d. SMACNA Leakage Class for Round: 6.

D. Intermediate Reinforcement:
1. Galvanized-Steel Ducts: Galvanized steel.

E. Elbow Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
4) Radius-to Diameter Ratio: 1.5.
b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam or Welded.

F. Branch Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: Spin in.
2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
a. Velocity 1000 fpm or Lower: 90-degree tap.
b. Velocity 1000 to 1500 fpm: Conical tap.
c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION

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PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Insulated flexible ducts.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Sustainable Design Submittals:
   1. Product data showing compliance with ASHRAE 62.1.
   2. Laboratory Test Reports: For Insulation, indicating compliance with requirements for low-emitting materials.
   3. Product Data : For insulation, indicating that R-values comply with tables in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air Conditioning."
C. Shop Drawings: For flexible ducts.
   1. Include plans showing locations and mounting and attachment details.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, and coordinated with each other, using input from installers of the items involved.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
C. Comply with the Air Diffusion Council's "ADC Flexible Air Duct Test Code FD 72-R1."
D. Comply with ASTM E 96/E 96M, "Test Methods for Water Vapor Transmission of Materials."

2.2 INSULATED FLEXIBLE DUCTS

A. Insulated, Flexible Duct: UL 181, Class 1, two-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
   1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
   2. Maximum Air Velocity: 4000 fpm.
   3. Temperature Range: Minus 10 to plus 160 deg F.
   4. Insulation R-Value: Comply with ASHRAE/IES 90.1.

2.3 FLEXIBLE DUCT CONNECTORS

A. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.
B. Non-Clamp Connectors: Adhesive plus sheet metal screws.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install flexible ducts according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
B. Install in indoor applications only. Flexible ductwork should not be exposed to UV lighting.
C. Connect diffusers or light troffer boots to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.
D. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.
E. Install duct test holes where required for testing and balancing purposes.
F. Installation:
    1. Install ducts fully extended.
    2. Do not bend ducts across sharp corners.
    3. Bends of flexible ducting shall not exceed a minimum of one duct diameter.
    4. Avoid contact with metal fixtures, water lines, pipes, or conduits.
    5. Install flexible ducts in a direct line, without sags, twists, or turns.
G. Supporting Flexible Ducts:
    1. Suspend flexible ducts with bands 1-1/2 inches wide or wider and spaced a maximum of 48 inches apart. Maximum centerline sag between supports shall not exceed 1/2 inch per 12 inches.
    2. Install extra supports at bends placed approximately one duct diameter from center line of the bend.
    3. Ducts may rest on ceiling joists or truss supports. Spacing between supports shall not exceed the maximum spacing per manufacturer's written installation instructions.
    4. Vertically installed ducts shall be stabilized by support straps at a maximum of 72 inches o.c.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Backdraft and pressure relief dampers.
   2. Manual volume dampers.
   3. Control dampers.
   4. Flange connectors.
   5. Turning vanes.
   6. Duct-mounted access doors.
   7. Flexible connectors.
   8. Duct accessory hardware.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Sustainable Design Submittals:
   1. Product data showing compliance with ASHRAE 62.1.
   2. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
      a. Special fittings.
      b. Manual volume damper installations.
      c. Control-damper installations.
      d. Fire-damper and smoke-damper installations, including sleeves; and duct-mounted access doors.
      e. Wiring Diagrams: For power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G60.
   2. Exposed-Surface Finish: Mill phosphatized.
B. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and number No. 2 finish for exposed ducts.
C. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

D. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.
E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 BACKDRAFT AND PRESSURE RELIEF DAMPERS

A. 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:
   1. American Warming and Ventilating; a Mestek Architectural Group company.
   2. Greenheck Fan Corporation.
   3. Nailor Industries Inc.
   4. Ruskin Company.
   5. United Enertech.
   6. Vent Products Co., Inc.
B. Description: Gravity balanced.
C. Maximum Air Velocity: 2000 fpm.
D. Maximum System Pressure: 2-inch wg.
E. Frame: Hat-shaped, 0.05-inch-thick, galvanized sheet steel, with welded corners or mechanically attached and mounting flange.
F. Blades: Multiple single-piece blades, center pivoted, maximum 6-inch width, 0.050-inch-thick aluminum sheet noncombustible, tear-resistant, neoprene-coated fiberglass with sealed edges.
G. Blade Action: Parallel.
H. Blade Seals: Extruded vinyl, mechanically locked.
I. Blade Axles:
   1. Material: Nonferrous metal.
   2. Diameter: 0.20 inch.
J. Tie Bars and Brackets: Aluminum.
K. Return Spring: Adjustable tension.
L. Bearings: Steel ball or synthetic pivot bushings.
M. Accessories:
   1. Adjustment device to permit setting for varying differential static pressure.
   2. Counterweights and spring-assist kits for vertical airflow installations.
   3. Electric actuators.
   4. Chain pulls.
   5. Screen Mounting: Rear mounted.
   6. Screen Material: Galvanized steel.
   7. Screen Type: Bird.
   8. 90-degree stops.

2.4 MANUAL VOLUME DAMPERS PF

A. Standard, Steel, Manual Volume Dampers:
   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:
      a. Aire Technologies.
      b. McGill AirFlow LLC.

c. Nailor Industries Inc.
d. Ruskin Company.
e. United Enertech.

2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:
   a. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel.
   b. Mitered and welded corners.
   c. Flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
   a. Multiple or single blade.
   b. Parallel- or opposed-blade design.
   c. Stiffen damper blades for stability.
   d. Galvanized-steel, 0.064 inch thick.
6. Blade Axles: Galvanized steel or Nonferrous metal.
7. Bearings:
   a. Oil-impregnated bronze, Molded synthetic, or Oil-impregnated stainless-steel sleeve.
   b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
8. Tie Bars and Brackets: Galvanized steel.

B. Standard, Aluminum, Manual Volume Dampers:
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:
   a. American Warming and Ventilating; a Mestek Architectural Group company.
   b. McGill AirFlow LLC.
   c. Nailor Industries Inc.
   d. Ruskin Company.
   e. United Enertech.
   f. Vent Products Co., Inc.
2. Standard leakage rating.
3. Suitable for horizontal or vertical applications.
4. Frames: Hat-shaped, 0.10-inch-thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
   a. Multiple or single blade.
   b. Parallel- or opposed-blade design.
   c. Stiffen damper blades for stability.
   d. Roll-Formed Aluminum Blades: 0.10-inch-thick aluminum sheet.
   e. Extruded-Aluminum Blades: 0.050-inch-thick extruded aluminum.
6. Blade Axles: Galvanized steel or Nonferrous metal.
7. Bearings:
   a. Oil-impregnated bronze or Molded synthetic.
   b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
8. Tie Bars and Brackets: Aluminum.

C. Jackshaft:
1. Size: 0.5-inch diameter.

2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

D. Damper Hardware:
1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.5 CONTROL DAMPERS

A. 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:
1. American Warming and Ventilating; a Mestek Architectural Group company.
2. Greenheck Fan Corporation.
3. McGill AirFlow LLC.
4. Nailor Industries Inc.
5. Ruskin Company.
6. United Enertech.

B. Frames:
1. Hat shaped.
2. 0.094-inch-thick, galvanized sheet steel.
3. Mitered and welded corners.

C. Blades:
1. Multiple blade with maximum blade width of 6 inches.
2. Parallel- and opposed-blade design.
3. Galvanized-steel.
4. 0.064 inch thick single skin.
5. Blade Edging: Closed-cell neoprene.
6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.

D. Blade Axles: 1/2-inch-diameter; galvanized steel or nonferrous metal; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
1. Operating Temperature Range: From minus 40 to plus 200 deg F.

E. Bearings:
1. Oil-impregnated bronze or Molded synthetic.
2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
3. Thrust bearings at each end of every blade.

2.6 FLANGE CONNECTORS

A. 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:
1. CL WARD & Family Inc.
2. Ductmate Industries, Inc.
3. Nexus PDQ.
4. Ward Industries; a brand of Hart & Cooley, Inc.

B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.
D. Gage and Shape: Match connecting ductwork.

2.7 TURNING VANES

A. 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:
   1. Aero-Dyne Sound Control Co.
   2. CL WARD & Family Inc.
   3. Ductmate Industries, Inc.
   4. Hardcast, Inc.
   5. METALAIRE, Inc.
   6. SEMCO LLC.
   7. Ward Industries; a brand of Hart & Cooley, Inc.
B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
   1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."
D. Vane Construction: Doublewall.

2.8 DUCT-MOUNTED ACCESS DOORS

A. 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:
   1. Aire Technologies.
   2. CL WARD & Family Inc.
   3. Ductmate Industries, Inc.
   4. Elgen Manufacturing.
   5. Greenheck Fan Corporation.
   6. McGill AirFlow LLC.
   7. Nailor Industries Inc.
   8. Pottorff.
   9. United Enertech.
   10. Ward Industries; a brand of Hart & Cooley, Inc.
B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
   1. Door:
      a. Double wall, rectangular.
      b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
      c. Vision panel.
      d. Hinges and Latches: 1-by-1-inchbutt or piano hinge and cam latches.
      e. Fabricate doors airtight and suitable for duct pressure class.
   2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
   3. Number of Hinges and Locks:

a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches.
d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

2.9 DUCT ACCESS PANEL ASSEMBLIES

A. 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:
   1. 3M.
   2. CL WARD & Family Inc.
   3. Ductmate Industries, Inc.
   4. Flame Gard, Inc.
B. Labeled according to UL 1978 by an NRTL.
C. Panel and Frame: Minimum thickness 0.0528-inch carbon steel.
D. Fasteners: Carbon steel. Panel fasteners shall not penetrate duct wall.
E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.
F. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.10 FLEXIBLE CONNECTORS

A. 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:
   1. CL WARD & Family Inc.
   2. Ductmate Industries, Inc.
   3. Elgen Manufacturing.
   4. JP Lamborn Co.
   5. Ward Industries; a brand of Hart & Cooley, Inc.
B. Materials: Flame-retardant or noncombustible fabrics.
C. Coatings and Adhesives: Comply with UL 181, Class 1.
D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.
E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
   1. Minimum Weight: 26 oz./sq. yd..
   2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
   3. Service Temperature: Minus 40 to plus 200 deg F.
F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
   1. Minimum Weight: 24 oz./sq. yd..
   2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
   3. Service Temperature: Minus 50 to plus 250 deg F.

2.11 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
    1. Install steel volume dampers in steel ducts.
    2. Install aluminum volume dampers in aluminum ducts.
E. Set dampers to fully open position before testing, adjusting, and balancing.
F. Install test holes at fan inlets and outlets and elsewhere as indicated.
G. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
    1. On both sides of duct coils.
    2. Upstream and downstream from duct filters.
    3. At outdoor-air intakes and mixed-air plenums.
    4. At drain pans and seals.
    5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
    6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
    7. At each change in direction and at maximum 50-foot spacing.
    8. Upstream and downstream from turning vanes.
    9. Upstream or downstream from duct silencers.
    10. Control devices requiring inspection.
    11. Elsewhere as indicated.
H. Install access doors with swing against duct static pressure.
I. Access Door Sizes:
    1. One-Hand or Inspection Access: 8 by 5 inches.
    2. Two-Hand Access: 12 by 6 inches.
    3. Head and Hand Access: 18 by 10 inches.
    4. Head and Shoulders Access: 21 by 14 inches.
    5. Body Access: 25 by 14 inches.
    6. Body plus Ladder Access: 25 by 17 inches.
J. Label access doors according to Section 15077 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
K. Install flexible connectors to connect ducts to equipment.

L. Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.
M. Connect diffusers or light troffer boots to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.
N. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.
O. Install duct test holes where required for testing and balancing purposes.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Operate dampers to verify full range of movement.
   2. Inspect locations of access doors and verify that purpose of access door can be performed.
   3. Operate fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
   4. Inspect turning vanes for proper and secure installation.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. In-line centrifugal fans.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.
   3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
   4. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

PART 2 - PRODUCTS

2.1 IN-LINE CENTRIFUGAL FANS

A. 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:
   1. Greenheck Fan Corporation.
   2. Loren Cook Company.
B. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.
C. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing; with wheel, inlet cone, and motor on swing-out service door.
D. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.
E. Accessories:
   1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
   2. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
   3. Companion Flanges: For inlet and outlet duct connections.

4. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
5. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

F. Capacities and Characteristics: As indicated on drawings
1. Vibration Isolators:
a. Type: Elastomeric hangers.
b. Static Deflection: 1 inch.

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 15053 "Common Motor Requirements for HVAC Equipment."
1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

B. Enclosure Type: Totally enclosed, fan cooled.

2.3 SOURCE QUALITY CONTROL

A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Equipment Mounting:
1. Comply with requirements for vibration isolation devices specified in Section 15074 "Vibration Controls for HVAC."

B. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

C. Support suspended units from structure using threaded steel rods and elastomeric hangers having a static deflection of 1 inch. Vibration-control devices are specified in Section 15074 "Vibration Controls for HVAC."

D. Install units with clearances for service and maintenance.

E. Label units according to requirements specified in Section 15077 "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 15820 "Air Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Section 16550 "Grounding."

D. Connect wiring according to Section 16200 "Wiring."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:
   1. Verify that shipping, blocking, and bracing are removed.
   2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
   3. Verify that cleaning and adjusting are complete.
   4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
   5. Adjust belt tension.
   6. Adjust damper linkages for proper damper operation.
   7. Verify lubrication for bearings and other moving parts.
   8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
   9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
   10. Shut unit down and reconnect automatic temperature-control operators.
   11. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Comply with requirements in Section 15950 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

D. Replace fan and motor pulleys as required to achieve design airflow.

E. Lubricate bearings.

END OF SECTION

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PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Rectangular and square ceiling diffusers.
   2. Perforated diffusers.
   3. Louver face diffusers.
B. Related Requirements:
   1. Section 15820 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 RECTANGULAR AND SQUARE CEILING DIFFUSERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Krueger.
   2. METALAIRE, Inc.
   3. Price Industries.
   4. Titus.
   5. Tuttle & Bailey.
B. Devices shall be specifically designed for variable-air-volume flows.
C. Characteristics and requirements shall be basis of design according to the equipment scheduled in the drawings.
D. Accessories:
   1. Equalizing grid.
   2. Plaster ring.
   3. Safety chain.
   4. Wire guard.
   5. Sectorizing baffles.
   6. Operating rod extension.

2.2 PERFORATED DIFFUSERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Krueger.
   2. METALAIRE, Inc.
   3. Price Industries.
   4. Titus.
   5. Tuttle & Bailey.
B. Characteristics and requirements shall be basis of design according to the equipment scheduled in the drawings.
C. Pattern Controller: Adjustable with louvered pattern modules at inlet.
D. Dampers: Opposed blade.
E. Accessories:

1. Equalizing grid.
2. Plaster ring.
3. Wire guard.
4. Sectorizing baffles.
5. Operating rod extension.

2.3 LOUVER FACE DIFFUSERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. METALAIRE, Inc.
   2. Price Industries.
   3. Titus.
   4. Tuttle & Bailey.
B. Devices shall be specifically designed for variable-air-volume flows.
C. Characteristics and requirements shall be basis of design according to the equipment scheduled in the drawings.
D. Accessories:
   1. Square to round neck adaptor.
   2. Adjustable pattern vanes.
   3. Throw reducing vanes.
   4. Equalizing grid.
   5. Plaster ring.
   6. Wire guard.
   7. Sectorizing baffles.
   8. Operating rod extension.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install diffusers level and plumb.
B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
C. Install diffusers with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.2 ADJUSTING

A. After installation, adjust diffusers to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Adjustable blade face registers and grilles.
   2. Fixed face registers and grilles.

B. Related Requirements:
   1. Section 15820 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to registers and grilles.
   2. Section 15855 "Air Diffusers" for various types of air diffusers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 ADJUSTABLE BLADE FACE REGISTERS AND FIXED FACE REGISTERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Krueger.
   2. METALAIRE, Inc.
   3. Price Industries.
   4. Titus.
   5. Tuttle & Bailey.

B. Characteristics and requirements shall be basis of design according to the equipment scheduled in the drawings.

2.2 GRILLES

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Krueger.
   2. METALAIRE, Inc.
   3. Price Industries.
   4. Titus.
   5. Tuttle & Bailey.

B. Characteristics and requirements shall be basis of design according to the equipment scheduled in the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install registers and grilles level and plumb.

B. Outlets and Inlets Locations: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install registers and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.2 ADJUSTING

A. After installation, adjust registers and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Airside testing, adjusting, and balancing of the air handling systems and fans.

1.2 SUBMITTALS

A. Test and Balance Reports:
   1. Submit prior to final acceptance of project and for inclusion in operating and maintenance manuals.
   2. Provide in soft cover, letter size, 3-ring binder, with index page and tabs, and cover identification.
   3. Include reduced scale drawings with thermostat locations, all air devices, air handling units, and fans located to correspond with data sheets.

B. Test and Balance Report Forms: NEBB forms, in English units.

1.3 AGENCIES

A. Work shall be performed by INDEPENDENT certified HVAC testing and balancing contractor sub-contracted to the General Contractor.

B. The HVAC testing and balancing contractor shall be certified by NEBB and use methods and procedures approved by the National Environmental Balancing Bureau (NEBB).

C. All work shall be performed at the site by a NEBB certified HVAC test and balance technician.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

A. Before commencing work, verify with the general contractor all air handling systems and fans systems start-up procedures have been completed by the mechanical contractor or manufactures representative.

B. Report any omissions, defects, deficiencies, or abnormal conditions with mechanical systems or equipment which prevents system testing, adjusting, and balancing.

C. Beginning of the testing, adjusting, and balancing process means acceptance by the testing and balancing contractor the systems are in acceptable operating condition.

D. Recorded data shall represent actually measured or observed condition.

E. Permanently mark settings of dampers and other adjustment devices. Set and lock memory stops.

F. Record return air, supply air, suction, and hot gas temperatures following balance. Provide in report.

3.2 INSTALLATION TOLERANCES

A. Air conditioning air handling systems supply airflow: within plus or minus 5 percent of design flow.

B. Air conditioning air handling systems return airflow: within plus or minus 10 percent of design flow.

C. Supply and return fan airflow: plus or minus 10 percent of design flow
D. Supply, and return air devices airflow: Adjust to within plus or minus 10 percent of design flow

3.3 AIR SYSTEM TESTING AND BALANCING EXPECTATIONS

A. Adjust air handling systems and fans systems to provide design supply, return, and outside air design air flow quantities within the stated tolerances.
B. Measure supply, return, and outside air flow quantity measurements by traversing the entire cross sectional area of duct as per NEBB standard practices.
C. Measure air quantities at all supply, and return air devices.
D. Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels.
E. Adjust all automatic volume dampers to provide airflow within the stated tolerances of the design airflow.
F. Where modulating dampers are provided, take measurements and balance to maximum airflow.

END OF SECTION

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required to provide, and make ready for operation, two (2) INDOOR 5kV Metal-Clad Switchgears (in combination with 5kV Vacuum Circuit Breakers), and with connecting 5kV overhead bus duct system (totally enclosed bus duct/tie bus duct, complete with overhead bus duct support system), as specified herein. Both Metal-Clad Switchgears and the connecting 5kV overhead bus duct system shall be used as the 5kV (voltage class) power distribution assemblies serving the 5kV medium voltage sub-distribution system to the Low Service Pump Station at the Ullrich Water Treatment Plant in Austin, Texas.

1. The Switchgears and the connecting 5kV overhead bus duct system (tie-bus) shall be installed in a climate controlled electrical building identified on the PLANS as Substation No. 4.

2. The switchgears are tagged “SUB4-SWGR-03” and “SUB4-SWGR-04” on the PLANS.

B. Furnish all labor, materials, equipment and incidentals required to provide, and make ready for operation, two (2) INDOOR 15kV Metal-Clad Switchgears (in combination with 15kV Vacuum Circuit Breakers), and with connecting 15kV overhead bus duct system (totally enclosed bus duct/tie bus duct, complete with overhead bus duct support system), as specified herein. Both Metal-Clad Switchgears and the connecting 15kV overhead bus duct system shall be used as the main 15kV (voltage class) power distribution assemblies serving the 15kV medium voltage sub-distribution system to the Low Service Pump Station and the Powder Activated Carbon building at the Ullrich Water Treatment Plant in Austin, Texas.

1. The Switchgears and the connecting 15kV overhead bus duct system (tie-bus) shall be installed in a climate controlled electrical building identified on the PLANS as Substation No. 4.

2. The switchgears are tagged “SUB4-SWGR-01” and “SUB4-SWGR-02” on the PLANS

C. Furnish all labor, materials, equipment and incidentals required to provide, and make ready for operation, two (2) INDOOR 15kV Metal-Clad Metering and Load Isolation Switchgears, hereinafter referred to as the Primary Metering Cabinets, (in combination with one (1) 15kV Load interrupter switch) as specified herein. Both Primary Metering Cabinets shall be used as the main 15kV (voltage class) Austin Energy metering assemblies serving the 15kV medium voltage sub-distribution system to the Low Service Pump Station and the Powder Activated Carbon building at the Ullrich Water Treatment Plant in Austin, Texas.

1. The Primary Metering Cabinets shall be installed in a climate controlled electrical building identified on the PLANS as Substation No. 4.

2. The Primary Metering Cabinets are tagged "SUB4-PMC-01" and "SUB4-PMC-02" on the PLANS

D. The bussing of all Switchgears is intended to be designed as such to allow direct/coupling with future feeder breaker sections added to the Switchgears.

E. The arrangement and dimensions of the Metal-Clad Switchgears and the overhead bussing shall be as shown on the PLANS. Design, arrangement and physical dimensions of the Switchgears and the medium voltage overhead bus duct systems are based on information provided by Schneider Electric (Square D) and Eaton. Any other arrangement will not be accepted without prior approval of the owner/engineer.

F. The arrangement and dimensions of the Primary Metering Cabinets shall be as shown on the PLANS and as specified in paragraph 2.01 D this Section of the Specifications. Design, arrangement and physical dimensions of the Primary Metering Cabinets are based on information provided by Powell Electrical Systems, Inc. and Elliott Industries, Inc. Any other arrangement will not be accepted without prior approval of the owner/engineer.

G. All parts, components, wiring, etc. within each section of each Metal-Clad Switchgear, and the medium voltage overhead bus duct systems shall be installed/assembled at the factory. No field work shall be involved besides unloading, setting, connecting Switchgear bussing at point of split-shipping, connecting medium voltage overhead bus duct system to the 5kV and 15kV Switchgears, and testing/commissioning the entire assemblies (Switchgear and Switchgear bus duct assemblies).

H. All parts, components, wiring, etc. within each section of each Primary Metering Cabinet shall be installed/assembled at the factory. No field work shall be involved besides unloading, setting and testing/commissioning the Primary Metering Cabinets.

1.02 RELATED REQUIREMENTS

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.

C. PLANS designate type, number, size, and rating of devices included in the Metal-Clad Switchgears, and the ratings of the medium voltage overhead bus duct system.

D. Comply with the requirements of all sections in Division-16 of the Contract Specifications, PLANS, and the Contract Documents.

1.03 QUALITY ASSURANCE

A. The manufacturer of the Metal-Clad Switchgears shall also manufacture the majority of components and subsystems therein (i.e., vacuum circuit breakers, current transformers, potential transformers, etc.).

B. The manufacturer of the 5kV and 15kV medium voltage overhead bus duct systems shall be the same as the manufacturer of the 5kV and 15kV Switchgears, respectively.

C. For the Metal-Clad Switchgears, furnish equipment meeting these specifications and manufactured by Schneider Electric (Square D), Eaton, Asea Brown Boveri "ABB", or approved equal. All equipment, components, etc., shall be manufactured in the USA if at all possible.

D. For the Primary Metering Cabinets, furnish equipment meeting these specifications and manufactured by Powell Electrical Systems, Inc., Elliott Industries, Inc., or approved equal. All equipment, components, etc., shall be manufactured in the USA if at all possible.

E. 5kV and 15kV medium voltage overhead bus duct system shall be as manufactured by Eaton type Metal-Enclosed, or approved equal by Schneider Electric (Square-D), Asea Brown Boveri "ABB", or approved equal. All equipment, components, etc., shall be manufactured in the USA if at all possible.

F. Standardization: All like equipment shall be the product and assembly of the same manufacturer.

G. Standards: Comply with the latest requirements of NEMA, OSHA, NEC and all building codes. Design, construct, assemble and test in accordance with AISC, AISI, ASTM, NEMA , IEEE, U.L. and ANSI standards, including NEMA SG-4, 5, 6 and ANSI C37.0/0, .04, .06, .07, .09, .100, .11, .20, .20.2, .20.21, .55 and .24. The Primary Metering Cabinets, the Metal-Clad Switchgears line-up and the Overhead Bus System, inclusive of the surge capacitors and lightning arresters installed in the Metal-Clad Switchgears, shall be U.L Listed.

1.04 SHOP DRAWING SUBMITTALS

A. Submit complete shop drawings and engineering data for review per the requirements of Section 01300 and Section 01730 of the Contract Specifications. At minimum, shop drawings data shall include the requirements of this Subsection of the Specifications.

B. As minimum, for each Metal-Clad Switchgear:

1. Elementary wiring diagrams.
2. Detailed control wiring diagrams.
3. One-line and three-line diagrams.
4. Plan view and front elevation.

5. Bill of materials and catalog cut sheets on all materials.
6. Instrument panel arrangements.
7. Component arrangement on large scale drawing.
8. Sections through each unit showing location of C.T.'s, P.T.'s, bussing, breaker, load interrupter switches, etc.
9. Complete CBA phase rotation drawings.
10. Outline drawings with weights and dimensions.
11. Certified copies of design test reports in addition to impulse withstand tests, heated continuous current tests, momentary current tests and interrupting tests reports.
12. Cubicle wiring diagrams showing terminal blocks and interconnecting wiring between equipment in the same relative position as the front view drawings.
13. Final as-built drawings and information for all items and components installed in the Switchgears.
14. Installation information including equipment anchorage provisions.
15. Seismic certification.
16. Key interlock scheme drawing and sequence of operations, where applicable.
17. Throat/connection assembly to the 15kV overhead bus-duct system for the two (2) 15kV Metal-Clad Switchgears.
18. Internal bus and tie breaker connection assembly between the two (2) 15kV Metal-Clad Switchgears.

C. As minimum, for the medium voltage overhead bus duct system submit:

1. Isometric drawings showing medium voltage overhead bus duct systems interconnect with bussing assembly of each 5kV Switchgear and each 15kV Switchgear, and showing medium voltage overhead bus duct support system. This shall include dimensional elevation layout of each 5kV Switchgear and each 15kV Switchgear, interconnect medium voltage overhead bus duct layout and complete dimensioned elevations.
2. Complete layout, isometric, elevation, and cross sectional view drawings of the bus duct systems and arrangement/layout with both 5kV Switchgears and both 15kV Switchgears and the bus duct support system.
3. Bill of materials and catalog cut sheets on all materials used (including bus-duct support system).

D. Special Submittal Requirements:

1. All Switchgear layout drawings, cross sectional view drawings, wiring diagram drawings, Connection detail drawings, physical layout and detail drawings, etc. shall be developed electronically using AUTO-CAD Version 2007 software. Submittals shall include hard copies and electronic copies (of the quantity and format required by Section 01300 and 01730 of the Contract Specifications). All electronic drawing submittals shall be in AUTO-CAD Version 2007. This applies to all drawings requested in Subsection 1.04A, 1.04B, and 1.04C above, and any other manufacturer's product standard drawings required for submittal, and ALL PRODUCT DRAWINGS TO BE SUBMITTED for this project.

E. General: Items which are manufactured by others shall have the original manufacturer's name, catalog number and descriptive data.

F. Submit report of results of arc-flash hazard analysis, short circuit analysis, and coordination study described in Subsection 1.09, this Section of the Specifications, in accordance with the requirements of Section 01300 and Section 01730 of the Contract Specifications. Submit preliminary analysis report(s) for review. Include the following data:

1. Executive Summary discussion narrative
2. Short-Circuit and Harmonic Methodology Analysis Results and Recommendations, with discussion narrative and device evaluation/comparison tables as applicable
3. Protective Device Coordination Methodology Analysis Results and Recommendations, with discussion narrative and device settings tables as applicable
4. Time-Current Coordination Graphs and Recommendations
5. Arc Flash Hazard Methodology Analysis Results and Recommendations with discussion narrative and tables as applicable. Include text of Arc Flash labels to be provided
6. One-line system diagram that shall be computer generated and will clearly identify individual equipment buses, bus numbers used in the analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location, device numbers used in the time-current coordination analysis, and other information pertinent to the computer analysis. Use 11" x 17" sized paper, at minimum
7. Studies input data such as X/R ratio, cable impedance, and other information, in tabular form.
8. Additional information as required by subsection 1.09, this section of the Specifications.

1.05 OPERATION AND MAINTENANCE MANUALS

A. Submit operation and maintenance manuals per the requirements of Section 01730 of the Contract Specifications. At minimum, the manuals shall be inclusive of the requirements of this Subsection of the Specifications.

B. As minimum, the content of the Operations and Maintenance Manuals shall include:

1. Equipment function, normal operating characteristics and limiting conditions.
2. Assembly, installation, alignment, adjustment and checking instructions.
3. Operating instructions, for start-up, routine and normal operation, regulation and control, shutdown and emergency conditions.
4. Lubrication and maintenance instructions.
5. Guide to “troubleshooting”.
6. Parts list and predicted life of parts subject to wear.
7. Outline, cross section and assembly drawings; engineering data; and wiring diagrams.
8. Test data and performance curves, where applicable.
9. Hard copy and electronic copy of the approved shop drawings (final versions) and the final as-built drawings.
10. Protective relays on-site setting, calibration and test reports.
11. Time delay and all transfer parameter settings of all control and transfer devices/components.
12. medium voltage overhead bus duct system Certified Production Test Reports and Installation information.
13. Electronic copy of all protection and management relay device final settings on CD-ROM or Universal Serial Bus Flash Drive.

1.06 PRE-SUBMITTAL CONFERENCE

A. General:

1. Review the manner in which the contract requirements will be met prior to preparation of submittals. The Contractor, Engineer, Owner, and Manufacturer shall attend. Schedule, conduct, and arrange the conference within 90 calendar days after receipt of written notice to proceed work is given by the Owner
2. The Manufacturer shall present the following at the conference:
   a. List of protective relays/monitoring units and major accessories (timing relays, etc.) required and the brand that shall be used for each item
   b. Sample submittals from similar projects including the types of drawings/data specified herein.

1.07 DELIVERY, STORAGE AND HANDLING

A. Protection:

1. The Contractor, and hence the Metal-Clad Switchgears supplier, shall be responsible for safety of the Metal-Clad Switchgears during storage, transporting and handling.
2. The Metal-Clad Switchgears shall be environmentally protected and stored in climate controlled (temperature and humidity, etc.) environment.
3. At all times the Metal-Clad Switchgears shall be housed inside a moisture free, non-porous extra heavy duty plastic weatherproof housing.
4. Energize space heaters within the Metal-Clad Switchgears during storage and installation for humidity control.
5. Interior and exterior of the Metal-Clad Switchgears bus shall be kept clean at all times.
6. Unload and handle equipment by suitable methods that are recommended and approved by the manufacturer of the equipment.
7. Do not store equipment in direct contact with the ground.

B. Additional project job site storage requirements: Upon delivery to the project site and prior to final installation, protect and store in accordance with the following:

1. Environmentally protected and stored in climate controlled (temperature and humidity) environment at the job site. Size, furnish and install temporary air conditioners, and additional environmental control equipment complete with branch circuiting conduit/wire as required to maintain in a controlled environment at the following conditions:
   a. Ambient Dry Bulb Temperature:
      1) Minimum: 68 degrees Fahrenheit.
      2) Maximum: 85 degrees Fahrenheit.
   b. Ambient Relative Humidity: Maximum: 50%.
2. Every effort shall be made to provide all necessary electrical power connections ready for immediate connection to equipment upon arrival of equipment on jobsite.
3. Upon arrival of equipment onto job site, a maximum of one day shall be allowed for equipment to be left without HVAC, but within a sealed enclosed building, to allow proper transition of power of equipment, especially any 120 VAC powered equipment, to ensure all air conditioning and heating equipment are fully operational with a maximum of a 10 minute down time during this transition of power.
4. Furnish and install replacement air filters, etc., as required for proper operation of the environmental control equipment.

1.08 TOOLS AND SPARE PARTS

A. Furnish the following spare parts with the equipment for each Metal-Clad Switchgear in conformance with the specifications:

1. One (1) - Spare timing relay for each different type furnished and/or specified. A minimum of Five(5) relays shall be furnished.
2. Ten (10) - Spare control relays for each type used. Each control relay shall be furnished complete with relay coils, Four (4) Normally Open (N.O.) contacts, Four (4) Normally Closed (N.C.) contacts, and shall be furnished with Relay Manufacturer's Transient Voltage Suppression Module.
3. One (1) - Maintenance handle for manually closing the medium voltage circuit breakers when not in housing and manually charging.
4. One (1) - Levering crank for moving the medium voltage circuit breaker between connected, test, and disconnected positions.
5. One (1) - Test cable for electrically operating the medium voltage circuit breakers outside the Metal-Clad Switchgear housings.
6. One (1) - Breaker test cabinet for testing the electrically operated medium voltage circuit breakers outside the housing of the Metal-Clad Switchgears.
7. One (1) - Test jumper for testing the medium voltage circuit breakers.
8. One (1) - Maintenance tool for the medium voltage circuit breakers.
9. One (1) – Breaker lifting yoke used for attachment to breaker for lifting breaker ON or OFF compartment rails.
10. One (1) – Portable lifting device for lifting the breakers ON or OFF the rails.
11. Two (2) – Electrical motor operated levering devices with integral remote pendant control unit to allow levering of breaker between the connected, test, and disconnected positions from the pendant control unit located remotely from breaker cubicle.
12. One (1) – Dockable transport dolly for moving breaker about outside its compartment.
13. Two (2) – Feeder Management Relays complete with the Case (draw-out housing)
14. One (1) – Bus Differential Protection and Management Relay complete with the Case (draw-out housing).
15. One (1) – Digital Synchronism Check Relay complete with the Case (draw-out housing).
16. Two (2) – Fuse pullers
17. Two (2) – Sets of fuses for each type and set used.
18. Ten (10) percent of the quantity of pilot lights for each color as hereinafter specified.

19. Ten (10) percent of the quantity of pilot light lamps/lenses for each color as hereinafter specified.

1.09 SPECIAL MANUFACTURER'S SERVICES

A. Furnish the services of a qualified, experienced, factory trained technical (non-sales type) representative to assist in the installation of the equipment. Include checking alignment of parts, wiring connections, operation of all parts (relays, circuit breakers, monitoring relays, power monitoring units, etc.), leveling and alignment of the Switchgear assemblies, torque check of horizontal bus connections between Sections of the Switchgears, interconnect wiring between Sections and within each Section of the Switchgears, medium voltage overhead bus duct installation and alignment and space heater wiring, Switchgears space heater wiring, etc. Include time to correct and recheck any discrepancies which are discovered. Also include providing the Owner with a report certifying that the equipment was installed properly, tested and set in accordance with the manufacturer's recommendations, and is in satisfactory operating condition. Format and quantity of reports shall be per the requirements of Section 01300 and 01730 of the Contract Specifications.

B. Work in conjunction with the project's Process Instrumentation and Control System Contractor (PICS) during start-up of the equipment (Breaker operation, Breaker controls, and other sub-distribution equipment) to ensure that all Instrumentation and Control System interlocks between the Metal-Clad Switchgears and the Main Control Panel (MCP), designated on the PLANS as "SUB4-MCP-001", are in satisfactory operating condition to the Owner/Engineer. Additionally, coordinate and work in conjunction with Austin Energy's Project distribution and metering representatives and make necessary adjustments to Primary Metering Cabinets to meet Austin Energy's requirements at no additional cost to the Owner.

The study shall also include any adjustments, recommendations, and. Coordinate with Austin Energy as required and submit documentation as required to meet Austin Energy's requirements at no additional cost to the Owner. The manufacturer's services should also include setting/re-adjusting and testing/calibration of the proposed protective devices and protective relaying, etc. (Referenced below).

C. Manufacturer's technical representative is to set, adjust and test all circuit breakers, protective relays, protective devices, etc., in the presence of an Owner representative. Additionally, the Manufacturer will select the characteristics of the protective devices that are most suitable for the system in providing proper protection and coordination. The settings will be based on coordination and short circuit studies performed in compliance with Section 16044 of the Specifications, paragraph 1.09 "Special Manufacturer's Services". Provide the OWNER with test report certified by the manufacturer. Include a record of all settings. Format and quantity of reports shall be per the requirements of Section 01300 and Section 01730 of the Specifications. The Manufacturer shall furnish the protective device of the appropriate characteristics selected by the OWNER that shall be the most suitable for the proper protection and coordination of the system at No Additional Cost to the OWNER.

D. Prepare an arc-flash hazard analysis study, and a coordination study, complete with short circuit calculations and coordination curves reflecting calculated fault values and recommended and/or proposed fuse type/ratings, motor protective relay settings, equipment/cable thermal (damage) limits, equipment/device settings (as applicable) from the proposed Austin Energy 12,470V level (with close coordination with Austin Energy upstream devices) through the 208/120V subsystem level equipment and devices. Coordination with Austin Energy is required. Additional details concerning the implementation of the short circuit, coordination, arch flash studies such as main-tie-main circuit breaker states to be assumed, etc., will be provided after Bid Award during the Pre-Submittal conference.

E. In addition to all proposed equipment, the study shall include all existing plant electrical equipment from the proposed Austin Energy 12,470V level (with close coordination with Austin Energy upstream devices) through the 208/120V level. The contractor shall coordinate with owner for field data collection of all necessary existing electrical equipment data (e.g., transformer KVA ratings, impedance, etc.), existing cable data, existing protective device settings and protective device data, and other additional data as required for use in the completion of the electrical system studies. The Study shall clearly identify all existing equipment data and existing protective device settings.

F. The study should also include adjustments/ recommendations in the proposed/new protective relaying devices to better coordinate with the existing protective devices in lieu of replacing any of the existing protective devices. Where required, and approved by owner, the study should also include adjustments/recommendations in the existing protective devices to better coordinate with the overall electrical system protective devices. The study shall also include any adjustments, recommendations, and requirements of Austin Energy and be fully coordinated with Austin Energy and Austin Energy's requirements. Coordinate with Austin Energy as required and submit documentation as required to meet Austin Energy's requirements at no additional cost to the Owner. The manufacturer's services should also include setting/re-adjusting and testing/calibration of the proposed protective devices and protective relaying, etc. (Referenced below).

G. Perform the arc flash hazard analysis in conjunction with the short circuit and coordination analysis previously described herein and also in compliance with IEEE 1584 and NFPA 70E standards. The flash protection boundary and incident energy shall be calculated at all points in the distribution system (transformers, motor control centers, panelboards, etc.) where work could be performed on energized parts. The following additional requirements apply for the arc flash hazard analysis:

1. Perform arc flash hazard studies assuming one Austin Energy main utility service is energized, the tie circuit breakers are closed, and the second Austin Energy main utility service is de-energized.
2. Repeat studies for each Austin Energy electrical service.
3. Calculations to address worst case (maximum) hazard analysis. Describe scenario employed in submittals.

H. The arc flash hazard analysis effort shall also include:

1. Reporting incident energy values based upon recommended protective device settings for all equipment,
2. Reporting recommendations to reduce AFIE levels and enhance worker safety
3. Furnish and install label(s) for all equipment included in the study indicating the following, at minimum:
   a. System voltage
   b. Shock and Flash protection boundaries
   c. Personal protective equipment requirements for each electrical task based upon hazard category (including flame resistant clothing requirements).
   d. Arc flash incident energy value (cal/cm2)
   e. Limited, restricted, and prohibited approach boundaries
   f. Study report number and issue date
   g. Additional information required by the applicable NFPA and IEEE standards.
   h. Labels shall be manufacturer's standard labels with quantity and mounting location per manufacturer's standard.

I. THE ARC-FLASH STUDIES, THE SHORT CIRCUIT CALCULATIONS AND ANALYSIS, AND THE COORDINATION STUDY SHALL BE PERFORMED:

1. UTILIZING SKM SOFTWARE, LATEST RELEASE – MICROSOFT WINDOWS VERSION. In addition to the hard copy submittal, an electronic copy of the FINAL VERSION of the short circuit analysis/calculations and the protective device setting curves (time-current curves) and summary setting tables, etc. shall be submitted on CD-ROM.
2. By a State of Texas Registered Professional Engineer. The final version of the studies shall be signed and sealed by a Professional Engineer who is Licensed in the State of Texas as an Electrical Engineer.

J. Manufacturer's technical representative is to set, adjust and test all existing circuit breakers, protective relays, protective devices, etc., in the presence of an Owner representative, where a protective device adjustment is identified in the electrical system studies for the existing protective device and approved by the owner. Additionally, the Manufacturer will select the characteristics of the protective devices that are most suitable for the system in providing proper protection and coordination. The settings will be based on coordination and short circuit studies performed in compliance with Section 16044 of the Specifications, paragraph 1.09 "Special Manufacturer's Services". Provide the OWNER with test report certified by the manufacturer. Include a record of all settings. Format and quantity of reports shall be per the requirements of Section 01300 and Section 01730 of the Specifications.

K. Any problems encountered with the operation of equipment, parts, components, etc. installed within the new line-up shall be repaired/remedied by the manufacturer's technical representative.

L. The Switchgear manufacturer shall furnish and install arc-flash labels for all equipment in this study, including existing equipment. The data provided on the arc-flash labels shall be based on arc-flash hazard analysis studies performed by others as well as the arc-flash hazard analysis study described in this Specification, and shall indicate the following, at minimum:

1) System voltage
2) Shock and Flash protection boundaries
3) Personal protective equipment requirements for each electrical task based upon hazard category (including flame resistant clothing requirements).
4) Arc-flash incident energy value (cal/cm2)
5) Limited, restricted, and prohibited approach boundaries
6) Study report number and issue date
7) Additional information required by the applicable NFPA and IEEE standards.
8) Labels shall be manufacturer's standard labels with quantity and mounting location per manufacturer's standard

1.10 WARRANTIES

A. The manufacturer shall warrant that the equipment furnished will be fabricated in accordance with the requirements of this specification and the recommendations of the manufacturer. If, within 5 years after acceptance by the Owner and after the final completion date of the project as indicated in the Contract Documents, the equipment of any parts installed, are found defective because of material, workmanship, selection of materials, or design, the manufacturer shall at the manufacturer's expense furnish and install replacement parts of a design, workmanship, and material approved by the Owner. Any repairs or replacement parts furnished under the above stated warranty shall carry warranties of the same terms as set forth above from the date of its repair or replacement. Cost of Travel, lodging, labor and parts required as a result of any Warranty Work shall be covered by the warranty (the Manufacturer).

PART 2 - PRODUCTS

2.01 GENERAL AND STRUCTURE REQUIREMENTS – 5KV AND 15KV METAL-CLAD SWITCHGEARS

A. General

1. Each vertical section shall house no more than one (1) draw-out circuit breaker which shall be located in the bottom front-compartment (bottom-front-bay) of each vertical section. The top front-compartment (top-front-bay) of each vertical section shall house the metering equipment, protective relaying, control power, breaker control interlock wiring, pilot devices (indicating lights, switches, etc.), terminal blocks, terminal strips, control circuitry circuit breakers and fuse blocks, etc. A back-panel shall be furnished and installed in the top-front-compartment of each vertical section of each Switchgear for mounting control devices, instruments, Auxiliary Equipment Ground Bus, Terminal Strips, Terminal Blocks, wireways, etc. i.,e. DO NOT MOUNT devices directly to the sheet-metal housings/barriers and/or doors (other than front-visible face mounted metering and pilot devices as well as power protective relaying devices) of the Switchgears. The backpanels shall be painted WHITE (or manufacturer's standard color) and shall hereinafter be named as device panels.

2. Furnish the Metal-Clad Switchgears complete with all necessary equipment, wiring, power, controls, protective relaying, current transformers, potential transformers, space heaters, ground buses, etc. within the compartments as specified herein and as required by the PLANS

3. The stationary primary contacts shall be tin-plated copper and recessed within insulating tubes. A steel shutter shall automatically cover the stationary primary disconnecting contacts when the breaker is in the disconnected position or out of the cell. Provide rails to allow withdrawal of each medium voltage circuit breaker for inspection and maintenance without the use of a separate lifting device.

4. In each vertical section containing a circuit breaker, the front instrument and control compartment (upper compartment) of each breaker Section within each Switchgear shall be completely barriered and isolated from the corresponding circuit breaker compartment (lower compartment) by a solid metal barrier that shall extend the full depth and width of the vertical section.

5. For rigidity during fault conditions all connections to roll-out potential transformer trays shall be rigid bus bars insulated to full voltage rating of the Metal-Clad Switchgear assembly.

6. Energized bare parts mounted on doors shall be guarded where the door must be opened for maintenance of equipment or removal of drawout equipment.

7. Each structure shall be shipped with crane lifting provisions and with a maximum width such that they will pass through an opening measuring 6'-0" wide x 8'-0" high, for handling and installation purposes. The split sections of the Metal-Clad Switchgears shall then be bolted and wired together in the field to obtain the assembled Metal-Clad Switchgear line-up. The manufacturer is responsible for providing the experienced non-sales type technical representative to oversee, perform and direct the installation as also required by paragraph 1.09, above.

8. The overall dimensions of each Switchgear line-up shall be as shown on the PLANS. Equipment arrangement within each Switchgear line-up shall also be as shown on the PLANS.

9. An inter-phase barrier shall be self-contained in the circuit breaker compartment and the compartment shall be equipped with an interlock that prevents insertion of the breaker elements if the inter-phase barrier is not in place. The stationary primary contacts shall be tin-plated copper and recessed within insulating tubes.

10. In general, the stationary structure shall be so constructed and arranged that circuit breakers, busses, instrument transformers and controls are completely isolated from each other within the same cubicle and that cubicles are isolated from adjoining cubicles. Power circuits will enter the Switchgear as shown on the PLANS.

B. 5kV Metal-Clad Switchgears

1. The 5kV Metal-Clad Switchgears shall be indoor, NEMA-1A gasketed, non-walk-in type, and shall consist of individual vertical sections housing various combinations of circuit breakers and auxiliaries, bolted to form a Metal-Clad Switchgear assembly. Metal side sheets shall provide grounded barriers between adjacent structures and solid removable metal barriers shall isolate the major primary sections of each circuit.

2. Each vertical section of the 5kV Switchgears shall have two (2) flanged and hinged (piano hinge) rear doors which SHALL NOT BE PAD LOCKABLE but shall be BOLTED with HEX-TYPE 316-Stainless Steel Bolts. Additionally, each vertical section of the 5kV Switchgears shall have two(2) flanged and hinged (piano hinge) front doors and shall be equipped with two(2) 3-point latch type pad-lockable handles. Front and rear doors shall be provided complete with door handles, in addition to providing each door complete with provisions for padlocking. Door handles shall be of 316-Stainless Steel.

3. The front steel door of the instrument and control compartment (overall upper compartment door) and the front steel door of the breaker compartment (overall lower compartment door) of each vertical section shall be hinged to the main structure, and shall be provided with suitable 3-point latching mechanism which shall be mechanically interlocked with the door handle. Front doors shall also be furnished complete with provisions for padlocking.

4. Vertical section of each 5kV Metal-Clad Switchgear shall contain provisions for conduits entering from below and from top. Also, provide space sufficient to make traditional stress cone terminations.

5. Each structure shall have sufficient ventilation and full access for repair or replacement of any components through the front of the unit only.

6. Each vertical section shall be furnished with a space heater rated for 120 volts A.C. with a dedicated thermostat wired to terminal block in the respective section. Wire the space heater circuitry of each 5kV Switchgear (in conduit) to the 120/208 volt panelboard in the Substation No. 4 Building as shown on the PLANS.

   a. Thermostat:

      1) Type: Heavy Duty line voltage type, suitable for use in controlling heating and cooling circuits. Shall have field

adjustable temperature setpoint and also display the measured ambient temperature.

2) Measurement Range:

a) Thermostat: 40 to 90 degrees Fahrenheit

b) Thermometer: 50 to 90 degrees Fahrenheit

3) Sensing Element: Liquid filled with diaphragm and lever mechanism

4) Thermometer: Bi-metal type

5) Number and Type of Output Contacts: One Single Pole Double Throw (SPDT), snap acting

6) Contact Ratings:

a) Heating Contact: 16 ampere at 120 VAC

b) Cooling Contact: 8 ampere at 120 VAC

7) Enclosure: Thermoplastic cover, suitable for vertical or horizontal mounting configuration

8) Accessories:

a) Provide temperature adjustment knob

b) Provide faceplate with each thermostat with temperature measured in degrees Fahrenheit. Faceplate shall include cutout such that the measured ambient temperature is visible.

c) Mount each thermostat in a device enclosure on the enclosure backpanel in accordance with the manufacturer's recommendations.

9) Manufacturer: Johnson Controls Model T26T Series Line Voltage Thermostat, or approved equal.

7. The 5kV Switchgears inclusive of its hinged doors shall be fabricated from not less than 12-gauge steel. All cables and medium voltage overhead bus duct system must enter/exit the rear compartment of the 5kV Switchgear sections (both top and bottom entry, as shown on the PLANS).

8. Finish: Structure finish shall be primed and painted using the manufacturer's standard finishing process. Finish shall be applied at the manufacturing plant and shall be suitable for indoor located equipment. Color shall be ANSI No. 61 gray.

C. 15kV Switchgears

1. The 15kV Metal-Clad Switchgears shall be indoor, NEMA-1A gasketed, non-walk-in type, and shall consist of individual vertical sections housing various combinations of circuit breakers and auxiliaries, bolted to form a Metal-Clad Switchgear assembly. Metal side sheets shall provide grounded barriers between

adjacent structures and solid removable metal barriers shall isolate the major primary sections of each circuit.

2. Each vertical section of the 15kV Switchgears shall have two (2) flanged and hinged (piano hinge) rear doors which SHALL NOT BE PAD LOCKABLE but shall be BOLTED with HEX-TYPE 316-Stainless Steel Bolts. Additionally, each vertical section of the 15kV Switchgears shall have two(2) flanged and hinged (piano hinge) front doors and shall be equipped with two(2) 3-point latch type pad-lockable handles. Front and rear doors shall be provided complete with door handles, in addition to providing each door complete with provisions for padlocking. Door handles shall be of 316-Stainless Steel.

3. The front steel door of the instrument and control compartment (overall upper compartment door) and the front steel door of the breaker compartment (overall lower compartment door) of each vertical section shall be hinged to the main structure, and shall be provided with suitable 3-point latching mechanism which shall be mechanically interlocked with the door handle. Front doors shall also be furnished complete with provisions for padlocking.

4. Vertical section of each 15kV Metal-Clad Switchgear shall contain provisions for conduits entering from below and from top. Also, provide space sufficient to make traditional stress cone terminations.

5. Each structure shall have sufficient ventilation and full access for repair or replacement of any components through the front of the unit only.

6. Each vertical section shall be furnished with a space heater rated for 120 volts A.C. Provide a thermostat for control of enclosure space heating system per manufacturer's standard. Wire the space heater circuitry of each 15kV Switchgear (in conduit) to the 120/208 volt panelboard in the Substation No. 4 Building.

7. The 15kV Switchgears inclusive of its hinged doors shall be fabricated from not less than 12-gauge steel. All cables and medium voltage overhead bus duct system must enter/exit the rear compartment of the 15kV Switchgear sections (both top and bottom entry, as shown on the PLANS).

8. Finish: Structure finish shall be primed and painted using the manufacturer's standard finishing process. Finish shall be applied at the manufacturing plant and shall be suitable for indoor located equipment. Color shall be ANSI No. 61 gray.

D. 15kV Primary Metering Cabinets

1. The 15kV Primary Metering Cabinets shall be indoor, NEMA-1A gasketed, non-walk-in type, and shall consist of two (2) individual vertical sections bolted to form a Metal-Clad Switchgear assembly. Metal side sheets shall provide grounded barriers between adjacent structures and solid removable metal barriers shall isolate the major primary sections of each circuit. The Primary Metering Cabinets shall not require rear access and shall be suitable for back to wall mounting.

2. The line side vertical section shall be divided into two (2) compartments. The incoming line cable terminating compartment shall be equipped with four (4)

terminals per phase. The line side vertical section shall also contain a three-phase gang operated load interrupter switch compartment which shall be non-removable and padlockable. Refer to paragraph 2.05 this Section of the Specifications for load interrupter switch requirements.

3. The load side vertical section shall be divided into two (2) compartments. The utility metering compartment shall contain the current transformers and potential transformers (CT's and PT's). Refer to paragraph 2.08 this Section of the Specifications for the utility metering transformer requirements. The load side cable terminating compartment shall be equipped with terminals for four (4) connections per phase.

4. The combined Primary Metering Cabinet structure shall be not more than 93 inches nominal height, 64 inches nominal width and 60 inches nominal depth.

5. Comply with the most current requirements of AUSTIN ENERGY relative to primary metering current transformers and potential transformers. The drawings and Specifications depict the most recent model numbers provided by AUSTIN ENERGY for the main incoming line metering transformers. However, the model numbers may change prior to the construction of the 15kV Primary Metering Cabinets. Therefore, coordination with AUSTIN ENERGY IS ESSENTIAL prior to commencing the Shop Drawing Submittal and manufacturing activity of the 15kV Primary Metering Cabinets.

6. The front steel door of the upper compartment door and the front steel door of the lower compartment door of each vertical section shall be hinged to the main structure, and shall be provided with suitable 3-point latching mechanism which shall be mechanically interlocked with the door handle. Front doors shall also be furnished complete with provisions for padlocking.

7. Vertical section of each 15kV Primary Metering Cabinet shall contain provisions for conduits entering from below and from top, per the size and quantity of conduits shown in the plans. Also, provide space sufficient to make traditional stress cone terminations.

8. Each structure shall have sufficient ventilation and full access for repair or replacement of any components through the front of the unit only.

9. Each vertical section shall be furnished with a space heater rated for 120 volts A.C. Provide a thermostat for control of enclosure space heating system per manufacturer's standard. Wire the space heater circuitry of each 15kV Primary Metering Cabinet (in conduit) to the 120/208 volt panelboard in the Substation No. 4 Building.

10. The 15kV Primary Metering Cabinets inclusive of its hinged doors shall be fabricated from not less than 12-gauge steel. Structure finish shall be primed and painted using the manufacturer's standard finishing process. Finish shall be applied at the manufacturing plant and shall be suitable for indoor located equipment. Color shall be ANSI No. 61 gray.

2.02 MAIN BUS – 5KV AND 15KV METAL-CLAD SWITCHGEARS

A. The main bus shall be tin plated copper and rated as indicated in the PLANS. Bus bars shall have a continuous current rating based on temperature rise in a 40 degrees C ambient. Bus bars will be braced to withstand magnetic stresses developed by currents equal to main power circuit breaker close, carry, and interrupt ratings. The bus shall be insulated, and the bus insulation shall be of fluidized bed epoxy flame retardant and track resistant insulation. The bus supports shall be glass reinforced polyester.

B. The main bus shall extend the entire length of the line-up and shall be rated not less than the ratings shown on the PLANS at the Switchgear's maximum rated voltage. The bus shall consist of rigidly supported insulated tin-plated copper bars, having a symmetrical interrupting duty and a minimum momentary rating as shown on the PLANS. The bus bars shall be of suitable design and cross sectional area to satisfactorily carry the rated current without exceeding the temperature rise as specified in the IEEE and NEMA standards.

C. The main bus shall have insulated tin-plated-copper bars. The Switchgear shall be constructed so that all buses, bus supports and connections shall withstand stresses that would be produced by currents equal to the momentary ratings of the circuit breakers. The main bus shall have provisions for future extension. All bus joints shall be plated, bolted and insulated with easily installed boots. The temperature rise of the bus and connections shall be in accordance with ANSI standards and documented by design tests.

D. Bus insulation shall be molded material, designed for 5kV or 15kV service, as applicable, over the entire length and shall be able to withstand the ANSI standard 60 cycle impulse test voltages of 60kV and 95kV (1-1/2 x 40 microsec) full wave respectively. The molded insulation shall have a high resistance conducting surface in contact with the bus to eliminate Corona damage to the bus insulation. Utilize molded insulation (boots) at bus joints and junction points.

E. Connections to the bus shall be made with suitable bolts with lock washers, and the copper bars shall be tin-plated at current carrying connections. Use molded removable covers or similar devices at connections to the bus (including incoming and outgoing feeder connections to the 5kV and 15kV Metal-Clad Switchgear buses and medium voltage overhead bus duct connections to the 5kV and 15kV Switchgear buses).

F. Bus stand-off insulators shall be High Strength and High Creep finned type high resistant Epoxy insulators. Additionally, utilize high strength and high resistant Epoxy inserts in the bus support barriers and stand-off insulators on switches and fuse mountings.

2.03 GROUND BUSES – 5KV AND 15KV METAL-CLAD SWITCHGEARS

A. Main Ground Bus:

1. The main ground bus shall be of high conductivity tin-plated copper with a continuous rating of at least 50 percent of the Metal-Clad Switchgear's main bus rating and shall extend the entire length of each of the Metal-Clad Switchgears.

2. Each ground bus shall be securely attached to the stationary structure so it is accessible from the front of the Metal-Clad Switchgears. All equipment shall be grounded by connection to the ground bus.

3. The main ground bus shall be bolted to each stationary structure and all equipment grounded by direct electrical connection to this bus. Provide for attachment of four (4) 250 kCMIL stranded copper conductors at each end of the ground bus. Additionally, provide terminals on the ground bus for termination of the load circuit ground wires. Quantity and size of terminals shall be as required by the PLANS.

B. Auxiliary Systems Equipment Ground Bus:

1. A high conductivity copper ground bus mounted in the upper-front-compartment of each vertical section of the Metal-Clad Switchgear shall have a minimum length of 12-inches and shall be mounted using a minimum of two (2) 600 volts A.C. stand-off isolators/insulators. The auxiliary systems equipment ground bus shall have a minimum continuous current rating of 200 amperes and shall be furnished with a minimum of twelve (12) terminals (ground lugs).

2. In each vertical section of the Metal-Clad Switchgear, furnish a #1/0 AWG, 600 volts, GREEN insulated, type XHHW-2 grounding conductor to provide a dedicated grounding bond between each auxiliary systems equipment ground bus and the main ground bus of the respective Metal-Clad Switchgear.

3. In each vertical section of the Metal-Clad Switchgear, extend dedicated equipment grounding conductors from the auxiliary systems equipment ground bus to each instrument and control device installed in the respective vertical section of the Metal-Clad Switchgear.
   a. Each equipment grounding conductor shall not be less than #12 AWG, 600 volts, GREEN insulated, type XHHW-2 grounding conductor.
   b. Do not connect/terminate more than one (1) equipment grounding conductor to a single terminal point on the ground bus. Additionally, DO NOT daisy-chain equipment grounding conductors from one instrument/device to another. Moreover, DO NOT connect/bond equipment grounding conductors of each instrument/device to the Metal-Clad Switchgear enclosure.

2.04 CIRCUIT BREAKER SECTIONS – DRAWOUT VACUUM CIRCUIT BREAKERS – 5KV AND 15KV METAL-CLAD SWITCHGEARS

A. Main and Tie Circuit Breakers - Rating:

1. The Switchgears described in this specification shall be designed for operation on either a 5kV or a 15kV, three-phase, 3-wire, solidly grounded, 60-hertz system.

2. Each main and tie circuit breaker shall have the following ratings:

Main and Tie Circuit Breaker Rating	**5kV Switchgears**	**15kV Switchgears**
Maximum Voltage:	5kV	15kV
BIL Rated:	60kV	95kV
Continuous Current:	2000 Amperes	1200 Amperes
Rated Short-Circuit Current:	63kA	37kA
Three (3) Second Short Circuit Current at Rated Maximum kV:	63kA	48kA
Closing and Latching Capability At Rated Maximum kV:	170kA Peak	130kA Peak
Nominal 3-Phase MVA Class:	500MVA	Minimum 1000MVA
Rated Interrupting Time:	Five Cycles	Five cycles

B. Feeder/Branch Circuit Breakers - Rating:

1. The Switchgears described in this specification shall be designed for operation on either a 5kV or a 15kV, three-phase, 3-wire, solidly grounded, 60-hertz system.

2. Each feeder/branch circuit breaker shall have the following ratings:

Feeder/Branch Circuit Breaker Rating	**5kV Switchgears**	**15kV Switchgears**
Maximum Voltage:	5kV	15kV
BIL Rated:	60kV	95kV
Continuous Current:	2000 Amperes	1200 Amperes
Rated Short-Circuit Current:	63kA	37kA
Three (3) Second Short Circuit Current at Rated Maximum kV:	63kA	48kA
Closing and Latching Capability At Rated Maximum kV:	170kA Peak	130kA Peak
Nominal 3-Phase MVA Class:	500MVA	Minimum 1000MVA
Rated Interrupting Time:	Five Cycles	Five cycles

C. Circuit Breaker Assemblies (main, tie and feeder/branch circuit breakers):

1. The circuit breakers shall be horizontal drawout type, capable of being withdrawn without a lifting device and/or transport truck. The breakers shall be operated by a motor-charged stored energy spring mechanism, charged normally by a universal electric motor and in an emergency by a manual handle. The primary disconnecting contacts shall be tin-plated copper.

2. Each circuit breaker shall contain three vacuum interrupters separately mounted in a self-contained, self-aligning pole unit which can be removed easily. The vacuum interrupter pole unit shall be mounted on porcelain or glass polyester supports. A contact wear gap indicator for each vacuum interrupter, which requires no tools to indicate available contact life, shall be easily visible when the breaker is removed from its compartment.

3. The secondary contacts shall be tin-plated and shall automatically engage in the breaker operating position, which can be manually engaged in the breaker test position.

4. Interlocks shall be provided to prevent closing of a breaker between operating and test positions, to trip breakers upon insertion or removal from housing and to discharge stored energy mechanisms upon insertion or removal from the housing. The breaker shall be secured positively in the housing between and including the operating and test positions.

5. The vacuum circuit breakers shall be electrically operated. The control voltage shall be provided as shown on the PLANS. Where shown on the PLANS, circuit breakers shall also be provided with manufacturer's standard heavy duty stored energy capacitive trip accessory device to facilitate circuit breaker trip after loss of control power.
   a. 5kV Switchgear: 120 volts AC close, and 120 volts AC Trip.
   b. 15kV Switchgear: 120 volts AC close, and 120 volts AC Trip.

6. Each breaker shall be furnished complete with control switches/control stations, pilot devices, etc. as shown on the PLANS.

7. All circuit breaker units of the same rating shall be interchangeable.

8. As minimum, Each Circuit Breaker assembly shall be furnished with the number of NORMALLY OPEN (N.O.) and NORMALLY CLOSED (N.C.) circuit breaker auxiliary contacts shown on the PLANS. However, furnish one (1) additional spare NORMALLY OPEN (N.O.) and one (1) additional NORMALLY CLOSED (N.C.) breaker auxiliary contacts assembly over the number of contacts (of each type), including spare contacts, shown on the PLANS. The required pair of spare contacts applies to each type of breaker action auxiliary contacts (i.e., truck operated, mechanism operated, etc., as depicted on the PLANS). Pre-wired spare contacts shown on the PLANS and/or any additional spare contacts required herein shall be prewired to the appropriate terminal blocks/strips located in the Upper-Front-Compartments (upper front bay/cell) of the associated vertical section of the Switchgears. All mechanism operated circuit breaker auxiliary contacts shall reflect true circuit breaker open and close status positions and shall operate both when the circuit breaker is racked in as well as when the circuit breaker is racked out in the test position. All mechanism operated circuit breaker auxiliary contacts shall reflect circuit breaker open status when the circuit breaker is racked out AND NOT in test position.

2.05 15KV LOAD INTERRUPTER SWITCHES – PRIMARY METERING CABINETS

A. ALL load interrupter switches shall be non-fused manually-operated. Additionally, as a minimum each load interrupter switch shall have the following features:

1. Three-pole gang operated.
2. Manual quick-make quick-break over toggle type mechanism utilizing a heavy duty coil spring to provide opening and closing energy.
3. The speed of opening and closing the switch shall be independent of the operator, and it shall be impossible to tease the switch into any intermediate position under normal operation.
4. Separate main and break contacts to provide maximum endurance for fault close and load interrupting duty.
5. Insulating barriers between each phase and between the outer phases and the enclosure.
6. A maintenance provision for slow closing the switch to check switch blade engagement and slow opening the switch to check operation of the ARC interrupting contacts.
7. Insulate phases to ground with High Strength and High Creep finned type high resistant Epoxy insulators.

B. Load interrupter switch Rating: Each switch shall be of the load interrupter type (load break type) and shall have the following electrical ratings:

Continuous and rated full load current:	=1200 amperes
Short Time (2 second) Current::	=38,000 amperes
Maximum design voltage:	=15kV
Momentary current (switch closed 10 cycle)::	=61kA asymmetrical
Fault close current:	=61kA asymmetrical
Basic impulse level:	=95kV

C. Non-fused load interrupter switches shall be as manufactured by Powell Electrical Systems, Inc., Elliott Industries, Inc., or approved equal.

2.06 CONNECTION AND TERMINALS – 5KV AND 15KV METAL-CLAD SWITCHGEARS

A. All current-carrying connections to the main buses shall be insulated, tin-plated copper, of suitable capacity and to conform to the requirements of the main bus insofar as bracing, temperature limits, etc., are concerned.

B. Connections to the current transformers shall be such that the transformers may be removed and changed without damage to the connections. Utilize shorting terminal

blocks/strips for all connections to current transformers. Also refer to Subsection 2.11 and 2.12 of this Section of the Specifications.

C. Provide clamp type terminals for all power and ground cables and stress-cone type termination of all medium voltage power cables.

D. Except for interconnections between sections in each line-up, Metal-Clad Switchgears shall be designed for bottom and top entry of wiring for external connections to equipment (top/bottom conduit and wiring entrance to both 5kV and both 15kV Metal-Clad Switchgears as shown on the PLANS, and top medium voltage overhead bus duct entrance to both 5kV Switchgears and both 15kV Switchgears as shown on the PLANS).

E. All interior wiring to be neatly and carefully installed in suitable wiring gutters, as required. All wiring to be terminated at suitable terminal strips, marked in accordance to the manufacturer's wiring diagram and the wiring diagrams shown on the PLANS. Also refer to Subsection 2.11 and 2.12 of this Section of the Specifications.

F. In addition to the specified spare terminals and spare contact terminals, provide terminals marked for control circuit connections for all devices separate from the breakers.

G. All instrument and control wiring must be tagged at point of termination (at each end). Use heat shrink wire markers. All tags must be typed. Use of handwritten tags will not be permitted. Heat shrink all tags. Also refer to Subsection 2.11 and 2.12 of this Section of the Specifications.

H. Potential transformer leads shall be flexible cable insulated for service at the maximum voltage rating of the Metal-Clad Switchgear.

I. Provide sufficient clearances for all control and small wiring. Secure wiring to hinged doors and panels to the enclosure with flexibility provided around hinges to prevent fatigue and eventual breaking.

J. GROUND STUDS: Furnish and install Grounding Ball Studs, one for each phase terminal, plus one grounded Grounding Ball Stud per compartment to provide a convenient means of grounding with jumpers. Ground stud shall be tin coated copper, with stainless steel hardware. Ground stud shall have insulated covering to cover ground stud when not in use. The ground stud shall be designed and installed to meet the switchgear dielectric rating even when any grounding stud cover on any ground stud is removed. The ground stud assembly, with insulated cover, shall be UL listed for use in the switchgear or meet installation and testing requirements of IEEE ANSI C37. The ground stud short circuit rating shall at minimum be equal to or greater than the short circuit rating of the switchgear. Furnish and install Ground Studs in the rear compartment of each switchgear section with proposed or future vacuum circuit breaker.

2.07 MAIN METERING TRANSFORMERS – 15KV SWITCHGEARS

A. General: All instrument transformers specified shall be installed and connected at the factory. Mount instrument potential transformers in their drawout supports for factory

test. Note: The instrument transformers product specifications described herein applies to the following

1. The OWNER's Main Metering Transformers which shall each be installed in sections of the 15kV Metal-Clad Switchgears lineup.

B. Main Metering Instrument Current Transformers (C.T.'s):

1. Where shown on the PLANS, furnish and install a set of three (3) 1000/2000:5 (dual ratio) BAR TYPE current transformers for the OWNER's Main Utility Metering section of each 15kV Switchgear. All Main Utility Metering current transformers shall be indoor type, 15KV rated, with 0.3% metering accuracy, and a rating factor of 2.00/1.50 at (55°C) and shall be manufactured by ABB Catalog No. 7524A38G08, type KOT-11.

2. Install a tap changing-shorting terminal block for each current transformer (C.T.). Prewire all terminal of each C.T. and dual-ratio C.T. to its respective tap changing shorting terminal block. Shorting terminal blocks shall be as manufactured by "G.E.", or approved equal. Mount shorting terminal blocks (STB's) inside the upper-front compartment of the applicable vertical section of the 15kV Metal-Clad Switchgear. All wiring shall be #10 AWG copper terminated with insulated ring type compression terminators and shall conform to the AUSTIN ENERGY standard color code.

C. Instrument Potential Transformers (P.T.'s):

1. Where shown on the PLANS, furnish and install a set of three (3) – 12.5kV-to-120Volts AC fused Potential Transformers for the OWNER'S Main Utility Metering section of each 15kV Switchgear. All Main Utility Metering Potential Transformers shall have 60:1 ratio, 110 kV BIL, 0.3% meter accuracy, and shall be manufactured by ABB Catalog No. 75-25A67G05.

2. Potential Transformers shall be wired to separate potential terminal blocks. Mount potential terminal blocks inside the upper-front compartment of the applicable vertical section of the 15kV Metal-Clad Switchgear. All wiring shall be #10 AWG copper terminated with insulated ring type compression terminators and shall conform to the AUSTIN ENERGY standard color code.

3. The instrument Potential Transformers shall be installed in a draw-out assembly inside the designated section/compartment within the 15kV Switchgears. The instrument Potential Transformers shall also fit into the complete 15kV Metal-Clad Switchgear sections (of both 15kV Metal-Clad Switchgears).

2.08 UTILITY METERING TRANSFORMERS – 15KV PRIMARY METERING CABINETS

A. General: All instrument transformers specified shall be installed and connected at the factory. Note: The instrument transformers product specifications described herein applies to the following

1. AUSTIN ENERGY's Main Metering Transformers which shall each be installed in sections of the 15kV Primary Metering Cabinets.

B. Main Utility Metering Instrument Current Transformers (C.T.'s):

1. Where shown on the PLANS, furnish and install a set of three (3) 1200:5 BAR TYPE current transformers for the AUSTIN ENERGY incoming line Main Utility Metering section of each 15kV Primary Metering Cabinet. All Main Utility Metering current transformers shall be indoor type, 15KV rated, with 0.3% metering accuracy, and a rating factor of 1.50 at (55°C) and shall be manufactured by ABB Catalog No. LGX-15-585.

2. Install a tap changing-shorting terminal block for each current transformer (C.T.). Prewire all terminal of each C.T. and dual-ratio C.T. to its respective tap changing shorting terminal block. Shorting terminal blocks shall be as manufactured by "G.E.", or approved equal. Mount shorting terminal blocks (STB's) inside the upper-front compartment of the applicable vertical section of the 15kV Primary Metering Cabinets. All wiring shall be #10 AWG copper terminated with insulated ring type compression terminators and shall conform to the AUSTIN ENERGY standard color code.

3. Contractor shall coordinate with Austin Energy regarding all utility metering requirements prior to procuring the proposed Primary Metering Cabinets. In particular, the Contractor shall attain in writing from Austin Energy approval for the proposed utility metering CT and PT prior to manufacture and shipment of the switchgear. Should the contractor fail to coordinate with Austin Energy regarding the Austin Energy metering requirements prior to the procurement and installation of the switchgear, the contractor shall provide all labor and material to modify the utility metering, as required, to the satisfaction of Austin Energy at no additional cost to the owner.

C. Instrument Potential Transformers (P.T.'s):

1. Where shown on the PLANS, furnish and install a set of three (3) – 12.5kV-to-120Volts AC fused Potential Transformers for the AUSTIN ENERGY incoming line Main Utility Metering section of each 15kV Primary Metering Cabinet. All Main Utility Metering Potential Transformers shall have 60:1 ratio, 110 kV BIL, 0.3% meter accuracy, and shall be manufactured by GE Model JVM5A Catalog No. GE 765X023011.

2. Potential Transformers shall be wired to separate potential terminal blocks. Mount potential terminal blocks inside the upper-front compartment of the applicable vertical section of the 15kV Primary Metering Cabinet. All wiring shall be #10 AWG copper terminated with insulated ring type compression terminators and shall conform to the AUSTIN ENERGY standard color code.

2.09 INSTRUMENT TRANSFORMERS – 5KV AND 15KV METAL-CLAD SWITCHGEARS

A. General:

1. All instrument transformers specified shall be installed and connected at the factory. Mount instrument Potential Transformers (P.T.'s) in their drawout supports for factory test. Note: The instrument transformers (C.T.'s and P.T's) product specifications described herein does not apply to the Austin Energy Incoming Line Main Utility Metering Transformers and the OWNER's Main Utility Metering Transformers.

B. Instrument current transformers (C.T.'s):

1. The instrument current transformers (C.T.'s) shall be especially designed for installation in totally enclosed Metal-Clad Switchgears. The design shall coordinate the thermal, mechanical, and insulation limits of the current transformers with that of the vacuum circuit breakers and main bus of the Metal-Clad Switchgear in which they are to be installed.

2. Instrument current transformers shall be of the wound, through or bar and/or window type, with silver-plated primary terminals and suitable insulation over these terminals to withstand ANSI standard test voltages equivalent to the maximum voltage rating of the Switchgear.

3. Provide multi-ratio current transformers. Multi-ratio current transformers shall be of the five (5) terminal type as specified in this section and shown on the PLANS.

4. The accuracy of the instrument current transformers shall be suitable for the meters and/or relays specified, with normal burdens of the various devices of not less than an ANSI standard accuracy classification of 0.3 with burden B-0.1, B-0.5, and B-2.0.

5. Install a tap changing-shorting terminal block for each current transformer (C.T.). Prewire all terminal of each C.T. and multi-ratio C.T. to its respective tap changing shorting terminal block. Shorting terminal blocks shall be as manufactured by "G.E.", or approved equal. Mount shorting terminal blocks (STB's) inside the upper-front compartment of the applicable vertical section of the Metal-Clad Switchgear.

6. Additional requirements for zero sequence (core balance) current transformers:

a. Furnish and install window type zero sequence current transformers. Minimum window opening shall be 20 inches long by 8 inches wide. Window opening size shall be increased as required such to allow multiple feeder circuit cables to simultaneously pass through the window opening. Current transformer shall be located such to allow multiple feeder circuit cables to simultaneously pass through the window opening. Zero sequence current transformer shall be as manufactured by ABB BYZ-L or approved equal.

C. Instrument Potential Transformers (P.T.'s):

1. The instrument potential transformers and their associated primary and secondary fuses shall be installed in a draw-out assembly inside the designated section/compartment within the Switchgears. The instrument potential transformers shall also fit into and coordinate with the complete Metal-Clad Switchgear sections (of each Metal-Clad Switchgear), and with the instruments, relays, meters and other devices specified.

2. The instrument potential transformers shall have a rating of not less than 150 volt-amp (VA) on an accuracy basis, and 500 volt-amp (VA) on a thermal basis.

3. The instrument potential transformers shall have the following primary and secondary voltage ratings:
   a. Primary voltage = 12.5kV for 15kV Switchgears and 4.16kV for 5kV Switchgears
   b. Secondary voltage = 120 volt (AC)
   c. Frequency = 60 hertz

4. The accuracy classification of the instrument potential transformers shall be 0.3 with burdens of W, X, Y and Z.

5. Install instrument potential transformers with primary and secondary disconnect devices, grounding device, and accessories in conformance with IEEE and NEMA standards. The primary fuses furnished with these transformers shall be of the current limiting type. These fuses must clear a faulted transformer in approximately 1/2 cycle (on 60 cycle basis), but must not blow on magnetizing inrush current nor protect a transformer with a short circuited secondary.

2.10 MICRO-PROCESSOR BASED PROTECTIVE RELAYING AND COMMUNICATION – 5KV AND 15KV METAL-CLAD SWITCHGEARS

A. Main and Feeder Circuit Breaker Sections - Metering and Feeder Protective relay "FPR" for Each Metal-Clad Switchgear

1. The main and feeder circuit breaker section of each Metal-Clad Switchgear shall be furnished with a Feeder Protective Relay "FPR". Connect each Feeder Protective Relay "FPR" as shown on the PLANS. Each Feeder Protective Relay "FPR" shall be as manufactured by General Electric - MULTILIN model 850. Where the drawings indicate a "Feeder Protective Relay" device, furnish and install the "FPR" as identified in this section of the specifications.

2. In addition, the protective relay is to have the following features as provided by Manufacturer:
   a. Phase Current Inputs (refer to PLANS),
   b. Ground Current Inputs (refer to PLANS), as well as sensitive ground CT inputs option,
   c. 2 Form A and 3 Form C Output Contacts rated minimum 120VAC, 10A continuous, 2A inductive, as well as 7 Discrete inputs (120VAC). These

output contacts shall be in addition to the standard Trip and related output contacts.

d. 7 Analog Outputs (4-20mA) as well as 4 Analog Inputs (4-20mA) plus one(1) RTD input

e. 10 Digital Inputs + 4 Arc Flash Inputs

f. Additional I/O, as required, per control schematics as shown in PLANS,

g. Standard Front Panel (Rugged Key Pad),

h. Current Protection: Advanced Configuration,

i. Voltage Monitoring and Protection: Advanced Voltage Metering & Protection,

j. Control: Advanced Control

k. Monitoring: Advanced Monitoring

l. Communications: Advanced Communication,

m. Communications media: Copper Ethernet, unles shown as fiber on PLANS

n. No Wireless Communication

o. Security: Advanced security, CyberSentry Level 1

3. Furnish "FPR" with HI range control power supply option. Control power supply requirements for the Switchgears are:
   a. 5kV Switchgears: 120VAC
   b. 15kV Switchgears: 120VAC

B. Medium Voltage (5 kV and 15kV) Bus AND TRANSFORMER Differential Protective Relay "DPR"

1. Where shown on the PLANS, the 15kV medium voltage overhead tie bus system between the two (2) 5kV Switchgears and between the two (2) 15kV Metal-Clad Switchgears shall be protected by a Bus Differential Protective Relay. Connect the Bus Differential Protective Relay as sown on the PLANS. Each Bus Differential Protective Relay shall be as manufactured by General Electric - MULTILIN model 845. Where the drawings indicate a "Bus Protective Relay" device, furnish and install the "DPR" as identified in this section of the specifications.

2. Where shown on the PLANS, provide Transformer Differential Protective Relay within the two (2) 5kV Metal-Clad Switchgears. Connect the Transformer Differential Protective Relay as sown on the PLANS. Each Transformer Differential Protective Relay shall be as manufactured by General Electric - MULTILIN model 845. Where the drawings indicate a "Transformer Protective Relay" device, furnish and install the "DPR" as identified in this section of the specifications.

3. In addition, the protective relay is to have the following features as provided by Manufacturer:
   a. Phase Current Inputs 1: (refer to PLANS),
   b. Phase Current Inputs 2: (refer to PLANS),
   c. Ground Current Inputs (refer to PLANS),
   d. 2 Form A and 3 Form C Output Contacts rated minimum 120VAC, 10A continuous, 2A inductive, as well as 7 Discrete inputs (120VAC). These output contacts shall be in addition to the standard Trip and related output contacts.
   e. 7 Analog Outputs (4-20mA) as well as 4 Analog Inputs (4-20mA) plus one(1) RTD input
   f. 10 Digital Inputs + 4 Arc Flash Inputs
   g. Additional I/O, as required, per control schematics as shown in PLANS,
   h. Standard Front Panel (Rugged Key Pad),
   i. Current Protection: Advanced Configuration,
   j. Voltage Monitoring and Protection: Advanced Protection,
   k. Control: Standard Control
   l. Monitoring: Advanced Monitoring
   m. Communications: Advanced Communication,
   n. Communications media: Copper Ethernet, unles shown as fiber on PLANS
   o. No Wireless Communication
   p. Security: Advanced security, CyberSentry Level 1
4. Control power supply requirements for the Switchgears are 120VAC

C. 15kv Switchgears Bus Tie and Incoming Power – Synchronism Check Relay "SCPR"

1. Where shown on the PLANS, the 15kV class incoming power sources (one source per each 15kV Switchgear) shall be checked for synchronism prior to and/or while allowing a closed transition from one source to another. Source synchronization shall be checked by a Digital Synchronism Check Relay. The Synchronism Check Protective Relay (SCPR) shall be as manufactured by Basler Electric model BE1-25 also shown on the PLANS, No Equal. In addition, the relay is to have the following features as provided by Manufacturer:
   a. Single phase voltage sensing
   b. Sensing input range of 120VAC at 1 – 99 degrees
   c. Power supply of 120VAC
   d. Timing adjustable between 0.1 to 99 seconds
   e. One internally operated target

f. Option for voltage difference

g. Synchronous Check normally open dry relay contact, rated for 120VAC, 2A inductive minimum

h. Power supply status dry relay contact, rated for 120VAC, 2A inductive minimum:

1) The power supply output relay is energized and its output contact is opened when power is applied to the relay, closed otherwise.

i. Isolated contact sensing for discrete input signal

j. Semi-flush mounting

D. Patch Panel

1. Where patch panel shown on the PLANS or as required by this specification, furnish and install a dedicated patch panel for termination of the Ethernet data highway (serial communication) cabling for each Protective Relay and Power Monitoring Unit. Patch panels shall be two-port, surface mounted, fully enclosed type, Category 6A, with RJ-45 connectors, as manufactured by "Panduit", Model Mini-Com #CBXJ2IW-A, with "Mini-Com TX6A" UTP Coupler Module Model CJK6X88TGBU and blank cover plates, or approved equal. Ethernet patch cords shall be furnished and installed between the patch panel and the respective protective relay per the requirements of Section 17600 "Distributed Control System".

2.11 POWER MONITORING UNIT (PMU) – 15KV METAL CLAD SWITCHGEAR

A. Where required by the PLANS, furnish and install a Power Monitoring Unit (PMU).

1. The PMUs shall be as manufactured by General Electric - MULTILIN Model EPM 9700 (Transducer Module) with advanced software option complete with three line LED combination display and keypad Model P40NPLUS, with the Ethernet communication capability, harsh environment UL 746C/94 recognized conformal coating on all printed circuit assemblies and all required interconnect cabling as also shown on the PLANS, No Equal. Units shall be connected as shown on the PLANS.

2. Furnish and install an Ethernet connection to the PMU on the door adjacent to the LED display for accessing PMU settings files.

3. Where shown on the PLANS, furnish and install a patch panel in accordance with the requirements of Sub-Section 2.08 D, this Section of the Specifications.

2.12 INSTRUMENT AND CONTROL WIRING – 5KV AND 15KV METAL-CLAD SWITCHGEARS

A. General:

1. All Instrument and Control wire/cables shall be UL recognized/CSA approved.
2. Phase sequencing shall have proper identification.
3. Each single wire and/or cable shall be terminated at a terminal block. Also, refer to Subsection 2.14 of this Section of the Specifications.
4. All instrument transformer wiring, wiring to metering and protective relaying devices (Feeder Management Relays, etc.), wiring to control and pilot devices (selector switches, pushbuttons, pilot lights, etc.), control signal and low voltage power wiring in each vertical section of the Switchgears shall be terminated to appropriate Terminal Blocks and Terminal Strips (group of Terminal Blocks) that shall be housed and located in the upper-front-compartment (front-upper-bay) of the same/respective vertical Section. All Terminal Blocks/Strips shall be located within the upper-front-compartment (front-upper-bay) of the respective vertical Section of the Switchgears.
5. The Switchgears shall be completely assembled and wired at the factory such that installation can be accomplished by connecting field wiring to terminal strips located in the panel.

B. Secondary Signal Wiring to/from Instrument Transformers: Instrument Transformers Secondary Signal Wiring to/from Current Transformers, Ground Current Transformers and Potential Transformers shall be installed inside the Metal-Clad Switchgears in suitable wiring gutters. Where not possible to install in wiring gutters, spiral wrapping, or corrugated protective plastic. tubing, etc., must be used. Signal wiring shall be extra flexible 41-strand, tin-plated, 600 volt insulation, dual rated type XLPE (3173) 125° C, SIS 90° C., SIS wire manufactured by General Cable Company, The Okonite Company, or approved equal. Minimum acceptable size shall be #10 AWG.

C. 120 Volts AC - Discrete Control Wiring System – 5kV and 15kV Switchgears: 120 Volts AC Discrete Control Signal wiring shall be installed inside the Metal-Clad Switchgears in suitable wiring gutters. 120 volts AC discrete control wiring shall be extra flexible 41-strand, tin-plated, 600 volt insulation, dual rated type XLPE (3173) 125° C, SIS 90° C., SIS wire manufactured by General Cable Company, The Okonite Company, or approved equal. Minimum acceptable size shall be #12 AWG.

D. ModBus Digital Data Communication System Wiring: All ModBus Digital Data Communication System Wiring shall be twisted pair, #16 AWG stranded copper conductors with 600 volt PVC insulation over each conductor, a tinned copper drain wire, an overall aluminum mylar shield and an outer PVC jacket. Instrument wiring cables shall be manufactured by Belden, or approved equal. Color of the twisted pair shielded cable jacket shall be ORANGE.

E. Control and instrument wiring routed on inside face (directly behind the face) of access doors of the Switchgears and where not possible to route in wiring gutters, spiral wrapping, or corrugated protective plastic tubing, etc., must be used.

2.13 CONTROL AND PILOT DEVICES – 5KV AND 15KV METAL-CLAD SWITCHGEARS

A. Selector Switches:

Provide selector switches with the contact operation type (maintained action, momentary action, etc.) where shown on the PLANS. Switches shall be as manufactured by General Electric "G.E." Type SB1, Electro-Switch, or approved equal.

B. Indicating Pilot Lights:

Indicating lights shall be NEMA Style, full size 30-millimeter (30mm), Transformer Type Light Emitted Diode (LED), NEMA 4/13 oil tight and watertight, full size, push to test type, rated at 120VAC, with legend plate marked as shown on the PLANS. Lens color shall be as shown on the PLANS. Pilot lights shall be as manufactured by Allen-Bradley Bulletin 800T NEMA Type 4/13, oil tight and water tight, or approved equal. Miniature size pilot lights will not be accepted.

C. Control Relays:

1. General Control Relays (non-protective control logic relays):
General control logic relays, where required, shall be 600 volt AC and/or DC, as applicable). Minimum contact rating shall be 10 amperes continuous at the rated operating voltage and voltage type (AC or DC). Furnish each relay with one additional Normally Open (N.O.) and one additional Normally Closed (N.C.) contacts over the number required by the schematic diagrams. Relays shall be furnished with visual mechanical latch-unlatch indicators. Additionally, coil of each relay shall be furnished with Relay Manufacturer's Transient Suppression Module. Relays shall be Allen Bradley Bulletin 700, or approved equal. So called "International" and IEC rated relays will not be accepted. All relays shall be standard NEMA size.

2. General Control Time Delay Relays (non-protective control logic relays):
Solid state, multi-time, and multi-function type relay. Both timing ranges and timing modes shall be field selectable. Each relay shall be capable of the following timing modes: On Delay, Off Delay, One Shot, Repeat Cycle, and Interval. Minimum relay contact rating shall be 10 amps, continuous, at 120 VAC. Coils shall be 120 VAC. Timing relays shall be Square D Class 9050 model No. JCK70 complete with Type NR61 Socket, or approved equal.

3. Mount control relays inside the upper-front-compartment (upper front bay) of each respective and applicable vertical section of the Switchgears. DO NOT mount relays directly to the sheet metal barriers within the vertical sections of the Switchgear sections. Mount relays on the white-painted backpanel (device panels) located inside the upper front-compartment of each vertical section.

D. Lockout relay:

Provide each circuit breaker with Lockout Relay as also shown on the PLANS. The lockout relay shall be hand reset and wired per the PLANS. Lockout relays shall be as manufactured by Electro-Switch Series 24, General Electric Company "G.E", or approved equal.

2.14 INSTRUMENT AND CONTROL WIRING TERMINAL BLOCKS AND ASSOCIATED WIRING METHOD – 5KV AND 15KV METAL-CLAD SWITCHGEARS

A. Terminal Block and/or Terminal Strip:

1. Terminal blocks used 120 volts AC, 130 volts DC and 24 volts DC instrumentation and control wiring shall be NEMA Terminal Blocks, 600 volts with continuous current rating of 30-amperes, nylon or polypropylene, snap together Knife-Style isolating terminal blocks. Terminal blocks shall be mounted on a Heavy Duty DIN Rail. Terminal blocks shall be manufactured by Allen-Bradley catalog No. 1492-WKD6 (33 terminals per foot) complete with 1492-SM6X12 detachable multi-character Snap-in Marker Card, and manufacturer's insulated side jumpers, or approved equal. Use of wire as jumper between terminal blocks will not be accepted. Tag each terminal block (each point on a terminal strip). Tag of each terminal block shall be typed with an indelible marking process. Handwritten tags WILL NOT BE ACCEPTED.

2. Shorting Terminal Blocks for wiring to/from Instrument Current Transformers: Terminal blocks shall be Tap-Changing-Shorting Terminal Blocks, NEMA Terminal Blocks, 600 volts with minimum continuous current rating of 55-amperes. The Shorting Terminal Blocks (designated on the PLANS as STB's) shall be utilized for secondary wiring of all Multi-Ratio and Dual Ratio Current Instrument Transformer. The Shorting Terminal Blocks shall be as manufactured by General Electric "G.E.", or approved equal.

B. Terminal Strip/Block General Wiring Methods, Tagging and Identification:

1. Terminal strips/blocks associated with wiring of equipment within a vertical section of the Switchgears shall be located in the UPPER-FRONT COMPARTMENT (upper front bay) of the respective vertical section (lower front bay or lower compartment shall be utilized for drawout assemblies such as circuit breakers, Potential Transformers P.T.'s, and window type Current Transformers C.T.'s, etc.).

2. Each instrument and control wiring terminal block shall be in a vertical section of the Switchgears shall be mounted on a heavy-duty RAIL (DIN-RAIL mount). Each Terminal Strip within a vertical section shall be mounted on a rail that is physically isolated from any other terminal strip and associated rail in the section. All Terminal Strips must be separated from one another.

3. UNDER NO CIRCUMSTANCES SHALL ANY WIRE RUN FROM ONE DEVICE TO ANOTHER WITHOUT GOING THROUGH AND BEING TERMINATED TO A TERMINAL BLOCK. A point or multiple of points of wiring termination located at any device shall not be considered the same as a

terminal point OR termination point on a Terminal Block NOR shall it be considered the same as Terminal Block(s). Also, refer to the requirements shown on the PLANS.

4. Tag each individual Terminal Block. Each terminal shall have the same tag as the tag of the wire connected to the respective terminal. Utilize the Terminal Blocks manufacturer's tagging assembly (markers, marking strip, etc.) as specified in this Section of the Specifications. All tags must be typed and neatly attached to the marking surface per the recommended procedure of the Terminal Block Manufacturer. Handwritten tags WILL NOT BE ACCEPTED.

5. Physically segregate/separate and isolate AC control wiring terminal strips and its associated DIN-RAIL mount from the DC control wiring terminal strips and its associated DIN-RAIL mount. Also, refer to terminal strip layout and arrangement shown on the PLANS.

6. Utilize the terminal block manufacturer's plated copper terminal-to-terminal insulated side jumpers for making connections between adjacent terminal blocks and/or between terminal blocks located on the same terminal strip. Use of wires as jumpers between terminal blocks will not be accepted.

7. DO NOT mount Terminal Strip assemblies (inclusive of DIN Railing, where applicable) directly to the sheet metal barriers within the vertical sections of the Switchgear sections. Mount Terminal Strip assemblies on the white-painted backpanel located inside the upper front-compartment of each vertical section.

2.15 DEVICE/COMPONENT IDENTIFICATION AND WIRE TAGGING REQUIREMENTS – 5KV AND 15KV METAL-CLAD SWITCHGEARS

A. Properly identify all devices, general control relays, CT's, PT's, PMU's, FMR's, Pilot Lights, Terminal Blocks, terminal strips, shorting terminal blocks, breakers, auxiliary contact blocks...etc. that are located within/inside, on face, and on back (access doors/panels) of each section/compartment of the Metal-Clad Switchgears. For identification nameplates of equipment located inside/within each section of the Metal-Clad Switchgears, utilize manufacturer's standard laminated labels, "Black" with White typed lettering. Secure and attach label per manufacturer's standards. Lettering type and size shall be as such that is clear and visible and acceptable to the Owner.

B. Identify all wiring, such as control/status wiring, power wiring, instrument wiring, etc. at the terminal blocks, lugs, starter/controller/auxiliary compartments, at termination to control devices/PMU's/ FMR's/Instruments/ CT's/PT's,....etc. Each end of a wire shall be tagged with manufacturer's standard heat shrinkable wire tags. All wire tag identifications, etc. must be typed and not handwritten and shall be per manufacture's standards.

C. Provide identification strips for all terminal blocks, marked in compliance with the applicable wiring diagram drawings (as-builts). Handwritten marking on wiring and terminal blocks will not be accepted. All marking/identification of terminal blocks and wiring shall be typed and shall be per the manufacturer's standard.

D. Furnish and install laminated 3-ply "White-Black-White", phenolic identification nameplate for each equipment/device/etc. installed/mounted on the face of the Metal-Clad Switchgears. Lettering font shall be manufacturer's standard with minimum lettering size of 1/4" in height. Attach nameplate with 316 Stainless Steel screws, use of adhesives shall not be accepted. Note: Each pilot and control device shall be provided with a function and device Name-Tag identification nameplate in addition to the device manufacturer's legend plate

E. Properly identify each section and compartment of the Metal-Clad Switchgears. For identification nameplates, utilize laminated 3-ply phenolic, "White-Black-White", plastic laminated nameplates, a minimum of 3/32" thick, with white lettering on black background. Lettering font shall be manufacturer's standard. Attach nameplate with 316 Stainless Steel screws. Minimum lettering size of identification nameplates pertaining to section/compartment content and name identification in the Metal-Clad Switchgears shall be 3/8" in height

F. For devices mounted on the face of the doors of the Metal-Clad Switchgears, install identification nameplate on the back side of the doors in addition to the nameplates installed on the front face of the Metal-Clad Switchgears. Nameplates installed on the back side of the doors shall be per the requirements of paragraph-A (above) of this subsection.

2.16 LIGHTNING AND SURGE ARRESTERS - 5KV AND 15KV METAL-CLAD SWITCHGEARS

A. General:

In the incoming line section of each Metal-Clad Switchgear, install three (3-phase) station class lightning arresters, and three (3-phase) station class surge capacitors, as shown on the drawings.

B. Lightning Arresters:

Station class (type), 3-phase lightning arresters with rating equivalent to the maximum voltage rating of the respective Metal-Clad Switchgear. Lightning arresters shall be U.L. listed and certified, and of valve type. Install three lightning arresters in the incoming line section of each Metal-Clad Switchgear, as shown on the drawings.

C. Surge Capacitors:

Station class (type), 3-phase surge capacitors with rating equivalent to the maximum voltage rating of the respective Metal-Clad Switchgear. Surge capacitors shall be U.L. listed and certified, and of sway capacitors. Install three surge capacitors in the incoming line section of each Metal-Clad Switchgear, as shown on the drawings.

2.17 600 VOLT MOLDED CASE CIRCUIT BREAKERS – 5KV AND 15KV METAL-CLAD SWITCHGEARS

A. Where required by the PLANS, install 600 volts AC (120/208 volt AC or 480 volts AC, as applicable) molded case circuit breakers in the Metal-Clad Switchgears, as shown on the PLANS.

B. Molded case circuit breakers shall be thermal magnetic molded case circuit breakers with continuous current rating indicated on the PLANS (at the operating voltage of the system). Breakers shall operate continuously, without tripping, when operating/running current is equal to 80% of the long time trip setting (or frame rating, as applicable) of the breakers. Furnish and install current limiting type circuit breakers where called for, and with the characteristics noted, on the PLANS.

C. Circuit breaker shall be one (1), two (2) or three (3) poles (as shown on the PLANS), 600 volts AC or 600 volts DC, with a maximum continuous current carrying capacity shown on the PLANS and a U.L. listed minimum RMS symmetrical short circuit current rating equal to or greater than the minimum RMS symmetrical short circuit current rating shown on the PLANS (at the operating voltage of the system). However, under no circumstances shall the RMS symmetrical short circuit current rating of the circuit breakers be less than 42,000 amperes at the operating voltage of the system (480 volts AC, 208/120 volts AC, etc., as shown on the PLANS). Breakers shall be U.L. listed and shall comply with NEMA Standard No. AB1-1975 and Federal Specification W-C-3758/GEN 21a. Circuit breaker shall be fully rated and not require rating for ambient temperatures of 40 degrees C. or less.

2.18 MEDIUM VOLTAGE (5KV AND 15KV) OVERHEAD BUS DUCT SYSTEM

A. Rating:

1. 15kV Overhead Bus Duct System - 12,470 volt, 2000 amperes, 3-phase, 3-wire, braced to withstand not less than 1000MVA symmetrical interrupting duty and a minimum momentary rating of 80KA at 12,470 volts.

2. 5kV Overhead Bus Duct System - 4,160 volt, 2000 amperes, 3-phase, 3-wire, braced to withstand not less than 1000MVA symmetrical interrupting duty and a minimum momentary rating of 80KA at 4,160 volts.

B. Bus bars:

Insulated flat tin-plated copper bar, full round edge, type ETP, 100% conductivity. Of suitable design and cross sectional area to satisfactorily carry rated current without exceeding IEEE and NEMA specified temperature rise. Current carrying capacity based on actual service conditions, including skin and proximity effect, insulation, steel enclosure and ambient temperature of 40 degrees C.

C. Insulation:

The bus insulation shall be of the manufacturer's offered PREMIUM QUALITY insulation (manufacturer's offered premium option for bus insulation at no additional

charge to the Owner). High resistance conducting surface in contact with the bus to eliminate corona damage to bus insulation. Heat shrink all bus insulation.

D. Supports:

All bus supports (insulation from ground) shall be High Strength and High Creep finned type high resistant Epoxy insulators.

E. Connections to bus duct:

Suitable bolts and lockwashers. Tin-plated copper bars at all current carrying connections. Provide molded removable covers at connections to the bus. At final connection point of the medium voltage overhead bus duct to the switchgear assembly, utilize tin-plated extra flexible soft and braided copper connectors which shall meet the same technical specifications as the main bus bars of the switchgears and the medium voltage overhead bus duct systems, described in this section of the specification.

F. Housing:

Flange to flange, gasketed dust-tight and water-tight, non-ventilated, corrosion resistant #11 gauge steel enclosure. The enclosure shall have bolted removable housing. The enclosure shall be designed to be hung from overhead by hangers.

G. Space Heaters:

Two 125 watt, 120 volt type minimum, complete with thermostatic control contained within the housing of each bus duct. Wire (in conduit) to the 120/208 volt panelboard in the Substation No. 4 building.

PART 3 - EXECUTION

3.01 5KV AND 15KV METAL-CLAD SWITCHGEARS

A. Level and mount Metal-Clad Switchgears with leveling channels and anchoring bolts, as recommended by the manufacturer and detailed on the drawings. Leveling insert type channels shall be 316 stainless steel, as manufactured by “Unistrut” Series 3783-ST, or approved equal. Install leveling insert channels in the concrete floor slab of the Switchgear building, as detailed on the drawings. All mounting hardware shall be stainless steel.

B. The manufacturer shall provide certified copies of factory test reports prior to shipment of the equipment to the project site. Format and quantity of reports shall be per the requirements of Section 01300 and 01730 of the Contract Specifications.

C. Furnish the services of the manufacturer's technical representative (non-sales type representative) to assist and supervise in the installation of the equipment, and to perform the initial operation (start-up). Also, refer to the requirements of Subsection (paragraph) 1.09 in this section of the specifications.

D. Wire the space heater circuitry of each Metal-Clad Switchgear as shown on the PLANS. Location and quantity of space heater circuits and associated points of terminations shown on the PLANS are approximate estimates, exact and final location of the space heaters as well as the number of circuits and associated points of terminations shall be based on, and as shown on, the manufacturer's shop drawing submittals. Make all field modifications as required by the manufacturer's submittal drawings and as pre-approved/pre-accepted by the Engineer/Owner, and make all final connections to the satisfaction of the Engineer/Owner and at No additional cost to the Owner.

3.02 MEDIUM VOLTAGE (5KV AND 15KV) OVERHEAD BUS DUCT SYSTEM

A. Install in accordance with manufacturer's recommendations and as shown on the PLANS.

B. Provide supports as shown on the PLANS or as otherwise required and recommended by the manufacturer.

C. Connect to the 5kV Switchgears and the 15kV Switchgears (inside the appropriate vertical sections) with braided flexible connectors.

D. Wire the space heater circuitry of the Medium voltage overhead bus duct (in conduit) to the 120/208 volt panelboard in the Substation No. 4 building. Location and quantity of space heater circuits and associated points of terminations shown on the PLANS are approximate estimates, exact and final location of the space heaters as well as the number of circuits and associated points of terminations shall be based on, and as shown on, the manufacturer's shop drawing submittals. Make all field modifications as required by the manufacturer's submittal drawings and as pre-approved/pre-accepted by the Engineer/Owner, and make all final connections to the satisfaction of the Engineer/Owner and at No additional cost to the Owner.

E. Test for proper phasing of power connections.

F. Standard factory tests shall be performed on the equipment specified under this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards. The manufacturer shall provide certified factory test reports prior to shipment of the equipment to the project site. Format and quantity of reports shall be per the requirements of Section 01300 and Section 01730 of the Contract Specifications.

G. Follow manufacturer's instructions and approved practice for installation of the equipment. Refer to Subsection 1.09, this Section of the Specifications.

H. Furnish the services of the manufacturer's technical representative (non-sales type representative) to assist and supervise in the installation of the equipment, and to perform the initial operation (start-up). Include time to correct any defects or malfunctions. The

manufacturer shall provide a report certifying that the equipment was installed in accordance with manufacturer's recommendations and are in proper working order. Format and quantity of reports shall be per the requirements of Section 01300 and Section 01730 of the Contract Specifications. Also, refer to Subsection 1.09 in this Section of the Specifications.

3.03 FACTORY TESTING – 5KV AND 15KV SWITCHGEARS

A. As minimum, the following standard factory tests shall be performed on the circuit breaker element provided under this section. All tests shall be in accordance with the latest version of ANSI standards:

1. Alignment test with master cell to verify all interfaces and interchangeability
2. Circuit breakers operated over the range of minimum to maximum control voltage
3. Factory setting of contact gap
4. One-minute dielectric test per ANSI standards
5. Final inspections and quality checks

B. The following production test shall be performed on each breaker housing:

1. Alignment test with master breaker and/or breaker installed in the accompanying Switchgear to verify interfaces and interchangeability
2. One-minute dielectric test per ANSI standards on primary and secondary circuits
3. Operation of wiring, relays and other devices verified by an operational sequence test.
4. Control circuits algorithm tests, hard-wired auto-transfer logic tests, protective device trip/alarm and breaker lockout/interlock tests.
5. Final inspection and quality check.

C. The manufacturer shall provide copies of the factory test reports per subsection 3.01 (above) of this Section of the Specifications.

D. Factory tests as outlined above shall be witnessed by the Owner's representative. The manufacturer shall include cost of two (2) factory trips, each trip attended by six (6) of the Owner's representatives.

1. The manufacturer shall notify the owner two (2) weeks prior to the date the tests are to be performed.
2. The manufacturer shall include the cost of transportation and lodging (e.g.- airfare, rental car, hotel rooms, etc.) for up to six (6) Owner's representatives, per factory trip, and for a duration of up to 5-standard business days per factory trip, and 8-standard business hours per standard business day. Standard business days are Monday through Friday, excluding National Holidays. Standard business

hours 8:00 a.m. to 5:00 p.m. during standard business days. The cost of meals and incidental expenses during each trip shall be the owner's responsibility.

3.04 FIELD QUALITY CONTROL

A. Furnish the services of the manufacturer's technical representative (non-sales type representative) to assist and supervise in the installation of the equipment, connections and adjustments, and testing of the Switchgears components contained therein.

B. The manufacturer's technical representative (non-sales type representative) shall perform the initial operation (start-up). Include time to correct any defects or malfunctions.

C. Refer to the requirements of Subsection (paragraph) 1.09 in this Section of the Specifications.

3.05 FIELD ADJUSTMENTS AND TESTING

A. Set, adjust and test all protective relays based on the results of the coordination study.

B. Refer to the requirements of Subsection (paragraph) 1.09 in this Section of the Specifications.

C. Check phasing across the switchgears and connecting medium voltage overhead bus duct utilizing phasing sticks.

3.06 MANUFACTURER'S CERTIFICATION

A. The manufacturer shall provide a report certifying in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations and are in proper working order.

B. Format and quantity of Certification Reports shall be per the requirements of Section 01300 and 01730 of the Contract Specifications. Also, refer to Subsection 1.09 in this Section of the Specifications.

3.07 TRAINING

A. Provide training sessions for the Owner's representatives for Five (5) standard business days (normal workdays) at the job-site location and/or at a location determined by the Owner. If training is conducted in less than the time required by these Specifications, the remaining time shall be utilized at the discretion of the Owner.

B. The training session shall be conducted by the same manufacturer's non-sales-type technical representative who performed the field installation assistance and start-up/setting/adjustment services.

C. At minimum, the training session shall include:

1. Operation and maintenance procedure for the equipment and all components contained within the Metal-Clad Switchgears and training associated with the medium voltage overhead bus duct system.
2. Calibration, setting, adjusting and testing the microprocessor based metering and protective relays (units).
3. Use of calibration and setting software associated with the various microprocessor based metering and protective relays (units).
4. Factory contact persons phone numbers, persons names, ordering procedures and procedures to follow to obtain meaningful results from the factory.

3.08 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this Section. All costs are included in the Base Bid.

END OF SECTION

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PART 1 - GENERAL

1.01 SCOPE

A. The Contractor shall furnish and install the Switchboards as specified herein and as shown on the PLANS.

B. Furnish and install two (2) 480 volt OUTDOOR Switchboards at the Low Service Pump Station Area to serve the 480 volt sub-distribution system at the Low Service Pump Station at the Ullrich Water Treatment Plant in Austin, Texas. The Switchboards shall hereinafter be referred to as the "LSPSSWBD-1".

1. Each LSPSSWBD-1 shall be close coupled with a unit substation dry type transformer as specified in Section 16480 "Over 600 Volts Dry Type Transformers for Outdoor Service" and as shown on the PLANS. Refer to Section 16480 "Over 600 Volts Dry Type Transformers for Outdoor Service" of the Specifications.

2. The switchboards are tagged "LSPS-SWBD-01" and "LSPS-SWBD-02" on the PLANS.

C. Furnish and install four (4) 480 volt INDOOR Switchboards at the Low Service Pump Station to serve as the 480 volt distribution system to equipment at the Low Service Pump Station at the Ullrich Water Treatment Plant in Austin, Texas. The Switchboards shall hereinafter be referred to as the "LSPSSWBD-2".

1. The switchboards are tagged "LSPS-SWBD-03", "LSPS-SWBD-04", "LSPS-SWBD-05" and "LSPS-SWBD-06" on the PLANS.

D. Furnish and install one (1) 480 volt OUTDOOR Switchboard at the Low Service Pump Station Area to house two (2) automatic transfer switches that serve the 480 volt sub-distribution system at the Low Service Pump Station at the Ullrich Water Treatment Plant in Austin, Texas. The Switchboard shall hereinafter be referred to as the "ATSSWBD".

1. The ATSSWBD enclosure shall contain two automatic transfer switches as specified in Section 16524 "480 Volt Automatic Transfer Switches" and as shown on the PLANS. Refer to Section 16524 "480 Volt Automatic Transfer Switches" of the Specifications.

2. The switchboard is tagged "LSPS-ATS-01" and "LSPS-ATS-02" on the PLANS.

1.02 RELATED REQUIREMENTS

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.

C. PLANS designated type, number, size and rating of devices included in the Switchboards.

D. Related work as called for on the PLANS, as specified herein or in other Sections of the Specifications.

1.03 QUALIFICATIONS

A. All Switchboards on the project shall be manufactured by a single Switchboard manufacturer. The manufacturer of the Switchboards shall also manufacture the majority of components and subsystems therein (i.e., circuit breakers, control relays, etc. unless specified otherwise).

B. The Switchboards shall be designed, constructed, and tested in accordance with the latest applicable requirements of NEMA, ANSI, UL, and NEC standards.

C. Switchboards shall be as manufactured by Schneider Electric (Square D), Eaton (Cutler Hammer) Corporation, Asea Brown Boveri (ABB), or approved equal.

1.04 SUBMITTALS

A. Submit shop drawings in accordance with the requirements of Section 01300 of the Contract Specifications. Include:

1. Dimensioned/scaled top and bottom views and front elevations.
2. One-line diagrams and wiring diagrams.
3. Internal and external component listings by manufacturer.
4. Catalog cut sheets. Include protective device coordination curves and current limiting circuit breaker/fuse peak current let through curves, where applicable.
5. Key interlock scheme drawing and sequence of operations, where applicable.
6. List of spare parts per Switchboard, including spare part manufacturer's name and catalog numbers, and quantity furnished.

B. Operation and Maintenance Manuals

1. Furnish Operation and Maintenance Manuals in accordance with the requirements of Section 01730 of the Contract Specifications. Include:
   a. Installation and operation manuals.
   b. Renewal parts bulletin.
   c. As built drawings, including approved shop drawings.
   d. Test data.

1.05 DELIVERY, STORAGE AND HANDLING

A. Protection:

1. The Contractor, and hence the Switchboard supplier, shall be responsible for safety of the Switchboard and associated bus duct during storage, transporting and handling.
2. The Switchboard shall be environmentally protected and stored in climate controlled (temperature and humidity, etc.) environment.
3. At all times the Switchboard shall be housed inside a moisture free, non-porous, extra heavy duty plastic weatherproof housing.
4. Interior and exterior of Switchboard shall be kept clean at all times.
5. Energize the space heaters within the Switchboard and energize during storage and installation for humidity control.

B. Additional project job site storage requirements: Upon delivery to the project site and prior to final installation, protect and store in accordance with the following:

1. Environmentally protected and stored in climate controlled (temperature and humidity) environment at the job site. Size, furnish and install temporary air conditioners, and additional environmental control equipment complete with branch circuiting conduit/wire as required to maintain in a controlled environment at the following conditions:
   a. Ambient Dry Bulb Temperature:
      1) Minimum: 68 degrees Fahrenheit.
      2) Maximum: 85 degrees Fahrenheit.
   b. Ambient Relative Humidity: Maximum: 50%.
2. Every effort shall be made to provide all necessary electrical power connections ready for immediate connection to equipment upon arrival of equipment on jobsite.
3. Upon arrival of equipment onto job site, a maximum of one day shall be allowed for equipment to be left without HVAC, but within a sealed enclosed building, to allow proper transition of power of equipment, especially any 120 VAC powered equipment, to ensure all air conditioning and heating equipment are fully operational with a maximum of a 10 minute down time during this transition of power.
4. Furnish and install replacement air filters, etc., as required for proper operation of the environmental control equipment.

1.06 TOOLS AND SPARE PARTS

A. Furnish the following spare parts with the equipment for each Switchboard in conformance with the specifications :

1. One (1) – Set of fuses (minimum 3) for each type and size used.

2. One (1) Power Monitoring Unit (PMU).
3. One (1) Feeder Protection Relay complete with the Case (draw-out housing).
4. Provide breaker test set for Solid-State-Trip units for each type used.
5. One (1) quart of touch-up paint.

1.07 SPECIAL MANUFACTURER SERVICES

A. Furnish the services of a qualified, experienced, factory trained technical (non-sales type) representative to assist in the installation of the equipment. Include checking alignment of parts, wiring connections, operation of all parts (monitoring relays, etc.). Include time to correct and recheck any discrepancies which are discovered. Also include providing the OWNER with a report certifying that the equipment was installed, adjusted, properly tested, and set in accordance with the specifications and is in satisfactory operating condition. Format and quantity of reports shall be per the requirements of Section 01300 of the Contract Specifications.

B. Manufacturer's technical representative is to set, adjust and test all circuit breakers, etc., in the presence of an Owner representative. Additionally, the Manufacturer will select the characteristics of the protective devices that are most suitable for the system in providing proper protection and coordination. The settings will be based on coordination and short circuit studies performed in compliance with Section 16044 of the Specifications, paragraph 1.09 “Special Manufacturer’s Services”. Provide the OWNER with test report certified by the manufacturer. Include a record of all settings. Format and quantity of reports shall be per the requirements of Section 01300 and Section 01730 of the Specifications. The Manufacturer shall furnish the protective device of the appropriate characteristics selected by the OWNER that shall be the most suitable for the proper protection and coordination of the system at No Additional Cost to the OWNER.

C. Any problems encountered with the operation of equipment, parts, components, etc. installed within the Switchboard line-up, and associated bus duct, shall be repaired/remedied by the manufacturer's technical representative.

1.08 WARRANTIES

A. The manufacturer shall warrant that the equipment furnished will be fabricated in accordance with the requirements of this specification and the recommendations of the manufacturer. If, within 5 years after acceptance by the Owner and after the final completion date of the project as indicated on the Contract Documents, the equipment of any parts installed, are found defective because of material, workmanship, selection of materials, or design, the manufacturer shall at the manufacturer’s expense furnish and install replacement parts of a design, workmanship, and material approved by the Owner. Any repairs or replacement parts furnished under the above stated warranty shall carry warranties of the same terms as set forth above from the date of its repair or replacement. Cost of Travel, lodging, labor and parts required as a result of any Warranty Work shall be covered by the warranty (the Manufacturer).

PART 2 - PRODUCTS

2.01 GENERAL

A. For additional construction notes and special requirements, refer to the PLANS. Also refer and adhere to the requirements of the PLANS.

B. Switchboard shall not exceed the dimensions shown on the electrical PLANS. Compartment/component arrangement shall be as shown on the elevation drawings. Provide for incoming feeder entering from below or above, and for outgoing circuits exiting from above and below, as shown on the PLANS.

2.02 CONSTRUCTION

A. Structure

1. General requirements for all Switchboards

a. Enclosure shall be the totally enclosed, dead front, free standing type suitable for back-to-wall mounting. Switchboards shall be FRONT ACCESS ONLY. Switchboards shall be front and rear aligned.

b. Switchboard shall consist of required number of vertical sections bolted together to form a rigid self support free-standing assembly. Each vertical section shall be subdivided into compartments. Refer to the PLANS for additional dimensional requirements.

c. Switchboards shall be furnished with removal lifting facilities as well as basic construction designed for rolling or skidding.

d. Each vertical section may be rolled, moved, or lifted into position.

e. Switchboard shall comply with UL Service Entrance requirements for Switchboards.

f. Unused spaces in each vertical section shall be covered by blank covers.

g. Unused structure openings shall have plugs or covers to prevent entry of foreign objects into the Switchboard.

h. Structure finish shall be primed and painted using the manufacturer's standard finishing process. Finish shall be applied at the manufacturing plant. Color shall be manufacturer's standard.

i. Incoming line section shall include lugs for the connection of the field wiring shown on the PLANS.

j. Each vertical section shall be furnished with a space heater rated for 120 VAC with a dedicated thermostat wired to terminal block in the respective section. Refer to Subsection 2.05, below for requirements for control power transformers to drive the space heater circuitry.

k. Each Breaker compartment/section shall be provided with an individual front hinged door. The door shall be interlocked mechanically with the unit circuit breaker device to prevent unintentional opening of the door

while the breaker is in closed position. Means shall be provided for releasing the interlock for intentional access and/or application of power. Pad locking arrangements shall permit locking the disconnect device in the "OFF" position.

2. Requirements specific to OUTDOOR Switchboards

   a. Enclosures shall be NEMA Type 3R non-walk-in type, gasketed, suitable for outdoor use.

   b. Each vertical section shall be nominally 93 inches high.

   c. Each OUTDOOR Switchboard shall be fabricated of heavy gauge Stainless Steel, Type 316 when available from the manufacturer otherwise, Type 304 minimum, NOT PAINTED.

   d. Each vertical section shall have an overall full height hinged (piano hinge) and gasketed outer front door that shall provide access to the individual compartments contained within the associated vertical section. The overall front door shall have a padlockable three point latch and handle. All outer covers shall be gasketed

   e. All vertical sections shall have open bottoms.

   f. Each vertical section shall have a sloped drip-proof roof.

   g. Exterior openings shall be screened to prevent the entrance of small animals, insects, and also barriered to inhibit the entrance of snow, sand, etc. Ventilation openings shall be provided with field removable filters. It shall be possible to remove the filters for maintenance without providing access to energized Switchboard subcomponents.

3. Requirements specific for INDOOR Switchboards

   a. Enclosures shall be NEMA Type 1, Gasketed (dust tight).

   b. Each vertical section shall be nominally 90-inches high.

   c. Indoor switchboards shall be fabricated of formed steel of not less than 14 gauge thickness.

   d. A hinged door shall be provided for each of the following compartments:

      1) Metering compartment

      2) Incoming line section compartment.

   e. All vertical sections shall have open bottoms and field removable top plates.

B. Buses

1. General:

   a. All buses shall be tin plated copper.

b. The minimum RMS symmetrical short circuit current rating or withstand close rating, as applicable, of the bus shall be as indicated on the one-line diagram drawings.

c. A continuous tin plated copper ground bus shall be furnished for the entire length of the Switchboard. The ground bus shall be rated for 50 percent of the main horizontal power (phase) bus rating, at minimum. Provide ground bolted connectors for the size and quantity of wire at each end of the bus as shown on the PLANS.

2. Additional requirements for LSPSSWBD-1 and LSPSSWBD-2 Bussing:

a. The main horizontal bus shall extend the entire length of the Switchboard. Buses shall be fully rated and the rating shall be based on 65 degrees C maximum temperature rise in a 40 degree C ambient. The main bus bar shall be rated as shown on the PLANS and/or data sheets. The Neutral bus (if required by the PLANS) shall have the same continuous ampere rating as the phase power buses.

b. Full provisions for the addition of future sections shall be provided. Bussing shall include all necessary hardware to accommodate splicing for future additions.

c. Furnish and install barriers between adjacent vertical sections.

3. Additional requirements for ATSSWBD Bussing:

a. Furnish and install bus/cable to extend from the terminal points on the automatic transfer switches to lugs mounted in the Switchboard for connection of field wiring as shown on the detailed one-line diagram in the PLANS.

1) Lugs shall be able to accept the quantity of parallel conductors per phase and the size conductor shown on the PLANS. Refer to the PLANS.

b. Furnish and install bus/cable to interconnect the load termination point of one automatic transfer switch with the normal power input termination point of the second automatic transfer switch as shown on the detailed one-line diagram in the PLANS.

c. Buses/cables shall be fully rated and the rating shall be based on 65 degrees C maximum temperature rise in a 40 degree C ambient. The main bus bar shall be rated as shown on the PLANS and/or data sheets. The Neutral bus (if required by the PLANS) shall have the same continuous ampere rating as the phase power buses.

C. Wiring

1. Control and/or discrete signal wiring includes wiring to instrument current transformers, 600 volt wiring to secondary of instrument potential transformers, ammeters, power monitoring units “PMU’s”, lights, receptacles, control relays, control devices (pilot lights, selector switches, etc.), relaying etc. Control wiring shall be extra flexible 41 strand, tin-plated, 600 volt insulation, dual rated type

XLPE (3173) 125° C, SIS 90° C., SIS wire manufactured by General Cable Company, The Okonite Company, or approved equal. Minimum acceptable size to be #14 AWG.

2. Instrument signal wiring shall be twisted pair, #16 AWG stranded copper conductors with 600 volt PVC insulation over each conductor, a tinned copper drain wire, an overall aluminum mylar shield and an outer PVC jacket. Instrument wiring cables shall be manufactured by "Samuel Moore and Company, DeKoron Division, Cat. No. 1852". All instrument signal wiring shall be installed and tested at the factory.

3. All control/metering wiring shall be neatly bounded with tie-wraps and supported to wire ways supports.

4. Control/metering wiring shall be terminated to terminal blocks.

D. Identification

1. All component and control identification labels shall include the device name and number exactly as it appears on the PLANS. Refer to the PLANS.

2. All control and instrument wires shall be tagged and coded with an identification number. Tagging type and wire coding shall be per manufacturer's standard.

3. All terminal blocks shall be identified.

4. Properly label the control/metering devices mounted inside the each section using manufacturer's standard laminated labels installed in accordance with the manufacturer's standard method. Minimum text height shall be 3/16 inch.

5. Nameplates:
   a. Type: 3-ply, 1/8" thick, rigid thermoset phenolic resin laminated cellulose paper base engraving stock per ASTM D-709, Type I. Nameplates shall be ASTM Grade ES-1, ES-2, or ES-3 as applicable for the face and lettering colors specified hereinafter. Flexible or acrylic tags will be not be accepted.
   b. Color: White-Black-White
   c. Lettering: Engraved through the face layer to the melamine middle layer. Nameplates located on the face of each section/compartment of each MCC shall be legible at a distance of six feet from the nameplate. Minimum text height shall be 3/16 inch.
   d. Accessories: Provide holes for mechanical fastening
   e. Attachment Means: Secured with two Stainless Steel screws/bolts per manufacturer's standard; use of adhesives shall not be accepted.

6. Furnish and install nameplates for:
   a. Each equipment/device/etc. installed/mounted on the face of the Switchboard.
   b. Each exterior section/compartment of each Switchboard.

c. Overall entire lineup of Switchboard, i.e. a master nameplate. Master nameplate shall include the tag of the Switchboard as shown on the PLANS, at minimum, in addition to manufacturer's standard information for master nameplates.

2.03 MAIN, TIE AND BRANCH/FEEDER CIRCUIT BREAKERS – LSPSSWBD-2 AND LSPSSWBD-2

A. General:

1. Provide thermal magnetic molded case circuit breakers with the following minimum requirements:
   a. U.L. listed minimum RMS symmetrical short circuit current rating equal to or greater than that of the main bus.
   b. Circuit breaker shall be three pole, 600 volt with a maximum continuous current carrying capacity shown on the PLANS.
   c. Breakers shall operate continuously when operating/running current is equal to 80% of the long time trip setting (or frame rating, as applicable) of the breakers.
   d. Breakers shall have an overcenter, toggle handle-operated, trip free mechanism with quick make, quick break action independent of the speed of the toggle handle operation. The design shall provide common tripping of all poles. Breakers shall be suitable for reverse feeding.
   e. Provide complete with rating plug and other accessories as required for proper operation of circuit breaker.
   f. Provide mechanical padlock attachment for each circuit breaker.

B. Power Operated Circuit Breakers

1. Where shown on the PLANS, the circuit breakers shall be fixed mounted power operated. The breakers shall be operated by a motor charged stored energy spring mechanism, charged normally by a universal electrical motor, remotely operated from the Distributed Control System, and in an emergency by a manual handle. The primary disconnecting contacts shall be tin-plated copper. The breaker shall include a provision for padlocking open to prevent manual or electric closing. The padlocking shall also secure the breaker in the connected test, or disconnect position by preventing levering. The circuit breaker shall be manufactured by "Square D" model "Masterpact NW Series" or approved equal.
2. The circuit breakers shall be furnished with the following accessories and options:
   a. Shunt Trip Device
   b. Shunt Close Device
   c. Ready-to-Close Contact

d. Electrical Closing Pushbutton

e. Auxiliary Position Switches

f. Overcurrent Trip Switch

g. Micrologic Trip Unit Accessories: Circuit breakers shall have an electronic trip (solid state) unit. Trip unit shall be solid state with adjustable long time, short time, instantaneous with ground fault and pick up settings, "Square D" – model Micrologic Trip Unit with Harmonic Metering with specified accessories, with the shunt Trip Unit Attachment, and Internal Ground Fault Protection, or approved equal. Construction shall allow connection of supply conductors at either end.

1) External Neutral Current Transformer

2) Metering Current Transformers

3) Voltage Measurement Inputs

4) Sensor Plugs

5) Adjustable Rating Plugs

6) External Power Supply Module

7) External Battery Backup Module

h. Mechanical operations counter to record the number of circuit breaker operations.

3. The 120VAC source for each MAIN, TIE and BRANCH/FEEDER circuit breaker shall be supplied from a dedicated control power transformer internal to the Switchboard assembly and connected to the line side of the circuit breaker terminals. The control power transformer(s) shall be provided with fused primary windings and fused secondary windings as specified hereinafter. The Manufacturer shall size the control power transformer, fuses and related interconnect wiring.

4. Provide each circuit breaker with the following 120VAC operators: REMOTE OFF-REMOTE ON selector switch. Selector switch shall be as specified in Section 17200 "Instrumentation and Control Cabinets and Associated Equipment". All breaker control devices shall be wired in accordance to the manufacturer's standard control wiring diagram for power operated circuit breakers. Wire an additional REMOTE OFF-REMOTE ON selector switch contact to control wiring terminal blocks located within the breaker unit compartment indicating that the selector switch is in the "REMOTE ON" position. The selector switch will be monitored by the Distributed Control System as shown on the PLANS.

5. Each circuit breaker shall be furnished with Normally Open (N.O.) and Normally Closed (N.C.) auxiliary breaker status contacts that will change state when the breaker is opened and/or closed. The auxiliary breaker status contacts shall be rated 5-amps at 120VAC. Pre-wire both status contacts to the control wiring terminal blocks located within the breaker unit compartment to be monitored by the Distributed Control System as shown on the PLANS.

6. Provide each circuit breaker with the components required to comply with the Main, Tie and Branch/Feeder Circuit Breaker Control Wiring Schematics shown on the PLANS.

7. Terminations: Breakers shall have removable lugs, U.L. listed for copper and aluminum conductors and U.L. listed for installation of mechanical screw type lugs.
   a. Lugs shall be able to accept the quantity of parallel conductors per phase and the size conductor shown on the PLANS. Refer to the PLANS.

C. Additional requirements for Main/Tie circuit breakers only:

1. Rating: Circuit breaker shall be three pole, 600V with a maximum continuous current carrying capacity shown on the PLANS and a U.L. listed minimum RMS symmetrical short circuit current rating equal to or greater than 42,000 amperes at 480V A.C. Breaker shall be U.L. listed and comply with NEMA Standard No. AB1-1975 and Federal Specification W-C-3758/GEN 21a. Circuit breaker shall be fully rated and not require rating for ambient temperatures 40 degrees Celsius or less.

2. Provide where specifically shown on the PLANS:
   a. Electronic trip attachment. Trip unit shall be solid state type with field adjustable long time, short time, ground fault and pick up settings.

   b. Auxiliary contacts rated for 120 volts A.C. Contacts shall satisfy the requirements of the PLANS.

D. Additional requirements for Branch/Feeder circuit breakers only:

1. Furnish lugs for feeders where required to facilitate field wiring termination, sizes shall be as required by the PLANS.

2. All branch circuiting circuit breakers shall be group mounted.

3. Provide where specifically shown on the PLANS:
   a. Current limiting circuit breaker

   b. Electronic trip attachment. Trip unit shall be solid state type with field adjustable long time, short time, ground fault and pick up settings.

   c. Auxiliary contacts rated for 120 volts A.C. Contacts shall satisfy the requirements of the PLANS.

2.04 AUTOMATIC TRANSFER SWITCH – ATSSWBD

A. In switchboard ATSSWBD, furnish and install two Automatic Transfer Switches and Bypass Isolation Switches. The Automatic Transfer Switches and Bypass Isolation Switches shall have the characteristics required by Section 16524 of the Specifications. Refer to Section 16524 “480 Volt Automatic Transfer Switches”.

1. The enclosure for the Automatic Transfer Switch and Bypass Isolation Switch specified in Section 16524 “480 Volt Automatic Transfer Switches” shall not be

required for installation of the switches inside ATSSWBD. Install the open switch mechanisms on the backplane of the Switchboard enclosure.

2.05 INTEGRATED SURGE PROTECTION DEVICE (SPD) - LSPSSWBD-1 AND LSPSSWBD-2

A. Provide Surge Protective Device (SPD) system were required by the PLANS. The SPD shall have the following characteristics:

1. SPD shall be tested with the ANSI/IEEE Category C high exposure waveform of 10 kA for 8 x 20 microseconds, at minimum.
2. Integrated surge protective device recognized in accordance with UL 1449.
3. Minimum surge current withstand shall be 160 kA per phase (80 kA per mode)
4. Has a minimum pulse life of 5000 ANSI/IEEE Category C high transients without failure or degradation of clamping voltage by more than 10 percent.
5. Provide with manufacturer's standard line side disconnect.
6. Provide visual indication of SPD status.
7. Surge counter.
8. Provide dry contact failure status output contact. Contact shall be rated for 120 volts A.C. and shall satisfy the requirements of the PLANS.
9. 5 year warranty, at minimum.

2.06 CONTROL POWER TRANSFORMERS AND MISCELLANEOUS ACCESSORIES.

A. Provide control power transformer, fuses, power supplies, etc., and associated interconnect wiring as required to provide functional control power service to the circuit breaker trip circuitry for proper operation of circuitry, per manufacturer's standard.

B. Switchboard Space Heater control power transformer for the Switchboard, where required by the PLANS, shall have the following characteristics:

1. Adequately sized to drive the entire space heater circuitry of the Switchboard.
   a. Each LSPSSWBD-1 Switchboard space heater control power transformer shall be sized to drive the space heater circuitry in the respective LSPSSWBD-1 switchboard and in the ATSSWBD Switchboard. Refer to the PLANS.
2. 120 volt AC grounded secondary
3. Connect as shown on the PLANS.
4. The space heater of each vertical section of the Switchboard shall be individually protected with a fuse mounted in the control power transformer compartment.

C. The space heater circuitry shall be thermostatically controlled by a dedicated thermostat in each vertical section of the Switchboard. The thermostat shall have the following characteristics:

1. Type: Heavy Duty line voltage type, suitable for use in controlling heating and cooling circuits. Shall have field adjustable temperature setpoint and also display the measured ambient temperature.
2. Measurement Range:
   a. Thermostat: 40 to 90 degrees Fahrenheit
   b. Thermometer: 50 to 90 degrees Fahrenheit
3. Sensing Element: Liquid filled with diaphragm and lever mechanism
4. Thermometer: Bi-metal type
5. Number and Type of Output Contacts: One Single Pole Double Throw (SPDT), snap acting
6. Contact Ratings:
   a. Heating Contact: 16 ampere at 120 VAC
   b. Cooling Contact: 8 ampere at 120 VAC
7. Enclosure: Thermoplastic cover, suitable for vertical or horizontal mounting configuration
8. Accessories:
   a. Provide temperature adjustment knob
   b. Provide faceplate with each thermostat with temperature measured in degrees Fahrenheit. Faceplate shall include cutout such that the measured ambient temperature is visible.
   c. Mount each thermostat in a device enclosure on the enclosure backpanel in accordance with the manufacturer's recommendations.
9. Manufacturer: Johnson Controls Model T26T Series Line Voltage Thermostat, or approved equal.

D. Space Heater Transfer Switch Control Relay - ATSSWBD
   a. Type: 600 volt Heavy-Duty industrial type
   b. Rated: NEMA rated
   c. Coil Voltage: 120 volts A.C.
   d. Contact Rating: 20 ampere at 120 volts A.C.
   e. Number and Configuration of Contacts: 4 Normally Open and 4 Normally Closed, at minimum. Furnish and install one additional normally open (N.O.) and one additional normally closed (N.C.) contact, over that required by the PLANS. Field configurable type contacts.
   f. Position Indication: Visual mechanical unlatch-latch indicator
   g. Mounting: Provide universal mounting strip/plate for backpanel mounting.
   h. Accessories: Relay Manufacturer's Transient Voltage Suppression Module

i. Manufacturer: Allen Bradley Bulletin 700-PK, or approved equal.

E. Patch Panel: Where patch panel shown on the PLANS, furnish and install a dedicated patch panel for termination of the Ethernet data highway (serial communication) cabling for each Power Metering Unit (PMU) and Protective Relay. Patch panels shall be two-port, surface mounted, fully enclosed type, Category 6A, with RJ-45 connectors, as manufactured by "Panduit", Model Mini-Com #CBXJ2IW-A, with "Mini-Com TX6A" UTP Coupler Module Model CJK6X88TGBU and blank cover plates, or approved equal. Ethernet patch cords shall be furnished and installed between the patch panel and the respective protective relay/power monitoring unit per the requirements of Section 17600 "Distributed Control System".

F. Provide key interlocks where required by the PLANS.

G. Lightning and Surge Arresters:

1. Provide station class (type), 3-phase, rated 600 volts lightning arresters where shown on the PLANS. Lightning arresters shall be U.L. listed and certified, valve type, and shall be designed and manufactured in accordance with the latest revision of ANSI/IEEE C62.11.

2. Provide 3-phase surge capacitors where shown on the PLANS. Surge capacitors shall be U.L. listed and certified, and non-PCB type.

H. Temperature Indicating Transmitter - ATSSWBD

1. Provide a Type T103 Intelligent Temperature Measuring Indicator/Transmitter, as specified in Section 17380 Field Instrumentation and Sensing Devices, to monitor the ambient air temperature inside the ATSSWBD enclosure. Refer to the instrument wiring schematics in the PLANS for instrument connection information.

2.07 INSTRUMENT TRANSFORMERS

A. General:

1. All instrument transformers specified shall be installed and connected at the factory.

B. Instrument current transformers (C.T.'s):

1. Provide current transformers where required by the PLANS. Connect as shown on the PLANS.

2. Current transformers shall be the window type and shall have an ANSI 60 Hz Metering Accuracy Class of 0.3 measured at burden of B0.1, at minimum.

3. Install a shorting terminal block for each current transformer (C.T.). Prewire all terminals of each C.T. to its respective shorting terminal block. Shorting terminal blocks shall be as manufactured by "G.E.", or approved equal.

C. Instrument Potential Transformers (P.T.'s):

1. Provide potential transformers where required by the PLANS. Connect as shown on the PLANS.
2. Potential transformers shall have the following characteristics:
   a. Primary voltage: 480 volts AC
   b. Secondary voltage: 120 volts AC
   c. Accuracy rating: 0.6 Y at burden of 1.2X
   d. Thermal Burden: 150 VA at 30 degrees C ambient
   e. Frequency: 60 Hz
3. Install with primary and secondary disconnect devices, grounding device, and accessories in conformance with IEEE and NEMA standards.
4. Provide current limiting type primary fuses.

2.08 MICRO-PROCESSOR BASED PROTECTIVE RELAYING - LSPSSWBD-1

A. Metering and Feeder Protective relay "FPR"

1. Where shown on the PLANS, the circuit breakers of the switchboard shall be furnished with a Feeder Protective Relay “FPR”. Connect each Feeder Protective Relay “FPR” as shown on the PLANS. Each Feeder Protective Relay “FPR” shall be as manufactured by General Electric - MULTILIN model 850. Where the drawings indicate a “Feeder Protective Relay” device, furnish and install the “FPR” as identified in this section of the specifications. In addition, the protective relay is to have the following features as provided by Manufacturer:
   a. Phase Current Inputs (refer to PLANS),
   b. Ground Current Inputs (refer to PLANS), as well as sensitive ground CT inputs option,
   c. 2 Form A and 3 Form C Output Contacts rated minimum 120VAC, 10A continuous, 2A inductive, as well as 7 Discrete inputs (120VAC). These output contacts shall be in addition to the standard Trip and related output contacts.
   d. 7 Analog Outputs (4-20mA) as well as 4 Analog Inputs (4-20mA) plus one(1) RTD input
   e. 10 Digital Inputs + 4 Arc Flash Inputs
   f. Additional I/O, as required, per control schematics as shown in PLANS,
   g. Standard Front Panel (Rugged Key Pad),
   h. Current Protection: Advanced Configuration,
   i. Voltage Monitoring and Protection: Advanced Voltage Metering & Protection,
   j. Control: Advanced Control
   k. Monitoring: Advanced Monitoring

l. Communications: Advanced Communication,

m. Communications media: Copper Ethernet, unles shown as fiber on PLANS

n. No Wireless Communication

o. Security: Advanced security, CyberSentry Level 1

p. Furnish "FPR" with HI range control power supply option. Control power supply requirements are: 120VAC

B. Bus AND TRANSFORMER Differential Protective Relay "DPR"

1. Where shown on the PLANS, the tie bus system between the switchboards shall be protected by a Bus Differential Protective Relay. Connect the Bus Differential Protective Relay as sown on the PLANS. Each Bus Differential Protective Relay shall be as manufactured by General Electric - MULTILIN model 845. Where the drawings indicate a "Bus Protective Relay" device, furnish and install the "DPR" as identified in this section of the specifications.

2. In addition, the protective relay is to have the following features as provided by Manufacturer:

a. Phase Current Inputs 1: (refer to PLANS),

b. Phase Current Inputs 2: (refer to PLANS),

c. Ground Current Inputs (refer to PLANS),

d. 2 Form A and 3 Form C Output Contacts rated minimum 120VAC, 10A continuous, 2A inductive, as well as 7 Discrete inputs (120VAC). These output contacts shall be in addition to the standard Trip and related output contacts.

e. 7 Analog Outputs (4-20mA) as well as 4 Analog Inputs (4-20mA) plus one(1) RTD input

f. 10 Digital Inputs + 4 Arc Flash Inputs

g. Additional I/O, as required, per control schematics as shown in PLANS,

h. Standard Front Panel (Rugged Key Pad),

i. Current Protection: Advanced Configuration,

j. Voltage Monitoring and Protection: Advanced Protection,

k. Control: Standard Control

l. Monitoring: Advanced Monitoring

m. Communications: Advanced Communication,

n. Communications media: Copper Ethernet, unles shown as fiber on PLANS

o. No Wireless Communication

p. Security: Advanced security, CyberSentry Level 1

3. Control power supply requirements are 120VAC

2.09 POWER MONITORING UNIT (PMU) - LSPSSWBD-1

A. Where required by the PLANS, furnish and install a Power Monitoring Unit (PMU).

1. The PMUs shall be as manufactured by General Electric - MULTILIN Model EPM 9700 (Transducer Module) with advanced software option complete with three line LED combination display and keypad Model P40NPLUS, with the Ethernet communication capability, harsh environment UL 746C/94 recognized conformal coating on all printed circuit assemblies and all required interconnect cabling as also shown on the PLANS, No Equal. Units shall be connected as shown on the PLANS.

2. Furnish and install an Ethernet connection to the PMU on the door adjacent to the LED display for accessing PMU settings files.

2.10 AIR CONDITIONER UNIT - ATSSWBD

A. The OUTDOOR enclosure for ATSSWBD shall have an air conditioner unit(s) to provide conditioned air inside the enclosure for the automatic transfer switches. The air conditioner(s) shall have the following characteristics:

1. Sizing and Quantity: Provide the size and quantity of units as required for the application environment.

2. Type: Thermostatically controlled packaged closed-loop air conditioner climate control unit surface mounted to the exterior of the Switchboard. Suitable for use in an outdoor environment.

3. Material: Steel enclosure suitable and rated for use in and outdoor environment, 16-gauge minimum thickness. Internal components shall be coated for corrosion protection.

4. Electrical Service: Wire the air conditioner(s) (in conduit) to the panelboard in the Low Service Pump Station as shown on the PLANS.

5. Controls:
   a. Provide air conditioner manufacturer's standard air conditioning system package control system for the air conditioner. The air conditioner shall have the capability to be controlled by the industrial thermostat specified hereinafter.
   b. Each air conditioner shall include low ambient controls to allow the unit to operate down to 0 degrees Fahrenheit ambient conditions.
   c. Provide a dedicated thermostat for each air conditioner. The thermostat shall be per Sub-Section 2.05 C, this Section of the Specifications. The thermostat for each air conditioner unit shall be mounted inside the cabinet.

6. Accessories:

a. Condensate Management System: Each air conditioner unit shall have a condensate management system that evaporates moisture from the enclosure into the condenser air stream and shall not require disposal of liquid condensate and shall not cause build-up or spillage of liquid condensate.

b. Air filters: Field replaceable aluminum filters.

c. Extension frame with self-contained Drip Pan Tray

d. Mounting gaskets and hardware for a complete installation

e. Reinforce the cabinet enclosure as required to support the air conditioner.

7. Manufacturer: EIC Solutions, or approved equal.

PART 3 - EXECUTION

3.01 FACTORY INSPECTION AND TEST

A. Standard factory tests shall be performed on the equipment specified in this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards. The manufacturer shall provide certified copies of factory test reports prior to shipment of the equipment to the project site. Format and quantities of the test report shall be in accordance to Section 01330 and Section 01730 of the Contract Specifications.

B. The Owner may elect to witness the factory tests as outlined above. The manufacturer shall provide at least three (3) week notice prior to the date the tests are to be performed.

3.02 FIELD INSTALLATION (BY CONTRACTOR)

A. Install per manufacturer's instructions and recommendations. Install all required safety labels.

B. Perform manufacturer's field services as previously specified.

C. Coordinate sizing of the wireway/plenum/pullbox enclosures with the Switchboard manufacturer.

D. Coordinate construction of the "LSPSSWBD-1" switchboards with construction of the "LSPSUSUB" transformers specified in Section 16480 "Over 600 Volts Dry Type Transformers for Outdoor Service" for close coupling of the switchboard bus and enclosure to the transformer secondary.

3.03 FIELD TEST AND CHECKS

A. The following minimum test and checks shall be made before energizing the Switchboards. These tests shall be performed by a Factory Trained Field Technician (non sales type):

1. Thoroughly inspect the Switchboard.
2. Test for proper phasing of power connections. Additionally, check phasing across the Switchboards and connecting tie feeders (as applicable) using phasing sticks.
3. Set, adjust, and test all protective relays based on the results of the coordination study, refer to sub-section 1.08, this Section of the Specifications.
4. Megger terminals and buses for grounds, test per manufacturer's recommendations.
5. Verify ratios of all CT's, and proper operation of all metering.
6. Verify Switchboard enclosure space heater circuits are operational.
7. Test key interlock system for proper functionality.
8. Check tightness of accessible bolted bus joints using calibrated torque wrench per manufacturer's recommended torque values.

B. Submit documentation of all tests outlined above.

C. Submit manufacturer's certification report per sub-section 1.07, this Section of the Specifications.

3.04 EQUIPMENT PROTECTION AND RESTORATION

A. Clean and vacuum all interior of the equipment.

B. Touch-up and restore damaged surfaces to factory finish.

C. Remove all current transformer shunts after completing secondary circuit.

D. Energize the space heaters within the Switchboard and energize during storage and installation for humidity control.

3.05 TRAINING

A. Provide training sessions for owner's representatives for One (1) FULL normal workday at the job-site location and/or at a location determined by the OWNER. If training is conducted in less than the time required by these specifications, the remaining time shall be utilized at the discretion of the OWNER.

B. The training session shall be conducted by the Switchboard manufacturer's non-sales-type technical representative, who performed the field installation and start-up/setting/adjustment services.

C. At minimum, the training session shall include:

1. Operation and maintenance procedure for the equipment and all components installed within the Switchboards.

2. Factory contact persons phone numbers, persons names, ordering procedures and procedures to follow to obtain meaningful results from the factory.

3.06 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this Section. All costs are included in the Base Bid.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. This section specifies raceways, fittings, and supports for all cables, conductors and electrical equipment. The Contractor shall furnish and install complete raceway systems in accordance with the following specifications and as also shown on the PLANS.

B. Refer to the conduit/wire schedule shown on the PLANS for a listing of proposed raceways and other requirements. The conduit/wire schedule shown on the PLANS is not inclusive of all equipment required by this Contract. Refer to Part 2 of this section for additional requirements.

1.02 RELATED REQUIREMENTS

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors. Suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.

C. Related work as called for on the PLANS, as specified herein or in other Sections of the Specifications.

1.03 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The Publications are references in the text by designation only.

B. This section contains references to codes and standards. They are a part of this section as specified. In case of conflict between the requirements of this section and the listed standards, the requirements of this section shall prevail. All raceways, fittings and supports are to be U.L. listed and certified and shall conform to ANSI and NEMA standards.

1.04 SUBMITTALS

A. The Contractor shall submit manufacturer's catalog data for all material provided under this section and in accordance with the requirements of Section 01300 and 01730 of the Specifications. The Contractor shall submit certified notification from the Manufacturer that the rigid aluminum conduit system and all related materials, as described within this specification, is 99.0 percent copper-free.

1. Submit certifications of training associated with proper installation the PVC coated rigid galvanized conduit and Fiberglass conduit.
2. Submit Material Safety Data sheets for all sealants, solvents, etc.

PART 2 - PRODUCT

2.01 EXPOSED CONDUIT SYSTEM INDOOR, AND EXPOSED-OUTDOOR ABOVE GROUND LEVEL

A. General: All components shall be 99.0 percent copper free rigid aluminum.

B. Rigid Metal Conduit System

1. Conduit run above ground shall be rigid aluminum in all areas unless specifically specified otherwise hereinafter in subsection 3.02, this Section of the Specifications.
2. Rigid Aluminum Conduit shall meet the following requirements
   a. U.L. listed
   b. Comply with ANSI C80.5 and U.L.6.
3. Bending Requirements: Furnish factory bends. 90-degree bends of conduit sizes equal to or greater than 4-inches in diameter shall have a minimum bending radius of 48-inches unless otherwise noted on the PLANS. 90-degree factory bends of conduit sizes less than 4-inches in diameter, shall be per manufacturers standard unless otherwise noted on the PLANS.
4. Minimum conduit size for all work shall be 3/4 inches.
5. Manufacturer: VAW of America Inc., or approved equal.

C. Conduit Hubs:

1. Provide grounding type with integral threaded insulated throat, and with solderless grounding lugs, complete with rubber gasket.
2. Manufacturer: by “Myers”, or approved equal.

D. Grounding Bushings:

1. Provide with integral threaded insulated throat, and with solderless grounding lugs.
2. Manufacturer: “O.Z. Gedney” type ABLG with specified options, or approved equal.

E. Conduit Bodies:

1. Conduit body covers shall be of the bolt-on type and shall have Type 316-Stainless Steel screws/hardware.

2. Manufacturer: **"**Crouse-Hinds" Form-7, or approved equal.

F. Conduit Unions: Threaded, as manufactured by "Crouse-Hinds" type UNF or UNY, or approved equal

G. Conduit Reducers:

1. Threaded.
2. Shall be used for final conduit system connection to equipment where shown on the PLANS
3. Manufacturer: "Crouse-Hinds" type RE and type REA, or approved equal.

H. Cord and Cable Fittings:

1. Provide threaded gland nut, straight threaded body, and also a neoprene sealing cable bushing.
2. Furnished with a Type 316 Stainless Steel wire mesh grip
3. Shall be used only where specifically shown on the PLANS.
4. Manufacturer: "Crouse-Hinds" type CGB, complete with all specified accessories, or approved equal.

I. Expansion Fittings:

1. Furnished with oversized sleeve and insulated bushing
2. Furnished with tinned copper braided bonding jumper
3. Manufacturer: O.Z./Gedney Type EXPB-A, or approved equal

J. Sealing Fittings:

1. Furnish with drain
2. Manufacturer: Crouse Hinds, Type EYD, or approved equal
3. Sealing Compound:
   a. Where conduit seals are installed in compliance with NEC Class-I and Class-II requirements, the sealing compound shall be as manufactured by "Crouse-Hinds" type Chico-AP, or approved equal.
   b. Where conduit seals are not required for NEC Class-I and Class-II installations but are shown to be installed on the PLANS to block the migration of corrosive gases into the conduit system and conduit bodies, the conduit seals Sealing Compound shall be Scotchcast Reenterable Electrical Insulating Resin 2123 as manufactured by "3M", or approved equal.
   c. Coordinate application with the Owner.
   d. For vertical seals use mineral wool packing material to form a dam in the annular space around the conductors and hold the sealing compound in place while it cures. Packing material shall be as manufactured by "Crouse-Hinds" type Chico-X, or approved equal.

K. Miscellaneous Requirements:

1. Conduit nipples shall have two independent sets of threads.

2.02 UNDERGROUND CONDUIT IN DUCT BANK SYSTEM

A. General:

1. Type: All components shall be non-metallic, except where noted herein and specifically shown otherwise on the PLANS. Refer to the PLANS.

2. Bending Requirements: Furnish factory bends. 90-degree factory bends of conduit sizes equal to or greater than 4-inches in diameter shall have a minimum bending radius of 48-inches. Also, all 90-degree, 45-degree, and 30-degree conduit bends shall be factory made bends.

3. Minimum conduit size for all work shall be 1 inch.

B. Rigid Nonmetallic Conduit System:

1. All components shall be schedule 40 PVC, heavy wall, U.L. rated, No. 651, conforming to NEMA standard TC-2-75 and listed in conformity with Article 352 of the latest edition of the National Electrical Code (NEC).

2. Solvent weld: Shall be a type approved by the conduit manufacturer.

3. Manufacturer: Conduit shall be as manufactured by "Prime Conduit", or approved equal.

C. PVC Coated Rigid Galvanized Steel Conduit System

1. Material: Steel per UL 6 and ANSI C80.1, hot-dipped galvanized inside and out after the threads are cut.

2. Exterior Coatings:
   a. After galvanizing, the conduit/fittings shall be uniformly and consistently coated with a gray PVC coating of minimal 40 mil thickness. Exception: The threads shall be coated with urethane in lieu of PVC.

   b. The PVC coating adhesion performance shall be ETL verified to the Intertek ETL SEMKO, High Temperature H_2O PVC Coating Adhesion, Test Procedure for 200 hours.

3. Interior Coating:
   a. After galvanizing, the interior of conduit and fittings shall be uniformly and consistently coated with a urethane coating of nominal 2 mil thickness.

4. Accessories: Threads shall be furnished with plastic thread protector caps.

5. Manufacturer: Robroy Industries, Perma-Cote, or Plasti-Bond REDH_2OT.

D. Reinforced Thermosetting Resin Conduit (RTRC) Conduit System

1. General:

a. May be used only where specifically permitted by subsection 3.02.C.8, this Section of the Specifications.

b. Shall comply with NEC Article 355.

2. Material:
   a. Fiberglass, Reinforced Thermosetting Resin Conduit. Resin system shall be epoxy based, with no fillers, using an anhydride curing agent. The fiberglass shall consist of continuous E-glass Grade "A" roving. Conduit shall be low-halogen per UL 2515.
   b. Manufactured using the single circuit filament winding process. Oven cured. Nominal winding angle of 54.75 degrees.
   c. Carbon black shall be used as ultra violet inhibitor.
   d. Internal walls shall be smooth with all fibers embedded in epoxy.
3. Certifications: NEMA TC14, UL 2420 and 2515.
4. Suitable for installation exposed outdoors and encased in concrete
5. Fittings:
   a. The following fittings shall be provided. Example part numbers shown hereinafter apply to the raceway system manufacturer specified hereinafter. All part numbers required for this project are not shown. Contractor to coordinate necessary part numbers with the manufacturer for a complete installation.
   b. 90 degree bends with factory installed 2 deep socket PVC coupling and 1 fiberglass coupling bonded to elbow:
      1) For conduit sized 1" – 1 ½", provide type IPS. Example part number for 1": 10C-XW-90-2DF
      2) For conduit sized 2" – 6", use type ID. Example part number for 2": 20D-XW-90-2DF
   c. Sleeve couplings:
      1) For conduit sized 1" – 1 ½", use type IPS. Example part number for 1": 10C-XW-42
      2) For conduit sized 2" – 6", use type ID. Example part number for 2": 20D-XW-42
   d. Female Terminal Adapters:
      1) For conduit sized 1" – 1 ½", use type IPS. Example part number for 1": 10C-XW-32
      2) For conduit sized 2" – 6", use type ID. Example part number for 2": 20D-XW-32
   e. Straight Socket Conduit:
      1) For conduit sized 1" – 1 ½", use type IPS. Example part number for 1": 10C-XW-10S

2) For conduit sized 2" – 6", use type ID. Example part number for 2": 20D-XW-20-S

6. Mix Epoxy Adhesive:
   a. For ambient temperatures 40 - 70 degree F, provide type CM-2040-SFG
   b. For ambient temperatures 70 degree F and above, provide type CM-2070-SFG.

7. Mix Epoxy Adhesive Mixing Tip and Gun:
   a. Mixing Tip: CM-MT
   b. Mixing Gun: CM-AG

8. Accessories: Provide with adhesive couplings, spigots, adapters, and other adhesive fittings as required to connect to the other specified raceways as shown on the PLANS.

9. Manufacturer: Champion Fiberglass "Haz Duct XW", no equal.

2.03 LIQUID TIGHT FLEXIBLE CONDUIT

A. Sizes: - Greater than or equal to ¾ inch and smaller than or equal to 2 inch Flexible Conduit:

1. Conduit Type: Non-metallic type liquid tight conduit, formed from PVC plastic
2. Conduit Installation Temperature Range: –20 degrees Celsius to + 60 degrees Celsius (suitable for use outdoors and indoors)
3. Conduit Manufacturer: ELECTRI-FLEX series NM type B-PVC, or approved equal.
4. Fittings Type: Non-metallic PVC fittings
5. Fittings Manufacturer: CARFLEX, or approved equal.

B. Sizes:- Greater than 2 inch Flexible Conduit:

1. Conduit Type: PVC-COATED metallic liquid tight conduit, formed from PVC plastic
2. Conduit Temperature Range: –20 degrees Celsius to + 60 degrees Celsius (suitable for use outdoors and indoors)
3. Conduit Manufacturer: SEALTITE, or approved equal.
4. Fittings Type: 99.0 percent Copper-Free-Aluminum
5. Fittings Manufacturer: Appleton, Crouse-Hinds, or approved equal.

C. Minimum liquid-tight flexible conduit size for all work shall be ¾-inch unless specifically noted otherwise on the PLANS. Exception: ½" non-metallic conduit may be used for the final conduit connection to device with ½" threaded opening with prior Owner approval.

2.04 MISCELLANEOUS

A. Polyurethane foam duct sealant: FST-250 and FST-MINI Duct Sealant as manufactured by "Polywater", or approved equal

B. Pipe Tape: 20 mil, 3M company No.51, or approved equal.

C. Conduit Sleeves:

1. Conduit sleeves shall be schedule 80 PVC, heavy wall, U.L. rated, No. 651, conforming to NEMA standard TC-2-75 and listed in conformity with Article 352 of the National Electrical Code (NEC).

D. Conduit Hole Seals:

1. Hole seals shall be stainless steel, U.L. listed as NEMA 4X oil-tight, complete with oil-resistant gasketing, backplate, stud and wing nut. Hole seals shall be manufactured by Hoffman, Rittal, Cooper B-Line, or approved equal.

2.05 ELECTRICAL EQUIPMENT AND RACEWAY SYSTEM SUPPORT CHANNELS

A. General requirements for all support channels:

1. Channels located in all areas:
   a. Type: Type 316-Stainless Steel
   b. Manufacturer: "Unistrut Corporation" series P-1000ST and P-1001ST, or approved equal.

B. All fastening hardware, fittings, supports, post bases, conduit clamps, beam clamps channel nuts, threaded rod, framing system, etc. shall be as follows:

1. Items located in all areas:
   a. Type 316 stainless steel

2. Manufacturer: "Unistrut Corporation", or approved equal.

3. Additionally, the following designations correspond to the following "Unistrut Corporation" series numbers as used in the details shown on the PLANS:
   a. Items located in all areas:
      1) Beam clamps: "Unistrut Corporation" series P-2785ST and P-2786ST, or approved equal.
      2) Swivel fittings: "Unistrut Corporation" series M-2137ST, or approved equal.
      3) Post bases: "Unistrut Corporation" series P-2072AST and series P-2073AST, or approved equal.
      4) Hanger clevis fittings: "Unistrut Corporation" series P-2682ST, or approved equal.

C. Expansion anchors shall be installed per the manufacturer's recommendations and shall be as follows:

1. Anchors located in all areas:
   a. Type 316-Stainless Steel..

2. Also refer to the PLANS.

2.06 MANHOLES AND HANDHOLES

A. Refer to the PLANS and Specifications for manhole requirements.

B. Furnish and install handholes as shown on the PLANS and as specified herein.

C. Provide all cable pulling eyes, cable support system components and accessories indicated on the PLANS and as otherwise required. Arrange support systems so that each cable can be securely anchored.

D. The manhole structural wall opposite each duct bank penetration into the manhole shall be equipped with a cable pulling eye (one cable pulling eye per each duct bank penetration into the manhole). Position each pulling eye with coordinates (vertical elevation and horizontal alignment) to accommodate cable pulling and minimize cable pulling tension. Pulling eyes shall be bonded to the manhole wall structural reinforcement prior to pouring concrete. Pulling eyes may not be shown on the manhole vault structural PLANS, however, they are to be installed per the requirements of this specification.

2.07 CABLE SUPPORT SYSTEM IN UNDERGROUND ELECTRICAL MANHOLES AND HANDHOLES

A. General Requirements for support channels:

1. Type: Type 316-Stainless Steel

2. Manufacturer: "Unistrut Corporation" series P-1000ST and P-1001ST, or approved equal.

B. All fastening hardware, fittings, supports, post bases, conduit clamps, beam clamps channel nuts, threaded rod, framing system, etc. shall be fabricated with Type 316 stainless steel, as manufactured by "Unistrut Corporation", or approved equal. Additionally, the following designations correspond to the following "Unistrut Corporation" series numbers as used in the details shown on the PLANS:

1. Porcelain Clamps and Saddles-"Unistrut Corporation P1787A through P1795B Porcelain Cable Clamps", for both Electric and Communications and Instrumentation and Control.

2. Surface Mounted Vertical Channels (Columns)-"Unistrut P-1000ST Type 316 stainless steel channels and accompanying Unistrut post bases".

3. Surface Mounted Horizontal Channels (side mounted channels)-**"**Unistrut P-1001ST Type 316 stainless steel channels and accompanying Unistrut post bases as well as wall mounted vertical channels".

4. Brackets-**"**Unistrut" P-2515 ST of 15 inch length for Electric, and P-2542 ST of 15 inch length for Telephone and Communications. All parts given shall be Type 316 stainless steel.

5. Beam Clamps – "Unistrut" P-2785 ST". All parts given shall be Type 316 stainless steel.

PART 3 - EXECUTION

3.01 GENERAL

A. Install electrical equipment and conduit raceway system in accordance with the recommendations of the manufacturer, the requirements of the latest edition of the National Electrical Code, and the PLANS. All cables/wiring shall be installed in a raceway system.

B. Contractor shall be trained and certified by the PVC coated rigid galvanized steel conduit manufacturer in the proper installation of the PVC coated rigid galvanized conduit.

C. Contractor shall be trained and certified by the Fiberglass conduit manufacturer in the proper installation of the Fiberglass conduit.

3.02 CONDUIT SYSTEM

A. General:

1. Run conduits continuous from outlet to outlet, from outlets to cabinets, pull or junction boxes, etc.

2. Install all conduits as a complete system before wiring is pulled in. Conduits shall be reamed, thoroughly cleaned of debris, and swabbed immediately before wire is pulled.

3. Furnish and install expansion fitting for each conduit across structural expansion joints. Coordinate locations of expansion joints with the PLANS. Additionally, furnish and install additional appropriate fittings such as conduit unions, adapters, etc. as required for a complete installation.

4. Conduit shall contain no more than the equivalent of three (3) 90-degree bends between outlets or pull points.

5. Maintain a minimum 6-inch clearance between conduit and piping and a minimum 12-inch clearance between conduit and heat sources.

6. Protect all coated conduit from accidental coating damage during storage and installation. Repair all damaged conduits in accordance with manufacturer's recommendations at no additional cost to the OWNER.

7. Furnish and install temporary conduit closures during construction activities to prevent foreign matter from entering raceways.

8. Furnish and install conduit measuring tape in each empty spare conduit as manufactured by Ideal Industries Incorporated or approved equal.

B. Exposed Conduit System Indoor, and Exposed-Outdoor Above Ground Level:

1. Rigid conduit joints shall be cut square, threaded, reamed smooth and drawn up tight. Make field bends or offsets with an approved bender or hickey or hub type conduit fittings.

2. Run conduit parallel or at right angles to building lines and such to avoid moisture traps.

3. Arrange conduits to maintain headroom and present a neat appearance.

4. Support conduit using support channels as shown on the PLANS and as specified herein.

5. Coat all conduit threads with Penetrox or Noalox prior to assembly.

6. Secure conduit runs firmly to specified support channels by conduit straps or by hangers, as required, and as shown on the PLANS.

C. Underground Conduit in Duct Bank System

1. Install all underground conduit in concrete encased and steel reinforced duct banks.

2. Concrete shall be per Section 03300 “Cast-in-Place Concrete”. A red admixture shall be added to the concrete a rate of 12 pounds per cubic yard of concrete and per the requirements of Section 03300. Red admixture shall meet the requirements of ASTM C-979-82. Red admixture shall be as manufactured by ChemSystems, Inc. series HBS #120 Conduit Red, or approved equal. Also, refer to conduit/duct bank reinforcement and concrete encasement details shown on the PLANS.

3. Reinforcing Steel shall be per Section 03300 “Cast-in-Place Concrete” unless noted otherwise on the PLANS. Also, refer to conduit/duct bank reinforcement and concrete encasement details shown on the PLANS.

4. Install detectable underground warning tapes at 12-inches below finished grade along the entire length of each duct bank. Each tape shall be a minimum of 6-inches wide, 4 mil thick, laminated, and contain a aluminum foil core backing. The tape shall be detectable using a non-ferrous locator. The tape color shall be red and shall be labeled with the words “CAUTION BURIED ELECTRIC LINE BELOW” in black lettering. For duct banks less than 24-inches wide, install one length of tape aligned along the centerline of the duct bank. For duct banks 24-inches wide and larger, install two lengths of tape, with each length aligned with each edge of the duct bank along the width of the duct bank. Warning tape is not required along the length of the specific portion of a duct bank that is installed underneath a building concrete floor slab.

5. Provide a minimum of 3-inches separation between conduits installed in concrete construction except at panelboards, pull or junction boxes and/or other locations where the conduits are grouped. Furnish and install plastic spacers as shown on the PLANS.

6. Underground system conduits shall be installed with a minimum depth below finished grade of 24" to top of concrete envelope of duct bank and shall slope 3-inches per 100 feet from high points toward pull boxes and handholes/manholes, at minimum. Increase the minimum duct bank depths below finished grade as shown on the PLANS. Additionally, underground duct bank system shall be routed per the PLANS and coordinated with the depths of Civil/Structural foundations, beams, etc. No conduit shall be routed through grade beam slab of a building floor slab.

7. All underground conduit joints shall be watertight in accordance with the manufacturer's recommendations.

8. Transition from underground (underground work in duct bank) to above ground conduit as shown on the PLANS.

9. Where a duct bank penetrates a concrete structure, dowel between the duct bank and the structure at the point of penetration and tie the steel reinforcing rebar system of the underground duct bank system to the concrete structure and steel reinforcing rebar system of the concrete structure. Refer to the Civil/Structural Specifications and PLANS for additional requirements.

10. Where PVC coated rigid galvanized steel conduit is shown on the PLANS, Contractor may employ RTRC conduit in lieu of the PVC coated rigid galvanized steel conduit.

11. Where factory bends/elbows (11-1/4°, 22-1/2°, 30°, 45°, and 90°), as specified in Part 2.02 A 2 of this Specification, are not manufactured and field bends become necessary, field bends may be performed using a heat box type electric PVC conduit heater. The use of open flame to heat the PVC conduit is NOT permitted. Utilize a PVC conduit plug set to plug the ends of the conduit throughout the heating process and trap the air inside the conduit to help keep the PVC conduit from collapsing while forming the bend.

D. Conduit Penetrations:

1. Install sleeves for conduit penetrations of walls and floors unless shown otherwise on the PLANS. Install sleeves during erection of concrete and masonry walls. Exception: Sleeves are not required for conduits stub-ups through floor slab from underground duct bank.

2. Where aluminum conduit penetrates a wall/floor-slab and/or walls/floors of dissimilar material (other than Stainless Steel) or is in contact with dissimilar material, wrap the aluminum conduit with Pipe Tape using a 50 percent overlap throughout the entire distance/length of the penetration and an additional 6-inches of distance beyond either side of the penetration/contacted region.

3. Install pitch pans on conduits which penetrate through roofs.

4. Also refer to the conduit penetration details shown on the PLANS.

E. Miscellaneous:

1. Seal empty spare conduits (at above ground stub-ups) with an aluminum screw in plug sized to the trade size of the conduits.

2. Threaded insert plug shall have a square head and shall be constructed from copper-free Aluminum material.

3. Threaded insert plug shall be Type CUPX by Hubbell-Killark, Type PLG by Crouse-Hinds, or approved equal.

4. Seal and pack/fill ends of each conduit with polyurethane foam duct sealant.

5. In all sealing fittings, utilize sealing compound to seal around and between each conductor and associated sealing fitting body.

F. Requirements for cables inside of Manholes, Handholes, etc.:

1. Arrange cables so that there is a minimum of crossing. Provide slack in each cable.

2. Secure cables in handholes/manholes on support channel system as specified herein and as shown on the PLANS.

G. Connections to Equipment:

1. Liquid tight flexible conduit shall be used for connections to motors, field instruments, etc., and any equipment subject to vibration, and where shown on the PLANS. Length of conduit shall not exceed 36-inches, unless specifically noted otherwise on the PLANS or approved by the Owner.

3.03 INSTALLATION OF SUPPORT CHANNELS

A. Utilize support channels and mounting hardware as previously specified to install raceways, and any other surface mounted electrical, instrumentation and control equipment. Refer to details shown on the PLANS. Use 316 stainless steel split ring lock washers with mounting hardware when installing support channels.

B. Whenever support channels are cut in the field, the cut ends shall be filed smooth and shall be cleaned using liberal amounts of a contact cleaner to remove all residual elements from the cutting and filing process. Coat all field cut ends with cold galvanizing paint.

3.04 HOUSEKEEPING CONCRETE PAD FOR EQUIPMENT

A. Provide housekeeping concrete pad for all outdoor equipment whether it is free-standing or surface mounted. All housekeeping pad edges shall be chamfered. Outdoor electrical equipment pads shall be as detailed on the PLANS.

B. Provide housekeeping concrete pad for indoor all free-standing equipment. Indoor electrical equipment pads shall be as detailed on the PLANS.

3.05 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this Section. All costs are included in the Base Bid.

END OF SECTION

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PART 1 - GENERAL

1.01 SCOPE

A. Furnish and install all medium voltage cables (5kV and 15kV) required for this project. Comply with the requirements of the contract documents, as applicable.

B. PLANS indicate the size and quantity of cable required.

1.02 QUALITY ASSURANCE

A. Manufacturer: Furnish cable meeting these Specifications and manufactured by CME Wire, Kerite Company, Okonite Company, Inc., CABLEC Corporation, Perelli Cable Corp, or approved equal meeting all the special requirements of this specification.

B. Standards: Meet applicable requirements of NEC, OSHA, IPCEA, U.L. and IEEE. U.L. listed Type TC for use in cable trays and underground electrical duct bank systems.

C. Factory and On-Site (Field) Tests: Factory test cables in accordance with applicable UL, NEMA, ICEA and AEIC standards. Field test all cables by an independent testing company as indicated elsewhere in the Section of the Specifications. Furnish certified copies of both Factory and Field (On-Site) test reports. Format and quantity of the reports shall be per the requirements of Sections 01300 and 01730 of the Contract Specifications.

1.03 SUBMITTALS

A. Submit shop drawings in accordance with Section 01300 of the Contract Specifications. Additionally, at minimum, submit the following information and materials:

1. Cable material sample (minimum 12 inches long).
2. Catalog data for Cable, Stress Cone and Elbow Termination Kits, Splice Kits, and Wire Pulling Lubricant.
    a. Submit notification of approval issued by the Cable Manufacturer that indicates acceptance and approval of the use of the selected stress cones, elbows, splices, and wire pulling lubricant. NOTE: Proposed stress cones, elbows, splices, and pulling lubricant shall not be accepted without this notification.
3. HIPOT and Megger Test procedures, test results forms, manufacturer's recommended test voltages, and manufacturer's cable maintenance and periodic testing recommendations.
4. HIPOT and Megger Test results and testing instrument calibration certification. NOTE: Cables shall not be field tested without an approved cable test procedure and test results forms.

5. Pulling tension and sidewall pressure calculations.

6. A list of cable tags, showing the identity of each cable, the content of the tag, the initially suggested height and type of lettering, mounting/installation method, and the tag material and type and size (dimensions).

B. Submit Operations and Maintenance Manuals (O&M) which shall include bound hard-copies and electronic copies of the approved shop drawings, factory test and certification reports, and on-site/field test and certification reports.

1.04 PRODUCT PROTECTION

A. Deliver and store on appropriately sized cable reels. Do not allow flange to bump cables on adjacent reels.

B. Check for indication of any damage to the reels. Do not drop reels from any height.

C. Store cable on a solid, well drained location. Cover cable reels with plastic sheeting or tarpaulin.

D. Seal cable ends with heat shrinkable end caps. Do not remove end caps until cables are ready to be terminated.

1.05 SHIPMENT

A. Cable shall be shipped directly from the cable manufacturer facility to the project site. Ship cable in continuous lengths. Cable ends are to be completely sealed against moisture and contaminants. The cable on the reel is to be protected with plyboard or tekboard lagging held securely in place with steel banding.

PART 2 - PRODUCT

2.01 GENERAL

A. For 5kV cable installations, furnish single-conductor cable assemblies suitable for use in circuits not exceeding 5,000 volts measured phase-to-phase at conductor temperatures of 90 deg. C continuous normal operation, 130 deg. C for emergency overload conditions, and 250 deg. C for short circuit conditions, in wet or dry locations.

B. For 15kV cable installations, furnish single-conductor cable assemblies suitable for use in circuits not exceeding 15,000 volts measured phase-to-phase at conductor temperatures of 90 deg. C continuous normal operation, 130 deg. C for emergency overload conditions, and 250 deg. C for short circuit conditions, in wet or dry locations.

C. The manufacturer's name, the voltage class, type of insulation, thickness of insulation, conductor size, U.L. listing and date of manufacture shall be printed on the jacket.

D. Cables shall be suitable for use in partially submerged wet locations, in non-metallic or metallic conduits, underground duct systems and direct buried installation.

2.02 MATERIALS

A. General: Comply with ICEA S-93-639, AEIC CS8 and UL 1072.

B. Phase Conductors: Copper, stranded in accordance with ASTM B-496. Tinned in accordance with ASTM B-33.

C. Phase Conductors Strand Screen: Extruded semiconducting copolymer Strand Screen compatible with EPR. Concentrically extruded directly over the copper strands. Minimum average thickness of 40 mils with a minimum thickness of 35 mils and maximum thickness of 45 mils. Strand Screen shall meet the electrical and physical requirements of ICEA S-68-516, AEIC CS6 and UL 1072.

D. Phase Conductor Insulation: A homogenous wall of thermosetting Ethylene-Propylene Rubber (EPR) based elastomer applied directly over the Phase Conductor Strand Screen. Average thickness of 135 mils. Physical and electrical properties per IPCEA Paragraph 3.7. Test for voids and contaminants per AEIC 6-75, Section A-3.

E. Phase Conductor Insulation Screen: Extruded semiconducting copolymer Strand Screen compatible with EPR and providing 100% coverage directly over the Conductor Insulation. Minimum average thickness of 40 mils with a minimum thickness of 35 mils and maximum thickness of 45 mils. Strand Screen shall meet the electrical and physical requirements of ICEA S-68-516, AEIC CS6 and UL 1072.

F. Phase Conductor Shielding: Conductor shielding shall be concentrically extruded directly over the Conductor Insulation Screen. Apply a semi-conducting tape, providing 100% coverage directly over the insulation with 10% lap. Apply (helically) a 5 mil copper tape shield directly over the semiconducting tape (Conductor Insulation Screen) with a 20% lap over the auxiliary tape shield. Wire shielding to meet IPCEA Paragraph 4.1.1.3.

G. Manufacturer's Cable Overall Jacket: Overall cable jacket shall be Flame resistant and shall be PVC jacket encasing the cables round core.

H. Identification: Surface printed on overall jacket identifying manufacturer, insulation type, jacket type, conductor size, UL symbol and voltage.

I. Stress Cones and Splice Kits: Use Stress Cones as manufactured by 3M or approved equal, and splice kits of Model HVS as manufactured by Raychem, or approved equal, and as also recommended by the Medium Voltage Cable Manufacturer. A letter of approval must be issued by the Cable Manufacturer which shall accept and approve the use of the selected Stress Cones and Splice Kits. Stress cones located outdoors shall have skirts and shall be UV resistant.

J. Deadbreak Elbows: Provide Deadbreak Elbows with integral test point as manufactured by Elastimold (Thomas and Betts), or approved equal, and as also recommended by the

Medium Voltage Cable Manufacturer. A letter of approval must be issued by the Cable Manufacturer which shall accept and approve the use of the selected dead break elbows.

K. Cable Tags:

1. Cable tags with holders shall be Polyethylene tags.
2. Cable tags shall be installed at the following points on each cable:
   a. Origin
   b. Destination
   c. At each entry to manhole and pull box.
   d. In above ground electrical/cable closets.
3. Cable tags to indicate the following:
   a. Load (as indicated on One Line Diagram).
   b. Circuit number (as indicated on One Line Diagram).
   c. Phase
   d. Load break switch, controller, and/or circuit breaker tag serving the cable and served by the cable.
4. Tag each cable, cable tags shall be in BLACK lettering with YELLOW background. The height of each letter shall be 1½", in the submittal review process however the Owner at his/her discretion may elect to change the lettering height of certain tags to a size smaller than 1½" or maintain the height of each letter of each tag at 1½" in height, the Contractor shall make this adjustment as deemed necessary by the Owner at no additional cost to the Owner. Cable tags shall be model TH-10 complete with slip-in characters style EZ-H and nylon tie straps as manufactured by Almetek, 1451 Route 46, Ledgewood, New Jersey or approved equal. Fasten each end of wire tag with the nylon tie straps to insure a secure installation.
5. Additionally, comply with the Austin Water Utility Tagging Methodology described in Section 16200 of the Contract Specifications, Subsection 3.03 Wiring Methodology.

L. Cable Lubricant:

1. Cable lubricant shall be manufactured specifically for lubricating cable which is pulled through conduit.
2. Cable lubricant shall be of type recommended by cable manufacturer.

2.03 FACTORY TESTS AND INSPECTION

A. Perform manufacturers standard production testing and inspection in accordance with the latest version of UL, NEMA, ICEA and AEIC standards.

B. Final test on Shipping Reel:

1. Each length of completed cable shall pass an AC voltage withstand test applied for one minute at the manufacturer's recommended test voltage for 5kV cables or for 15kV cables, as applicable for the completed installation.

2. Following the AC voltage test, the insulation resistance shall be measured and must not be less than that specified in Subsection 2.03 A above.

C. Factory Certification: Certification shall be provided by the manufacturer that the cables similar in construction and materials have been subjected to and passed the following test.

1. U-Bend Discharge Test:
   a. As described in IPCEA S-68-516 paragraph 6.23.3 with the energy source equal to a minimum of 200 volts/mil of insulation thickness, cable must withstand this test for a minimum of 1000 hours without failure.

2. Conductor and Shield Continuity:
   a. Each length of completed cable is to be tested for conductor and shield continuity.

D. Factory Test Reports:

1. Furnish in writing certified test reports for the cables furnished on this project, including Production Test results for each shipment of cable. Format and quantity of reports shall be per the requirements of Section 01300 of the Contract Specifications.

E. Factory Test Inspection:

1. All tests may be witnessed by a representative of Austin Water Utility. Give written notice of test at least 14 Calendar days in advance.

2.04 5KV CABLE APPLICATION

A. Cable Type: Single conductor shielded cable.

B. Insulation Level: Insulation level shall be 133 percent

C. Operating Voltage: Operating voltage level shall be 4,160 volts, 3-phase, 60Hz, grounded distribution system.

2.05 15KV CABLE APPLICATION

A. Cable Type: Single conductor shielded cable.

B. Insulation Level: Insulation level shall be 133 percent

C. Operating Voltage: Operating voltage level shall be 12,470 volts, 3-phase, 60Hz, grounded distribution system.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install cable in accordance with manufacturer's instructions and recommendations.

B. After conduit banks are completed and in place, all conduit (new and existing) shall be swab-cleaned of all dirt, foreign material, and moisture.

C. Apply lubricant to one end of the conduit, before cable installation, and wipe to the other end with a mandrel. Apply sufficient lubricant to cause lubricant to spill from the conduit as the mandrel is withdrawn. Do not use soap, detergent, etc., to lubricate.

D. Use tension meter to monitor all cable pulling tension in order to ensure manufacturer's maximum recommended tension is not exceeded.

E. Start cable pulls from end which provides least pulling resistance.

F. After pulling and until final termination, seal cable ends to prevent entrance of dirt, moisture and other foreign material.

G. Carefully and neatly lace all cable entering and leaving manholes through cable supports.

H. Tag all cables. Utilize fire retardant and corrosion resistant cable tags with minimum of 1½"-high lettering, per Subsection 2.02-I (above) of this Section of the Specifications.

I. Terminate all cable with appropriate terminator.

J. Do not bend cable to a smaller radius than recommended by IPCEA and the cable manufacturer.

K. Record reel numbers, cable description, pulling tensions and any other observations which may be useful in defining any causes of trouble in the future.

L. Install cable in lengths sufficient to avoid splices. DO NOT splice cables except where the cables are scheduled to be spliced to the existing 5kV Plant Power Distribution System. Terminate all cable with stress cones.

M. Color code all cables per City of Austin color code.

N. Train cables around the sides of the manholes to avoid manhole traffic. Do not run cables diagonally across the manhole. Tag all cables in manhole with permanent tags identifying the power source and the load served. Allow sufficient slack in each cable, at each manhole and pull-box, to make splices in the future. Fireproof all cables within manholes with approved arc and fireproofing tape capable of withstanding temperatures to 23,000 deg. F (13,000 deg. K) for 70-cycles.

O. Arrange cable support systems so that each cable can be securely anchored to prevent migration downgrade through ducts installed on steep grades.

P. Install a 600 volt type THW insulated (Green color) ground wire in each conduit run of each individual Medium Voltage (5kV or 15kV) cable carrying conduit. Do not utilize the shield of any 5kV or 15kV cable as ground and/or grounding conductor/wire. Size of the 600 volt insulated ground wire (per conduit run, and per one piece of mechanical equipment only) shall be #250 MCM (minimum) or as noted/shown on the PLANS.

Q. Support and clamp cables in manholes and above ground cable closets per details shown on the PLANS and per the requirements of Section 16150 "Raceway, Fittings and Supports" of the Specifications.

3.02 TESTING

A. Megger Test: Give each cable a full dielectric absorption test with 5,000 volt motor-driven megger. Record reading for five (5) minutes before and after the HIPOT test.

B. HIPOT Test: Test all medium voltage cable with terminators after installation in conduit but before cable is connected to any equipment. Test each cable individually. HIPOT test shall not be performed for existing medium voltage cables which are being reused in renovation activity.

C. Test voltage for 5kV and 15kV cables shall be per the manufacturer's recommendations for fifteen (15) minutes in strict accordance with manufacturer's recommendations. Take leakage current readings every fifteen (15) seconds for the first minute and at one (1) minute intervals during the remainder of the test. Cable shall not be accepted if there is a continual increase in leakage current throughout the test. Test voltage for 5kV and 15kV cables shall be performed for both proposed medium voltage cables as well as existing medium voltage cables which are being reused during any point in the construction sequence.

D. Exercise extreme care to assure a solid ground of cable sheaths and conductors not being tested.

E. Field Testing Company and Witnessing: All Field Testing is to be performed by an independent testing company normally employed in this field. Testing shall be witnessed by the Owner and the Engineer. All test reports shall be certified by the testing company. Format and quantity of reports shall be per the requirements of Sections 01300 and 01730 of the Contract Specifications.

3.03 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this Section. All costs are included in the Base Bid.

END OF SECTION

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PART 1 - GENERAL

1.01 SUMMARY

A. Furnish and install the field wiring as specified herein and as shown on the PLANS.

B. Furnish and install all wiring required to make the electrical system completely and satisfactorily operable. Comply with the National Electrical Code and all applicable federal, state, and local codes, regulations and ordinances.

C. The requirements of this section also apply in whole to the installation of the fiber-optic cables and Ethernet copper cables. Fiber optic cables are specified in Section 17600 "Distributed Control System" of the Specifications.

1.02 RELATED REQUIREMENTS

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.

C. The PLANS designate the type, number, and size of field wiring.

D. Related work as called for on the PLANS, as specified herein or in other Sections of the Specifications.

1.03 SUBMITTALS

A. Submit shop drawings in accordance with Section 01300 of the Contract Specifications.

B. Submit Operations and Maintenance Manuals (O&M) in accordance with Section 01730 of the Contract Specifications. O&M Manuals shall include copies of the approved shop drawings, factory and on-site/field test data.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

A. All wire and cable on this project shall be new, unused, in good condition and shall be delivered in standard coils, packages or reels. Submit wire samples when requested by

the OWNER. Final acceptance of wire shall be made by the OWNER or its representative.

2.02 SINGLE CONDUCTOR - GENERAL ELECTRICAL POWER SYSTEM AND AUXILIARY ELECTRICAL SYSTEM WIRING

A. All wire shall be 98% conductivity copper, stranded, single conductor Type XHHW-2. This wire shall have moisture resistant insulation and clean stripping characteristics. Wire shall be marked at minimum distance of every ten feet (10') with the size, type and voltage of the wires as well as the manufacturer's name and measurement markers. All neutral and ground wires shall be insulated and identified and marked.

B. The pigmentation of the wire insulation shall conform to the color table listed below:

Phase	277/480 Volts	120/208 Volts AC	24 Volts DC
ΦA	Brown	Red	----------
ΦB	Yellow	Black	----------
ΦC	Purple	Blue	----------
Neutral	Gray	White	----------
Ground	Green	Green	Green
Motor Space Heater (H)	----------	Black	----------
DC (+)	----------	----------	Blue
DC (-)	----------	----------	Brown

C. Any interlock wiring installed in one device with power from another device shall be properly marked.

D. The minimum wire size shall be No.10 for all wiring unless shown otherwise on the PLANS.

E. Departures from the sizes shown shall be made only in those cases in which the National Electric Code requires the use of larger conductors.

F. General Electrical Power System and Auxiliary Electrical System Wiring shall be as manufactured by General Cable Company, The Okonite Company, or approved equal.

2.03 SIGNAL AND COMMUNICATION WIRING

A. 4-20 Milliamp Signal wiring:

1. Number of Pairs: One
2. Wire Size: #16 AWG
3. Type of Conductors: Stranded copper conductors, twisted
4. Individual Conductor Insulation: PVC

5. Individual Conductor Insulation Color: Positive (+) is Black, Negative (-) is White.
6. Drain Wire: Tinned copper
7. Overall Shield: Aluminum-mylar shield
8. Overall Jacket: PVC
9. Overall Jacket Color: Black
10. Manufacturer: Samuel Moore and Company, Dekoron Division, Cat. No. 1852 or approved equal.

B. Multi-Conductor RTD Temperature Signal Wiring:

1. Number of Triads: One
2. Wire Size: #16 AWG
3. Type of Conductors: Stranded copper conductors, twisted
4. Individual Conductor Insulation: PVC
5. Individual Conductor Insulation Color: Positive (+) is Black, Negative (-) is White, Sense (S) is Red.
6. Drain Wire: Tinned copper
7. Overall Shield: Aluminum-mylar shield
8. Overall Jacket: PVC
9. Overall Jacket Color: Black
10. Manufacturer: Samuel Moore and Company, Dekoron Division, Cat. No. 1862 or approved equal.

C. Ethernet Data Communication Wiring:

1. Number of Pairs: Four
2. Wire Size: #23 AWG
3. Type of Conductors: solid copper conductors, twisted
4. Individual Conductor Insulation: 300 volt polyolefin
5. Individual Conductor Insulation Color: White/Blue Stripe, Blue, White/Orange Stripe, Orange, White/Green Stripe, Green, White/Brown Stripe, Brown
6. Drain Wire: No. 24 AWG Tinned copper
7. Overall Shield: Aluminum-mylar shield
8. Overall Jacket: PVC, include ripcord
9. Overall Jacket Color: Blue
10. Maximum Attenuation at 100 MHz: 18.9 dB per 100 meters of cable length
11. Maximum Attenuation at 250 MHz: 31.2 dB per 100 meters of cable length

12. Manufacturer: Belden, Catalog No. 7851A, or approved equal.

13. Agency Compliance: ANSI/TIA/EIA-568 B.2-1 Category 6

D. Fiber Optic

1. Refer to Section 17600 Distributed Control System.

2.04 SINGLE CONDUCTOR CONTROL WIRING

A. Single conductor control wiring shall be 98% conductivity copper, stranded, single conductor Type XHHW-2. This wire shall have moisture resistant insulation and clean stripping characteristics. Wire shall be marked at minimum distance of every ten feet (10') with the size, type and voltage of the wires as well as the manufacturer's name and measurement markers.

B. Conductors shall have a minimum size of #14 AWG, unless shown otherwise on the PLANS. The color of the wire shall be RED.

C. Single Conductor Control Wiring shall be as manufactured by General Cable Company, The Okonite Company**,** or approved equal.

2.05 600 VOLTS MULTI-CONDUCTOR - GENERAL ELECTRICAL POWER SYSTEM AND AUXILIARY ELECTRICAL SYSTEM WIRING CABLES

A. General: Utilize multi-conductor cables for Electrical Power System and Auxiliary Electrical System Wiring where called for on the PLANS in addition to the following:

1. Utilize multi-conductor cables in all cable tray systems and in conduit system (above ground and underground) where it is the continuation of cable run entering/exiting the cable tray system (i.e., do not splice into a standard single conductor power and auxiliary electrical system wiring at/before or after transition from cable tray system to conduit system (underground and above ground conduit system). All cables shall be continuous without splices from source to destination of termination and visa-versa, thus type of cable must also remain the same throughout the entire run).

2. Multi-Conductor cables for Electrical Power System and Auxiliary Electrical System Wiring shall be the non-shielded type and shall be rated 600 volts. Cables shall be suitable and rated for installation in wet or dry locations, for AC or DC service at conductor temperature of 90 °C. Cables shall be suitable and rated for installation in conduit system, duct bank system, cable trough system, cable tray system, and directly buried in the ground/earth.

B. Features: As minimum, the Multi-Conductor control cables shall have the following features:

1. Excellent flame resistance. Passes the IEEE 383 Vertical Tray Flame Test at 70,000 BTU/hr and also when modified for 210,000 BTU/hr flame source utilizing the corner configuration.

2. Cables shall comply with IEEE 383 standards requirements “Type Test of Class IE Electrical Cables”.

3. Cables shall have mechanical rigidity and shall be flexible, easy to install and terminate.

4. Cables shall be resistant to water, oil, and chemicals. Cables shall also be stable at elevated temperatures.

C. Conductors:

1. Each individual conductor in the Multi-Conductor cables shall be coated copper per ASTM B-33, 19-strand (Class B Stranded per ASTM B-8), with 600 volt XHHW insulation. Insulation shall be heat, moisture, flame and chemical resistant, mechanically rugged Ethylene-Propylene insulation compound. . Size of each conductor shall not be less than No. 10 AWG. Also refer to PLANS for additional information.

D. Assembly:

1. Individual conductors cabled in accordance to U.L 1277, using extruded fillers with an overall binding tape (over entire multi-conductor and fillers assembly, and just prior to overall cable jacket).

E. Overall Jacket, Conductor sizes, Conductor Quantity, Overall Diameters:

1. Each Multi-Conductor cable shall be covered with overall FLAME-RETARDANT PVC jacket which shall meet or exceed the requirements of ICEA S-68-516. The jacket thickness, number of conductors, number of strands per conductor, conductor, ground wire size per cable, and cable overall diameters shall be as follows:

Total # of 600 volts insulated conductors in cable	Current Carrying Conductor size (AWG) and (x Qty)			600 volts Insulated ground wire size and (x Quantity)			Jacket Thick-ness in mils	Maximum Overall Outer Cable Diameter (inches)
	Size (AWG)	#of strands (min.)	Qty.	Size (AWG)	#of strands (min.)	Qty.		
5	#10	7	x4	#10	7	x1	60	0.62
5	#8	7	x4	#10	7	x1	60	0.73
5	#6	7	x4	#8	7	x1	60	0.83
5	#4	7	x4	#8	7	x1	80	1.00
5	#2	7	x4	#6	7	x1	80	1.12
5	#1	19	x4	#6	7	x1	80	1.21
5	#1/0	19	x4	#6	7	x1	80	1.23
5	#2/0	19	x4	#6	7	x1	80	1.40

F. Manufacturer:

1. 600 volts multi-conductor Electrical Power System and Auxiliary Electrical System Wiring Cables shall be as manufactured by Okonite-FMR-Okoseal Type TC/TC-ER Cable**,** or approved equal.

G. Color Coding:

1. The color coding of the individual conductors in a cable shall comply with the color coding requirements for the single conductors in a 480/277 volt and 208/120 volt systems, outlined under Subsection 2.02B.

2.06 MULTI-CONDUCTOR CONTROL WIRING

A. General: Multi-Conductor control system cables shall be shielded and shall be rated 600 volts. Cables shall be suitable and rated for installation for AC or DC service in wet or dry locations at conductor temperatures of 90 degrees C. Cable shall be suitable and rated for installation in conduit system, cable tray system, and directly buried in the ground/earth where electrostatic shielding is required.

B. Features: As minimum, the Multi-Conductor shielded control cables shall have the following features:

1. Passes the IEEE 383 and IEEE 1202 flame tests as well as ICEA T-29-520 (210,000 BTU/hour) flame test

2. Conductors: Each individual conductor in each multi-conductor cable shall be copper per ASTM B-3. Each conductor shall have the following additional features:
   a. Stranding: Class B stranding per ASTM B-8
   b. Insulation: Meet or exceed the requirements of ICEA S-73-532
   c. Conductor Identification: Color coded using base colors and tracers according to the following:

Conductor Size	Number of Conductors in a Cable	Conductor Insulation Thickness	Cable Maximum Overall Diameter	Color Code		
				Cond. No.	Base Color	Tracer
#12 AWG	Seven (7)	30 mils	0.74 inches	1	Black	----
				2	White	----
				3	Red	----
				4	Green	----
				5	Orange	----
				6	Blue	----
				7	White	Black
#12 AWG	Twelve (12)	30 mils	0.96 inches	1	Black	----
				2	White	----
				3	Red	----
				4	Green	----
				5	Orange	----
				6	Blue	----
				7	White	Black
				8	Red	Black
				9	Green	Black
				10	Orange	Black
				11	Blue	Black
				12	Black	White

#12 AWG	Nineteen (19)	30 mils	1.09 inches	1	Black	----
				2	White	----
				3	Red	----
				4	Green	----
				5	Orange	----
				6	Blue	----
				7	White	Black
				8	Red	Black
				9	Green	Black
				10	Orange	Black
				11	Blue	Black
				12	Black	White
				13	Red	White
				14	Green	White
				15	Blue	White
				16	Black	Red
				17	White	Red
				18	Orange	Red
				19	Blue	Red

3. Size of each conductor and quantity of conductors: There shall be three kinds of multi-conductor control cables: Seven (7) conductor (#12 AWG) cables, Twelve (12) conductor (#12 AWG) cables, and Nineteen (19) conductor (#12 AWG) cables. Sizes and quantities shall be as shown on the Conduit/Wire Schedule shown on the Drawings.

4. Overall Cable Shield: 100 percent shield consisting of 5-mil corrugated copper tape, longitudinally applied.

5. Overall outer jacket: Each multi-conductor cable shall be covered with overall black thermoset chlorinated polyethylene flame retardant outer jacket. Minimum jacket thickness is 60 mils.

6. Number of conductors in a cable: Number of conductors shall be as shown on the Conduit/Wire Schedule shown on the Drawings.

7. Manufacturer: Okonite FMR-LCS-Okolon TS-CPE, or approved equal.

2.07 WIRE TAGGING

A. Wire Tags:

1. Rating: Flame-Retardant
2. Style: Heavy-Duty Industrial Grade
3. Type: Heat Shrinkable type
4. Character Height: 1/8 inch
5. Maximum Length: 2 inches
6. Text Type: Typed with indelible marking process. Handwritten shall not be accepted.
7. Color: White.
   a. Exception: Use Yellow for instrumentation/control circuits as described in Section 17200.
8. Manufacturer: “Raychem type Heavy-Duty Industrial Grade ShrinkMark Heat-Shrinkable Marking Sleeves”, or approved equal. Utilize "Raychem" Portable-Marking-System” complete with wire tag cartridges, or approved equal.

2.08 MISCELLANEOUS

A. Wire Pulling Lubricant: Ideal ClearGlide, or approved equal

B. Vertical cable supports (in conduit): O.Z. Gedney Type “S”, or approved equal

C. Multi-Cable Connector Blocks:

1. Use only for power wiring termination for motors rated 600V and below
2. 600V rated
3. Insulated with UV rated chemical resistant plastisol compound that will not support combustion
4. Suitable for use with fine stranded extra-flexible wiring
5. Suitable for use with aluminum and copper conductors
6. U. L. 486A Listed
7. Pre-filled with an oxide inhibitor
8. Manufacturer: “Polaris Connectors” Series Polaris Grey, or approved equal.

D. Submersible Splice Connectors

1. Use only where indicated on the PLANS for submersible applications of 600V and below power and control wiring terminations.
2. 600V rated
3. Manufactured from high strength 6061-T6 aluminum alloy

4. Encapsulated in rubber with a nominal thickness of 125 mils. And high dielectric strength.
5. Suitable for use with aluminum and copper conductors
6. U.L. 486D Listed
7. Manufacturer: "Polaris Connectors" Series ISPBS Submersible Splice Connectors and Series ISPB2/0 and ISPBO2/0 Submersible Streetlight Connectors, or approved equal.

E. Corrosion Resistant and Moisture Repelling Electrical Coating/Spray:

1. Color: Clear. Coordinate spray color with the Owner. Furnish and install the color requested by the Owner at No Additional Cost to the Owner.
2. Type: Corrosion resistant and moisture repellant fast drying spray coating sealant
3. Manufacturer: "3M" 1601 Clear-Color Fast Drying Sealer and Insulator, or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Before wire is pulled into any conduit, thoroughly swab the conduit to remove all foreign material and to permit the wire to be pulled into a clean, dry conduit. Use wire pulling lubricant in pulling any wire. Pull all conductors into their respective conduits by hand except where written permission of the OWNER is secured to the contrary.

B. Furnish and install the previously specified vertical cable supports in conduit were required by the NEC.

C. No wire splices shall be accepted except as permitted below:

1. SPLICING OF 208/120 VOLT LIGHTING AND RECEPTACLE CIRCUITING:
   a. General: Perform all splicing in splice/junction boxes dedicated for this purpose.
   b. For splices where wiring is:
      1) #10 AWG and smaller: Utilize 600 volts WeatherProof Wire-Nut Wire Connectors. The WeatherProof Wire-Nut Wire Connectors shall be twist-on type and shall be pre-filled (factory-filled) with Silicone-Based Sealant for maximum protection against Moisture and Corrosion. The WeatherProof Wire-Nut Wire Connectors shall be as manufactured by IDEAL Model 61, 62, or 63 WeatherProof Wire-Nut Wire Connectors, or approved equal.

2) All other sizes: Use the Multi-Cable Connector Blocks as Specified in 2.06.C, this Section of the Specifications.

D. For wiring termination to motors rated 600 volt and below, use the Multi-Cable Connector Blocks as Specified in 2.06.C, this Section of the Specifications.

E. All wiring connections must be insulated with 600 volt insulation system.

F. Tagging:

1. Tag all power, Instrumentation and Controls, Fiber Optic Cables, and all other types of auxiliary electrical wiring and cables at both ends with the specified heat shrinkable tags and heat shrink the tags.

2. Tag per Subsection 3.03 of this Section of the Specifications and per the OWNER's cable and wire tagging standards.

3. Tag each wire in a Multi-Conductor cable in addition to the overall cable itself.

4. Group wiring routed in pullboxes that are routed in common conduits and tag each wiring group inside each pullbox with nameplates as follows:
   a. Type: 3-ply, 1/8" thick, rigid thermoset phenolic resin laminated cellulose paper base engraving stock per ASTM D-709, Type I. Nameplates shall be ASTM Grade ES-1, ES-2, or ES-3 as applicable for the face and lettering colors specified hereinafter. Flexible or acrylic tags will be not be accepted.
   b. Color: White-Black-White
   c. Lettering: 1/4 inch height, minimum, engraved through the face layer to the melamine middle layer.
   d. Accessories: Provide holes for mechanical fastening.

5. Secure each phenolic tag (where required) with a minimum of two nylon cable ties, one at each end of the tag.

G. Ground shielded instrument cables at one point only, e.g.; at the final destination in the associated instrument and control cabinets.

H. Terminate stranded wiring by use of lugs, clamps or pressure type terminals.

I. After all wiring connections have been made, the Contractor shall apply the Corrosion Resistant and Moisture Repelling Electrical Coating/Spray to all wiring connections. Coordinate application with the Owner prior to application, the Owner has the discretion to limit application. For bidding purposes, the minimum extent of spray application is further clarified as follows:

1. Spray shall be applied for all terminations of the following types of connections at a minimum:
   a. termination points, terminals, terminal blocks, ground bar, neutral bar/bus,
   b. lugs of circuit breakers, buses, doors, etc.

c. exposed/stripped ends of each conductor, etc.

d. bolt-on connections, split-bolt connections, ring lugs, etc.

e. submersible splice connectors, compression connectors, multi-cable connector blocks, etc.

f. all other connection types not listed above

2. Spray shall be applied for all terminations at the following types of equipment at a minimum:
   a. Local and main control panels, field instruments, junction boxes, field control stations, control relays, signal isolators, selector switches, pushbuttons, etc.,

   b. Panelboards, transformers, motor control centers, manual motor starters, contactors, light switches, light fixtures, etc.

   c. Motor termination enclosures, valve actuators, cathodic protection system, package control panels of process equipment, etc.

   d. Security system devices, cameras, roadway gate operators, etc.

   e. Convenience receptacles, scada receptacles, etc.

   f. All other types of equipment not listed above.

3.02 TESTS

A. Perform all tests as outlined in Section 16800 and all other tests which are necessary to determine that the electrical wiring system is in satisfactory operating condition. Wiring shall be tested end-to-end after it is pulled in the conduit system.

3.03 WIRE TAGGING METHODOLOGY

A. Single Conductor Wire Tagging Scheme:

1. All single conductor control and power wiring shall be tagged utilizing the source and destination method. In general, as minimum each tag shall be comprised of various fields which are:
   a. Device Identifiers,

   b. Terminal Numbers and,

   c. Equipment Identification name

2. The following is the format that shall be used for each control power single conductor wire tag:

XXXX	-	XX	(XXXX-XXXX-XXXX	/	XXXX	-	XX)
Device Identifier		Terminal Number	Equipment Identification Name		Device Identifier		Terminal Number

a. The tag information to the left refers to the point of termination. Tag information in parenthesis refers to the point of origination. Note: For wiring within the boundaries of a piece of equipment, The Equipment identification name shall not be required, only the Device Identifier and the Terminal Number from the point of origination. Examples to this exception would be, wiring from one terminal strip to another within the same control panel, etc.

3. The following provides a brief description to each of the fields required within a single wire tag:

FIELD	DESCRIPTION
Device Identifier:	A four (4) alphanumeric character field that shall uniquely identify a device within a piece of equipment. Examples are: TB1, for Terminal Block Number 1, and CR02 for Control Relay #02, etc.
Terminal Number:	A two (2) alphanumeric character field that shall identify which specific point on the Device the wire must be terminated to. Refer to manufacturer's labeling or record drawings for Device Terminal Numbers.
Equipment Identification Name:	A twelve (12) alphanumeric character field that shall be the same as the physical Equipment Identification Nameplate attached to the equipment.

B. Single Conductor Wire Tagging Scheme in a Multi-conductor Cable:

1. All single conductor control and instrument wiring (in Multi-conductor Instrument or Control Cables) shall be tagged utilizing the source and destination method. In general, each tag shall be comprised of various fields which are 1) Device Identifiers, 2) Terminal Numbers, and 3) Equipment Identification Name, as minimum.

2. The following is the format that shall be used for each single conductor wire tag in a multi-conductor cable (Instrumentation or Control wiring Cables):

XX	-	XX	(XXXX	/	XX)
Device Identifier		Terminal Number	Cable ID		Conductor Number

a. The tag information to the left refers to the point of termination. Tag information in parenthesis refers to the point of origination.

3. The following provides a brief description to each of the fields required within a single tag (in a Multi-conductor Cable):

FIELD	DESCRIPTION
Device Identifier:	A four (4) alphanumeric character field that shall uniquely identify a device within a piece of equipment. Examples are: TB1, for Terminal Block Number 1, and CR02 for Control Relay #02, etc.
Terminal Number:	A two (2) alphanumeric character field that shall identify which specific point on the Device the wire must be terminated to. Refer to manufacturer's labeling or record drawings for Device Terminal Numbers.
Cable Identification (Cable ID):	A five (5) alphanumeric character field that shall uniquely identify a cable within the facility. The first character shall identify the cable type as follows: C - for Control Cables I - for Instrumentation Cables P - for Power Cables The remaining four (4) alphanumeric characters shall make-up a unique number for a given cable type within the facility.

C. Overall Cable Tag of a Multi-conductor Cable:

1. In addition to tagging each single conductor in a multi-conductor cable (as described in 3.03 B, above), the overall jacket of each multi-conductor cable shall also be tagged to uniquely identify each cable within the facility. In general, each cable tag shall be comprised of various fields which are 1) Cable Identification (Cable ID), and 2) Equipment Identification Name, as minimum.

2. The following is the format that shall be used for overall cable tag of each multi-conductor cable:

XXXX	(XXXX-XXXX-XXXX	/	XXXX-XXXX-XXXX)
Cable ID	Source Equipment Identification Name.		Destination Equipment Identification Name

a. The tag information to the left refers to the actual cable Identification (name). Tag information in parenthesis refers to the Identification Name of the Equipment at point of origination (source), followed by the Identification Name of the Equipment at the point of termination (Destination Point).

3. The following provides a brief description to each of the fields required within a cable tag:

FIELD	DESCRIPTION
- Cable Identification (Cable ID):	A five (5) alphanumeric character field that shall uniquely identify a cable within the facility. The first character shall identify the cable type as follows: C - for Control Cables I - for Instrumentation Cables P - for Power Cables The remaining four (4) alphanumeric characters shall make-up a unique number for a given cable type within the facility.
- Source Equipment Identification Name:	A twelve (12) alphanumeric character field that shall be the same as the physical Equipment Identification Nameplate attached to the source (origination) equipment.
- Destination Equipment Identification Name:	A twelve (12) alphanumeric character field that shall be the same as the physical Equipment Identification Nameplate attached to the destination equipment (equipment at point of termination).

4. All cable tags (except in Manholes, handholes, above ground cable closets, and in cable tray system), shall be of 3-ply engraved plastic (phenolic) with background color, letter sizes, etc. as follows:

Cable Type	Tag Color	Color of Lettering	Letter Height
600 volt Power Cable	Orange	White	3/16” (min.)
600 volt Control Cable	Orange	White	3/16” (min.)
Instrumentation Cable	Black	White	3/16” (min.)

3.04 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this Section. All costs are included in the Base Bid.

END OF SECTION

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PART 1 - GENERAL

1.01 SUMMARY

A. Furnish and install all cabinets, junction boxes, pull boxes and outlet boxes as shown on the PLANS, required by the Specifications or National Electrical Code (NEC), or as otherwise necessary for a satisfactory operating system.

1.02 RELATED REQUIREMENTS

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.

C. Related work as called for on the PLANS, as specified herein or in other Sections of the Specifications.

1.03 SUBMITTALS

A. Submit shop drawings in accordance with the Section 01300 of the Specifications.

B. Submit Operations and Maintenance Manuals (O&M) in accordance with Section 01730 of the Specifications. O&M Manuals shall include copies of the approved shop drawings, factory and on-site/field test data.

PART 2 - PRODUCTS

2.01 JUNCTION AND PULL BOXES

A. Lighting and power, signal, telephone, voice communication, instrumentation and controls, and any other junction and pull boxes hereinafter specified or shown on the PLANS shall be as provided as follows:

1. Outdoor boxes shall be NEMA-4X Type 316-Stainless Steel Boxes. Boxes shall be equipped with hinged doors complete with 1/4 (quarter) turn door latches.

2. Indoor boxes in non-environmentally controlled rooms shall be as follows:
   a. All areas:
      1) Smaller than or equal to 12" wide x 12" high: 99.0% copper-free rigid Aluminum NEMA-4X corrosion resistant and water tight boxes.
      2) Larger than 12" side x 12" high: NEMA-4X Type 316-stainless steel Boxes.
   b. Boxes shall be equipped with hinged doors complete with 1/4 (quarter) turn door latches.

3. Indoor boxes in environmentally controlled rooms shall be as follows:
   a. NEMA 12 with ANSI No. 61 Gray finish
   b. Boxes shall be equipped with hinged doors complete with 1/4 (quarter) turn door latches.

B. Boxes or cabinets shall be not less than 6-inches deep and their minimum height and width dimensions shall be determined by the requirements of, and in compliance with the NEC.

C. Each type of box and cabinet on the project shall be manufactured by a single manufacturer.

D. Manufacturer:
   1. Hoffman Concept Series, Rittal, Millbank, or approved equal.

2.02 DEVICE BOXES FOR CONVENIENCE/SPECIAL PURPOSE RECEPTACLES AND LIGHT SWITCHES

A. Boxes for convenience/special-purpose receptacles shall be as specified in Section 16300 "Wiring Devices".

B. Boxes for Light Switches shall be as specified in Section 16300 "Wiring Devices".

2.03 NAMEPLATES

A. General:
   1. Type: 3-ply, 1/8" thick, rigid thermoset phenolic resin laminated cellulose paper base engraving stock per ASTM D-709, Type I. Nameplates shall be ASTM Grade ES-1, ES-2, or ES-3 as applicable for the face and lettering colors specified hereinafter. Flexible or acrylic tags will be not be accepted
   2. Color: White-Black-White
   3. Lettering: 1/4 inch height, minimum, engraved through the face layer to the melamine middle layer

4. Accessories: Provide holes for mechanical fastening. Provide adhesive backplane where required in Part 3, Execution.

PART 3 - EXECUTION

3.01 APPLICATION

A. General:

1. Pullboxes shall be used only to reduce the number of bends for conduit, supports, taps, troughs and similar applications. No splicing shall be performed in pullboxes.

2. Junction boxes shall only be used where shown on the PLANS. Any other use of junction boxes other than for receptacle and lighting circuit wiring, is not permitted.

3. Outlet boxes shall be used for ceiling or wall mounting of light fixtures, receptacles, open type manual motor starters, and where required by the PLANS and Specifications to facilitate proper connection to equipment.

3.02 INSTALLATION

A. Set box square and true with building surfaces. Secure boxes firmly to support channels. Coordinate final location of boxes with other trades to avoid any conflicts.

B. Utilize specified support channels, then secure/mount boxes and cabinets to the support channels. All mounting hardware shall be Type 316-stainless steel. Equipment support channels shall be per the requirements of Section 16150 “Raceways, Fittings, and Supports”. Additionally, refer to details shown on the PLANS.

C. Tagging:

1. Tag each box with the name as it appears on the PLANS using the specified namplates.

2. Attach identification nameplates with two stainless steel screws.

D. Cap all outlets not used under this Contract with blank outlet covers.

E. Furnish and install labels as required by the NEC.

3.03 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this Section. All costs are included in the Base Bid.

END OF SECTION

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PART 1 - GENERAL

1.01 SUMMARY

A. Furnish and install the 480 Volt Uninterruptible Power Supply (UPS) system as specified herein and as shown on the PLANS.

1.02 RELATED REQUIREMENTS

A. The PLANS designate the size, rating, and other requirements of the UPS.

B. Related work as called for on the PLANS, as specified herein or in other Sections of the Specifications.

1.03 SUBMITTALS

A. Submit Shop Drawings in accordance with Section 01300 of the Specifications. Submittals shall include:

1. Dimensioned/scaled top and bottom views, front elevations, and internal component/device layouts
2. One-line and wiring diagrams,
3. Catalog cut sheets, including weight and heat dissipation

B. Submit Operations and Maintenance Manuals (O&M) in accordance with Section 01730 of the Specifications. O&M Manuals shall include copies of the approved shop drawings. Also, as minimum the Operations and Maintenance Manuals shall include:

1. Copies of certified and approved shop drawings.
2. Detailed information on each component used, including:
   a. Installation and operation manual.
   b. Renewal parts bulletin.
   c. As built drawings, including approved shop drawings.
   d. Test data.
   e. Detailed UPS setting parameters, DIP-switch settings, ranges, options, operating setting and calibrating instructions, etc.

1.04 QUALITY ASSURANCE

A. The UPS shall be designed, constructed, and tested in accordance with the latest applicable requirements of NEMA, ANSI, U.L., and NEC standards.

B. The UPS shall be as manufactured by "Liebert Model eXM" meeting these specifications and all the additional options required hereinafter, or approved equal.

1.05 DELIVERY, STORAGE AND HANDLING

A. Protection

1. The Contractor, and hence the UPS supplier, shall be responsible for safety of the UPS during storage, transporting and handling.

2. At all times the UPS shall be housed inside a moisture free, non-porous, extra heavy duty plastic weatherproof housing.

3. Interior and exterior of the UPS shall be kept clean at all times.

4. Size, furnish and install temporary space heaters within the UPS and energize during storage and installation for humidity control.

B. Additional project job site storage requirements: Upon delivery to the project site and prior to final installation, protect and store in accordance with the following:

1. Environmentally protected and stored in climate controlled (temperature and humidity) environment at the job site. Size, furnish and install temporary air conditioners, and additional environmental control equipment complete with branch circuiting conduit/wire as required to maintain in a controlled environment at the following conditions:
   a. Ambient Dry Bulb Temperature:
      1) Minimum: 68 degrees Fahrenheit.
      2) Maximum: 85 degrees Fahrenheit.
   b. Ambient Relative Humidity: Maximum: 50%.

2. Every effort shall be made to provide all necessary electrical power connections ready for immediate connection to equipment upon arrival of equipment on jobsite.

3. Upon arrival of equipment onto job site, a maximum of one day shall be allowed for equipment to be left without HVAC, but within a sealed enclosed building, to allow proper transition of power of equipment, especially any 120 VAC powered equipment, to ensure all air conditioning and heating equipment are fully operational with a maximum of a 10 minute down time during this transition of power.

4. Furnish and install replacement air filters, etc., as required for proper operation of the environmental control equipment.

1.06 SPECIAL MANUFACTURER'S SERVICES

A. Furnish the services of a qualified, experienced, factory trained technical (non-sales type) representative to perform the field testing hereinafter specified. Include checking alignment of parts, wiring connections, operation of all parts (inverter, battery charger, rectifier, etc.). Include time to correct and recheck any discrepancies which are

discovered. Also include providing the OWNER with a report certifying that the equipment was installed, adjusted, properly tested, and set in accordance with the manufacturer's recommendations and is in satisfactory operating condition. Format and quantity of reports shall be per the requirements of Section 01300 of the Contract Specifications.

B. Prepare an arc-flash study, harmonic study, motor starting study and a coordination study, complete with short circuit calculations and coordination curves, etc. as required by and in compliance with Section 16044 of the Specifications "5kV and 15kV Metal-Clad Switchgear and Medium Voltage Overhead Bus Ducts", paragraph 1.09 "Special Manufacturer's Services".

C. Manufacturer's technical representative is to set, adjust and test all circuit breakers, relays, motor circuit protectors, etc. in the presence of a representative of the OWNER. The settings will be based on coordination and short circuit studies performed per subsection 1.06.B, this Section of the Specifications. Provide the OWNER with test report certified by the manufacturer. Include a record of all settings. Format and quantity of reports shall be per the requirements of Section 01300 and 01730 of the Contract Specifications. The Manufacturer shall furnish the protective device of the appropriate characteristics that shall be the most suitable for the proper protection and coordination of the system at No Additional Cost to the OWNER.

D. Any problems encountered with the operation of equipment, parts, components, etc. installed within the UPS system shall be repaired/remedied by the manufacturer's technical representative.

1.07 SPARE PARTS

A. One (1) quart of touch up paint.

PART 2 - PRODUCT

2.01 UNINTERRUPTIBLE POWER SUPPLY SYSTEM REQUIREMENTS AND UNIT DESCRIPTION

A. General System Requirements:

1. Uninterruptible Power Supply system shall consist of the following major sub-components as a minimum:
   a. Solid State Inverter, Pulse width modulated design
   b. Solid State Rectifier
   c. UPS system controller with manufacturer's standard field adjustable control and protective features
   d. UPS Module Internal Bypass Static Switch
   e. External Maintenance Bypass Switch

f. Input and output circuit breakers

g. Batteries

h. Battery Charger

i. Transformer

j. Input filters and surge protection

k. Mounting enclosures and miscellaneous accessories

The UPS manufacturer shall furnish and install the UPS system complete with all sub-components required to achieve a functional uninterruptible power system in compliance with the requirements of the PLANS and Specifications at no additional cost to the Owner regardless if all of the needed UPS sub-components are identified in the above listing.

2. Enclosure:
   a. Provide the number of modular free standing enclosures as hereinafter specified and as shown on the PLANS and as required to house the various UPS system subcomponents. Mount and wire all components inside of each enclosure unless shown/specified otherwise.

   b. Enclosure shall be the totally enclosed, NEMA Type 1 rated, and suitable for back-to-wall mounting. Refer to the PLANS for additional dimensional requirements. Each enclosure shall have a hinged door with latching mechanism and exterior operating handle. Three point type latch is preferred. Each enclosure shall have provisions for lifting and jacking. Each enclosure shall have field adjustable leveling feet as well as suitably sized casters.

   c. Enclosure finish shall be primed and painted using the manufacturer's standard finishing process. Finish shall be applied at the manufacturing plant. Color shall be manufacturer's standard.

   d. Provide enclosure grounding lug and door bonding jumper for each enclosure section, sized per NEC.

3. The UPS shall consist of a configurable bypass mode for automatic or manual bypass to the AC input source.

4. For additional construction notes, features, and special requirements, refer to the PLANS and the Specifications.

5. UPS complete with all accessories shall not exceed the dimensions shown on the PLANS. Provide for incoming feeder entering from below or above, and for outgoing circuits exiting from above and below, as shown on the PLANS.

B. General Requirements:

1. Duty: Continuous

2. Number of Phases: Three

3. Apparent Power: As shown on the PLANS

4. Run Time (without input power): Minimum duration of thirty (30) minutes in the event of permanent power loss to the UPS AC input with the UPS serving all loads operating at full load.

5. Power Factor: Greater than 0.9 lagging

6. Operating Temperature Range: 0 - 40°C, with relative humidity of 20 – 90% non-condensing.

7. Connections: Provide termination lugs to facilitate the termination of the field shown on the PLANS.

8. UPS System Input:
   a. Input Voltage: 480 volts AC, 60 Hz, three wire.
   b. Voltage Range: +10%, -20% of Nominal
   c. Frequency Range: 45 to 65 Hertz.
   d. Power Factor: Minimum 0.80 lagging
   e. Inrush Current into overall system: no greater than 800% of full load current
   f. Current Limit: 115% of nominal AC input current, at minimum.
   g. Input Current Walk-In Duration: 5 to 20 seconds, field adjustable.
   h. Current Distortion: 5% reflected input THD maximum at full load.
   i. Surge Protection: The UPS shall be able to sustain input surges without damage per criteria listed in ANSI C62.41 Category A and B or IEC 1000-4-5.
   j. Connections: Provide termination lugs as required by the PLANS

9. UPS System Output:
   a. Wave form: Continuous, 208/120volts AC, 60Hz, three phase, four wire, sine wave.
   b. Voltage Regulation: ±3%
   c. Frequency: Nominal frequency ±0.1%
   d. Frequency Slew Rate: 5.0 Hertz per second maximum. Field selectable from 1 to 5 Hertz per second.
   e. Phase Displacement: ±2 degree for balanced load, ±4 degree for 100% unbalanced load.
   f. Bypass Line Sync Range: ±2 Hertz. Field selectable.
   g. Voltage Distortion: 5% THD for 100% nonlinear loads, maximum
   h. Load Power Factor Range: 1.0 to 0.7 lagging
   i. Output Power Rating: Rated kVA at 0.8 lagging power factor
   j. Overload Capability:
      1) 125 % for 90 seconds (without bypass source)

2) 150 % for 30 seconds (without bypass source).

k. Inverter Output Voltage Adjustment: ±5 %

l. Voltage Unbalance: ±2 % for 100 % unbalanced load

m. Filtering: Filtered with 0.3% IEEE surge let-through and zero clamping response time, complying with UL 1449 requirements.

C. UPS Controller Features:

1. Manufacturer's standard microprocessor based automatic controller for controlling and monitoring the UPS start-up, shutdown, load transfer, bypass, battery charging/testing, alarming, and protective functionality.

2. Combination keypad and graphical LCD display user interface means for status display and monitoring. The display shall be used to show a mimic single-line diagram of the UPS with power flow, UPS metering data, status, and alarms per the manufacturer's standard. Furnish and install additional pushbuttons, selector switches, indicating pilot lights, etc., as needed for the proper monitoring and control of the UPS system per the manufacturer's standard product offering. All of the operator controls and monitors shall be located on the face of the UPS enclosure door. Additional features of the monitoring system shall include:
   a. Menu-driven display with pushbutton navigation
   b. Real time clock (time and date)
   c. Alarm history with time and date stamp
   d. Battery backed-up memory
   e. Metering and display of input, battery, and output voltages and currents
   f. Provisions for field adjustment of the UPS setpoints.

3. The UPS controller shall consist of automatic self test, executed on start up and at regular field adjustable intervals, fault detection annunciating self test failure functionality.

4. The UPS shall consist of automatic voltage regulation to maintain its sine wave output in accordance to these specifications. The settings for the UPS AC input source voltage high and low values to initiate transfer to battery power shall be field adjustable.

5. Indications and alphanumeric display, at minimum:
   a. UPS On Status
   b. Fault
   c. On Battery
   d. Bypass
   e. Battery Replacement Needed

6. Audible Alarms , at minimum:
   a. UPS Failure

b. Battery Failure

c. Power Loss to the UPS

7. Push Buttons, at minimum:
   a. Energizing UPS
   b. De-energizing UPS
   c. Manual UPS Self test initiation
   d. Alarm reset,

8. Network Interface Card:
   a. The UPS shall come equipped with an internal Simple Network Management Protocol (SNMP) adapter, which will connect the UPS directly to any I.P. based network using Ethernet communications. The UPS will become a managed device on the network. From a network management station the system administrator shall be capable of monitoring important system measurements, alarm status and alarm history data. In the event of a utility failure the SNMP shall continue with live communication without the requirement of additional or separate UPS equipment until such time as the UPS shuts down for Low battery. On resumption of Utility power the SNMP shall resume full SNMP communication automatically.

D. UPS Module Internal Maintenance Bypass Static Switch:

1. Located integral to the UPS module
2. Solid state type switch rated to continuously conduct the full load UPS load current, at minimum.
3. Switch shall provide for automatic transfer of the load to an alternate bypass source, bypassing the UPS Module.

E. External Maintenance Bypass Switch:

1. Provide make-before-break switching means for load transfers to and from the external maintenance bypass line. Switching means to enable the UPS module to be completely isolated from the electrical system and directly connect the critical load to the input power source transformer secondary, bypassing the UPS module internal static bypass transfer switch. With the critical load powered from the maintenance bypass circuit, it shall be possible to perform maintenance on the rectifier/charger, inverter, battery, and static bypass transfer switch. All energized terminals shall be shielded to ensure that maintenance personnel do not inadvertently come in contact with energized parts or terminals.
2. External maintenance bypass switching means to be provided in a dedicated enclosure and be manually operated. The maintenance bypass switch shall be sized such to carry the full load current of the UPS inclusive of inrush current, at minimum. Also refer to the requirements of the PLANS. The maintenance bypass

switch shall be installed in such a manner that the selector switch is accessible from the front of the cabinet

3. External maintenance bypass switch shall be provided with input and output circuit breakers and shall be the standard product of the UPS manufacturer.

4. External maintenance bypass switch is required regardless if the UPS module is provided with an internal maintenance bypass switch

F. Batteries:

1. Type: sealed valve regulated lead acid (VRLA). The batteries shall be suitable for use in the application environment.

2. Operating Temperature: 20 - 30°C, with relative humidity of 20 – 90% (without condensation)

3. Group mount batteries in modular cabinet(s) in a manner that facilitates maintenance and replacement in the field without disassembly of the battery cabinet.

4. Provide the required number of modular battery cabinets to obtain the previously specified minimum runtime duration at full load.

G. Battery Charger:

1. Furnish and install battery charger for charging the UPS batteries. The charger may be an integral part of the rectifier at the discretion of the UPS manufacturer.

2. Battery charger shall be sized such to recharge the batteries from a fully discharged state to 95 percent capacity within a maximum of five (5) hours.

3. Battery charger shall have means for float charging to maintain the batteries at full charge.

H. Transformer:

1. Input: 480 volts A.C., three phase, 60 Hertz, three wire system

2. Output: 208 volts A.C., three phase, 60 Hertz, four wire system

3. Type: Dry Type

4. Windings Material: Copper

5. Accessories: 100 percent electrostatic shield wound between the primary and secondary windings. Shield must be connected to a terminal inside the enclosure. Shield terminal/lug shall be electrically isolated from the transformer frame/housing/enclosure. Furnish and install lug to terminate the wiring shown on the PLANS.

I. Circuit Breakers:

1. Provide thermal magnetic molded case circuit breakers with the following minimum requirements:
   a. U.L. listed minimum RMS symmetrical short circuit current rating equal to or greater than that of the bus serving the equipment. Provide the

rating required to comply with Subsection 1.09, this Section of the Specifications.

b. Current carrying capacity as determined by the UPS manufacturer for the application.

c. Breakers shall have an overcenter, toggle handle-operated, trip free mechanism with quick make, quick break action independent of the speed of the toggle handle operation. The design shall provide common tripping of all poles. Breakers shall be suitable for reverse feeding.

d. Provide complete with rating plug and other accessories as required for proper operation of circuit breaker.

e. Provide mechanical padlock attachment for each circuit breaker.

f. Furnish lugs for feeders where required to facilitate field wiring termination, sizes shall be as required by the PLANS.

J. Warranty: Two (2) year manufacturer's warranty

K. Accessories:

1. Auxiliary forced air cooling fans per the manufacturer's standard product offering where needed for air circulation. Thermal design shall include consideration of the installation environment. Fans control power shall be served by UPS output.

2. Provide a detailed instruction plate for convenient operation.

3. Auxiliary Contacts:
   a. Furnish and install field programmable contacts rated for 1 ampere at 24VDC, at minimum. Wire to terminal blocks. Furnish and install the quantity and state of contacts as shown on the PLANS. Contacts rated 5 ampere at 120 volts A.C. are preferred if available from the manufacturer.

4. Nameplates:
   a. Provide nameplates/legend plates for each pilot device and each component/device/equipment installed on the face and inside the enclosure of the UPS

   b. Identification Nameplates, unless otherwise specified, shall be constructed of laminated 3-ply "Black-White-Black", phenolic identification nameplates with engraved lettering. Nameplate shall be legible at a distance of six feet from the nameplate. Nameplates located on the face of the cabinet shall be secured with two Stainless Steel screws. Exception: Nameplates located inside of the UPS enclosures shall be manufacturer's standard.

PART 3 - EXECUTION

3.01 FACTORY INSPECTION AND TESTS

A. Standard factory tests shall be performed on the equipment specified in this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards. The manufacturer shall provide certified copies of factory test reports prior to shipment of the equipment to the project site. Format and quantities of the test report shall be in accordance to Section 01300 and Section 01730 of the Contract Specifications.

3.02 FIELD INSTALLATION (BY CONTRACTOR)

A. Mount the UPS as shown on the PLANS. Also refer to the details shown on the PLANS.

B. Size, furnish, and install (field route) the interconnect wiring between the individual modular sections of the UPS per the NEC and the recommendations and wiring diagrams of the UPS manufacturer. Route the interconnect wiring in liquid-tight flexible conduit per Section 16150 "Raceways, Fittings, and Supports" of the Specifications. Include additional length of conduit/wire to facilitate the movement of the UPS modular sections by the Owner's maintenance personnel for UPS maintenance and inspection. Coordinate the required interconnect conduit/wire length with the Owner and furnish and install the length required at no additional cost to the Owner.

3.03 FIELD TEST AND CHECKS

A. The following minimum test and checks shall be made before energizing the UPS. These tests shall be performed by a Factory Trained Field Technician (non sales type):

1. Thoroughly inspect UPS.
2. Test for proper wiring connections and operation.
3. Calibrate, set and test UPS setpoints and protective features according to settings provided and required by this Specifications Section and as recommended by the manufacturer.
4. Submit documentation of all tests outlined above. Include all test documentation data in operation and maintenance manuals.

3.04 EQUIPMENT PROTECTION AND RESTORATION (BY CONTRACTOR)

A. Clean and vacuum clean all interior of the equipment.

B. Touch-up and restore damaged surfaces to factory finish.

3.05 TRAINING

A. Provide training sessions for owner's representatives for Two (2) normal workday and Four (4) working hours each day, at the job-site location. If training is conducted in less than the time required by these Specifications, the remaining time shall be utilized at the discretion of the OWNER.

B. The training session shall be conducted by the UPS manufacturer's non-sales-type technical representative.

C. At minimum, the training session shall include:

1. Operation and maintenance procedure for the equipment and all components installed within the UPS.

2. Factory contact persons phone numbers, persons names, ordering procedures and procedures to follow to obtain meaningful results from the factory.

3.06 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this Section. All costs are included in the Base Bid.

END OF SECTION

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PART 1 - GENERAL

1.01 SUMMARY

A. Furnish and install all necessary wiring devices at the locations indicated on the PLANS and as specified herein.

1.02 RELATED REQUIREMENTS

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.

C. Related work as called for on the PLANS, as specified herein or in other Sections of the Specifications.

1.03 SUBMITTALS

A. Submit shop drawings in accordance with Section 01300 of the Contract Specifications. Include manufacturer's catalog data/notification certifying Aluminum Device Boxes, as specified hereinafter, to be 99.0% copper-free.

B. Submit Operations and Maintenance Manuals (O&M) in accordance with Section 01730 of the Contract Specifications. O&M Manuals shall include copies of the approved shop drawings, factory and on-site/field test data.

PART 2 - PRODUCTS

2.01 LIGHT SWITCHES

A. Installed indoors inside the environmentally and climate controlled ELECTRICAL ROOMS:

1. Specification grade, 20 amp, 120/277 volts
2. Provide the number of poles as required by the PLANS.
3. Provide maintained action type operation, unless momentary action is specifically required by the PLANS.
4. Ivory color switch handle operator.
5. Manufacturer: Pass and Seymour No. PS20AC, or approved equal.

B. Installed indoors inside STORAGE ROOMS and PROCESS MECHANICAL EQUIPMENT ROOMS and installed in ALL OUTDOOR AREAS:

1. Specification grade, 20 amp, 120/277 volts
2. Provide the number of poles as required by the PLANS.
3. Provide maintained action type operation, unless momentary action is specifically required by the PLANS.
4. Factory-sealed where each switch is enclosed in a unique sealing well with double flanges that mate with the light switch cover and box assembly.
5. Raintight, corrosion resistant and rated for use in wet locations and in Class I Division 2 hazardous areas (as classified by NEC).
6. Manufacturer: Cooper Crouse-Hinds, Killark, or approved equal.

C. Box: Provide as hereinafter specified.

2.02 120 VOLTS AC, COVENIENCE RECEPTACLES

A. Installed indoors inside the environmentally and climate controlled ELECTRICAL ROOMS:

1. Receptacle
   a. Specification grade
   b. Duplex, 3-wire, polarized grounding type, rated 20 amp, 125 volt, 60 Hertz
   c. Ivory color
   d. Manufacturer: Hubbell No. HBL5362I, Bryant**,** Pass and Seymour, or approved equal.
2. Ground Fault Interrupter Receptacle:
   a. Provide where G.F.I receptacles are indicated on the PLANS
   b. Specification grade, weather-resistant type,
   c. Duplex, 3-wire, polarized grounding type, rated 20 amp, 125 volt, 60 Hertz.
   d. Red indicator light
   e. Test and Reset pushbutton
   f. Ivory color.
   g. Manufacturer: Pass & Seymour Cat. No. 2095TRWR, or approved equal.
3. Box: Provide as hereinafter specified.

B. Installed indoors inside STORAGE ROOMS and PROCESS MECHANICAL EQUIPMENT ROOMS and installed in ALL OUTDOOR AREAS:

1. Specification grade
2. 2-wire, 3-pole, rated 20 amp, 120 volt,
3. Twist-lock, factory-sealed, pin and sleeve
4. Internal horsepower and AIC-rated switch that shall activate only after the Plug is inserted into the receptacle and twisted.
5. Dead-front, mechanically interlocked where plug cannot be engaged or disengaged under load.
6. Brass receptacle blades/contacts
7. Watertight, raintight and corrosion resistant and rated for use in Class I Division 2 hazardous areas.
8. Fully gasketed, watertight, dustight and corrosion resistant twist-on cover.
9. Type 12 nylon enclosure with 316 stainless steel hardware
10. Manufacturer: Cooper Crouse-Hinds Series IEC-309 Hazardous Area Receptacles/Plugs and Interlocks, Factory-Sealed, TYPE GHG Pin and Sleeve receptacles complete with device boxes and specified accessories.
11. Furnish and install a total count of Two (2) Sets of completely assembled matching CORD and PLUG assembly for the Pin and Sleeve Receptacles. The cord and plug assembly (of each set) shall consist of:
    a. Matching Male Plug manufactured by Cooper Crouse-Hinds Series IEC-309 Hazardous Area Plugs and Interlocks, Factory-Sealed, TYPE GHG Pin and Sleeve Twist-On plug
    b. 25-feet of #12AWG, 3-conductor extra-flexible Type SO-CORD power cord (each conductor shall be 100%-conductive-soft-copper conductors with 41-strands).
    c. NEMA 5-20R Female Connector, 20-amp, 125 volt rated having tin-plated-copper spade-connectors.

2.03 DEVICE ENCLOSURES AND COVERPLATES

A. Installed indoors inside the environmentally and climate controlled ELECTRICAL ROOMS:

1. Enclosures for exposed surface mounted devices:
    a. Sand Cast Aluminum, 99.0% copper-free, one piece construction, suitable for surface mounting
    b. Single and Multi-Gang Weatherproof Outlet boxes, as required.
    c. 3/4-inch threaded hubs, minimum box depth shall be 2-5/8". Use 2-3/4" depth when "gang" arrangements of outlets are used.

d. Manufacturer: Crouse-Hinds Series FS or FD, Appleton, or approved equal.

2. Coverplates:
   a. Switches: Die Cast Aluminum, 99.0% copper-free, gasketed coverplate with external operating handle for on-off operation (with hole for lock), as manufactured by Crouse-Hinds or approved equal.
   b. Receptacles: Die Cast Aluminum 99.0% copper-free, complete with rubber gasket, as manufactured by Crouse-Hinds WLRS (single cover), WLRD (duplex cover), WLGF-FS and WLGF-FSV (GFCI cover) or approved equal.

B. Installed indoors inside STORAGE ROOMS and PROCESS MECHANICAL EQUIPMENT ROOMS and installed in ALL OUTDOOR AREAS:

1. Enclosures:
   a. Sand Cast Aluminum, 99.0% copper-free, one piece construction, suitable for surface mounting
   b. Single and Multi-Gang Weatherproof Outlet boxes, as required.
   c. 3/4-inch threaded hubs, minimum box depth shall be 2-5/8". Use 2-3/4" depth when "gang" arrangements of outlets are used.
   d. Manufacturer: Crouse-Hinds Series FS or FD, Appleton, or approved equal.

2. Coverplates:
   a. Switches: Die Cast Aluminum, 99.0% copper-free, watertight and corrosion resistant and having an external front operator (for snap switches). In a group installation, provide manufacturer's assemblies for two gang tandem, three, four and/or five gang bodies (device boxes). Light switch covers shall be as manufactured by Crouse-Hinds, Killark, or approved equal.
   b. Receptacles: See Part 2.02 B this Section of the Specifications.

2.04 MISCELLANEOUS

A. All mounting hardware shall be Type 316-stainless steel.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Mounting: Device enclosures shall be surface mounted on conduit support channels per Section 16150 and as shown on the PLANS.

B. Mounting heights shall be as follows unless otherwise noted on the PLANS:

1. Light switches: 48 inches above finished floor to center of switch
2. Receptacles: 36 inches above finished floor to center of receptacle.

C. Tagging:

1. Tag all receptacles and switches
2. Tagging format: "ckt. LPY-XX" where Y represents the panel number (e.g. for panel "LP-01", Y is 1) and XX represents the circuit number. Add voltage if other than 120V.
3. Tag type:
   a. Type: 3-ply, 1/8" thick, rigid thermoset phenolic resin laminated cellulose paper base engraving stock per ASTM D-709, Type I. Nameplates shall be ASTM Grade ES-1, ES-2, or ES-3 as applicable for the face and lettering colors specified hereinafter. Flexible or acrylic tags will be not be accepted.
   b. Color: White-Black-White.
   c. Lettering: Engraved through the face layer to the melamine middle layer.
   d. Accessories: adhesive backplane.

D. Provide 6-inches offset for receptacles or other wiring devices mounted on opposite sides of a wall.

E. Do not use switch boxes as junction boxes for switch and receptacle.

F. Set box square and true with building surfaces.

G. Maintain symmetry of all devices as closely as possible within the Architectural Section contained. For example, center a light fixture over a doorway, or a receptacle in a section of wall, if shown in that approximate position.

H. Verify location of receptacles and switches in finished rooms. In centering devices and locating device boxes, allow for overhead pipes, and mechanical equipment; etc., and correct any inaccuracy from failure to do so without extra expense to the OWNER.

I. Cap all device boxes not used under this Contract with blank outlet covers.

3.02 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this Section. All costs are included in the Base Bid.

END OF SECTION

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PART 1 - GENERAL

1.01 SUMMARY

A. Furnish and install lighting fixtures, outdoor lighting photocells, electrical lighting contactors and flashing light beacons or rotating beacons as specified herein and as indicated on the PLANS.

B. Refer to the lighting fixture schedule shown on the PLANS for a listing of proposed lighting fixtures and other requirements. The lighting fixture schedule shown on the PLANS is not inclusive of all equipment required by this Contract. Refer to Part 2 of this section for additional requirements.

1.02 RELATED REQUIREMENTS

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.

C. The PLANS designate the number of lighting fixtures and other requirements for the proposed equipment specified under this Section.

D. Related work as called for on the PLANS, as specified herein or in other Sections of the Specifications.

1.03 SUBMITTALS

A. Submit shop drawings in accordance with Section 01300 of the Contract Specifications. Submit a lighting fixture brochure for each fixture indicating catalog number, pertinent physical characteristics, and complete photometric data.

B. Submit Operations and Maintenance Manuals (O&M) in accordance with Section 01730 of the Contract Specifications. O&M Manuals shall include copies of the approved shop drawings, factory and on-site/field test data.

1.04 SPARE PARTS

A. Provide quantities of spare parts as follows:

1. Spare LED lamp modules: Five percent spare LED lamp modules for each fixture type specified, with minimum of 3 lamp modules of each type.

2. Spare Drivers: Five percent spare drivers for each fixture type specified, with minimum of 6 drivers of each type.

3. Spare Ballasts: Five percent spare ballasts for each fixture type specified, with minimum of 6 ballasts of each type.

PART 2 - PRODUCTS

2.01 GENERAL

A. General:

1. Furnish and install fixtures in accordance with the requirements of this specification and the requirements of the PLANS. Fixtures shall bear the U.L. label and such labels shall apply to entire fixture as installed.

2. Deliver lamps to job site in original cartons. Lamps shall be as manufactured by General Electric, Sylvania, or approved equal.

2.02 LIGHT FIXTURES

A. General: Multiple types of light fixtures are required for this project and as described hereinafter. Refer to the PLANS for application of the specific light fixture types.

2.03 ACCESSORIES

A. Deliver all fixtures complete with suspension chains, accessories, canopies, hickeys, casings, sockets, holders, reflectors, ballast, diffusers, frames, recessing boxes, etc.

2.04 PROTECTION

A. Protect all fixtures, lenses and louvers from damage. Leave protective coverings on lenses and louvers until fixtures are installed. Replace all damaged lenses and louvers immediately prior to final inspection at no cost to the OWNER.

2.05 SUBSTITUTIONS

A. Comply with requirements of the Contract Specifications.

2.06 LIGHTING CONTACTOR

A. Furnish and install totally enclosed Lighting Contactors and associated controls, as specified hereinafter and as shown on the PLANS.

B. General:

1. Number of Poles and Configuration: Four (4) pole single throw
2. Contactor Type: Electrically held
3. Contacts Configuration: Normally Open (N.O.) contacts.
4. Minimum continuous current rating of the contacts: 60 amperes at 208 volts AC, unless otherwise shown to be greater on the PLANS.
5. Contact Application: Suitable to drive Ballast Tungsten and Inductive Loads
6. Certifications: U.L. listed
7. Symmetrical Short Circuit Rating: Minimum of 10,000 ampere at 208 volts A.C. unless shown to be greater on the PLANS.
8. Control Coil Voltage: 120 volts A.C..
9. Accessories:
   a. Two wire control relay per manufacturer's standard product to facilitate the control logic as shown on the PLANS.
   b. Vibration isolators
   c. Hand-Off-Auto selector switch. Selector switch shall be 30-millimeter, rated NEMA-4X corrosion resistant oil-tight industrial grade with minimum contact rating of 10-amperes at 120 volts AC. Miniature size selector switches will not be accepted. Mount to face of contactor enclosure and wire as shown on the PLANS.

C. Enclosure: NEMA-4X Type 316 Stainless Steel gasketed cabinet enclosure.

D. Manufacturer: "General Electric Company "G.E." Series CR360L with specified accessories, or approved equal.

2.07 PHOTOCELL FOR OUTDOOR AND PERIMETER LIGHTING CONTROL

A. Style: 180 swivel type furnished with 3/4" conduit nipple.

B. Enclosure: Metallic gray polycarbonate (e.g., all lexan).

C. Control: Light level selector for "ON/OFF" adjustment, and minimum of two (2) minutes built-in delay to prevent false switching caused by light from vehicles, lighting etc.

D. Operating Voltage: 120VAC and/or 208VAC as shown on the PLANS, dry contact output.

E. Accessories: NEMA-4X stainless steel gasketed outlet box coverplate complete with 3/4" threaded opening.

F. Manufacturer: TORK Catalog No. 2001 (120VAC) and/or Catalog No. 2002 (208VAC), or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION AND TESTING

A. Maintain perfect horizontal and vertical alignment of fixtures throughout.

B. Do not locate circuiting splices or taps within an arm, stem or chain.

C. Replace any damaged fixture or lens at no cost to the OWNER.

D. Support all pendant fixtures with swivel type hangers.

E. Install recessed luminaries to permit removal from below, to gain access to outlet or prewired fixture box.

F. Locate fixtures where shown on the PLANS and coordinate fixture location such to avoid interference with piping, fans, ducts, and other obstructions. Obtain approval of any location differing from the location shown on the PLANS.

G. Furnish and install outlet box for photocell mounting as specified in Section 16300 "Wiring Devices". Orient and make wiring connections to photocell per photocell manufacturer's recommendations.

H. Lighting fixtures shall not be used as raceways for conductors that do not supply the connected fixtures.

3.02 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this Section. All costs are included in the Base Bid.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. Furnish and install dry type transformers as specified herein and as shown on the PLANS.

1.02 RELATED REQUIREMENTS

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.

C. The PLANS designate the number, size and rating of transformers required.

D. Related work as called for on the PLANS, as specified herein or in other Sections of the Specifications.

1.03 SUBMITTALS

A. Submit shop drawings in accordance with Section 01300 of the Specifications. For each individual Transformer include:

1. Dimensioned/scaled plan view and elevation
2. Ratings, product data sheets, including weight and nameplate data
3. Wiring connection diagram

B. Submit Operations and Maintenance Manuals (O&M) in accordance with Section 01730 of the Specifications. Include:

1. Copies of the approved shop drawings
2. Factory and on-site/field test data.

1.04 DELIVERY, STORAGE AND HANDLING

A. Deliver, receive, unload and handle equipment by suitable methods. Inspect for damage before accepting shipment. Wrap in protective plastic wrapping and store in climate controlled (temperature and humidity, etc.) environment. Use heat lamps as necessary to prevent condensation.

1.05 ACCEPTABLE MANUFACTURER

A. General Use (Power & Lighting) Dry-Type Ventilated Isolation Transformers shall be Watchdog Premium Quality units manufactured by Square D (Schneider Electric) class 7400, or approved equal

PART 2 - PRODUCT

2.01 GENERAL AND BASIC REQUIREMENTS FOR ALL 600 VOLT AND BELOW DRY TYPE TRANSFORMERS

A. Type:

1. Manufacturer's premium quality dry type transformers.
2. Primary and secondary voltage ratings, and, KVA ratings to be as shown on the PLANS.
3. All windings shall be copper.
4. Transformers shall be of ventilated type.

B. Core and coils:

1. Continuous wound core impregnated with non-hygroscopic, thermosetting varnish.
2. Core to be of high grade, non-aging silicon steel with high magnetic permeability.
3. Core and coil bolted to base of enclosure but isolated from it by rubber vibration absorbing mounts.

C. Additional Requirements:

1. Furnish with four (4) 2-1/2 percent full capacity primary taps, two (2) above and two (2) below rated primary voltage.
2. Core is to be visibly grounded to enclosure by means of a flexible grounding conductor sized per NEMA, IEEE and ANSI standards.
3. All transformers shall be U.L. listed and certified and carry the U.L. label.

4. Sound levels: Guaranteed not to exceed the following:

Transformer KVA Range	Sound Level
15 to 50KVA	45dB
51 to 150KVA	50dB
151 to 300KVA	55dB

2.02 GENERAL USE (POWER & LIGHTING) VENTILATED DRY TYPE ISOLATION TRANSFORMERS

A. General:

1. Transformers shall be suitable for indoor installation. Comply with all requirements/specifications outlined in subsection 2.01, above (Basic and General Requirements for All 600 volt and Below Dry Type Transformers).

2. Transformers shall meet NEMA TP-1 efficiency requirements.

B. Temperature Rise and Insulation System:

1. Temperature Rise: 80 degrees Celsius above a 40 degree Celsius ambient.

2. All insulating materials shall be in accordance with NEMA ST20 standards for a 220 degree Celsius. U.L. component recognized insulation system.

C. Enclosure: Heavy gauge sheet steel with ventilation openings designed in accordance with U.L., NEMA and the N.E.C. Phosphatized, primed and finished with ANSI#61 gray baked enamel. Provide surface/wall mounting brackets where surface/wall mounting is shown on the PLANS.

2.03 NAMEPLATES

A. General:

1. Type: 3-ply, 1/8” thick, rigid thermoset phenolic resin laminated cellulose paper base engraving stock per ASTM D-709, Type I. Nameplates shall be ASTM Grade ES-1, ES-2, or ES-3 as applicable for the face and lettering colors specified hereinafter. Flexible or acrylic tags will be not be accepted.

2. Color: White-Black-White

3. Lettering: 3/8 inch height, minimum, engraved through the face layer to the melamine middle layer.

4. Accessories: Provide holes for mechanical fastening.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install at the locations shown on the PLANS in accordance with manufacturer's recommendations. Furnish and install equipment pads as shown on the PLANS for floor mounted transformers and surface/wall mounted brackets for surface/wall mounted transformers as required.

B. Make grounding connections as required by the N.E.C. and as shown on the PLANS.

C. Tagging:

1. Tag each transformer with the name as it appears on the PLANS using the specified nameplates attached with stainless steel screws. Include the following additional information: name of the load served by the transformer, primary voltage rating, secondary voltage ratings, KVA rating, phase, wire, primary and secondary winding configuration, and transformer type.

3.02 TESTS AND INSPECTIONS

A. All test results (including factory test) shall be certified.

3.03 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this Section. All costs are included in the Base Bid.

END OF SECTION

PART 1 - GENERAL

1.01 SCOPE

A. Furnish and install two (2) Unit Substation Dry-Type Transformers at Substation No. 4 for primary voltage step-down from 12470 volts to 4160 volts. The Substation No. 4 unit substation transformers are identified on the PLANS as SUB4-XFMR-03 and SUB4 - XFMR-04 and shall hereinafter be referred to as the "SUB4USUB-1". Provide the SUB4USUB-1 complete from the incoming line terminals to the outgoing line terminals as specified herein. Also refer to the PLANS.

B. Furnish and install two (2) Unit Substation Dry-Type Transformers at Substation No. 4 for primary voltage step-down from 12470 volts to 480 volts. The Substation No. 4 unit substation transformers are identified on the PLANS as SUB4-XFMR-01 and SUB4 - XFMR-02 and shall hereinafter be referred to as the "SUB4USUB-2". Provide the SUB4USUB-2 complete from the incoming line terminals to the outgoing line terminals as specified herein. Also refer to the PLANS.

C. Furnish and install one (1) Unit Substation Dry-Type Transformer at the Powder Activated Carbon building for primary voltage step-down from 12470 volts to 480 volts. The Powder Activated Carbon unit substation transformer is identified on the PLANS as PAC-XFMR-01 and shall hereinafter be referred to as the "PACUSUB". Provide the PACUSUB complete from the incoming line terminals to the outgoing line terminals as specified herein. Also refer to the PLANS.

D. Furnish and install two (2) Unit Substation Dry-Type Transformers at the Low Service Pump Station for primary voltage step-down from 12470 volts to 480/277 volts. The Low Service Pump Station unit substation transformers are identified on the PLANS as LSPS-XFMR-01 and LSPS-XFMR-02 and shall hereinafter be referred to as the "LSPSUSUB". Provide the LSPSUSUB complete from the incoming line terminals to the outgoing line terminals as specified herein. Also refer to the PLANS.

1. The low voltage secondary of each LSPSUSUB shall be close coupled with a 480-volt outdoor switchboard as specified in Section 16140 "Switchboards" and as shown on the PLANS. Refer to Section 16140 "Switchboards" of the Specifications.

E. Each transformer shall be the manufacturer's premium quality, encapsulated and sealed Unit Substation Dry-Type Transformer mounted in a suitable outdoor enclosure with side-wall mounted primary and secondary terminations.

F. This specification covers the electrical characteristics and mechanical features of three-phase, 60 Hertz, delta-wye connected, Dry-type transformers, rated 500 KVA through 12,000 KVA @ 80° C temperature rise above ambient.

G. Comply with the requirements of the Contract Documents.

1.02 RELATED REQUIREMENTS

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.

C. The PLANS designate the size, rating, and other requirements of the Unit Substation Dry Type Transformers.

D. Related work as called for on the PLANS, as specified herein or in other Sections of the Specifications.

1.03 QUALITY ASSURANCE

A. Equipment is to be designed, built and tested in accordance with the latest revisions of all applicable standards of NEMA, IEEE, ANSI and U.L.

B. In addition to the tests required by the standards, each unit is to be given a standard production line impulse test.

C. Comply with the requirements of NEMA, OSHA, NEC and all building codes. Design, construct, assemble and test in accordance with AISC, AISI, ASTM, NEMA, IEEE, U.L. and ANSI standards

D. Standardization: All like equipment to be the product of one manufacturer.

E. Testing: Shop test transformers in accordance with ANSI test code for transformers, including:

1. Ratio test for winding and taps.
2. No load loss, load losses, efficiency, regulation, impedance, resistance, and reactance.
3. Impulse and induced potential test.
4. Furnish certified copies of the test results for comment prior to shipment. Format and number of copies shall be in accordance with the requirements of Section 01300 and Section 01730 of the Contract Specifications.

1.04 ACCEPTABLE MANUFACTURERS

A. All Unit Substation Dry-Type Transformers on the project shall be manufactured by a single Transformer manufacturer. The manufacturer of the Unit Substation Dry-Type Transformers shall also manufacture the major transformer components within the transformers.

B. Furnish manufacturer's premium quality units constructed to withstand adverse environments. Units shall be as manufactured by Square D, Hammond Power Solutions, Inc., or approved equal.

1.05 MANUFACTURER'S SERVICE

A. Technical Services: Furnish services of a technical representative of the manufacturer to inspect the equipment after installation and to supervise initial operation. Include time to correct any defects.

B. Report: Furnish a written report certifying that the equipment was checked and found to be installed in accordance with manufacturer's recommendation and operated properly. Format and quantity of the reports shall be per the requirements of Section 01300 of the Contract Specifications.

C. In addition to the requirements of this Subsection, fuses shall also be furnished by the manufacturer based on the results of the short circuit and coordination study. Additionally, the Manufacturer will select a variety of protective devices having the characteristics that are most suitable for the system in providing proper protection and coordination. The selection of the fuse will be based on coordination and short circuit studies performed in compliance with Section 16044 of the Specifications, paragraph 1.09 "Special Manufacturer's Services". The final selection will be based on the manufacturer's submittal of a variety of fuse curves for the OWNER to select from. The Manufacturer shall furnish the protective device of the appropriate characteristics selected by the OWNER that shall be the most suitable for the proper protection and coordination of the system at No Additional Cost to the OWNER. Provide the OWNER with test report certified by the manufacturer. Include a record of all settings. Format and quantity of reports shall be per the requirements of Section 01300 and Section 01730 of the Specifications.

D. Any problems encountered with the operation of equipment, parts, components, etc. installed shall be repaired/remedied by the manufacturer's technical representative.

1.06 SUBMITTALS

A. Shop Drawings and Product Data: Submit complete shop drawings and engineering data for review and comment in accordance with this Section and the contract documents. Include the following:

1. Dimensional drawings including plan view and elevations.
2. Bill of materials.
3. Transformer nameplate data, weight, and product data.
4. Wiring diagrams.

B. Factory certification report: Submit a manufacturer's certified test reports on each transformer covering exciting current, no load, full load losses and impedance, and noise level test data (dB: decibels). Typical data from other previously tested transformers will

not be accepted. The factory certification report shall be submitted to, and accepted by the Owner prior to shipment of the transformers to the project site. Format and quantity of reports shall be per the requirements of Section 01300 of the Contract Specifications.

C. Operation and Maintenance Manuals: Submit Operation and Maintenance Manuals in accordance with this section and Section 01730 of the Contract Specifications. Include approved shop drawings.

1.07 RECEIVING AND STORING

A. Unload and handle equipment by suitable methods that are recommended and approved by the manufacturer of the equipment.

B. Carefully inspect the unit upon its arrival to the job site. Note any deficiencies observed.

C. Protect unit with plastic covering and use heat lamps (or appropriate heaters as recommended by the manufacturer) to prevent condensation.

D. Examine unit for indication of moisture. Take appropriate measures to dry out transformer if moisture is found.

PART 2 - PRODUCTS

2.01 RATINGS

A. The SUB4USUB-1, the SUB4USUB-2, the PACUSUB and the LSPSUSUB shall conform to the ratings provided in the following table:

Rating Category	**SUB4USUB-1**	**SUB4USUB-2**
Frequency	60 Hertz	60 Hertz
KVA	As indicated on the plans	As indicated on the plans
Impedance	7.5%	5.5%
Primary Voltage	12470 volts, delta connected	12470 volts, delta connected
Secondary Voltage	4160 volts, grounded wye connected	480/277 volts, grounded wye connected
Primary BIL	95 kV; Insulation class: 15 kV	60 kV; Insulation class: 15 kV
Secondary BIL	60 kV; Insulation class: 5 kV	30 kV; Insulation class: 1.2 kV
Maximum Sound Level	71 dB (including forced air fan cooling system)	66 dB (including forced air fan cooling system)
Rating Category	**PACUSUB**	**LSPSUSUB**
Frequency	60 Hertz	60 Hertz
KVA	As indicated on the plans	As indicated on the plans
Impedance	5.5%	5.5%
Primary Voltage	12470 volts, delta connected	12470 volts, delta connected

Secondary Voltage	480/277 volts, grounded wye connected	480/277 volts, grounded wye connected
Primary BIL	60 kV; Insulation class: 15 kV	60 kV; Insulation class: 15 kV
Secondary BIL	30 kV; Insulation class: 1.2 kV	30 kV; Insulation class: 1.2 kV
Maximum Sound Level	66 dB (including forced air fan cooling system)	66 dB (including forced air fan cooling system)

2.02 HIGH VOLTAGE TAPS

A. The transformer shall have two (2) 2-1/2% taps above and two (2) 2-1/2% taps below the rated voltage.

2.03 RATED VOLTAGE.TEMPERATURE RISE

A. Transformers shall have a maximum temperature rise of 80°C above a 40°C maximum ambient

2.04 TESTING

A. Transformers shall be manufactured and tested in accordance with IEEE standards C57.12.01, C57.12.91, C57.12.50, and C57.12.51.

2.05 CONSTRUCTION

A. General:

1. The transformer(s) shall be combination self-cooled and fan-cooled (when called for by a built-in thermostat). Transformer shall be suitable for mounting on a pad and shall comply with the latest applicable standards. Transformers shall be equipped with forced-air cooling system (electric operated fans). Fan motor and fan controls shall operate off the secondary voltage of the transformers which shall be located inside the transformer housing. The forced air cooling shall be regulated automatically by sensors placed in the low voltage air ducts. As minimum, the forced cooling shall include:
   a. Thermal sensors
   b. Electric operated fans
   c. Control wiring, terminals, etc.
   d. Temperature controller with test switch
   e. Current limiting fuses
   f. Indicating lights
   g. Visual and audible alarm
   h. Alarm Silencing relay and pushbutton operated control switches
   i. Automatic fan exerciser functionality

j. Additional requirements as shown on the PLANS.

B. Core and Coil Construction:

1. The transformers coils shall be designed to maintain their nameplate KVA rating throughout the temperature range.

2. Transformer coils shall be cast coil construction where the entirety of the primary and secondary coils are entirely immersed and fully sealed within epoxy resin material under vacuum in a mold.

   a. High and low voltage windings shall each be separately cast as one rigid tubular coil, and arranged coaxially. Each cast coil shall use a mineral-filled epoxy reinforced with fiberglass mat, and cast to provide complete, void-free resin impregnation throughout the entire insulation system. The coil supports shall maintain constant pressure during thermal expansion and contraction of the coils. There shall be no rigid mechanical connection between high and low voltage coils.

   b. The coils are to be cast in epoxy in a mold, using a computer-controlled mixing and casting process that ensures the absence of voids. The epoxy used in the casting process shall be mineral-filled epoxy that is Underwriters Laboratories (UL) approved. The mineral filling shall enhance the pure epoxy to increase its thermal conductivity, mechanical strength, arc resistance, and adhesion to the conductor, and change its coefficient of thermal expansion to be close to that of the conductor material.

   c. The windings shall be fiberglass reinforced to provide additional mechanical strength.

   d. Each winding shall be partial-discharged tested using induced voltage to ensure that it is void-free. The transformer windings must be free of partial discharge up to at least 1.2 times the rated line-to-ground voltage. All coils shall be subjected to a partial discharge test to verify its partial discharge.

3. The windings must not absorb moisture and shall be suitable for both storage and operation in adverse environments, including indefinite storage in 100% humidity at temperatures from -30 °C to + 50 °C and shall be capable of immediately being switched on after storage without pre-drying.

4. All cores shall be constructed of high grade, grain oriented, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Core laminations shall be miter cut at the core corners. The laminations shall be clamped together utilizing insulated bolts through the core laminations. The core shall be manufactured to ensure optimum performance and minimal sound levels. Magnetic flux densities shall be kept well below the saturation point.

5. Provision shall be made to completely isolate the core and coil from the enclosure. There shall be no metal-to-metal contact. Rubber vibration isolation pads shall be installed by the manufacturer between the core and coil and the

enclosure base. The core shall be visibly grounded to the ground bus or ground pad by means of a flexible grounding conductor sized in accordance with applicable NEC standards.

C. Core and Coil Assembly:

1. The core and coil, after assembly, shall be mounted in a rigid steel frame, constructed in such a way as to hold the coil in a rigid position within the core window. No wood other than the processed hardwood maple shall be used in core-coil assembly and then only in proper ratio with other materials.

2.06 ENCLOSURE

A. Dry-type transformers shall be mounted in a heavy gauge Type 316 Stainless Steel enclosure. The enclosure shall have ventilated openings to provide for the circulation of external air through the enclosure. All ventilating openings shall be in accordance with NEMA and National Electrical Code (N.E.C.) Standards for ventilated enclosures. Provide enclosure with special ventilating grills that restrict the passage of rain and prevent the entrance of rodents. The enclosure shall be of NEMA Type 3R construction rated for Outdoor use.

B. The enclosure base shall be provided with lifting devices and jacking pads designed to be flush with the enclosure.

C. Access to the transformer section shall be through removable panels.

D. Transformer finish shall be manufacturer's standard.

E. Transformer shall be front accessible.

F. The LSPSUSUB, enclosure shall have provisions for close coupled coordination to other power distribution equipment as specified in Section 16140 "Switchboards" and as shown on the PLANS. Refer to Section 16140 "Switchboards" of the Specifications.

2.07 SUB4USUB-1, SUB4USUB-2 AND PACUSUB HIGH AND LOW VOLTAGE TERMINALS:

A. The bushings and terminals shall be located in accordance with ANSI C57.12.26.

B. The transformer shall be provided with externally clamped, porcelain bushings. High voltage bushings shall be provided with a two-hole spade connector. Low voltage bushings shall coordinate with the field wiring termination requirements as shown on the PLANS.

C. The transformer shall be equipped with high voltage air terminal compartment and a low voltage air terminal compartment. The compartments shall have the full height and depth of the transformer enclosure and be a part of the entire transformer assembly. Low

voltage terminal compartment depth shall be no less than 30 inches. Coordinate with the requirements of the PLANS.

D. The low voltage neutral bushing shall be an insulated bushing with a removable external ground connection factory bonded to the grounding wire inside the secondary low voltage air terminal compartment. The ground strap shall be adequate to carry the fault current based on the rating of the transformer.

E. Furnish multi-ratio current transformers (C.T.'s) for differential relaying on the low voltage bushings. Install a multi-ratio current transformer per phase. Connect the secondary wiring of the C.T.'s to a shorting terminal block (one per phase). Mount shorting terminal blocks in a NEMA-4X watertight and corrosion resistant metal cabinet. Cabinet shall be furnished with hinged and lockable door, attach cabinet to the frame of the main power transformer.

F. SUB4USUB-1, SUB4USUB-2 and PACUSUB high and low voltage terminals shall be located as follows:

Transformer Name (as Shown on the PLANS)	Terminal Location (When Facing the Transformer Front)	
	High Voltage	Low Voltage
SUB4-XFMR-01	Right	Left
SUB4-XFMR-02	Right	Left
SUB4-XFMR-03	Left	Right
SUB4-XFMR-04	Left	Right
PAC-XFMR-01	Left	Right

2.08 LSPSUSUB HIGH AND LOW VOLTAGE TERMINALS:

A. The bushings and terminals shall be located in accordance with ANSI C57.12.26.

B. The transformer shall be provided with three high voltage porcelain bushings. Bushings shall be provided with a two-hole spade connector.

C. The transformer shall be equipped with high voltage air terminal compartment. The compartment shall have the full height and depth of the transformer enclosure and be a part of the entire transformer assembly. Coordinate with the requirements of the PLANS.

D. The transformer shall be equipped with an integral secondary transition section which will allow a close couple connection to the secondary switchboard. The connection to the secondary low voltage switchboard shall be made utilizing tin-plated extra flexible soft

and braided copper connectors which shall meet the same technical specifications as the main bus bars of the switchboard. Also refer to Specification Section 16140 "Switchboards".

E. Furnish multi-ratio current transformers (C.T.'s) for differential relaying in the secondary transition section. Install a multi-ratio current transformer per phase. Connect the secondary wiring of the C.T.'s to a shorting terminal block (one per phase). Mount shorting terminal blocks in a NEMA-4X watertight and corrosion resistant metal cabinet. Cabinet shall be furnished with hinged and lockable door, attach cabinet to the frame of the main power transformer.

F. LSPSUSUB high and low voltage terminals shall be located as follows:

Transformer Name (as Shown on the PLANS)	Terminal Location (When Facing the Transformer Front)	
	High Voltage	Low Voltage
LSPS-XFMR-01	Left	Right
LSPS-XFMR-02	Right	Left

2.09 NAMEPLATE

A. The instruction nameplate shall be located at convenient spot on the inside of the low voltage cable termination area (within the transformer) and shall be readable with cables in place. An additional nameplate shall be located on the exterior of the low voltage cable termination section (located on face of the transformer enclosure panels).

B. The nameplate shall be made of a corrosion resistant material.

C. Install a phenolic nameplate on the exterior of the high voltage Section (cable termination area). The nameplate shall have 2" high, white letters on black face, fastened to the doors by stainless steel screws. The nameplate shall indicate the name as shown on the PLANS.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Construct a concrete pad for each unit, as detailed on the PLANS, at the locations indicated. Follow manufacturer's instructions and approved practice for installation of the transformer.

B. Level and mount with leveling and anchoring bolts as recommended by the manufacturer.

C. Coordinate construction of the "LSPSUSUB" transformers with construction of the 480 Volt "LSPSSWBD-1" switchboards specified in Section 16140 "Switchboards" for close coupling of the transformer secondary to the switchboard bus and enclosure.

3.02 TESTING AND PLACING IN SERVICE

A. Energize the transformers and place them into service with representative of Austin Water witnessing the same. Coordinate start-up with other phases of construction.

B. Before placing into service, megger test primary and secondary windings per the requirements of Section 16800.

C. Before placing into service, ensure transformer is connected for proper operation at the required voltage and on the proper tap.

3.03 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this Section. All costs are included in the Base Bid.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. Furnish and install panelboards and surge protective devices where indicated on the PLANS and as specified herein.

1.02 RELATED REQUIREMENTS

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work

C. The PLANS designate the type, size, ratings, and other requirements of the equipment specified in this Section.

D. Related work as called for on the PLANS, as specified herein or in other Sections of the Specifications.

1.03 SUBMITTALS

A. Submit Shop Drawings in accordance with Section 01300 of the Specifications. For each individual Panelboard include:

1. Panelboard dimensions
2. Ratings
3. Branch circuit breaker schedules
4. Main circuit breakers size
5. Protective device coordination curves and current limiting circuit breaker/fuse peak current let through curves
6. Transformer impedance, where applicable

B. Submit Operations and Maintenance Manuals (O&M) in accordance with Section 01730 of the Specifications. Include:

1. Copies of the approved shop drawings
2. On-site/field test data.

1.04 QUALITY ASSURANCE

A. Panelboards to be U.L. labeled "U.L. 67", "U.L 508" and meeting Fed. Spec. WP-115, Type 1, Class 1, latest revisions. Breakers to meet Fed. Spec. WC-375, latest revision.

1.05 DELIVERY, STORAGE, HANDLING, AND TOOLS

A. Deliver, receive, unload and handle equipment by suitable methods. Store in climate controlled (temperature and humidity, etc.) environment in original packaging, or, in protective plastic wrapping.

B. Provide breaker test set for Solid-State-Trip units for each type used.

1.06 ACCEPTABLE MANUFACTURERS

A. All Panelboards on the project shall be manufactured by a single Panelboard manufacturer.

B. 480 volts A.C., 3-phase, 3-wire Power Distribution Class Panelboards:

1. Bus Capacity Greater Than 250 Amperes: Square D Company Series I-LINE with specified accessories. Approved equal Panelboards manufactured by Eaton Cutler-Hammer or Asea Brown Boveri are acceptable as equals.

2. Bus Capacity 250 Amperes or Less: Square D Company Series NF with specified accessories. Approved equal Panelboards manufactured by Eaton Cutler-Hammer or Asea Brown Boveri are acceptable as equals.

C. 208/120 volts A.C., 3-phase, 4-wire Panelboards:

1. Eaton Cutler-Hammer Corporation Type POW-R-Line 3a with specified accessories. Approved equal Panelboards manufactured by Square-D Company or Asea Brown Boveri are acceptable as equals.

D. 240/120 volts A.C., 1-phase, 3-wire Mini-power Center Transformer/Panelboard:

1. Square D Type Mini-power Zone with specified accessories. Approved equal Panelboards manufactured by Eaton Cutler-Hammer or Asea Brown Boveri are acceptable as equals.

1.07 SPECIAL MANUFACTURER'S SERVICES

A. Prepare an arc-flash study, harmonic study, and a coordination study, complete with short circuit calculations and coordination curves, etc. as required by and in compliance with Section 16044 of the Specifications "5kV and 15kV Metal-Clad Switchgear and Medium Voltage Overhead Bus Ducts", paragraph 1.09 "Special Manufacturer's Services".

B. Manufacturer's technical representative is to set, adjust and test all electronic trip circuit breakers, etc. in the presence of a representative of the Owner. The settings will be based

on coordination and short circuit studies performed per subsection 1.10.A, this Section of the Specifications. Provide the Owner with test report certified by the manufacturer. Include a record of all settings. Format and quantity of reports shall be per the requirements of Section 01300 of the Specifications. The Manufacturer shall furnish the protective device of the appropriate characteristics that shall be the most suitable for the proper protection and coordination of the system at No Additional Cost to the Owner.

PART 2 - PRODUCTS

2.01 GENERAL

A. Bussing Requirements:

1. Main Bus:
   a. All buses shall be tin-plated copper, distributed phase sequence type, and shall extend the full length of the panelboard.
   b. Refer to the PLANS for bus ratings. Ratings to be established by heat rise tests with maximum hot spot temperature on any connector or bus bar not to exceed 50 degrees Celsius rise above an ambient of 40 degrees Celsius.
   c. Circuit numbering to be such that odd numbered circuits are on the left and even numbered on the right facing the front of the panel.

2. Ground Bus:
   a. Each panelboard shall have a tin plated copper ground bus for connecting equipment grounds. Ground bus shall not be connected to the neutral bus.

3. Isolated Ground Bus:
   a. In all 208/120 volts A.C., 3-phase, 4-wire Panelboards served from shielded ultra-isolation transformers, furnish a second tin-plated isolated ground bar in addition to the equipment ground bar. The isolated ground bar shall be electrically isolated from the panelboard cabinet/enclosure by 600 volt isolators. Isolated ground bar shall have the same current rating as the phase-bussing (bus rating) of the panelboard.

B. Circuit Breakers:

1. General:
   a. Circuit breakers to be single pole, two pole or three pole as shown on the PLANS.
   b. All breakers to be quick-make, quick-break thermal magnetic molded case bolt-on type, with inverse time thermal trip and instantaneous time magnetic trip. Multi-pole breakers to be common trip with a single trip handle. Provide overload tripping elements in each pole. A tripped

condition to be indicated by the breaker assuming a neutral position between "ON" and "OFF".

c. Circuit breakers to be equipped with individually insulated, braced and protected connectors. Affix large, permanent, individual circuit numbers to each breaker in a uniform position.

d. Circuit breakers for lighting circuit protection are not to be larger than 20 amperes.

e. Key interlocks shall be provided for circuit breakers where shown on the PLANS.

f. Padlock attachments shall be provided for circuit breakers where shown on the PLANS.

g. Provide lugs as required to facilitate the field wiring termination shown on the PLANS.

2. Circuit breaker interrupting ratings and type to be as follows:

a. Main/Branch Circuit Breakers in Power Distribution Panelboards, Main Circuit Breakers in Lighting/Control Power Panelboards: and Main/Branch Circuit Breakers in Mini-power Centers:

1) Minimum U.L listed Symmetrical Current Interrupting rating (A.I.C. rating) at rated voltage shall be as shown and required by the PLANS.

2) Panelboards shall be provided with high interrupting capacity or current limiter type breakers where necessary to withstand the available short circuit or limit it to a value which the downstream breakers can withstand.

3) Provide current limiting circuit breakers where shown on the PLANS.

4) Provide electronic trip attachment were shown on the PLANS. Trip unit shall be solid state type with field adjustable long time, short time, ground fault and pick up settings.

5) Provide as manufactured by Square D Company Type FC, or approved equal by Asea Brown Boveri, Eaton Cutler-Hammer Corporation.

b. Branch Circuit Breakers in Lighting/Control Power Panelboards:

1) U.L listed Symmetrical Current Interrupting 10,000 A.I.C. symmetrical at rated voltage.

2) Provide as manufactured by Square D Company Type QOB, or approved equal by Asea Brown Boveri, Eaton Cutler-Hammer Corporation.

c. Branch Circuit Breakers in Mini-power Centers:

1) U.L listed Symmetrical Current Interrupting 10,000 A.I.C. symmetrical at rated voltage.

2) Although required otherwise elsewhere, bolt-on type circuit breakers are not required for these assemblies.

3) Provide as manufactured by Square D Company Type QO, or approved equal by Asea Brown Boveri, Eaton Cutler-Hammer Corporation.

C. Miscellaneous Requirements:

1. Integrated Equipment Rating: Each panelboard, as a complete unit, shall have a rating equal to or greater than the integrated equipment rating shown on the PLANS.

2. Provide a minimum of 20 percent spares on all panelboards and/or as shown on panel schedules on the PLANS.

2.02 MINI-POWER CENTER TRANSFORMER

A. General:

1. All windings shall be copper.

2. Transformer shall be totally encapsulated in epoxy resin.

3. Furnish with two (2) 5 percent full capacity primary taps below rated primary voltage.

4. 115 degrees Celsius temperature rise above 40 degrees Celsius ambient.

5. All insulating materials shall be in accordance with NEMA ST20 standards for a 175 degree Celsius U.L. component recognized insulation system.

B. Enclosure: NEMA-4X, Type 316 stainless steel

2.03 CABINET

A. Adhere to the requirements of UL 50.

B. Panelboard assemblies installed indoors:

1. Enclosure: NEMA-12, gasketed

2. Doors:
   a. Provide door-in-door type arrangement.
   b. Provide hinged doors complete with door handles.

3. Finish: Primed and painted using the manufacturer's standard finishing process. Finish shall be applied at the manufacturing plant. Color shall be ANSI #61 Gray finish

C. Panelboard assemblies installed outdoors:

1. Enclosure: NEMA 4X, 316 stainless steel

2. Doors:
   a. Provide door-in-door type arrangement.
   b. Provide hinged doors complete with door handles.

D. A circuit directory in a metal frame with clear plastic covering shall be provided on the inside of the door. A directory card shall be typed to identify the load served by each circuit. Spare breakers shall be noted in pencil, however.

E. The panelboard interior assembly to be dead front with panelboard front removed. Main lugs or main breaker to be barrier on five sides. The end of the bus structure opposite the mains to be barriered.

2.04 NAMEPLATES

A. General:

1. Type: 3-ply, 1/8" thick, rigid thermoset phenolic resin laminated cellulose paper base engraving stock per ASTM D-709, Type I. Nameplates shall be ASTM Grade ES-1, ES-2, or ES-3 as applicable for the face and lettering colors specified hereinafter. Flexible or acrylic tags will be not be accepted.
2. Color: White-Black-White
3. Lettering: 1/2 inch height, minimum, engraved through the face layer to the melamine middle layer.
4. Accessories: Provide holes for mechanical fastening.

2.05 SURGE PROTECTIVE DEVICE

A. Furnish and install Surge Protective Devices (SPD) where required by the PLANS. Each SPD shall have the following features:

1. Number of phases and system configuration (delta, wye grounded) to match and fully protect the bus to which the SPD is connected.
2. SPD shall be tested with the ANSI/IEEE Category C high exposure waveform of 10 kA for 8 x 20 microseconds, at minimum.
3. Visual indication of SPD status
4. Surge counter
5. Provide dry contact failure status output contact. Contact shall be rated for 120 volts A.C. and shall satisfy the requirements of the PLANS.
6. UL 1449
7. 10 year minimum warranty

8. SPD surge current withstand ratings shall be as follows:

Panelboard Voltage	Minimum Current Withstand Rating (Ampere per Phase)	Minimum Current Withstand Rating (Ampere per Mode)
480 volts AC	160kA	80kA
120/208 volts AC	80kA	40kA
120/240 volts AC	80kA	40kA

B. Enclosure:

1. SPD located indoors in environmentally controlled rooms: NEMA 12
2. SPD located outdoors or indoors in non-environmentally controlled rooms: NEMA 4X, Type 316 stainless steel.

C. Manufacturer: Innovative Technologies Model PTX 120, Surge Suppression Inc. or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install panelboards at the locations shown on the PLANS per the manufacturer's instructions and recommendations.

B. Top of all panelboards shall be at no higher than 6 foot 0 inches above the finished floor elevation, unless specifically noted otherwise on the PLANS.

C. Tagging:

1. Tag equipment with the name as it appears on the PLANS using the specified nameplates. Panelboard nameplate shall also include: voltage ratings, phase, wire, ampere rating, AIC and withstand current rating, size and type of the main circuit breaker OR Main Lug Assembly (as applicable).
2. Panelboards shall be provided with typed circuit schedule including circuit number, breaker rating and circuit description.

D. Balance phases as closely as possible and type in directory at the close of the job. Use erasable pencil to indicate "Spares" and "Spaces".

E. For surface mounting, use support channel per the requirements of Section 16150 "Raceways, Fittings and Supports" and per the details shown on the PLANS. For floor mounting, provide equipment pad as shown on the PLANS. Also refer to the details shown on the PLANS.

F. Connect SPD per the requirements of the PLANS and in accordance with the SPD manufacturer's recommendations.

3.02 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this Section. All costs are included in the Base Bid.

END OF SECTION

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Furnish and install the 480 Volt Automatic Transfer Switch (ATS) as specified herein and as shown on the PLANS.

B. Where specifically shown on the PLANS, furnish and install the Automatic Transfer and Bypass Isolation Switch as specified herein and as shown on the PLANS. The Automatic Transfer and Bypass Isolation Switch shall consists of two major elements that are furnished and installed pre-wired, factory interconnected, and mounted inside a single common enclosure as an assembly:

1. The automatic transfer switch (ATS) as specified hereinafter,
2. The bypass-isolation switch, hereinafter specified by Subsection 2.7, this Section of the Specifications

All other requirements of each ATS described hereinafter shall also apply to each Automatic Transfer and Bypass Isolation Switch.

C. Furnish and install one (1) 480 volt Automatic Transfer and Bypass Isolation Switch to serve the 480 volt power distribution panel system at Substation No. 4 at the Ullrich Water Treatment Plant in Austin, Texas. The Automatic Transfer and Bypass Isolation Switch shall be tagged “SUB4-ATS-01” on the PLANS.

D. Furnish and install two (2) 480 volt Automatic Transfer and Bypass Isolation Switches to serve the 480 volt power distribution panel system at the Low Service Pump Station at the Ullrich Water Treatment Plant in Austin, Texas. The Automatic Transfer and Bypass Isolation Switches shall be tagged “LSPS-ATS-01” and “LSPS-ATS-02” on the PLANS.

1. LSPS-ATS-01” and “LSPS-ATS-02 complete with the enclosures, components and accessories specified in this Section of the Specifications shall be furnished to the Section 16140 “Switchboards” manufacturer for installation inside an outdoor switchboard enclosure. Refer to Section 16140 “Switchboards” of the Specifications.

1.02 RELATED WORK NOT INCLUDED

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. It is the CONTRACTOR’s responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR’s Work.

C. The PLANS designate the size, rating, and other requirements of the equipment specified under this Section.

D. Related work as called for on the PLANS, as specified herein or in other Sections of the Specifications.

1.03 QUALIFICATIONS

A. The ATS shall be designed, constructed, and tested in accordance with the latest applicable requirements of NEMA, ANSI, U.L., and NEC standards.

B. All ATS's on the project shall be manufactured by a single ATS manufacturer.

C. The ATS shall be as manufactured by "Automatic Switch Company-ASCO, Model 7000" or Russelectric Inc, No Equal.

1.04 SUBMITTALS

A. Submit Shop Drawings in accordance with Section 01300 of the Specifications. Submittals shall include:

1. Dimensioned/scaled top and bottom views, front elevations, and internal component/device layouts
2. One-line and wiring diagrams,
3. Catalog cut sheets

B. Submit Operations and Maintenance Manuals (O&M) in accordance with Section 01730 of the Specifications. O&M Manuals shall include copies of the approved shop drawings. Also, as minimum the Operations and Maintenance Manuals shall include:

1. Copies of certified and approved shop drawings.
2. Detailed information on each component used, including:
   a. Installation and operation manual.
   b. Renewal parts bulletin.
   c. As built drawings, including approved shop drawings.
   d. Test data.
   e. Detailed transfer switch setting parameters, DIP-switch settings, ranges, options, operating setting and calibrating instructions, etc.

1.05 STORAGE AND HANDLING

A. Protection

1. The CONTRACTOR, and hence the ATS supplier, shall be responsible for safety of the ATS during storage, transporting and handling.

2. The ATS shall be environmentally protected and stored in climate controlled (temperature and humidity, etc.) environment.

3. At all times the ATS shall be housed inside a moisture free, non-porous, extra heavy duty plastic weatherproof housing.

4. Interior and exterior of the ATS shall be kept clean at all times.

5. Size, furnish and install temporary space heaters within the ATS and energize during storage and installation for humidity control.

B. Additional project job site storage requirements: Upon delivery to the project site and prior to final installation, protect and store in accordance with the following:

1. Environmentally protected and stored in climate controlled (temperature and humidity) environment at the job site. Size, furnish and install temporary air conditioners and additional environmental control equipment complete with branch circuiting conduit/wire as required to maintain in a controlled environment at the following conditions:
   a. Ambient Dry Bulb Temperature:
      1) Minimum: 68 degrees Fahrenheit.
      2) Maximum: 85 degrees Fahrenheit.
   b. Ambient Relative Humidity: Maximum: 50%

2. Every effort shall be made to provide all necessary electrical power connections ready for immediate connection to equipment upon arrival of equipment on jobsite.

3. Upon arrival of equipment onto job site, the Contractor shall provide proper transition of power to equipment, especially any 120 VAC powered equipment, to ensure all air conditioning and heating equipment are fully operational and that the equipment is in a conditioned space on the day the equipment arrives.

4. Furnish and install replacement air filters, etc., as required for proper operation of the environmental control equipment.

1.06 SPARE PARTS

A. One (1) quart of touch up paint.

PART 2 - PRODUCT

2.01 AUTOMATIC TRANSFER SWITCHES (ATS) REQUIREMENTS AND UNIT DESCRIPTION

A. General:

1. ATS shall be completely factory interconnected, pre-wired and tested.
2. ATS mechanism shall be of the electrically operated, double throw mechanically held type, actuated by a single solenoid operator momentarily energized to assure quiet operation.
3. ATS shall be inherently interlocked, mechanically in either normal or emergency position with no "OFF" position possible. Gravity or spring operated switches will not be acceptable. ATS shall be the "open transition" type of automatic transfer switch.
4. All main contacts shall be provided with silver alloy material for high conductivity under all conditions of service. The ATS shall be suitable for all classes of loads, including inductive loads, resistive loads, control loads, and electrical discharge and tungsten-filament loads.
5. Inspection of contacts shall be possible from the front of the switch.
6. A manual operating handle shall be provided.
7. The ATS shall have a U.L. listed minimum RMS symmetrical short circuit current rating equal to or greater than the minimum RMS symmetrical short circuit current rating shown on the PLANS. The ATS contacts rating and number of poles shall be as shown on the PLANS (electrical one line diagrams).
8. The ATS shall be furnished complete with the automatic transfer control system.
9. The ATS, automatic control transfer system, sensors, timers, etc. shall be mounted, as one unit, in a single enclosure as specified hereinafter. The ATS shall be mounted where shown on the PLANS.

2.02 ADDITIONAL REQUIREMENTS FOR THE AUTOMATIC TRANSFER AND BYPASS-ISOLATION SWITCH

A. Furnish and install the automatic transfer and bypass-isolation switch where specifically required by the PLANS. The following are additional requirements for each Automatic Transfer and Bypass-Isolation Switch over and above the requirements for each ATS:

1. The bypass-isolation switch shall provide manual bypass of the load to either source and permit isolation of the automatic transfer switch from all source and load power conductors without interrupting power to the load. All main contacts shall be manually driven.
2. Separate bypass and isolation handles shall be utilized to provide clear distinction between the functions.

3. The bypass handle shall have three operating modes: "Bypass to Normal," "Automatic," and "Bypass to Emergency." In the “Bypass to Normal” mode, the “normal” source serves the load. In the "Automatic" mode, the ATS control system selects the source to serve the load. Additionally, the bypass contacts shall be out of the power circuit so that they will not be subjected to fault currents to which the system may be subjected. In the “Bypass to Emergency” mode, the “emergency” source serves the load.

4. The isolation handle shall provide three operating modes: "Closed," "Test," and "Open." The “Closed” mode shall permit the normal operation of the ATS. The "Test" mode shall permit testing of the ATS with no interruption of power to the load. The "Open" mode shall completely isolate the automatic transfer switch from all source and load power conductors. When in the "Open" mode, it shall be possible to completely withdraw the automatic transfer switch for inspection or maintenance without the removal of power conductors.

5. When the isolation handle is in the "Test" or "Open" mode, the bypass switch shall function as a manual transfer switch and shall allow manual transfer of load to either power source (normal or emergency) regardless of the position (normal or emergency source selection) of the ATS or if the ATS is drawn-out.

2.03 AUTOMATIC TRANSFER SWITCH (ATS) CONTROL REQUIREMENTS

A. General:

1. The ATS shall automatically transfer power from one power source to another, in the event of normal/primary power source failure, one primary feeder failure, etc. The ATS shall ensure continuity of the load circuit power supply for as long as one of the two primary feeders to the ATS is active. The ATS shall also include functionality to initiate transfer of power from one source to another based upon discrete commands received from the Owner’s Distributed Control System, as also shown on the PLANS.

B. Voltage and frequency sensing:

1. Provide field adjustable setpoints with the following Dropout and Pickup ranges for the following parameters:

Parameter	Source	Dropout Range	Pickup Range
Undervoltage	Normal and Emergency	70% – 98%	85% - 100%
Underfrequency	Normal and Emergency	85% - 98%	90% - 100%
Voltage Unbalance	Normal and Emergency	5% - 20%	2% below dropout

C. Transfer time delays:

1. Provide the following field adjustable setpoints with the following ranges:
   a. Time delay to override momentary normal power source outages to delay transfer switch: 0 to 6 seconds.

   b. Transfer to backup power source time delay: 1 to 300 seconds.

c. Time delay to re-transfer to normal power source (upon restoration): 0 to 30 minutes.

D. Manual transfer switch controls:

1. Combination Display and Keypad: Provide manufacturer's standard four line, 20 character liquid crystal display (LCD) combination display and pushbutton keypad user interface module. The combination display and keypad module shall be an integral part of the ATS for viewing all available data and field adjustment of desired operational parameters. Mount the Combination Display and Keypad to the face of the ATS.

E. Accessories:

1. Provide a detailed instruction plate for convenient operation.

2. Auxiliary Contacts:
   a. All contacts shall be rated for 10 ampere at 120 volts A.C. Wire to terminal blocks.

   b. Provide contacts for the following:

      1) ATS in normal position.

      2) ATS in emergency (backup) position.

      3) Normal source voltage is present.

      4) Emergency (backup) source voltage is present.

      5) Additional contacts where required by the PLANS.

3. Nameplates:
   a. Provide nameplates/legend plates for each pilot device and each component/device/equipment installed on the face and inside the enclosure of the ATS.

   b. Identification Nameplates:

      1) Type: 3-ply, 1/8" thick, rigid thermoset phenolic resin laminated cellulose paper base engraving stock per ASTM D-709, Type I. Nameplates shall be ASTM Grade ES-1, ES-2, or ES-3 as applicable for the face and lettering colors specified hereinafter. Flexible or acrylic tags will be not be accepted.

      2) Color: White-Black-White.

      3) Lettering: Nameplate shall be legible at a distance of six feet from the nameplate. Lettering shall be engraved through the face layer to the melamine middle layer.

      4) Accessories: Provide holes for mechanical fastening

      5) Nameplates located on the face of the cabinet shall be secured with two Stainless Steel screws.

2.04 AUTOMATIC TRANSFER SWITCH (ATS) ENCLOSURE

A. The ATS assembly (controls, contactors, sensors, relays, etc.) shall be mounted in a NEMA-12 gasketed enclosure. The ATS controller combination display and keypad and switch operators shall be mounted on the face of the enclosure door. Each door shall have a continuous piano hinge with key-lockable stainless steel handle (3-point latching mechanism).

PART 3 - EXECUTION

3.01 FACTORY INSPECTION AND TESTS

A. Standard factory tests shall be performed on the equipment specified in this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards. The manufacturer shall provide certified copies of factory test reports prior to shipment of the equipment to the project site. Format and quantities of the test report shall be in accordance to Section 01300 and Section 01730 of the Contract Specifications.

3.02 FIELD INSTALLATION (BY CONTRACTOR)

A. Mount the ATS as shown on the PLANS. Top of ATS shall be no higher than 6 foot 0 inches above the finished floor elevation. For surface mounting, use support channel per the requirements of Section 16150 “Raceways, Fittings and Supports” and per the details shown on the PLANS. For floor mounting, provide equipment pad as shown on the PLANS. Also refer to the details shown on the PLANS.

3.03 FIELD TEST AND CHECKS

A. The following minimum test and checks shall be made before energizing the ATS. These tests shall be performed by a Factory Trained Field Technician (non sales type):

1. Thoroughly inspect ATS.
2. Test for proper operation.
3. Calibrate, set and test control timers, relays according to settings provided and required by this Specifications Section and as recommended by the manufacturer.
4. Submit documentation of all tests outlined above. Include all test documentation data in operation and maintenance manuals.

3.04 EQUIPMENT PROTECTION AND RESTORATION (BY CONTRACTOR)

A. Clean and vacuum clean all interior of the equipment.

B. Touch-up and restore damaged surfaces to factory finish.

3.05 TRAINING

A. Provide training sessions for OWNER's representatives for Two (2) normal workday and Four (4) working hours each day, at the job-site location. If training is conducted in less than the time required by these Specifications, the remaining time shall be utilized at the discretion of the OWNER.

B. The training session shall be conducted by the ATS manufacturer's non-sales-type technical representative.

C. At minimum, the training session shall include:

1. Operation and maintenance procedure for the equipment and all components installed within the ATS.

2. Factory contact persons phone numbers, persons names, ordering procedures and procedures to follow to obtain meaningful results from the factory.

3.06 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this Section. All costs are included in the Base Bid.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. Provide grounding in accordance with the PLANS, these Specifications and the National Electrical Code "N.E.C." Included within this section are furnishing and installing all the wire, connections, and other devices associated with the grounding system associated with the aforementioned.

1.02 RELATED REQUIREMENTS

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.

C. Related work as called for on the PLANS, as specified herein or in other Sections of the Specifications.

1.03 SUBMITTALS

A. Submit shop drawings on all grounding system product and in accordance with Section 01300 of the Specifications. Include material safety data sheet for ground enhancement material.

B. Submit Operations and Maintenance Manuals (O&M) in accordance with Section 01730 of the Specifications. O&M Manuals shall include copies of the approved shop drawings, and on-site/field test data.

PART 2 - PRODUCTS

2.01 GENERAL

A. Ground electrodes shall be 24 inch long by 24 inch wide high conductivity copper sheet plates with 0.25 inch minimum plate thickness as manufactured by Erico (Cadweld), or approved equal. Each ground plate shall have two bare copper 250 kCMIL wire pigtails exothermically welded to the plate by the plate manufacturer. Exception: ground plates connected to test wells are not required to have pigtails. Refer to the PLANS for additional requirements.

B. Concrete encased ground electrodes for all new buildings or structures having a concrete foundation shall be encased in the concrete foundation a minimum of 20 feet and tied to the foundation's steel reinforcing bar system. The concrete encased ground electrode shall be a minimum 3/4 inch diameter Type 316 stainless steel reinforcing bar per ASTM A955/A955M. The concrete encased ground electrode shall extend outside of the concrete foundation and turn up into a concrete encased electrode accessibility ground port enclosure as shown on the PLANS. Refer to the PLANS for additional requirements. The enclosure shall comply with the requirements of Section 16250 of the Specifications "Boxes and Cabinets".

C. Connections between ground electrode and grounding electrode conductors shall be made below grade using Cadweld, Burndy Thermoweld, or equal thermite reaction welding system. Exception: Connections between ground electrode and grounding electrode conductors made inside an accessible underground Grounding System Test Well, only where noted/detailed/shown on the PLANS, shall be permitted to be made with tin-plated Bolted Ground Lug connectors as manufactured by BURNDY Type GK, or approved equal.

D. Grounding electrode conductors/wire shall be green insulated stranded copper. Use bare copper for grounding grids only (as shown on the PLANS).

E. Equipment and/or static voltage and/or any other ground buses/bars (for any other type of use) called for on the PLANS and Specifications shall be tin-plated copper.

2.02 GROUND ENHANCEMENT MATERIAL

A. The Contractor shall encase the underground ground electrodes with the hereinafter specified Ground Enhancement Material.

B. Material: Low resistance non-corrosive carbon based backfill material, free of concrete and bentonite. Material shall not require periodic wetting or other Owner intervention in order to maintain its conductivity.

C. Application: Suitable for use as backfill material in rocky, sand, gravel, and other high resistance soil types to lower the ground resistance. Suitable for use in horizontal and vertical trench applications.

D. Manufacturer: Harger Model "Ultrafill", Erico "Ground Enhancement Material (GEM)", or approved equal.

PART 3 - EXECUTION

3.01 GENERAL

A. Connect each Ground Bus/bar directly to the Grounding Network conduit routed in the duct bank system in addition to the Grounding System around the manhole/handhole, as also shown on the PLANS.

B. Extend a dedicated equipment ground wire, minimum size No. 6 AWG green insulated wire, from each Ground Bus/bar to each individual conduit system grounding bushings, each cable clamp, each support channel, etc. housed inside the associated electrical manhole/handhole. Also, refer to the PLANS

C. Ground all electrical and instrumentation equipment, including lights, receptacles, instruments, etc., with a separate equipment ground wire installed in the conduit with the power conductors.

D. Install grounding system electrically and mechanically continuous throughout. System neutral shall be bonded only at the building service transformer.

E. Ground lighting transformer neutrals to their housing and bond the housing to the equipment grounding conductor.

F. Connect equipment grounding conductors to ground bars or busses provided at panelboards, motor control centers, disconnect switches, switchgears, etc., from which the equipment is served.

G. Where the equipment has no facility to attach an equipment ground wire, use a Burndy Quicklug or equal. Clean the metal surface under the lug to bright metal so that good contact can be made. Repaint metal surfaces after the lug and connecting ground wires are installed.

H. Make ground connections to equipment by using ground lugs or ground bars, where they are provided.

I. Use a thermite reaction welding system process as previously specified to make connections to ground plates; and, at any joint or connection which will be inaccessible after the construction. Exception: Connect to Grounding System Test Wells as previously specified and as also shown on the PLANS. Do not cover until each connection has been inspected by the Owner.

J. Furnish bonding jumpers as shown or as otherwise required by the National Electrical Code “N.E.C.” Use stranded copper wire.

K. Inside buildings and at above ground level and through concrete floor slabs, route the ground wire(s) in a conduit raceway system. Fill annular space between ground wire and conduit with Crouse Hinds, Nelson or Raychem watertight and flame-retardant sealant.

L. Connect ground wires entering outlet boxes in such a manner that removal of the receptacle will not interrupt the continuity of the grounding circuit. A grounding screw attached to the box, and used for no other purpose, may be used to accomplish this.

M. After ground wire connections have been made to equipment, to structures, in test wells and encased grounding electrode accessibility ground port enclosures, etc., the Contractor shall apply "3M" 1601 Clear-Color Fast Drying Sealer and Insulator, or approved equal corrosion resistant and moisture repelling electrical coating/spray to all exposed wiring and all wire connections, inclusive of mechanical and exothermic weld connections. Coordinate application with the Owner.

N. Test grounding in accordance with Section 16800. Maximum resistance to ground shall not exceed 2.0-ohms. At no additional cost to the owner, install additional ground plates over the number required by the PLANS, as necessary to accomplish the 2.0-ohms or less resistance.

O. Install a bonding jumper from the grounding lug of each Conduit-Grounding-Bushing to the ground bar or bus of each enclosure and/or equipment housing (such as pull boxes, junction boxes, panelboards, motor control centers, transformers, automatic transfer switches, instrument and control panels, etc.), as applicable. Instrument Grounds to be separate from power grounds. Instrument ground to be insulated up to the connection to the ground grid. Also refer to details shown on the Drawings. Bonding jumper wire for Conduit system Grounding-Bushings shall be STRANDED bare copper wire with minimum of 19-strands. Bonding jumper wire size as required by the National Electrical Code "N.E.C.", however, minimum wire size shall be #10 AWG.

P. Where Grounding System bare copper underground conductors pass through a transition from soil to concrete/mud slab concrete/flowable fill concrete/etc., the conductors shall be wrapped with 20 mil polyvinyl chloride based Pipe Tape using a 50 percent overlap. Pipe tape coverage shall be installed at the point of the transition and an additional 12 inches of distance beyond either side of the point of transition/contacted region. Pipe Tape shall be 3M Company No.51, or approved equal.

Q. At the proposed Substation No. 4, in addition to the Grounding Network shown on the PLANS, furnish and install one (1) separate concrete encased electrode grounding system to comply with City of Austin Amendment to the National Electrical Code Ordinance 20170928-094 Article 250.52(A)(3) and obtain City inspection prior to concrete placement of building grade beams or slab. Each said grounding system shall include 20 feet of 3/4 inch stainless steel rebar, routed horizontally and encased in a minimum of 4 inches of concrete, located above building foundation slab waterproofing and attached to the building foundation slab reinforcing steel bars. Additionally, each concrete encased electrode shall also extend vertically to finished grade and terminate at a concrete encased electrode accessibility ground port enclosure as shown on the PLANS. Label each enclosure cover "GROUND PORT" to comply with City of Austin Amendment to the National Electrical Code Ordinance 20170928-094 Article 250.68(A)(1).

R. Ground Enhancement Material Installation:

1. All underground grounding electrodes shall be encased in an envelope of grounding enhancement material extending beyond the extents of the grounding electrode a minimum of 4 inches in all directions.

2. Prior to installation, all ground enhancement material shall be mixed with water into a slurry in accordance with the ground enhancement material manufacturer's installation instructions. Salt water shall not be mixed with the grounding enhancement material.

3. Refer to and comply with the installation details shown on the PLANS. Additionally, follow the ground enhancement manufacturer's installation instructions.

3.02 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this Section. All costs are included in the Base Bid.

END OF SECTION

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PART 1 - GENERAL

1.01 SUMMARY

A. Furnish and install disconnect switches and enclosed circuit breakers as shown on the PLANS and specified herein.

1.02 RELATED REQUIREMENTS

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.

C. The PLANS designate the size, rating, and other requirements of the equipment specified under this Section.

D. Related work as called for on the PLANS, as specified herein or in other Sections of the Specifications.

1.03 SUBMITTALS

A. Submit Shop Drawings in accordance with Section 01300 of the Contract Specifications. For each individual Disconnect Switch and Enclosed Circuit Breaker include:

1. Dimensioned/scaled fabrication drawings
2. Ratings
3. Wiring connection diagram
4. Protective device coordination curves and current limiting circuit breaker/fuse peak current let through curves, where applicable.

B. Submit Operations and Maintenance Manuals (O&M) in accordance with Section 01730 of the Contract Specifications. Include:

1. Copies of the approved shop drawings
2. On-site/field test data.

PART 2 - PRODUCTS

2.01 DISCONNECT SWITCHES

A. Construction:

1. U.L. Listed, Non-fused, Single Throw, Heavy Duty type. Complies with UL98 and NEMA KS-1.
2. Switchblades shall be fully visible in the "OFF" position when the door is open.
3. Dead-front construction with permanently attached arc suppressors.
4. Switches to have quick-make and quick-break operating mechanism and handles with provision for padlocking in all three positions, with at least four padlocks. The locking provisions shall be such that the padlock directly interferes with the operating handle and is fully visible.
5. Switches shall have a dual cover interlock to prevent unauthorized opening of the switch door in an "ON" position from either source, or closing of the switch mechanism with the door open.
6. Furnish lugs to terminate the incoming/outgoing field wiring as shown on the PLANS. Refer to the PLANS. Additionally, provide a grounding lug for equipment ground wire connection. Lugs to be U.L. listed.
7. All current-carrying parts to be plated.

B. Ratings:

1. Voltage Rating: 600 Volts A.C.
2. Current Rating: Maximum continuous current capacity shown on the PLANS
3. Number of Phases: Three, unless shown otherwise on the PLANS
4. Minimum RMS symmetrical short circuit current rating: 10000 ampere at 208 volts A.C.

C. Enclosure:

1. NEMA-4X Type 316-Stainless Steel gasketed cabinets.

D. Manufacturer:

1. All Disconnect Switches on the project shall be manufactured by a single Disconnect Switch manufacturer.
2. Square D Company Class 3110, Asea Brown Boveri, Eaton Cutler-Hammer Corporation, or approved equal.

2.02 ENCLOSED CIRCUIT BREAKERS

A. Construction:

1. Molded case type, NEMA rated, and U.L. Listed.
2. Circuit breakers shall have an overcenter, toggle handle-operated, trip free mechanism with quick make, quick break action independent of the speed of the toggle handle operation. Breakers shall be thermal magnetic molded case type having inverse time thermal trip and instantaneous time magnetic trip. The design shall provide common tripping of all poles.
3. Circuit breaker shall have handles with provision for padlocking in the ”OFF” position. The locking provisions shall be such that the padlock directly interferes with the operating handle and is fully visible. Circuit breakers shall have a dual enclosure interlock to prevent unauthorized opening of the enclosure door when the circuit breaker is in the "ON" position, or closing of the circuit breaker mechanism with the door open.
4. Furnish lugs to terminate the incoming/outgoing field wiring as shown on the PLANS. Refer to the PLANS. Additionally, provide a grounding lug for equipment ground wire connection. Lugs shall be U.L. listed.

B. Enclosures: NEMA-4X type 316 Stainless Steel gasketed cabinet.

C. Circuit Breaker Ratings:

1. Voltage Ratings: 600 volts A.C.
2. Current Rating: Maximum continuous current carrying capacity shown on the PLANS
3. Number of Phases: Three, unless shown otherwise on the PLANS
4. Minimum RMS symmetrical short circuit current rating: Equal to or greater than that of bus serving the circuit breaker at rated bus voltage A.C.
5. Breakers shall operate continuously when operating/running current is equal to 80% of the long time trip setting (or frame rating, as applicable) of the breakers.
6. Provide complete with rating plug and other accessories as required for proper operation of circuit breaker.
7. Furnish current limiting type circuit breakers when specifically required by the one-line drawings shown on the PLANS.
8. Provide auxiliary contacts where required by the PLANS. Contacts shall be rated for 5 ampere at 120 volts A.C. Coordinate contact requirements with the PLANS.
9. Provide electronic trip attachment where specifically shown on the PLANS. Trip unit shall be solid state type with adjustable long time, short time, instantaneous, ground fault and pick up settings as manufactured by **“**Square D” Micrologic LSIG Series B Trip Unit and Internal Ground Fault Protection, or approved equal.

D. Manufacturer: Enclosed Circuit breakers shall be Square D Company Type FCL, Asea Brown Boveri, Eaton Cutler-Hammer Corporation, or approved equal.

2.03 IDENTIFICATION

A. General:

1. Furnish and install identification nameplates for each piece of equipment as follows:
   a. Type: 3-ply, 1/8" thick, rigid thermoset phenolic resin laminated cellulose paper base engraving stock per ASTM D-709, Type I. Nameplates shall be ASTM Grade ES-1, ES-2, or ES-3 as applicable for the face and lettering colors specified hereinafter. Flexible or acrylic tags will be not be accepted.
   b. Color: White-Black-White
   c. Lettering: 1/4 inch height, minimum, engraved through the face layer to the melamine middle layer.
   d. Accessories: Provide holes for mechanical fastening
   e. Attachment Means: Secured with two Stainless Steel screws.
2. Exception: Identify manual motor starters mounted in environmentally controlled rooms as specified in Section 16300 "Wiring Devices".

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install where the top of each enclosure is no higher than 6-feet-0-inches above the finished floor elevation, unless otherwise noted on the PLANS.

B. Surface mount on support channels per the requirements Section 16150 "Raceways, Fittings and Supports" and the details shown on the PLANS. Also refer to details shown on the PLANS.

C. Tag equipment with the name as it appears on the PLANS using the specified nameplates.

3.02 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this Section. All costs are included in the Base Bid.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. Provide all equipment and labor required for calibration, setting and testing as described herein or otherwise required. All tests shall be witnessed by the OWNER or the OWNER's designated representative. Give written notification of the tests at least seven days prior to the desired date to perform the tests. Repair or replace all defective material, equipment or workmanship disclosed as a result of these tests at no cost to OWNER.

B. All work, including installation, connection, calibration, testing, and adjustment, shall be accomplished by qualified, experienced personnel working under continuous, competent supervision. The completed installation shall display competent work, reflecting adherence to prevailing industrial standards and methods.

C. Tests: The Contractor shall make all tests required by these specifications, or other authorities having jurisdictions. All such tests shall be performed in the presence of the OWNER or the OWNER's designated representative. The Contractor shall furnish all necessary testing equipment and pay all costs of tests, including all replacement parts and labor necessary due to damage resulting from damaged equipment or from test and correction of faulty installation.

1.02 SUBMITTALS

A. Submittals shall include copies of the test results/reports. Submittals shall be per the quantity and format requirements of Section 01300 and 01730 of the Specifications. Include the following at minimum:

1. Test results, inclusive of catalog number/drawing cross-reference, where applicable, and any other data entered on the field test report
2. Testing Plans
3. All test instrument data sheets and calibration certificates

1.03 TEST PLAN AND TEST RESULTS

A. Performance: Testing shall be performed in compliance with the approved Test Plan. The Test Plan shall be submitted in accordance with the outline given below. Provide the OWNER with typewritten results of all tests, including a description of the equipment tested, the date and time of day tested, names of witnesses, weather conditions; and test values and results.

B. Test plan: At minimum, Submit a Test Plan for each of the Sections listed in Division 16 of these specifications. Test Plan shall be submitted at least two (2) weeks prior to the

desired date and time of the test. Test Plan shall clearly identify the following, as applicable:

1. Desired date and time to perform the test
2. Name of Entity/individual that shall perform the test
3. Test procedures and recording data sheets
4. Name, description, catalog number, calibration date, and calibration entity's name of each of the test instruments to be used in executing the test
5. Expected duration of the test
6. Request for type, time and duration of any shutdown that may be required during the test.

C. Test Results: Submit Test Results for each of the Sections listed in Division 16 of these specifications. Test Results shall be submitted no later than at least two (2) weeks after the last date of the respective test. Test Results shall be typewritten and shall include the following, as minimum:

1. All data and information provided in the Test Plan
2. Name of Entities and individuals that attended and witnessed the test
3. Weather Conditions
4. Tabulated test values and results
5. Corrective measures taken and/or to be taken toward defective material, equipment or workmanship disclosed as a result of these tests. Also include Re-Test dates and procedures for defective material, equipment or workmanship disclosed from the previous test.

1.04 TEST EQUIPMENT

A. Each test instrument shall have been certified by an established calibration laboratory within the six (6) months prior to its use in testing and calibration procedures. Calibration shall be traceable to the National Institute of Standards and Technology (NIST).

PART 2 - PRODUCTS

A. No products are required by this Section of the Specifications.

PART 3 - EXECUTION

3.01 INSULATION RESISTANCE (MEGGER) TESTS:

A. Use a minimum 500 volt megohmeter.

B. Take each reading for at least one minute.

C. Include the following tests:

Equipment	Minimum Resistance
115 and 230 volt motors	5.0 Megohms
460 volt motors	7.0 Megohms
600 volt transformer winding	100.0 Megohms
600 volt wiring up to 1000 ft.	25.0 Megohms

Coordinate minimum values shown with equipment manufacturer's recommendations.

D. Test all transformer windings as follows:

1. Primary to ground
2. Secondary to ground
3. Primary to secondary

E. Test medium voltage cables, 5kV and 15kV, in accordance with Section 16182 "Medium Voltage Cables".

F. Record and submit all Megger readings to the OWNER/ENGINEER for review and record keeping purposes. Neatly type all readings and organize in a Database table form. Incremental megger readings shall also be recorded and included in the table.

3.02 GROUND TEST

A. Ground System testing shall be performed by an independent professional testing company specialized in, and well equipped to perform, ground resistance testing.

B. Ground testing shall assure resistance to ground values listed in the Grounding Specification. All tests must be witnessed by the Owner or the Owner's designated representative.

C. At a minimum, test each of the following separately, with ground under test isolated from other grounds:

1. Each process area/building grounding network, i.e., Substation 4, Low Service Pump Station, etc. Furnish and install additional grounding/ground electrodes if

the resistance to ground measures more than the values stipulated in the Grounding Section of the Specifications. This shall be executed at no additional cost to the Owner.

2. Each manhole,

3. Each handhole,

D. Finally, after all tests of each individual process area/building, manhole, handhole, etc., are performed as previously specified, perform a final test after all of the individual process areas/buildings, manholes, handholes, etc. grounding networks are interconnected as also shown on the PLANS.

3.03 MOTORS

A. Test the insulation resistance (megger test) of all motors installed under this Contract inclusive of process mechanical drive motors and the Heating and Ventilation System drive motors such as exhaust fans, fan and coil units drive motors, etc. Test all motors in accordance to with subsection 3.01 above.

B. Dry out any wet insulation by use of space heaters or other approved methods.

C. Check coupling alignment, shaft end play, lubrication, and other mechanical checks as required. Follow manufacturer's instructions.

D. Check for proper motor rotation.

3.04 RECEPTACLES

A. Test all receptacles for proper connections and grounding. Use an approved plug-in tester equal to Woodhead 1750 or Hubbell 5200.

3.05 CONTROL CIRCUITS

A. Check all circuits for continuity, proper connection, and proper operations.

B. Set all time delay relays and timers for the desired operations. Record the settings, indicating the relay or timer, its location, and the setting used. Verify all settings with a stopwatch.

3.06 CONTINUITY TESTS

A. Perform continuity test on all low voltage conductors (600 volt, and below, wiring system). Continuity test must be performed after wiring is pulled in the conduit system and/or underground electrical system (as applicable). Continuity test must be performed on each conductor between its source and final destination (point of termination to load/device/etc.). Utilize Ohmmeter for this test. Ohmmeter must be set to lowest ohm setting (highest resolution).

3.07 EXISTING TRANSFORMER OIL TESTS

A. Take oil samples of the Owner's existing oil filled transformers identified on the PLANS as "LSPS-XFMR-01" and "LSPS-XFMR-02". Include all costs associated with the packaging, insurance, and transmission of the transformer oil samples to and from a reputable testing laboratory, and all related expenses.

B. Furnish to the Owner a certified written report for each sample that identifies the transformer from which the sample was taken, the date of the oil sample, and the quantity of PCBs contained in the tested transformer oil sample. Format and number of report copies shall be in accordance with the requirements of Section 01300 and Section 01730 of the Contract Specifications.

C. Transformer oil testing shall be performed by an independent professional testing company specialized in, and well equipped to perform, transformer oil testing.

D. Disposal of existing transformers containing PCB oil:

1. Disposal of existing transformers tested and confirmed to contain PCB oil shall comply with federal, state and local laws and regulations. Disposal of materials containing concentrations of PCB shall be by/at a permitted PCB disposal company possessing permit or approval to perform PCB disposal activities.

2. Furnish to the Owner a manifest or bill of laden of the transport of the PCB oil from the Owner's site to the disposal site, as well as the date of transfer, and the name and company name of the individuals who removed the oil from the Owner's site and transported it to the disposal site.

3.08 480 VOLT SWITCHBOARDS AND 5KV AND 15KV METAL-CLAD SWITCHGEARS

A. Set all feeder circuit breakers and protective relaying system.

B. Take and record voltage and current (amperage) readings on all feeders to ensure proper phase balance.

C. Refer to and comply with the requirements of Specification Section 16044 "5kV and 15kV Metal-Clad Switchgear and Medium Voltage Overhead Bus Ducts".

D. Refer to and comply with the requirements of Specification Section 16140 "Switchboards".

3.09 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this Section. All costs are included in the Base Bid.

END OF SECTION

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PART 1 - GENERAL

1.01 SUMMARY

A. Provide all labor, materials, and equipment to design, furnish, install, calibrate, test, adjust, and place in operation the facility complete monitoring and control system as specified herein and as shown on the PLANS. The PLANS and Specifications show and specify those features required to illustrate and describe functional requirements of the monitoring and control system.

B. A single Instrument and Control System Contractor (ICS) shall furnish all services and equipment defined herein and in other Specification sections as listed below under Related Work. The Instrument and Control System Contractor is referred to herein and after (in Division 17 of the Specifications) as the ICS, ICS supplier/firm, or Contractor. The ICS shall have the qualifications as described in subsection 2.0, "Quality Assurance", this Section of the Specifications.

C. The ICS shall also:

1. Terminate and tag all field wiring associated with the process instrumentation and control system shown on the PLANS and specified herein and in other Specification sections listed below under Related Work**.**
2. Tag Instrumentation and control wiring/cable per the requirements and methodology/scheme outlined in specifications Section 16200 "Wiring (600 Volts and Below)" paragraph 3.03 "Wire Tagging Methodology".
3. Calibrate, set and test the PICS equipment, components, cables, hardware, and software.
4. For all PICS equipment and ancillaries, provide:
   a. Required submittals.
   b. Equipment and ancillaries.
   c. Instructions, details, and recommendations to, and coordination with, all other installation entities for Certificate of Proper Installation.
   d. Certifying readiness for operation.
   e. Starting up.
   f. Testing.
   g. Training
   h. Use of testing/calibration equipment to facilitate calibration/testing of field sensors and instruments. Equipment shall include, but not be limited to:

1) Test pressure pump for field calibration/testing of pressure transmitters.

2) Signal generator/multi-function meter for field calibration/testing of resistance temperature detector (RTD) monitoring devices

3) Temperature/heat generator for field calibration/testing of temperature transmitters.

4) Shaker table for vibration transmitters, etc.

5. Provide special additional services during installation, including:
   a. Verifying that the following are furnished and installed:

      1) Correct type size, and number of signal wires with their raceways.

      2) Correct electrical power circuits and raceways.

      3) Correct size, type, and number of PICS related pipes, valves, fittings, and tubes.

      4) Correct size, type, materials, and connections of process mechanical piping for in-line primary elements

   b. For equipment not provided by the ICS, but directly connected to the PICS:

      1) Obtain manufacturer's information regarding installation, interface, function, and adjustment for equipment from the Contractor.

      2) Coordinate with Contractor to allow required interface and operation with the PICS.

      3) Verify that installation, interfacing signal terminations, calibration, and adjustments have been completed in accordance with the manufacturer's recommendations.

      4) Test to demonstrate the required interface and operation with the PICS.

      5) Examples of equipment in this category include, but are not limited to the following:

         a) OWNER's Top-End Computer System

         b) Metal Clad Switchgear

         c) Switchboards

         d) Process/Mechanical Equipment

6. Provide equipment, software, and services for the installation of the DCS configuration system at the ENGINEER's Austin, Texas office.

7. Assist OWNER/ENGINEER, as specified in applicable DCS subsystem specifications sections, in the PAT testing of the Applications Software which

shall be developed by OWNER/ENGINEER for the DCS and Laptop Computer (as applicable).

D. As also shown on the PLANS, the proposed Distributed Control System at Substation No. 4 and the Low Service Pump Station are networked with the OWNER's existing plant Top-End computer system by means of DCS equipment at the OWNER's existing Low Service Pump Station Control Panels. Refer to the PLANS. Effort is required of the ICS to establish functional and complete communication network links between the proposed equipment of this project and the Owner's existing DCS equipment in order to achieve proper and complete system operation. This effort shall include, but not be limited to:

1. Furnish and install proposed communication equipment and associated cabling in the OWNER's existing Low Service Pump Station Distributed Control Panels. Refer to the PLANS.
2. Coordination with all responsible parties, i.e. OWNER, manufacturers, etc., to facilitate proper communication equipment selection, cable termination connector quantities/types, patch panel locations in controls panels to address minimum cable bending radius, etc., as required
3. System startup testing, diagnosing, and resolving communication system issues, etc.
4. Modifications to the single mode fiber patch panel patch cord connections at the existing single mode fiber patch panels in other existing process areas within the Owner's treatment plant to achieve a functional and operating data communication network to the Owner's Top-End system. Refer to the PLANS for quantity of process areas and overall plant control system architecture. Furnish and install quantity of single mode patch cords within the existing plant process areas as required as well as reconfigure existing patch cords within process areas as required to establish the functional data communication links.

E. Extensive field verification is required for all modifications to existing control panels. The ICS shall include effort associated with field verifying spatial dimensions inside the existing control panels for proposed equipment, wiring terminations, loop power supply sizes, loads on existing instrument loops, points of connections to existing equipment, etc. as required to support the proposed modification effort associated with this project. The ICS shall field locate proposed equipment to be installed inside the existing control panel as also shown on the PLANS. The proposed location shall be coordinated with the arrangement of the existing control panel internal and externally mounted components.

F. The OWNER's existing distributed control system is vital to the OWNER's treatment plant process system. Therefore, required interruptions to the OWNER's existing distributed control system shall be minimized and coordinated with the OWNER. Should an outage to a facility be required, the Contractor shall request such an outage in writing no less than ninety-six (96) hours in advance. Contractor's written request shall identify the desired date, time, duration, and purpose of the requested day unless he/she obtains a written approval from the owner authorizing the outage. The OWNER reserves the right to modify or reject any request such an outage. Modification or rejection of the

contractors request be the OWNER shall not be considered reason for delays in the construction schedule. Unless otherwise noted, the duration of the outage shall be limited to four (4) hours or less. The OWNER reserves the right to limit the duration of the outage to less than 4 hours. Modification of the outage duration by the OWNER shall not be considered reason for delays in the construction schedule.

G. The OWNER's existing distributed control system equipment and its associated interconnect wiring, power supplies, fuses, etc., is in perfect working condition. Should the existing equipment, its associated interconnect wiring, power supplies, fuses, etc., as applicable, be damaged or become otherwise unusable during the construction course of this project, the ICS shall determine the problem, correct it, and furnish and install all necessary wiring/hardware/etc., to match existing and make all final connections such that all affected equipment operates as previously operated to the OWNER's satisfaction at No Additional Cost to the OWNER.

1.02 RELATED REQUIREMENTS

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.

C. Division-16 ELECTRICAL SPECIFICATIONS

D. Division-17: INSTRUMENTATION AND CONTROL SPECIFICATIONS

E. All other divisions of the Specifications related to the installation of the process mechanical equipment, etc. that are related to the operation of the instrumentation and control system.

F. Related work as called for on the PLANS, as specified herein or in other Sections of the Specifications.

1.03 SUBMITTALS

A. General:

1. Do not design, manufacture, or ship any PICS equipment until all related submittals have been reviewed and approved by the ENGINEER. Submit shop drawings and product data in complete functional packages; i.e., submit all shop drawings and product data for a given loop or subsystem together as a functional package. Piecemeal submittals not organized by systems or incomplete submittals for a given loop or subsystem will not be accepted.

2. All system layout drawings, cross sectional view drawings, wiring diagram drawings, Connection detail drawings, physical layout and detail drawings, etc. shall be developed electronically using "AUTOCAD software".

B. Administrative Submittals:

1. Schedule of Values
   a. Purpose: Project Schedule of Values to provide a basis for Partial Payment for Work completed.
   b. Content: Summary of major milestones and associated Partial Payments for Work provided under PICS Subsystems.

2. PICS Progress schedule
   a. Purpose: Supplement the overall Project Progress Schedule to:
      1) Coordinate activities between the Contractor and the ICS
      2) Coordinate interactions with the OWNER/ENGINEER for coordination meetings, submittal reviews, etc.
      3) Clarify required work sequences and major milestone prerequisites.
   b. Provide multiple submittals of the project schedule throughout the duration of the Project as required.

3. OWNER Training Plan: Submit description/schedule of OWNER Training to be provided.

4. Statements of Qualification: Submit for PICS firm, site representative, start-up and testing team member.

C. Submit shop drawings in accordance with Section 01300 of the Specifications and as specified below:

1. Detailed product data, catalog cut sheets, cabinet exterior and interior front elevations, bill of materials, and spare parts list

2. Point-to-Point Wiring Diagrams: Prepare Point-to-Point Instrument Loop Wiring Diagrams, ladder diagrams (control schematics), cabinet wiring, and other field wiring diagrams in accordance to the format shown on the PLANS. Drawings shall be neat, and legible, and on 11 inch x 17 inch sized sheets. Drawings to include all relevant information for equipment connected to the PICS, regardless if the equipment is provided by the ICS or not, i.e., include motor control centers, OWNER pre-purchased equipment, etc. Contractor shall also submit for approval a complete schedule of all wire tag numbers sorted by area and equipment/instrument/field device.

3. Although typical control schematics/instrument loops are presented on the PLANS for some equipment, the Contractor shall generate specific equipment control schematic drawings/instrument loops (i.e., individual control schematic/instrument loop drawings dedicated for each specific equipment) based upon the typical control schematic/instrument loop drawings, the device identification/tag replacement schedules shown on the PLANS, and the additional requirements described herein. The Contractor generated specific equipment control schematics/instrument loops shall follow the same overall

presentation format as the typical equipment control schematics/instrument loops presented on the PLANS. The specific equipment control schematics/instrument loop drawings complete with all specific equipment/device tags (as a minimum, also refer to the additional requirements described herein) shall be generated by the Contractor and included with the project submittals (i.e., prior to equipment purchase) and the "As-Built" drawings. Any Contractor generated control schematic/instrument loop shown as applicable for multiple equipment shall not be accepted.

4. Contractor may submit wire tag samples for all types of interconnect and field wiring from the proposed/existing cabinets/panels with associated point-to-point wiring diagrams in a separate submittal for approval prior to submitting the complete wire tag schedule for review. After approval of the sample wire tags, a wire tag table showing all provided wire tags shall be submitted for review with the associated point-to-point wiring diagrams. Refer to Specification 17100 Subsection 1.03.C.5 for additional wire tag table requirements. Refer to Specification 16200 Subsection 3.03 for wiring tagging methodology.

5. Wire Tags: Contractor shall also submit for approval a complete schedule of all wire tag numbers sorted by area and equipment/instrument/field device. It is anticipated that all wire numbers cannot be accommodated on the loop diagrams, ladder diagrams, control schematics, etc. format shown on the PLANS. As a minimum, to facilitate the depiction of the wire numbers on the loop diagrams, ladder diagrams, control schematics, etc., the Contractor shall generate and include uniquely identified alpha-numeric wire codes on the loop diagrams, ladder diagrams, control schematics, etc. The wire codes shall cross-reference tables of wire numbers shown on additional drawings that shall be generated by the Contractor. At minimum, the Contractor shall generate the wire codes and the cross-reference tables which depict the wire numbers associated with each wire code and shall group the cross-reference tables by specific equipment (Sludge Pump No. 1, Sludge Pump No. 2, Sludge Pump No. 3, etc.). As a minimum, the Contractor shall generate drawings to depict the wire code and wire tag cross-reference tables and these drawings shall also be grouped by specific equipment (Sludge Pump No. 1, Sludge Pump No. 2, Sludge Pump No. 3, etc.). Additional requirements concerning the cross-reference table headings, table organization, wire code generation, formatting, etc., shall be provided by the Owner during the Pre-Submittal Conference specified hereinafter (*refer to subsection 1.03G in this Section of the Specifications*) and the Contractor shall incorporate these requirements at no additional cost to the Owner. Contractor shall submit wire tag samples for all types of interconnect and field wiring from the proposed/existing cabinets/panels with associated point-to-point wiring diagrams in a separate submittal for approval prior to submitting the complete wire tag schedule for review.

D. Testing Related Submittals:

1. Submit factory and field calibration reports

2. Submit the following for each of type of test (ORT and PAT) required under Division 17 of the Specifications:

a. Preliminary Test Procedures: Outlines of proposed tests, forms, and checklists.

b. Final Test Procedures: Proposed test procedures, forms, and checklists.

c. Test Documentation: Copy of signed off test procedures when tests are completed.

E. Training Related Submittals:

1. Submit the following for each type of training required under Division 17 of the Specifications:
   a. Training plan, course topics, subjects to be addressed in the training
   b. Schedule
   c. Training agenda for each course
   d. Instructor qualifications
   e. Listing of available training courses and outline of course topics and agendas

F. Submit Operation and Maintenance manuals in accordance with Section 01300 and 01730 of the Specifications and as specified below:

1. Include approved shop drawing data in the Operation and Maintenance manuals with the following modifications to the shop drawing exhibits:
   a. Reflect “As-Built” conditions.
   b. Prints of exhibits, wiring diagrams, etc. shall be half size (11 inch by 17 inch).
   c. Submittals shall include hard copies (of the quantity and format required by the Contract Documents) and electronic Version in “AUTOCAD”; This applies to all drawings requested in this Section of the Specifications and any other manufacturer’s product standard drawings required for submittal.
2. Procedures for operating and shut-down
3. Included approved Testing Related Submittals with final “As-Built” conditions.
4. Safety instructions.
5. Calibration instructions and factory test results of each instrument.
6. Maintenance and repair instructions.
7. Recommended spare parts list.
8. Name, address and phone number of instrumentation control system supplier's local representative.
9. Additionally, comply with the requirements of the Contract Documents.

G. Pre-submittal conference

1. General:
   a. Review the manner in which the contract requirements will be met prior to preparation of submittals. The Contractor, Engineer, OWNER, and ICS shall attend. Schedule, conduct, and arrange the conference within 90 calendar days after receipt of written notice to proceed work is given by the OWNER.
   b. The ICS shall present the following at the conference:
      1) List of equipment and materials required and the brand that shall be used for each item
      2) Sample submittals from similar projects including the types of drawings/data/lists specified herein

1.04 SPECIAL CONDITIONS

A. All components used in the instrument and control systems shall be new (not used) and the current model produced by the manufacturer.

B. All equipment of a common type shall be the product of a single manufacturer.

PART 2 - QUALITY ASSURANCE

2.01 ACCEPTABLE PROCESS INSTRUMENTATION AND CONTROL SYSTEM (PICS)

A. Provide a complete, workable, and installed-in-place Process Instrument and Control System, hereinafter referred to as the PICS, as specified herein. The PICS shall be designed, installed, and started up by the single ICS firm.

B. Acceptable ICS firm shall have the following minimum qualifications:

1. ICS Firm: Minimum of 5 years experience in providing, integrating, installing, testing, and start-up similar systems as those required for this project
2. ICS Firm Site Representative: Minimum of 8 years experience installing similar systems as those required for this project
3. ICS Firm Start-up and Testing Team Members: Minimum of 3 years experience in testing systems similar to those required for this project.

C. PICS meetings to be scheduled in accordance with the Contract Documents.

2.02 SYSTEM COORDINATION AND QUALITY

A. Coordinate installation of instrumentation with mechanical and electrical systems.

B. Coordinate subsystems to provide a complete operational and functional instrumentation system to the satisfaction of the OWNER and ENGINEER.

C. Equipment, instruments, components, and materials for PICS components shall be new (not used) and of the current model.

D. Instrument and Control Components Furnished By Others: Certain items of instrumentation and controls shall be furnished by various equipment manufacturers. Coordinate the purchase orders of the items such that the resulting system will function properly.

2.03 DESIGN CRITERIA

A. Design, construct, and install all PICS components in compliance with the applicable provisions of the following standards, codes, and regulations:

1. American National Standards Institute (ANSI) Standards.
2. American Institute of Steel Construction (AISC) Standards.
3. American Society for Testing and Materials (ASTM) Standards.
4. American Waterworks Association (AWWA) Standards.
5. Joint Industrial Council (JIC) Standards.
6. National Electric Code (NEC)
7. National Electrical Manufacturer's Association (NEMA) Standards.
8. Local and State Building Codes.
9. Occupational Safety and Health Administration (OSHA) Regulations.
10. Scientific Apparatus Manufacturer's Association (SAMA) Standards.
11. International Society of Automation (ISA) Standards.
12. National Fire Protection Association (NFPA)
13. Institute of Electrical and Electronics Engineers (IEEE).

2.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery: Enclose cabinets and subassemblies in heavy polyethylene envelopes to protect them from dust and moisture. Place corrosive-inhibitive vapor capsules in shipping containers, and related equipment as recommended by the capsule manufacturer.

B. Storage: All materials and equipment shall be environmentally protected and stored in climate controlled (temperature and humidity, etc.) environment. The Instrument Control Panels and the field control and instrument/monitoring panels shall not be moved `from climate controlled storage room to the project site until the construction of each electrical/control room is completed, and, the air-conditioning and heating system of the facility is in an operating condition satisfactory to the OWNER and ENGINEER.

2.05 CALIBRATION INSTRUMENTS

A. Each instrument used for calibrating PICS equipment shall bear the seal of a reputable laboratory certifying that instrument has been calibrated within the previous twelve (12) months to a standard endorsed by the National Institute of Standards and Technology (NIST). At OWNER's request, ICS shall submit calibration certification report.

2.06 START DATE OF THE PROCESS INSTRUMENTATION AND CONTROL SYSTEM AND ASSOCIATED SUBSYSTEM WARRANTY (PICS INCLUDING SUBSYSTEMS)

A. Start Date of the process instrumentation and control system and associated subsystem Warranty (PICS including Subsystems) shall commence the date in which the Warranty period commences for the overall project per the requirements of the Procurement Documents.

PART 3 - SEQUENCING AND SCHEDULING

3.01 GENERAL

A. All work provided under this section shall be in accordance with the OWNER/ENGINEER-approved Schedule of Submittal Submissions and Schedule of Values.

B. Specification and Construction Implementation Plan requires phased installation of equipment and systems. Stage all PICS activities (submittals, fabrication, installation, testing, start-up, training, etc.) to support the construction sequencing requirements of the project.

C. Wherever language in this section refers to the PICS, the entire installed PICS, the entire PICS, or similar language, it shall be interpreted to apply to the individual phases of the work; except the requirements for the Performance Acceptance Test (PAT).

D. Key milestone dates associated with PICS activity shall be included in the overall project schedule. Include the following dates as a minimum:

1. ORT start and end date
2. PAT start and end date
3. Date Configuration System is delivered to the Engineer
4. Date Configuration System is expected to be retrieved from the Engineer.
5. Training dates

3.02 PREREQUISITE ACTIVITIES AND LEAD TIMES:

A. Start the following key Project activities when prerequisite activities and lead times listed below have been completed and satisfied:

1. Shop Drawings submittal prerequisite: Completion of the Pre-submittal conference

2. Test Prerequisite:
   a. All associated process and mechanical equipment, controlled and monitored by the instrumentation and control system, complete in place

   b. Associated test plan submittal completed. For ORT and PAT, notice of test schedule required 4 weeks prior to the start of test

3. ORT Prerequisite:
   a. Approved ORT test procedures

   b. Approved ORT test forms

   c. 30 calendar days advance written notice to given to OWNER of impending ORT.

4. PAT Prerequisite:
   a. Six (6) months minimum elapsed time after delivery of Configuration System to Engineer's office.

   b. ORT successfully completed.

   c. Approved PAT test procedures

   d. 30 calendar days advance written notice to given to OWNER of impending PAT.

5. O&M submittal prerequisite: PAT successfully completed.

B. Configuration System Delivery: Deliver the entire Configuration System to the Engineer's office no later than 90 days after the completion of the Pre-Submittal Conference.

PART 4 - PRODUCTS

4.01 GENERAL

A. Refer to requirements of PICS Subsystem provided in Division-17 Specifications.

4.02 SOURCE QUALITY CONTROL

A. General:

1. Test all PICS elements, both hardware and specific software, to demonstrate that PICS satisfies all requirements.

2. On-Site Tests Described Under PART 5 - EXECUTION:
   a. Operational Readiness Test "ORT"
   b. Performance Acceptance Tests "PAT".

3. Test Format: Cause and effect
   a. Person conducting test initiates an input (cause)
   b. Specific test requirement is satisfied if the correct result (effect) occurs

4. Procedures, Forms, and Checklists:
   a. Conduct all tests in accordance with, and documented on, ENGINEER accepted procedures, forms, and checklists.
   b. Describe each test item to be performed.
   c. Have space after each test item description for sign off by appropriate party after satisfactory completion.

5. Required Test Documentation: Test procedures, forms, and checklists. All signed by OWNER/ENGINEER and Contractor.

6. Conducting Tests:
   a. All special testing materials and equipment.
   b. Wherever possible, perform tests using actual process variables, equipment, and data.
   c. If it is not practical to test with real process variables, equipment, and data, provide suitable means of simulation.
   d. Define simulation techniques in test procedures
   e. For PICS Subsystems for which OWNER provides applications software, provide sufficient temporary software configuring to allow for ORT testing of these subsystems.

7. OWNER/ENGINEER will actively participate in many of the tests.

8. OWNER/ENGINEER reserves the right to test or retest all specified functions whether or not explicitly stated in the Test Procedures.

9. OWNER's/ENGINEER's decision will be final regarding acceptability and completeness of all testing.

B. Maintenance of Configuration System (as defined in Section 17600 "Distributed Control System):

   1. Provide for maintenance of the Configuration System at the ENGINEER's office. Repair or replace failed equipment within two days of notice by ENGINEER..

C. Provide field support during OWNER/Engineer testing of installed applications software

PART 5 - EXECUTION

5.01 EXAMINATION

A. Equipment furnished by Supplier or any other subcontractor and installed by the ICS/Contractor, requires Supplier to observe and advise on installation to extent required to certify that equipment has been properly installed and will perform as required.

B. For equipment not provided by the ICS, but that directly interfaces with the PICS, verify the following conditions:

1. Proper installation.
2. Calibration and adjustment of all instrumentation and control devices.
3. Correct control action.
4. Switch settings.
5. Opening and closing speeds and travel stops.
6. Input and output signals.

5.02 INSTALLATION

A. Material and Equipment Installation:

1. Follow manufacturer's installation instructions, unless otherwise indicated or directed by the OWNER/ENGINEER
2. Retain a copy of the manufacturer's instructions at the project site, available for review at all times.

B. Wiring:

1. All wiring connected to PICS components and assemblies shall be in accordance to the requirements of Division 16 and 17 of the Specifications.

5.03 FIELD QUALITY CONTROL

A. General: All requirements listed in Subsection Source Quality Control, above, also apply to this Subsection, Field Quality Control.

B. Onsite Supervision:

1. The ICS Project Site Representative shall supervise and coordinate all onsite PICS activities.
2. The ICS Project Site Representative shall be On-Site during total period required to complete all On-Site PICS activities.

C. Startup and Testing Team:

1. Thoroughly check installation, termination, and adjustment for all PICS Subsystems and their components.
2. Completed On-Site tests.
3. Provide and conduct startup services
4. Complete onsite training.

D. Sequence of Work: Provide individual ORTs and PATs for individual process equipment where required to support the staged construction and startup of the facility. Coordinate the construction sequencing requirements with the OWNER.

E. Specialty Equipment: For certain components or systems provided under this Section but not manufactured by the ICS, provide services of qualified manufacturer's representative during installation, start-up, testing (both ORT and PAT) and OWNER's training. For example: RTD calibrator, vibration shaker table (which may be furnished/operated by vibration sensor manufacturer representative), pressure calibrator, etc, shall be provided as required.

F. Operational Readiness Test (ORT):

1. Prior to start of the Performance Acceptance Test "PAT", the ICS firm shall inspect, test the PICS equipment and systems, document the resulting tests performed, implement all corrective actions necessary, perform all associated re-testing, and document that the PICS is installed and ready for operation. Subsequent to the ICS documentation that the PICS is installed and ready for operation, perform jointly with the OWNER an ORT on the associated PICS equipment to demonstrate that it is fully operable as required by the Contract Documents.
2. For PICS subsystems where the PLC application software is provided by the OWNER, provide sufficient temporary software configuring to allow testing of these subsystems.
3. Loop/Component Inspections and Tests:
   a. Check PICS for proper installation, calibration, and adjustment on a loop-by-loop, and component-by-component basis.
   b. Develop and provide forms as required to document ORT. All forms generated shall have provisions for signature by PICS representative.
   c. Develop and provide test form hereinafter called the "Loop Status Report" to organize, track inspection, adjustment, and calibration of each loop. Loop Status Report shall include the following as a minimum:
      1) Project name
      2) Loop number
      3) Tag number for each component
      4) Checkoff/signoffs for each component:
         a) Tag/identification

b) Installation

c) Wiring termination

d) Tubing termination

e) Calibration/adjustment

5) Checkoffs/signoffs for each loop:

a) Panel interface termination

b) PLC I/O interface terminations

6) PLC I/O Signals are Operational: Received/sent, processed, adjusted

7) Total loop operational

8) Space for comments.

d. Develop and provide test form hereinafter called the "Component Calibration Sheet" to organize, track inspection, adjustment, and calibration of each component (except hand switches, pilot lights, gauges, and similar items) and each PLCs I/O Module. The Component Calibration Sheet shall include the following as a minimum:

1) Project Name

2) Loop Number

3) Component tag number or I/O module number

4) Manufacturer name

5) Model number/serial number

6) Summary of functional requirements. For example:

a) Indicators

b) Transmitters/converters, input and output ranges

c) Computing elements' functions

d) Controllers, action (direct/reverse) and control modes (P&ID)

e) Switching elements, unit range, differential (fixed/adjustable), reset (auto/manual)

f) PLC I/O modules: input or output

7) Calibrations, for example, but not limited to:

a) Analog devices: Actual inputs and output at 0, 25, 50, 75, and 100 percent of span, rising and falling

b) Discrete Devices: Actual trip points and rest points

c) Controllers: Mode settings (P&ID)

d) PLC I/O Modules: Actual inputs or outputs of 0, 25, 50, 75, and 100 percent of span, rising and falling.

8) Space for comments

e. Maintain loop status reports, valve adjustment sheets, and component calibration sheets at the project site and make them available to the OWNER at all times.

f. These inspections and tests, inclusive of the above described forms, will be spot checked by the OWNER.

g. The ICS shall implement all corrective measures needed and perform re-test on any modified sub-system/component.

h. The Contractor shall claim and validate a thorough ORT was performed successfully and all resulting corrective action measures taken were performed successfully and re-tested successfully. Upon successful completion of the ORT, the Contractor shall submit letter notification to the OWNER stating that the ORT has been successfully completed. The letter notification shall further state that the ICS is ready to begin the Performance Acceptance Test. Submit all forms upon completion of ORT as required by the OWNER.

G. Performance Acceptance Tests "PAT":

1. Once the ORT has been successfully completed, perform jointly with the OWNER a PAT on the associated PICS to demonstrate that it is operating as required by the Contract Documents. The PAT will employ the OWNER's PLC application software developed for the project.

2. Minimum duration of the PAT shall be a cumulative total of thirty-five (35) calendar days. The cumulative total quantity of calendar days shall be consumed in association and in synch with the overall construction sequence for the project. Any Holidays that occur during the PAT shall result in a corresponding number of days being added to the duration of the PAT. The PAT encompasses startup and testing period of the instrumentation and control system for the associated process and mechanical equipment that are controlled and monitored by the instrumentation and control system. The PAT shall be conducted using application software developed by the Engineer. The ICS shall test functions installed and the hard-wired system and the entire associated instrumentation and control system including validating the operation and monitoring and control functions of the all instruments, all control devices, all instrument and control components, control functions, alarm function, monitoring function, calibration ranges, control/alarm setpoint operations, etc. OWNER/Engineer shall test software functions. The ICS shall also test the DCS.

3. Demonstrate each required function on a paragraph-by-paragraph, loop-by-loop, and site-by-site basis based upon the operating description used by the OWNER for PLC application software development.

4. Non-loop specific tests shall be the same as previously required except that the entire installed PICS shall be tested using actual process variables and all functions demonstrated.

5. Perform local and manual tests for each loop before proceeding to remote and automatic modes

6. Where possible, verify test results using visual confirmation of process equipment and actual process variable. Unless otherwise directed, exercise and observe devices supplied by Others, as needed to verify correct signals to and from such devices and to confirm overall system functionality. Test verification by means of disconnecting wires or measuring signal levels is acceptable only where direct operation of plant equipment is not possible.

7. Make updated versions of documentation required for PAT available to the OWNER at the project site, both before and during tests.

8. Develop and provide PAT test forms that include the following, at minimum:
   a. Project name
   b. Lists the requirements of the loop
   c. Briefly describes the test
   d. Cites the expected results and the actual results
   e. Provides space for checkoff by witnesses.

9. Make one copy of all O&M manuals available to the OWNER at the site both before and during testing.

10. The ICS shall implement all corrective measures needed and perform re-test on any modified system.

5.04 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this Section. All costs are included in the Base Bid.

END OF SECTION

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PART 1 - GENERAL

1.01 SUMMARY

A. Furnish, install, and put into satisfactory service the Substation No. 4 proposed Main Instrumentation/Control Panel as specified herein and as shown on the PLANS.

B. Furnish, install, and put into satisfactory service the Low Service Pump Station proposed Remote I/O Instrumentation/Control Panel as specified herein and as shown on the PLANS.

C. Furnish, install, and put into satisfactory service and perform renovation to the Low Service Pump Station existing Hub "A" Instrumentation/Control Panel and PLC I/O Cabinet "A1" as specified herein and as shown on the PLANS.

D. The requirements of this Section of the Specifications applies to all of the various types of instrumentation and control cabinets/boxes as specified herein and shown on the PLANS.

1.02 RELATED REQUIREMENTS

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.

C. Related work as called for on the PLANS, as specified herein or in other Sections of the Specifications.

1.03 SUBMITTALS

A. Submit the following in accordance with the Section 01300 and 01730 of the Specifications:

1. Shop drawings and product data. Include paint color selection chart for selection of paint color by OWNER.
2. Operation and maintenance manuals.

1.04 TOOLS AND SPARE PARTS

A. Furnish the following spare parts in conformance with the specifications:

1. One set (minimum 3) of fuses for each type and size used.

2. One set (minimum 3) of Circuit Breaker Overcurrent Protection Devices for each type and size used.
3. Twenty (20) terminal blocks of each color and type used.
4. Four (4) control relay assemblies of each type specified, complete with all accessories.
5. Four (4) timing relay assemblies of each type specified, complete with all accessories.
6. Two (2) complete Instrument Loop Current Isolators (I/I converters) for each type specified.
7. Two (2) complete Programmable Pump Controllers, complete with all accessories.
8. 25 percent spare push-buttons, selector switches, indication light assemblies for each type used (minimum of 2 per type).
9. 50 percent of spare lenses and lamps for each type, color and size used (minimum of 4 per type)

PART 2 - PRODUCTS

2.01 INSTRUMENT AND CONTROL CABINETS/PANELS

A. General:

1. The various instrument and control cabinets/panels shall be constructed to the approximate dimensions and instrument arrangement as shown on the PLANS. The ENGINEER will review alternate arrangements and recommendations.
2. Hinges and doors shall be capable of supporting weight of equipment mounted on doors.
3. Mounting channels and interior panels shall be provided in the cabinets for mounting terminals, relays, etc.
4. The cabinet shall be completely assembled and wired at the factory such that installation can be accomplished by connecting field wiring to terminal strips located in the panel.
5. Furnish and install both isolated and non-isolated ground bars for each cabinet. Furnish and install for each ground bus:
   a. Required number of terminals for proper wiring in addition to 20 percent spare terminals for future connections
   b. Isolated Ground Bus Only: 600 volt mounting isolators.
   c. Certain microprocessor based control equipment (e.g. PLCs, etc.) will require the connection of both distorted and undistorted (isolated) ground wires. Provide this wiring as required.

B. Freestanding Cabinets/Panels, as well as parts/components required for renovation of existing control cabinets::

1. Type: Free Standing, modular design, completely enclosed
2. Configuration: Provide Single Bay and Double Bay as required. Use Double-Bay where possible. Each Single Bay section shall have one door, and each Double-Bay section shall have two doors, unless specifically shown otherwise on the PLANS. Provide sections with rear doors where specifically shown on the PLANS.
3. Enclosure Material: Steel
4. Framing Member Thickness: 12 gauge, minimum
5. Door/panel member Thickness: 14 gauge, minimum.
6. Rating: NEMA-12 gasketed
7. Finish: Prime and paint using manufacturer's standard process.
8. Finish color: For Contract Bidding purposes, Foxboro beige with textured finish. The final exterior cabinet components color shall be selected by the OWNER after Contract Bid Award.
9. Interior Panel Finish Color: All interior back and side panels shall be factory painted white.
10. Additional Requirements for each Door:
    a. Solid, Gasketed, and Hinged
    b. 3-point latching mechanism, door latch rods shall have rollers.
    c. Oil-tight key-locking handle.
    d. Reinforcing bars for inner device panels
    e. Data pocket,
    f. Door stop kit
    g. Thermostatically controlled exhaust fan complete with filtered louver. Fan rated for 120 volts A. C. Connect as shown on the PLANS. Refer to the PLANS. Exception: fans and louvers are not required for rear doors.
    h. Air intake/exhaust louver. Refer to the PLANS.
    i. Electrically bonded to the frame using manufacturer's grounding device assembly and #8 AWG green insulated ground wire.
11. Comply with the requirements of the PLANS.
12. Miscellaneous Accessories:
    a. Provide each section with 7.5-inch high solid plinth base. Include solid base access panel covers.
    b. Provide 1-1/2 inches high removable heavy-duty fiberglass floor grating at the bottom of each section (above the plinth base). The floor grating

shall meet OSHA safety standards for personnel traffic. Wiring routed underneath grating shall be neatly laced/arranged.

c. Include all back, joining, side, hinged swing-out, etc. panels, slide-out shelves, 19" rack mounting brackets, all associated mounting hardware to facilitate a complete installation and a totally enclosed overall cabinet. Also refer to the PLANS. All panels shall be full height unless specifically shown otherwise on the PLANS.

1) 19" Racking assembly to allow for installation of 19" rack mount equipment.

a) Furnish install all brackets and support systems for mounting the 19" racking assembly within the control cabinet enclosure.

b) The 19" rack angle shall consist of minimum thickness of 12 gauge plated steel with 10-32 tapped holes.

c) Adjust depth of rack to avoid conflict with door and mounted equipment.

d) Furnish and install vertical wire duct for the entire height of the 19" rack on both sides of the rack. Furnish and install brackets to allow vertical wire way to be installed along entire height of 19" rack without interfering with the rack's equipment mounting holes. Furnish and install all required brackets and bolts for fastening equipment onto rack.

e) The 19" rack assembly is to be integral part of a swing out 19" rack to be mounted within the enclosure.

(1) Swing out rack shall be heavy duty type with mounting load up to 300 pounds

(2) The swing out rack shall be capable of supporting equipment with a maximum depth up to 20.25", where rack can freely swing out minimum 120 degrees and re-close without any conflict of the equipment or any attachments thereto, such as wires, cables, etc.

(3) Furnish and install the respective blank filler panel kit, for the entire height of the swing out rack. Filler panel shall swing with the rack assembly. Furnish and install vertical wire way to be installed to the left and/or right of the racking system on blank filler panel.

(4) Attach with wire ties all cables and wires to the swing out rack, such that when the rack is fully rotated or in place, no tension is caused to the cable connections at the connection point.

(5) Neatly organize and wire tie all cabling to/from the rack, with sufficient slack, to allow swing out of the rack.

(6) Furnish and install horizontal Rack Guides across width of rack for equipment support and as point of wire tying cables. Guides are 14 gauge G60 galvanized steel. Furnish minimum one (1) guide per copper patch panel and beneath patch panel for supporting by wire tie cabling exiting rear of patch panel.

(7) Position the location of the rack along the depth of the enclosure such that, after all racking equipment, wire way, etc is installed on the rack, rack does not interfere with enclosure door in the closed position, or any components on the enclosure door. Should the swing out rack be located at or near mid-depth of the enclosure, then the rack is not required to swing out more than 90 degrees.

(8) Install and terminate to components the fiber cabling on rear of rack at near the pivot point of swing out rack and securely wire tie so as not to get cable caught or be stressed when rack is rotated.

(9) Furnish and install all brackets and fastening assemblies as required to mount 19" swing out racking system within enclosure.

d. Folding Shelf: where shown on PLANS, furnish and install Folding Shelf as part of the control panel. The shelf shall be 18" x 18", Model # AASHLF1818, as manufactured by Hoffman, or approved equal. The shelf shall be colored White.

e. Removable lifting eyes

f. Panel stabilizers and extra support brackets where conduit connects to the enclosures.

g. Cabinet manufacturer's additional hardware and component accessories shall also be provided that will result in a neat, safe, aesthetically pleasing installation.

h. Provide overall master nameplate for the cabinet, as hereinafter specified, with the exception that the text height shall be 3/8 inch.

13. The cabinets shall be as manufactured by "HOFFMAN" Model PROLINE Modular Industrial Enclosures complete with specified accessories, or approved equal by "RITTAL"

C. Wall/Rack Mounted Cabinets/Panels

1. Each enclosure shall be 316 stainless steel NEMA 4X. Enclosure shall be equipped with hinged doors complete with 1/4 (quarter) turn door latches. Provide door latch handle. Furnish and install pad locking means for the door/handle.

2. Each enclosure door assembly shall be furnished with manufacturer's door stop kit that will hold the door open in any position between 0-130 degrees. Each door shall be electrically bonded to the frame of the associated enclosure with #8 AWG 600 volts insulated green ground wire. Utilize manufacturer's grounding device assembly. The inside of each door shall be equipped with the manufacturer's data-pocket for storing drawings and manuals.

3. Each enclosure shall be furnished with a full and solid backpanel (one piece full subpanel). The backpanel shall extend the full height and width of the cabinet/panel. The backpanel shall be factory painted white.

4. Cabinet/Panel manufacturer's additional hardware and component accessories shall also be provided that will result in a neat, safe, aesthetically pleasing installation. Adherence to this requirement is necessary in order to accomplish a good craftsmanship-like system installation to the satisfaction of the Owner and Engineer.

5. Each enclosure shall be as manufactured by "Hoffman" model Concept series industrial enclosures complete with specified accessories, or approved equal by "Rittal".

6. The minimum anticipated panel size for each wall/rack mounted cabinet/panel is shown on the PLANS. The Contractor shall size each cabinet/panel per the requirements of the NEC. Contractor to determine exact as-built size required for the cabinet/panel to meet the contract documents (drawings and specifications) without any additional cost to the Owner (should the final size be larger than that which was anticipated by the PLANS). Additionally, the Contractor is to carefully review the electrical/control floor plan drawing and make any adjustments/equipment rearrangements necessary to meet National Electrical Code requirements and any other safety codes adopted by the City of Austin should the cabinet/panel size be any greater/larger than the minimum size required by the PLANS. Conduit/wiring, etc. adjustment caused by any equipment rearrangement, etc. shall also be provided at no additional cost to the Owner.

2.02 INSTRUMENT AND CONTROL WIRING

A. General wiring and control power and alarm wiring:

1. Extra flexible, #14 AWG, tin plated copper conductor 600V insulation, SIS wire manufactured by General Cable Company, The Okonite Company or approved equal. The pigmentation of the wire insulation shall conform to the color table listed below:

Wiring Function	Wire Jacket Color
Wiring for 120 volts A.C. control/status signal wiring. This does not apply to control/status signal wiring that are scheduled for interface with Programmable Logic Controller (PLC) and Alarm wiring	Red
Wiring for 120 volts A.C. control to relay coils (L1 & L2 terminals or H&N terminals) that are not generated from a PLC Discrete Output point (DO)	Gray
Wiring for 120 volts A.C. power to instrumentation and control devices that are not generated from a PLC Discrete Output point (DO)	Gray
Alarm wiring	Yellow
Wiring for 24 volts D.C. power supply wiring	Blue = Positive Brown = Negative
Wiring for 120 volts A.C. light fixtures, convenience receptacles and exhaust fans	Red = Line (Phase A) Black = Line (Phase B) Blue = Line (Phase C) White = Neutral
Wiring to Discrete Input PLC modules	Violet
Wiring to Discrete Output PLC modules	Pink
Ground wires	Green

B. 4-20 Milliamp Signal wiring:

1. Number of Pairs: One
2. Wire Size: #16 AWG
3. Type of Conductors: Stranded copper conductors, twisted
4. Individual Conductor Insulation: PVC

5. Individual Conductor Insulation Color: Positive (+) is Black, Negative (-) is White
6. Drain Wire: Tinned copper
7. Overall Shield: Aluminum-mylar shield.
8. Overall Jacket: PVC
9. Overall Jack Color: Black.
10. Manufacturer: Samuel Moore and Company, Dekoron Division, Cat. No. 1852 or approved equal.

C. Multi-Conductor RTD Temperature Signal Wiring:

1. Number of Triads: One
2. Wire Size: #16 AWG
3. Type of Conductors: Stranded copper conductors, twisted
4. Individual Conductor Insulation: PVC
5. Individual Conductor Insulation Color: Positive (+) is Black, Negative (-) is White, Sense (S) is Red.
6. Drain Wire: Tinned copper
7. Overall Shield: Aluminum-mylar shield.
8. Overall Jacket: PVC
9. Overall Jack Color: Black.
10. Manufacturer: Samuel Moore and Company, Dekoron Division, Cat. No. 1862 or approved equal.

D. RS-232 ModBus Digital Data Communication System Wiring:

1. Number of Pairs: Two
2. Wire Size: #22 AWG
3. Type of Conductors: Tinned stranded copper conductors, twisted
4. Individual Conductor Insulation: 300 volt PVC
5. Individual Conductor Insulation Color: Red, Black, Green, and White.
6. Drain Wire: No. 24 AWG Tinned copper
7. Overall Shield: Aluminum-mylar shield.
8. Overall Jacket: PVC
9. Overall Jacket Color: Chrome.
10. Manufacturer: Belden, Catalog No. 8723, or approved equal.

E. Fiber Optic Cable:

1. Refer to Section 17600 Distributed Control System.

2.03 INSTRUMENT AND CONTROL CABINETS EQUIPMENT

A. Overcurrent Protection

1. General: Individually protect each device as shown on the PLANS. Furnish and install protection using the devices shown on the PLANS and as specified hereinafter.

2. 120 volts AC circuit Protective Devices:
   a. Ratings: 120 volts A. C., one pole. Size per NEC. Note: Use 20 ampere rating for control panel convenience receptacles.
   b. Certifications: U. L. Listed.
   c. Mounting: Din Rail Mountable
   d. Indications: Visible trip indicator
   e. Manufacturer: Allen-Bradley Series 1492-SP, Phoenix Contact, or approved equal.

3. 24 volts DC circuit breakers:
   a. Ratings: 24 volts DC, one pole. Size per NEC.
   b. Certifications: U. L. Listed
   c. Mounting: DIN rail mountable
   d. Indications: Visible trip indicator
   e. Manufacturer: Allen-Bradley Series 1492-GH, Phoenix Contact, or approved equal.

B. Convenience Receptacle:

1. Furnish and install where required by the PLANS. Additional receptacle assembly features are as follows:
   a. Specification grade
   b. Duplex, 3-wire, polarized grounding type, rated 20 amp, 125 volt, 60 Hertz
   c. Ivory Color
   d. Manufacturer: Hubbell No. HBL5362I, Bryant**,** Pass and Seymour, or approved equal.
   e. Coverplate: 304 brushed stainless steel, as manufactured by Hubbell, Killark, or approved equal.
   f. Install in NEMA-1 enclosure inside of the control panel.

C. Lighting Fixture:

1. Furnish and install where required by the PLANS. Additional light fixture features are as follows:
   a. Type: LED
   b. Voltage: 120 volts A.C
   c. Length: 14 inches
   d. Lumens per fixture: 400 lumens
   e. Although it may not be shown on the PLANS, furnish and install two light fixtures per vertical section of control panel enclosure
   f. Motion sensors shall not be accepted.
   g. Furnish and install manufacturer's extension cable to connect to fixture.
   h. Furnish and install door switch wired to switch the light based upon door position

D. Pushbuttons, Selector Switches, Pilot Lights

1. General Requirements:
   a. Rating: NEMA 4/13 watertight/oiltight, Heavy Duty
   b. Size: NEMA Style full size 30-millimeter (30mm),
   c. Contacts: 10 ampere minimum at 120 volts A.C. Provide number of contacts to satisfy the requirements of the PLANS.
   d. Legend Plate: Furnish and install per manufacturer's standard with inscription as shown on the PLANS.
   e. Manufacturer: Allen Bradley Bulletin 800T, or approved equal.

2. Additional Requirements for Selector Switch/ Pushbuttons:
   a. Operator Color: Furnish and install the color as shown on the PLANS, black otherwise.
   b. Selector Switch Action Type: Maintained action, unless shown otherwise on the PLANS.
   c. Pushbutton Action Type: Momentary action, unless shown otherwise on the PLANS.

3. Additional Requirements for Pilot Lights:
   a. Type: Transformer Type Light Emitting Diode (LED),
   b. Style: Push-to-test
   c. Lens Color: Furnish and install the colors as shown on the PLANS.

4. Additional requirements for Emergency Stop/Trip Push-Button Stations:
   a. Action Type: Push-Pull maintained

b. Operator Type: Mushroom head

c. Operator Color: Red, unless shown otherwise on the PLANS

d. Padlock attachment: Furnish and install as manufactured by Allen-Bradley Bulletin Push-Pull Padlocking Attachment Catalog Number 800T-N314, or approved equal.

e. Padlock: Furnish and install padlock with 0.25 inch diameter padlock shackle. Coordinate the shackle diameter with the padlock attachment. Furnish and install padlock as manufactured by Master Lock, or approved equal.

E. Control Relays: Control relays shall be furnished and installed as required by the schematic diagrams. All control relays shall be Type II relays unless specifically noted otherwise on the PLANS or as specified hereinafter.

1. Type I Control Relays:
   a. Type: 300 volt "Ice-Cube" type
   b. Rated: Pilot-Duty C300 rated
   c. Coil Voltage: 120 volts A.C.
   d. Contact Rating: 12 ampere at 120 volts A.C.
   e. Number and Configuration of Contacts: three Form-C Contacts (3PDT)
   f. Position Indication: Integral LED pilot light
   g. Manual Operator: Integral to relay
   h. Mounting: DIN rail mountable socket
   i. Accessories: Socket, Retaining Clip, Relay Manufacturer's Transient Voltage Suppression Module.
   j. Manufacturer: "Allen-Bradley" Bulletin 700-HA33A1-3-4, complete with 700-HN205 socket, 700-AV3R surge suppressor, and 700-HN157 retainer clip, or approved equal.
   k. The following are additional requirements associated with Type I control relays:
      1) Of the maximum of three Form-C type contacts that are available from each Type I Control Relay, one of the Form-C contacts shall be dedicated as "spare" and wired to terminal blocks for future use by the OWNER. Multiple Type I relay coils shall not be connected in parallel in order to develop additional contacts as may be shown on the PLANS. Should the PLANS require greater than two contacts from a control relay, then furnish and install a Type II Control Relay in lieu of a Type I Control Relay.

2. Type II Control Relays:
   a. Type: 600 volt Heavy-Duty industrial type

b. Rated: NEMA rated

c. Coil Voltage: 120 volts A.C.

d. Contact Rating: 10 ampere at 120 volts A.C.

e. Number and Configuration of Contacts: 4 Normally Open and 4 Normally Closed, at minimum. Furnish and install one additional normally open (N.O.) and one additional normally closed (N.C.) contact, over that required by the PLANS. Field configurable type contacts.

f. Position Indication: Visual mechanical unlatch-latch indicator

g. Mounting: Provide universal mounting strip/plate for backpanel mounting.

h. Accessories: Relay Manufacturer's Transient Voltage Suppression Module

i. Manufacturer: Allen Bradley Bulletin 700-P, or approved equal.

3. Type III Control Relays:
   a. Type: 300 volt "Ice-Cube" type

   b. Coil Voltage: 24 volts D.C. (nominal voltage)

   c. Position Indication: Integral LED pilot light

   d. Manual Operator: Integral to relay

   e. Contact Rating: 12 ampere at 120 volts A.C.

   f. Number and Configuration of Contacts: four (4) Form-C Contacts (4PDT)

   g. Mounting: DIN rail mountable socket

   h. Accessories: LED indicator light, Push-to-Test button, socket and retaining clip

   i. Miscellaneous: Used only where specifically noted on the DRAWINGS.

   j. Manufacturer: "Allen-Bradley", catalog 700-HF34Z24-3-4, complete with relay socket base catalog number 700-HN264 and relay retaining clip 700-HN266, or approved equal.

4. Type IV Control Relays:
   a. Type: 300 volt "Ice-Cube" type

   b. Coil Voltage: 24 volts A.C. (nominal voltage)

   c. Position Indication: Integral LED pilot light

   d. Manual Operator: Integral to relay

   e. Contact Rating: 12 ampere at 120 volts A.C.

   f. Number and Configuration of Contacts: four (4) Form-C Contacts (4PDT)

g. Mounting: DIN rail mountable socket

h. Accessories: LED indicator light, Push-to-Test button, socket and retaining clip

i. Miscellaneous: Used only where specifically noted on the DRAWINGS.

j. Manufacturer: "Allen-Bradley", catalog 700-HF34A24-3-4, complete with relay socket base catalog number 700-HN264 and relay retaining clip 700-HN266, or approved equal.

5. Type V Control Relays:

a. Type: 600 volt Heavy-Duty industrial type

b. Rated: NEMA rated

c. Coil Voltage: 120 volts A.C.

d. Contact Rating: 20 ampere at 120 volts A.C.

e. Number and Configuration of Contacts: 4 Normally Open and 4 Normally Closed, at minimum. Furnish and install one additional normally open (N.O.) and one additional normally closed (N.C.) contact, over that required by the PLANS. Field configurable type contacts.

f. Position Indication: Visual mechanical unlatch-latch indicator

g. Mounting: Provide universal mounting strip/plate for backpanel mounting.

h. Accessories: Relay Manufacturer's Transient Voltage Suppression Module

i. Manufacturer: Allen Bradley Bulletin 700-PK, or approved equal.

F. Timing Relays:

1. Type: Solid state, multi-time, and multi-function type relay. Both timing ranges and timing modes shall be field selectable. Each relay shall be capable of the following timing modes: On Delay, Off Delay, One Shot, Repeat Cycle, and Interval

2. Coil Voltage: 120 volts A. C.

3. Contact Rating: 10 amps, continuous, at 120 VAC.

4. Number and Configuration of Contacts: 2 Form C (2PDT)

5. Mounting: DIN rail mountable socket

6. Accessories: Socket, DIN rail mountable

7. Manufacturer: Square D Class 9050 model No. JCK70 complete with Type NR61 Socket, or approved equal.

G. Single Input, Dual Output Instrument Loop Current Isolators (I/I Converters)

1. Number and Type of Input Signals: One 4-20mA input signal

2. Number and Type of Output Signals: Two 4-20 mA isolated output signals. Integral load trimmer.
3. Maximum Load: 1200 Ohms per output channel.
4. Power Requirements: External 24 VDC supply as also shown on the PLANS.
5. Accuracy: +/- 0.1% of full span
6. Housing: Corrosion resistant metal
7. Mounting: DIN rail mountable.
8. Noise Protection: Provide RFI /EMI protection such that less than +/- 0.1 % of span error is incurred when tested against a reference signal of 30 volts per meter over the frequency range of 20 to 1000 MHz, inclusive.
9. Transmitter Excitation: Provide with field selectable transmitter excitation option which allows the isolator to supply 24VDC power to a 2-wire instrument connected to the isolator input.
10. Manufacturer: MOORE Industries Model ECT-DIN with TX, or approved equal.

H. Single Input, Single Output Instrument Loop Current Isolators (I/I Converters)

1. Number and Type of Input Signals: One 4-20mA
2. Number and Type of Output Signals: One 4-20mA. Integral load trimmer
3. Maximum Load: 1000 Ohms
4. Power Requirements: External 24 VDC supply as also shown on the PLANS.
5. Accuracy: +/- 0.1% of full span
6. Housing: Corrosion resistant metal
7. Mounting: DIN rail mountable
8. Noise Protection: Provide RFI/EMI protection such that less than +/- 0.1 % of span error is incurred when tested against a reference signal of 30 volts per meter over the frequency range of 20 to 1000 MHz, inclusive.
9. Transmitter Excitation: Provide with field selectable transmitter excitation option which allows the isolator to supply 24VDC power to a 2-wire instrument connected to the isolator input.
10. Manufacturer: MOORE Industries Model ECT-DIN with TX option, or approved equal

I. Programmable Pump Controller

1. General: Field programmable pump controller with integral front display and programming buttons.
2. Display: Six (6) LED, fourteen (14) segment alphanumeric characters
3. Input signals: 0-20mA, 4-20mA, 0-5V, 0-10V, or -10-10V selected from keypad
4. Output signal: 4-20mA analog retransmission

5. Alarm points:
   a. Four (4) independently set, trip and reset points
   b. Latching or non-latching, selected from keypad
   c. Contacts: SPDT (form C) relays rated 7.5 amps at 240 VAC / 24 VDC
   d. Audible alarm configurable for each channel
   e. Front panel flashing display

6. Performance:
   a. Accurracy: ±0.01% of input range
   b. A/D resolution: 20 bits
   c. Display resolution: +9999 to -1999 in count steps
   d. Common mode rejection: Greater than 120 dB at 50/60 Hz
   e. Normal mode rejection: Greater than 64 dB at 50/60 Hz
   f. Operating temperature: 32° to 158° Fahrenheit

7. Power: 120 VAC

8. Housing:
   a. Aluminum body
   b. Splash proof front panel

9. Mounting: Panel mountable on the face of the instrumentation and control cabinet door

10. Menu Access Security: Six (6) digit, user selectable, password to enter configuration menu

11. Manufacturer: Devar, Inc. Model 3020 with specified options, or approved equal.

J. Instrument Control Panels/Cabinets Dual Input Single Output 24VDC Instrument Loop Power Supply:

1. Number of inputs and voltage: Two, 120 volts A.C.

2. Number of outputs and voltage: Two, 24 volts D.C.

3. Type: Dual Redundant primary-backup (secondary) arrangement

4. Topology: Two switching type power supplies connected in parallel via current steering diodes with automatic switchover from the primary to the backup (secondary) power supply unit.

5. Input Power Regulation: 0.2% from 105 to 130 VAC.

6. Output Current, per unit: 15 ampere

7. Output Voltage Adjustment Range: 24 to 28 VDC, field adjustable

8. Output Voltage Ripple: 0.5% at full load, maximum

9. Output load regulation: 0.2% maximum from zero to full load.
10. Output Protection: Integral current limiting and over voltage
11. Common Alarm Contact Ratings: 5 ampere at 120 volts A.C.
12. Mounting: Provide rack/wall mounting configuration as shown on the PLANS
13. Accessories:
    a. Draw-out handles mounted on the face of the power supply unit.
    b. Voltage level analog indicator, one per source (primary and redundant).
    c. Current level analog indicator, one per source (primary and redundant)
    d. Ventilated metal case.
14. Manufacturer: Acopian Switching Regulated Redundant Power Package, or approved equal.

K. Instrument Control Panels/Cabinets Single Input Single Output 24VDC Instrument Loop Power Supply:

1. Number of inputs and voltage: One, 120 volts A.C.
2. Number of outputs and voltage: One, 24 volts D.C.
3. Type: Suitable for use as a single stand-alone power supply as well as parallel operation in conjunction with a second power supply and a redundancy/switchover module. Field selectable switch for single or parallel operation.
4. Topology: Switching type power supply.
5. Output Current, per unit: 5 ampere
6. Output Voltage Adjustment Range: 22 to 28.5 VDC, field adjustable
7. Output Voltage Ripple: 50 milliVolts at full load, measured peak-to-peak, maximum
8. Output load regulation: 2% maximum from zero to full load.
9. Output Protection: Integral current limiting and over voltage
10. Common Alarm Contact Ratings: 2 ampere
11. Mounting: Provide DIN rail mounting configuration
12. Accessories:
    a. Ventilated metal case.
13. Manufacturer: Sola/Hevi-Duty Model SDN 5-24-100P, or approved equal.

L. Instrument Control Panels/Cabinets 24 VDC Power Supply Redundancy/Switchover Module:

1. Number of inputs and voltage: Two, 24 volts D.C.
2. Number of outputs and voltage: One, 24 volts D.C.

3. Type: Unit shall have the capability to immediately and automatically transfer load from the primary to the backup (secondary) power supply unit, as also shown on the PLANS.
4. Topology: Switching type power supply.
5. Output Current, per unit: 40 ampere
6. Vout Alarm Contact Ratings: 2 ampere at 240 volts A.C.
7. Vin Alarm Contact Ratings (2 contacts, one for each input): 2 ampere at 240 volts A.C.
8. Mounting: Provide DIN rail mounting configuration.
9. Accessories:
   a. Ventilated metal case
   b. Green light emitting diode (LED) to indicate output voltage exceeds 18 volts D.C.
10. Manufacturer: Sola/Hevi-Duty Model SDN 30/40RED, or approved equal.

M. Control Power Transformer:

1. Size: 300 VA
2. Primary Voltage: 120 VAC
3. Secondary Voltage: 24 VAC
4. Windings: Copper
5. Epoxy encapsulated to protect cores and coils against moisture and contaminants.
6. Integrally molded, flame retardant terminal blocks
7. Heavy gauge steel mounting plate
8. Accessories:
   a. Primary and secondary fuse holders with finger safe covers
9. Manufacturer: SOLA/Hevi-Duty SBE Encapsulated Series with specified accessories, or approved equal.

N. Thermostat:

1. Type: Heavy Duty line voltage type, suitable for use in controlling heating and cooling circuits. Shall have field adjustable temperature setpoint and also display the measured ambient temperature.
2. Measurement Range:
   a. Thermostat: 40 to 90 degrees Fahrenheit
   b. Thermometer: 50 to 90 degrees Fahrenheit
3. Sensing Element: Liquid filled with diaphragm and lever mechanism
4. Thermometer: Bi-metal type

5. Number and Type of Output Contacts: One Single Pole Double Throw (SPDT), snap acting

6. Contact Ratings:
   a. Heating Contact: 16 ampere at 120 Vac.
   b. Cooling Contact: 8 ampere at 120 Vac

7. Enclosure: Thermoplastic cover, suitable for vertical or horizontal mounting configuration

8. Accessories:
   a. Provide temperature adjustment knob
   b. Provide faceplate with each thermostat with temperature measured in degrees Fahrenheit. Faceplate shall include cutout such that the measured ambient temperature is visible.
   c. Mount each thermostat in a device enclosure on the enclosure backpanel in accordance with the manufacturer's recommendations.

9. Manufacturer: Johnson Controls Model T26T Series Line Voltage Thermostat, or approved equal

O. Terminal Blocks:

1. Type: Single Layer
2. Rating: 600 volts A.C./D.C., 55 ampere
3. Wire Range: No. 22 through No. 8 AWG
4. Material: Nylon or polypropylene
5. Quantity per Foot: 37
6. Terminal Block Colors: Provide terminal blocks with the colors as follows:

Terminal Block Function	Terminal Block Color
Terminal Blocks for 120 volts A.C. control/status/alarm/PLC monitoring	Red
Terminal Blocks for 120 volts A.C. power wiring	Black
Terminal Blocks for Ground wiring	Green
Terminal Blocks for 24 volts D.C. wiring	White

7. Manufacturer: Allen-Bradley Bulletin 1492-HM3, Phoenix Contact, or approved equal.
8. Accessories:
   a. All terminal blocks shall be provided with manufacturer's standard snap-in marker card and holder as manufactured by Allen-Bradley Bulletin No. 1492-SMN81, Phoenix Contact, or approved equal. Provide

manufacturer's standard typed adhesive terminal block tag for each terminal block.

b. Provide manufacturer's standard insulating jumpers, DIN rail, barriers, end anchors, etc., and all related mounting hardware as required for a complete and functional installation. Coordinate models of terminal block accessories such as end anchors, jumpers, DIN rail, etc., with the terminal blocks as specified hereinafter for a complete and functional installation.

P. Flexible spiral wrapping: Size as required. Provide as manufactured by Electrovert Spiraband, or approved equal.

Q. Plastic Wireway: Size as required. Also refer to the PLANS. Provide white color unless specified otherwise. Provide as manufactured by Panduit, or approved equal.

R. Multi-Outlet Power Strip: Furnish and install where shown on the PLANS.

1. Shelf Mounted: Provide white color unless specified otherwise. Multi-Outlet Power Strip shall have six 15 ampere, 120 volt NEMA 5-15R receptacles, U. L. Listed, main circuit breaker and integral on/off switch and indicator light and integral 4 foot power cord. Furnish and install as manufactured by Kensington Model 50688 or approved equal.

2.04 INSTRUMENT CONTROL PANELS/CABINETS UPS:

A. Where required by the PLANS, furnish and install the quantity of Uninterruptible Power Supply (UPS) units in each of the instrument/control/communication cabinets as shown on the PLANS. Each UPS shall be as follows:

1. The UPS shall have the apparent power rating as shown on the PLANS at minimum.

2. Each UPS shall operate from 120 VAC input power and shall provide 120 VAC output power. The UPS shall have a capacity to deliver the continuous full load AC output current shown on the PLANS at 120 VAC for fifteen (15) consecutive minutes at minimum, after the input power is removed. The output wave form shall be 60Hz sinusoidal with 5% maximum harmonic distortion. The UPS shall be filtered with 0.3% IEEE surge let-through and zero clamping response time, complying with UL 1449 requirements. The output shall have over current protection with latched shutdown.

3. The UPS shall consist of a field configurable bypass mode for automatic or manual bypass to the AC input source.

4. The UPS shall consist of automatic self test, executed on start up and at regular intervals (minimum of once per 14 days), and fault detection LED annunciating self test failure. Upon inverter module failure, the UPS shall automatically direct connect the connected load to the input power source and bypass the inverter module.

5. The UPS shall consist of automatic voltage regulation to maintain its sine wave output in accordance to these specifications. The settings for the UPS AC input source voltage high and low values to initiate transfer to battery power shall be field adjustable.

6. The UPS shall have the following front panel indications (LED type) and alphanumeric display:
   a. UPS On Status
   b. Fault
   c. On Battery
   d. Bypass
   e. Battery Replacement Needed

7. The UPS shall have the following audible alarms:
   a. UPS failure
   b. Battery failure
   c. Power loss to the UPS

8. The UPS shall have the following front panel mounted push buttons:
   a. Energizing UPS
   b. De-energizing UPS
   c. Manual UPS Self test initiation

9. The batteries shall be maintenance-free, fumeless, sealed, leak proof batteries that are accessible for replacement by the OWNER. The batteries shall be rated for use in Computer Rooms (by NFPA and all other Safety Codes). Batteries shall have maximum of five (5) hours to charge to 95 percent capacity. Provide battery extension cabinet where required to obtain a minimum duration runtime of fifteen (15) minutes for the connected load in the event of a power loss and where shown on the PLANS.

10. The UPS shall be provided with a manufacturer's standard external maintenance bypass switch. The external maintenance bypass switch shall be sized such to carry the full load current of the UPS inclusive of inrush current, at minimum. Also refer to the requirements shown on the PLANS. The maintenance bypass switch shall be installed in such a manner that the selector switch is accessible from the front of the control cabinet. Provide any additional accessories necessary to facilitate the installation of the maintenance bypass switch.

11. The UPS and the battery backup units shall be installed in NEMA-12 enclosures.

12. The UPS shall be able to operate from 0 to 40 degrees Celsius.

13. Accessories:
   a. The UPS shall consist of a relay I/O module which provides 24VDC, 1A rated relay output contacts. At minimum, the card shall consist of a dry contact indicating UPS fault, and a dry contact indicating requirement for

Battery Replacement. Wire the UPS fault alarm, the battery replacement alarm, and the UPS in bypass status in series to a 24VDC rated Type II control relay as specified in section 17200. An alarm contact from the 24VDC UPS fail relay shall be wired as a discrete input into the programmable logic controller to indicate a UPS common trouble/fail alarm. Also refer to PLANS for wiring to the UPS relay I/O module.

b. The UPS shall be provided with all necessary interconnecting cables, connectors, Windows compatible configuration software (if necessary), for a complete and functional installation.

14. Mounting
    a. Provide all upright position mounting supports necessary to facilitate installation of the UPS tower on the floor of the Instrumentation and Control Cabinet.
    b. Mount UPS within the control cabinet, without obstructing access to components within cabinet. Install UPS in accordance to manufacturer's requirements and recommendations, including proper UPS power termination, ventilation, and cooling.

15. The UPS shall have a two (2) year manufacturer's warranty at minimum after the final completion of the project.

16. The UPS shall be as manufactured by Eaton Model 9PX Series UPS with external maintenance bypass switch Eaton HotSwap MBP Model EHBPL****R-PDU1U (where **** is based on UPS rating shown on the PLANS or as required), and Relay Interface Card Eaton Model No. Relay-MS , or approved equal.

2.05 PROGRAMMABLE LOGIC CONTROLLERS "PLCS", AND ASSOCIATED EQUIPMENT

A. Refer to Specifications Section 17600, "Distributed Control System DCS" of the Specifications.

2.06 IDENTIFICATION

A. Instrument and Control Devices Identification

1. General:
    a. The device designations shall agree with those shown on the PLANS.
    b. Each device shall be provided with permanent type identifying nameplate.
    c. Nameplates:
        1) Type: 3-ply, 1/8" thick, rigid thermoset phenolic resin laminated cellulose paper base engraving stock per ASTM D-709, Type I. Nameplates shall be ASTM Grade ES-1, ES-2, or ES-3 as

applicable for the face and lettering colors specified hereinafter. Flexible or acrylic tags will be not be accepted.

2) Color: White-Black-White, unless shown otherwise on the PLANS.

3) Lettering: 1/4 inch height minimum unless shown otherwise on the PLANS, engraved through the face layer to the melamine middle layer.

4) Accessories: Provide holes for mechanical fastening.

2. Devices located on the face of, on the back, or inside of instrument control cabinets/panels:
   a. Devices which penetrate the door shall be provided with two nameplates, one located on face of the door and one located on the rear of the door.
   b. Nameplates located on the panels/cabinets face shall be secured with two Type 316-Stainless Steel screws.

3. Field mounted control and instrument devices:
   a. Securely hang nameplates from each instrument/control device by a flexible stainless steel snap-on type hanger/key-chain cord (neatly drill a hole through the top of the identification nameplate for this purpose).

B. Wire Tag:

1. Rating: Flame-Retardant,
2. Style: Heavy-Duty Industrial Grade
3. Type: Heat Shrinkable type.
4. Character Height: 1/8 inch.
5. Maximum Length: 2 inches.
6. Text Type: Typed with indelible marking process. Handwritten shall not be accepted.
7. Color: Yellow. Exception: Use White for 120 volts A.C. power circuits to instrument/devices, and branch circuit lighting and convenience receptacle circuits.
8. Manufacturer: “Raychem type Heavy-Duty Industrial Grade ShrinkMark Heat-Shrinkable Marking Sleeves”, or approved equal. Utilize "Raychem" Portable-Marking-System” complete with wire tag cartridges, or approved equal.

2.07 MISCELLANEOUS

A. Corrosion Resistant and Moisture Repelling Electrical Coating/Spray:

1. Color: Clear. Coordinate spray color with the Owner. Furnish and install the color requested by the Owner at No Additional Cost to the Owner.

2. Type: Corrosion resistant and moisture repellant fast drying spray coating sealant

3. Manufacturer: "3M" 1601 Clear-Color Fast Drying Sealer and Insulator, or approved equal.

PART 3 - EXECUTION

3.01 STORAGE

A. Storage: Refer to Section 17100.

3.02 PANEL ASSEMBLY

A. All panel assembly, internal wiring, device installation, tagging, etc. shall be accomplished by the ICS prior to shipment. All wiring shall be connected as shown on PLANS and all systems shall be thoroughly checked out prior to shipment of the panel to the site. Additional requirements are as described below.

B. Termination and Routing of Wiring:

1. Prior to being connected to any instrument or switch, all incoming wiring shall be terminated to terminal blocks located on an interior panel.

2. Each PLC shall have dedicated terminal strips for each analog input, analog output, discrete input, and discrete output module, with each point from each module wired out and terminated to terminal blocks i.e., all input/output module points, where shown active or as spare, shall be wired out and terminated to terminal blocks. Spare points shall be treated the same as any other active point and shall follow the same format described under wiring/terminal block tagging scheme/strategy/method. Also refer to and comply with the requirements of the PLANS.

3. Provide separate terminal blocks for power wiring, from control/discrete signal wiring, and from analog/instrument wiring. Additionally, segregate and isolate analog/instrument terminal strips from control/discrete signal wiring terminal strips from power wiring terminal strips.

4. Terminate shield wire of each shielded cable to a terminal point (block) on the terminal strip (i.e., treat as current carrying conductor), with each shield terminated to a dedicated terminal block. Extend No. 14 AWG insulated green ground wire from each shielded cable shield termination terminal point to the isolated main ground bar of the cabinet (shield/drain wire ground).

5. Wire spare contacts of each device (i.e., control relays, timing relays, selector switches, indicating/controlling instruments/devices, etc.) to terminal blocks for future use by the OWNER.

6. Tag each terminal block. All tags must be typed and neatly attached to the marking surface.

7. Tag each terminal strip/string of terminal blocks with nameplates as previously specified.

8. Terminal blocks shall have the colors previously specified according to the function of the terminal block.

9. Utilize manufacturer's standard terminal block insulated side jumpers for making connections between adjacent terminal blocks.

10. Route all wiring from a device (instrument, relay contact, push button, etc.) through the terminal block to the other device (instrument, relay contact, push button, etc.) rather than directly from one device to the other.

11. All wiring shall be neatly bundled, laced together and routed as required throughout the cabinet. Enclose wiring routed against the back panel in plastic wireways where possible. Otherwise, group where possible and wrap with flexible wire wrapping or waxed twine. Wiring routed on doors shall be routed such that the door can be fully opened without stressing the wiring.

12. Wire entering the cabinets shall enter through the floor, the side and/or the top of the cabinets via conduits with bushings or hubs.

13. Also refer to and comply with the requirements of the PLANS.

C. Wire Tagging

1. Tag each wire at each end.

2. Tag each wire in multi-conductor cable in addition to the overall cable.

3. Heat shrink all wire tags.

4. Wire Tag Content:
   a. Wiring of each equipment (such as Distribution Service Pump, Pump Discharge Control Valve, etc.) within the facility must be tagged different from any other equipment

   b. Terminal block terminal designation must be included in the wire tag.

   c. To represent all of the text to be shown, multiple wire tags may be needed at each end of the wire. Provide additional tags as necessary at no additional cost to the OWNER.

   d. Provide per Section 16200 "Wiring (600 volt and Below), subsection 3.03 "Wire Tagging Methodology".

D. Special and additional installation requirements associated with fiber optic communication system:

1. The fiber cables entering each cabinet shall be coiled, allowing at least 8-feet of additional cable. The coiled fiber shall be positioned vertically. The fiber bend radius upon entry and coiling must not be less than the minimum required for the cable.

2. The fiber optic cable shall be enclosed in a plastic, flex material. This flex material shall surround the cable for all routing of the cable.

E. After all wiring connections have been made, the Contractor shall apply the Corrosion Resistant and Moisture Repelling Electrical Coating/Spray to all wiring connections. Coordinate application with the Owner. The extent of spray application is further clarified as follows:

1. Spray shall be applied for all terminations of the following types of connections at a minimum:
   a. termination points, terminals, terminal blocks, ground bar, neutral bar/bus,
   b. lugs of circuit breakers, buses, doors, etc.
   c. exposed/stripped ends of each conductor, etc.
   d. bolt-on connections, split-bolt connections, ring lugs, etc.
   e. compression connectors, connector blocks, etc.
   f. all other connection types not listed above

2. Spray shall be applied for all terminations at the following types of equipment at a minimum:
   a. Local and main control panels, field instruments, junction boxes, field control stations, control relays, signal isolators, selector switches, pushbuttons, etc.,
   b. Panelboards, transformers, motor control centers, manual motor starters, contactors, light switches, light fixtures, etc.
   c. Motor termination enclosures, valve actuators, cathodic protection system, package control panels of process equipment, etc.
   d. Security system devices, cameras, roadway gate operators, etc.
   e. Convenience receptacles, scada receptacles, etc.
   f. All other types of equipment not listed above.

3.03 FIELD INSTALLATION

A. Install the panels in the locations shown on the PLANS. Also refer to the installation details shown on the PLANS.

B. All wiring shall be connected as shown on PLANS and all systems shall be thoroughly checked out.

C. Install all equipment in accordance with the drawings and instructions furnished by the manufacturer.

D. Inspect each new instrument, control component, etc., before installation. Replace deficient items.

E. Touch-up and restore damaged surfaces to factory finish to match existing.

3.04 INSTALLATION REPORT

A. After installation, the manufacturer's representatives shall inspect the installation and prepare a report or reports to include the following:

1. A list of all deficiencies found.
2. Recommend corrective action for all deficiencies.
3. Certification that the item or system is properly installed, except as noted.

3.05 FIELD CALIBRATION AND TESTING

A. Calibrate instruments and prepare calibration reports. All calibration shall be performed by factory-trained technical personnel. Calibration shall be witnessed by OWNER.

B. The complete system shall be tested by an experienced factory-trained technical person. All system tests shall be witnessed by OWNER.

C. Perform the following tests using simulated inputs:

1. Check the overall system and each subsystem to see that they function as specified based on simulated inputs at each sensor and at each set of field contacts monitored. This check shall include the testing of all automatic functions, sounding of alarms, shutdowns, etc.
2. Check the overall accuracy of each new and modified instrument loop to ensure that it is within acceptable tolerance.

D. If defects are found under simulated conditions, make corrections and retest.

E. After start-up, test the complete system under actual conditions to determine that all specified functions can be performed.

F. After completion of testing, submit a System Test Report. This report shall include:

1. Certification that the system is operating correctly and within tolerances.
2. Listing of calculated tolerances for each new and modified instrument loop.

3.06 OPERATION AND MAINTENANCE TRAINING

A. Start-up Training: Provide required instruction to the OWNER's personnel during start-up period.

B. Special Training School: Provide services of a factory-trained instructor or instructors for a period of not less than two (2) working days for the purpose of instructing the OWNER's personnel in the correct operating and maintenance procedures for all the instrument and hard-wired control system components and the entire Instrumentation and Control System, and Communications System including the various instrument and control system cabinets/panels installed in this project. This is in addition to the training requirements defined in Section 17600 of the Specifications. The date of this school shall be scheduled with the OWNER, but will be after the entire instrument and control systems is in operation. Also, refer to the additional training requirements defined in Section 17600 of the Specifications.

3.07 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this Section. All costs are included in the Base Bid.

END OF SECTION

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PART 1 - GENERAL

1.01 SUMMARY

A. The work performed under this Section consists of furnishing, installing, calibrating and placing into satisfactory service the following field mounted devices/elements as shown on the PLANS:

1. Hydrogen Gas Analyzer and Indicating Transmitter
2. Intelligent Temperature Measuring Indicating Transmitters

B. Refer to the "Instrument List" on the PLANS.

1. The minimum and maximum range in the Instrument List provides the required calibrated span of each instrument.
2. Where the instrument functions as a switch, the minimum/maximum value indicates the low/high switch setting. Where the value is noted as "N/A", the low or high setting is not applicable for the instrument.
3. The Instrument List is not inclusive of all instruments required by this contract. Refer to Part 1 of this section for quantities of spare parts and instruments in addition to those listed in the Instrument List. Refer to the PLANS and other specification sections for additional instruments required by these contract documents.
4. Where a PLAN sheet number is shown in the list, and a "/" is listed, the number shown prior the "/" refer to a specific detail number on that sheet.
5. The list includes PLAN drawing numbers applicable to the specific instrument installation and wiring. This list of drawing numbers is not complete. Refer to the PLANS for additional instances and requirements for these instruments.
6. Where items in the list are left blank and/or not entered, the CONTRACTOR shall note these items on the data submittals and request input from the Process Mechanical ENGINEER for clarification during submittal review.

C. Instrument Type Code:

1. An Instrument Type Code identifies each instrument and consists of alphabetical character(s) followed by three numeral characters.
2. Example Instrument Type Code: "A123".
3. The Type Code listed in the Instrument List serves as a means to reference each instrument in the Instrument List to the specifications.

1.02 RELATED REQUIREMENTS

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.

C. Related work as called for on the PLANS, as specified herein or in other Sections of the Specifications.

1.03 SUBMITTALS

A. Submit the following in accordance with the requirements of Sections 01300 and 01730 of the Specifications and in accordance to Section 17100 of the Specifications:

1. Shop drawings and product data.
2. Wiring schematics for all equipment.
3. Submit a physical mock-up of a product/item where a mock-up is noted/required for the product/item in this specification section.
4. Certifications of training associated with proper installation the fiberglass reinforced vinyl ester support channel system.
5. Test Reports: Completed and certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
   a. Include factory calibration for each instrument with stated accuracy.
6. Operation and maintenance manuals.
   a. Include all completed and certified test reports in manuals.
      1) Refer to specifications herein for transmitter ambient and process fluid temperature ranges to be used for basis of accuracy analysis.
7. Submit detailed listing of training class curriculum including, as a minimum, the following at least four (4) months prior to class:
   a. Specific topics for each instrument, including but not limited to, general trouble-shooting, calibration, wiring, and general set-up/configuration.
   b. Anticipated duration of class for each instrument type.
   c. Names of instructor(s) for each specific instrument.
   d. Refer to instrument by Instrument Type Code as listed in this specification section where applicable.

1.04 QUALITY ASSURANCE

A. Standardization: All equipment of the same Instrument Type Code to be the product of a single manufacturer.

B. Notify the ENGINEER if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

C. Material Compatibility:

1. Material selections of instrument components noted in this section provide a basis for the minimum material compatibility requirements.

2. Instrument component material selections shall be subject to additional restrictions and compliance with recommendations of instrument manufacturers for the intended service.

1.05 TOOLS AND SPARE PARTS

A. Furnish the following spare Field Instrumentation and Sensing Devices in conformance with the Specifications:

1. One set of complete Type A107 Hydrogen Gas Analyzer and Indicating Transmitter, furnished complete with accessories specified.

2. One set of complete Type T103 Intelligent Temperature Measuring Indicator/transmitter, furnished complete with accessories specified.

B. Spare instrument shall be configured to match one of the installed instruments.

1. Where multiple instruments of the same type are installed:
   a. Configuration of spare instrument shall be as directed by Engineer during construction.

   b. Request input from Engineer during submittal process as to which configuration is desired for the spare instrument.

C. Furnish the following tools:

1. Two (2) handheld HART communicator configurators, each complete with 120 VAC charging station, test lead kit, rechargeable battery, USB cable, carrying case, hand strap, SD card, and software as manufactured by Yokogawa Model YHC5150X FieldMate Handheld Communicator, no equal.

1.06 ACCEPTABLE MANUFACTURERS

A. Each type of Instrument shall be manufactured by a single Instrument manufacturer and additional requirements as follows:

1. All temperature indicating transmitters shall be manufactured by a single Instrument manufacturer.

B. Refer to the individual instrument subsection in PART 2 - PRODUCTS, below.

PART 2 - PRODUCTS

2.01 HYDROGEN GAS ANALYZER AND INDICATING TRANSMITTERS

A. A107 Requirements:

1. General:
   a. Furnish gas analysis and indicating/transmitter for the detection of Hydrogen gas concentration and with integral auxiliary fail alarm relay.
   b. Measure combustible gas concentrations using poison-resistant catalytic bead type sensors.
   c. Provide in a dual condulet version to allow the sensor only to be mounted near the ceiling while the transmitter display and controls are mounted near finished floor.
      1) Field installed flexible tubing shall be permanently installed to allow calibration gas to be fed to the sensor from the transmitter location.

2. Indicating/Transmitter Module:
   a. General Performance:
      1) Four-wire loop
      2) Shall operate from power supplies of 12-30 VDC, 200 mA maximum.
      3) Response Time: (T90) 10 seconds.
      4) Accuracy: ±10% of value.
      5) Electronic Repeatability: ±1%
      6) Electronic Linearity: ±0.5%
      7) Zero Drift: Less than 2% full scale per month
      8) Span Drift: Less than 3% per month
      9) Operating Temperature:
         a) Toxic Gas Measurement: -30º to +60º C
         b) Combustible Gas Measurement: -40º to +70º C
   b. Local Indicator:
      1) LCD local indicator (integral to gas Indicator/Transmitter).
      2) Range: 0-100% LEL.

c. Operator Local Controls:

1) Provide operational interface for service personnel

2) Four (4) minimum controls to allow calibration functions, lock the 4-20mAdc output, or manually vary the output signal for test procedures.

d. Transmitter Output:

1) 4-20 mAdc insulated analog output linear to gas concentration.

2) Capable of driving external loads up to 1000 ohms with a standard 24 VDC supply.

3) Electrically isolated from ground and from all other internal circuits that are not isolated from ground.

4) Output isolation shall be provided by the transmitter.

e. Alarm Relays:

1) Three (3) SPDT Relays, each 5 A at 230 VAC resistive.

2) Relay coil programmable either normally energized or normally de-energized.

3) Alarms field programmable for Setpoint, Hysteresis, Alarm delay, Manual or automatic reset, and Instrument fault.

f. Instrument Enclosure:

1) Housed in explosion-proof enclosure with window.

2) Magnetic controls shall be operable through the enclosure window without removing the cover.

3) Transmitter and sensor shall meet explosion-proof specifications for Class 1, Group B, C, & D, Class 2, Groups E & F; and Class 3 locations.

g. Electronic Module:

1) The Combustible Gas transmitter electronic module shall be designed as plug-in unit that can be easily removed for service without disconnecting field wiring.

2) Modules shall be interchangeable, allowing immediate exchange of transmitter electronics in the event of a fault in a module.

h. Auto-Test Function:

1) Hydrogen generator shall be used to provide an Auto-Test function that will automatically test combustible gas sensors for response every 24 hours.

2) During sensor functional test, the transmitter output shall be held at 4 mA.

3) In the event that the Auto-Test detects a sensor failure, the output of the transmitter will go to 3 mA to provide remote trouble indication.

4) The electronic transmitter shall keep a test log and display the results of each test on the LCD display.

5) The log shall be accessible to operators through an information sequence activated by the front magnetic switches.

3. Sensor Module:
   a. Housing/Assembly:
      1) Housed in a 316 stainless steel housing with flame arrestor to meet explosion-proof requirements.
      2) Contained in a housing that also incorporates an electrochemical hydrogen generator.
      3) Sensing element assembly shall consist of factory furnished explosion proof junction box, combustible gas sensor and calibration adaptor.
      4) Includes 1/4" barbed fitting calibration port to accept 1/4" outside diameter flexible PVC tubing.
   b. Furnished with the following manufacturer accessories:
      1) Splash Guard: Clear polycarbonate splash protection guard.
      2) Calibration Adapter: for routine zero air and span gas calibration checks.
      3) Flowcell Assembly: An assembly to allow for sample draw system in addition to monitoring a flowing sample stream.
      4) Sensor Module Keeper (case).
      5) Provide all required accessories including hardware to mounted transmitter and sensor.
   c. The sensor module and the indicator/transmitter module shall be the product of the same manufacturer.

4. Gas Calibration Kit:
   a. As minimum, the Gas Calibration Kit shall include the following:
      1) One (1) 103-Liter non-disposable gas aluminum cylinder filled with HYDROGEN calibration gas.
      2) Mechanical Valve and Flowmeter assembly (inclusive of mechanical gauge) suitable for use with the gas cylinder.
      3) Includes 1/4" barbed fitting gas discharge port to accept 1/4" outside diameter flexible PVC tubing fixed adjacent to transmitter.

4) Hard brief-case type calibration case made specifically for housing the Cylinders, mechanical valve and flowmeter assemblies, and all that is associated with the Calibration Kit.

b. The Calibration Kit shall be the product of the same manufacturer as the gas Indicator/Transmitter module and the Sensor module.

5. Each Indicator/Transmitter module shall be as manufactured by Analytical Technology, Inc. "Ati" Series D12 or Engineer approved equal Universal Gas Transmitter, complete with the specified accessories.

6. Each Sensor module shall be as manufactured by Analytical Technology, Inc. "Ati" Model UniSens or Engineer approved equal HYDROGEN gas sensor, complete with the specified accessories.

7. Each Gas Calibration Kit shall be as manufactured by Analytical Technology, Inc. "Ati" or Engineer approved equal complete with regulator.

2.02 INTELLIGENT TEMPERATURE MEASURING INDICATORS/TRANSMITTERS

A. T100 Series General Requirements:

1. The Temperature Indicators/Transmitters shall be of the intelligent type and shall measure and convert the temperature from a temperature sensor element to a 4-20 mAdc electrical and digital output that is Linear with the actual temperature of fluid being measured.

2. The Temperature Indicator/Transmitters shall have the following features:
   a. Communication Signal: Two-wire 4-20 mAdc (loop powered) and HART digital output (software selectable) proportional and Linear with the actual measured temperature of the process variable.
   b. Temperature Span: 140 degrees F to 1200 degrees F.
   c. Accuracy: 0.02 percent of calibrated span of the 4-20mA analog output
   d. Stability: 0.25 percent of calibrated span or 0.5 degrees Fahrenheit, whichever is greater, for five years.
   e. Operating Temperature: –40 degrees Fahrenheit to +185 degrees Fahrenheit.
   f. DC Loop Supply Voltage: 12 to 42 VDC.
   g. Output Load: 0 to 1,250 Ω (Ohms).
   h. Conduit Connection: 1/2 inch NPT.
   i. Digital Accuracy: +/- 0.18 degrees Fahrenheit.
   j. Hardware: All bolts, process connections, and hardware shall be Type 316 Stainless Steel.
   k. Housing:

1) Enclosure of the Indicator/Transmitter shall be Low-copper aluminum.

2) Rated for use in Class-I, Division 1, Groups C and D hazardous areas (as classified by NFPA 70 National Electrical Code)

l. Local Indication:

1) Local indicator (integral to Indicators/Transmitters) which is calibrated in "degrees F" and to the range of the transmitter (or to the range of the process variable range selected by the Owner).

2) The indicator shall be of the digital type with liquid crystal display (LCD), driven by the loop power (4-20mA at 24 VDC), and have an accuracy within 0.075 percent full scale.

m. Local Operators:

1) The Indicator/Transmitters shall be equipped with operators on the face of the unit for configuration and calibration functions.

2) External and/or internal source/devices (such as handled programmer and/or Portable Computer) shall not be required in order to configure, program, and calibrate the Indicators/Transmitters.

n. Mounting Hardware: Manufacturer's Type 316 Stainless Steel mounting bracket suitable for mounting transmitter on 2-inch pipe stand, support channel, wall/panel or other surface as shown on PLANS. Refer to the PLANS for additional requirements.

3. The Temperature Sensor Element for each Indicator/Transmitter shall have the following features:

a. General: 4-wire, single element, 100Ω (Ohms) Resistance Thermometer Detector (RTD), Platinum, in accordance with IEC 60751 Class A.

b. Enclosure: Enclosed in a Type 316 Stainless Steel sheath.

c. Sensor Lead Wire Termination: For application where sensor is not mounted integral to the transmitter, provide sensor with aluminum connection head and cover with 1/2 inch NPT conduit connection.

d. Sensor Assembly: Type 316 Stainless Steel spring-loaded style sensor assembly having 1/2 inch NPT.

e. Temperature Range: -328 to +932 degrees Fahrenheit.

f. Length: Provide length of element required to span entire length of thermowell and required sensor connections.

4. The Sensor Element Thermowell shall have the following features:

a. General: Each Sensor Element shall be provided with a Type 316 Stainless Steel Full Length thermowell (protecting tube).

b. Shank Style: Tapered shank geometry, with smaller diameter at terminal tip of thermowell.

c. Hardware: The thermal well assembly shall be furnished complete with external threads, explosion proof union, and required accessories/hardware for installation onto process mechanical piping, duct/chamber and/or raceways shown on PLANS. All mounting accessories/hardware shall be constructed of Type 316 Stainless Steel.

1) Exception: Union is not required when thermowell is mounted only to transmitter and not mounted to process mechanical piping, duct/chamber, raceways or other fixed element.

5. Each Intelligent Temperature Measuring Indicator/Transmitter along with the associated Temperature Sensing Element and System shall be as manufactured by Rosemount Series 644 Intelligent Temperature Transmitters with Series 214C Sensor Element, Series 114C Thermowell and specified manufacturer furnished accessories, or Engineer approved equal.

B. T103: Intelligent Temperature Measuring Indicators/Transmitters with Integral Temperature Element for Ambient Temperature Measurement

1. General Requirements for T100 Series Intelligent Temperature Measuring Indicators/Transmitters apply to this type of instrument.

2. The Temperature Indicator/Transmitters shall have the following features:
a. Mounting: Integral to sensor.

3. The Sensor Element Thermowell shall have the following features:
a. Length: 6 inches.

b. Transmitter with required 316 Stainless Steel connector fittings.

PART 3 - EXECUTION

3.01 STORAGE AND HANDLING

A. The field instrumentation and control devices shall be handled carefully to prevent damage. Units shall be stored in a weatherproof structure prior to installation.

3.02 INSTALLATION

A. General: The following apply to all products in this Section:

1. Furnish and install devices in locations shown, and per the details provided in the PLANS, unless otherwise noted.

2. Unless otherwise specified, all instrument mounting channels, pipes, pipe caps, etc. shall be Type 316 stainless steel; also, all hardware connecting and securing

the mounting hardware and instruments such as nuts, bolts, cush-a-clamp assembly pipe/tube clamp, all instrument tubing channels and their support elements, etc. shall be Type 316 Stainless Steel. Refer to Division 16 Specifications for additional support system requirements.

3. All field mounted sensor/control/instrument devices shall be permanently identified. The device designations shall agree with those shown on the PLANS. Each device shall be provided with permanent type identifying nameplate. Nameplates, unless otherwise specified, shall be shaped as a circle and shall be constructed of 3-ply "White-Black-White" laminated phenolic material having engraved letters approximately 1/4 inch high extending through the white face into the black layer. Securely hang nameplates from each sensor/control/instrument device by a flexible stainless steel snap-on type hanger/key-chain cord (neatly drill a hole through the top of the identification nameplate for this purpose).
   a. All proposed instruments shall receive new permanent identification.
   b. All existing instruments shown on the PLANS that are to be relocated and/or to receive new wiring for signals/power/etc. as part of this Work shall also receive new permanent identification. Remove the existing identification tags from existing instruments that are to receive new tags.

4. Nameplates:
   a. Type: 3-ply, 1/8" thick, rigid thermoset phenolic resin laminated cellulose paper base engraving stock per ASTM D-709, Type I. Nameplates shall be ASTM Grade ES-1, ES-2, or ES-3 as applicable for the face and lettering colors specified hereinafter. Flexible or acrylic tags will be not be accepted.
   b. Color: White-Black-White
   c. Lettering: 1/4 inch height, minimum, engraved through the face layer to the melamine middle layer.
   d. Accessories: Provide holes for mechanical fastening.
   e. Attachment Means: Securely hang nameplates from each sensor/control/instrument device by a flexible stainless steel snap-on type hanger/key-chain cord (neatly drill a hole through the top of the identification nameplate for this purpose).

5. Submit listing of all field instruments tag numbers for verification by OWNER.

6. Install, set, adjust and test all devices per the requirements of Section 17100 of the Specifications. Also, setpoint values shall be reviewed by and coordinated with the OWNER/ENGINEER.

7. The instruments specified under this Section of the Specifications shall be installed and calibrated to match its respective system and per the requirements of the Contract Documents and as recommended by the manufacturers.

8. Verify ranges with Owner and Engineer prior to ordering instruments.

9. Refer to Specification Section 16150 "Raceways, Fittings, and Supports" for instrument support channel system requirements.

10. Make all final connections and terminations per the instrument manufacturers' recommendations.

11. Unit and Range of each instrument from the Instrument shall be as listed in the Appendix A Instrument List and shall be clearly noted on the instrument Submittals. Instrument ranges shall be confirmed via the submittal process with the ENGINEER prior to ordering any of the Field Instrumentation and Sensing Devices specified under this Section of the Specifications. Select instruments within approved manufacturer series that provide the greatest level of accuracy within the span of measurements listed in the Instrument List.

12. Submit comprehensive calibration sheets to the OWNER indicating "as found" and "final settings". Submit a typical (blank) field calibration sheets/forms to the OWNER for review and comment prior to utilizing the same for recording calibration parameters. Include final field calibration settings in the Operation and Maintenance Manuals.

13. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances including weld-o-lets, valves, etc. for proper installation of instruments.

14. Provide manufacturer's services to perform start-up and calibration/verification.

15. Verify factory calibration of all instruments in accordance with the manufacturer's instructions. Return factory calibrated devices to the factory if they do not meet the field verification requirements for calibration.

16. Where piping is provided as a support element in lieu of support channels, including, but not limited to, 2-inch diameter pipe posts, all open ends of piping shall be capped with a welded cap having the same material and diameter as the piping. Refer to the PRODUCTS PART 2 Section of this specification and the PLANS for additional requirements.

17. For each instrument specified in this section that includes an integral display screen/indicator and/or user interface button(s), unless indicated otherwise on the Drawings, install the instrument such that the top of the display screen/indicator and/or user interface button(s) is as high as possible but no greater than 60 inches above the finished floor of the working area immediately adjacent to the instrument. Refer to the Drawings for additional requirements. Refer to additional installation height requirements for each specific instrument as specified in this section.
    a. Note: For each instrument that includes an instrument tubing connection, refer to the applicable instrument tubing installation requirements in this section for the required slope of the instrument tubing and other additional requirements that impact the installed height of the instrument.

B. Hydrogen Gas Analyzer with Remote Mounted Indicating/Transmitters:

1. Indicating/transmitter shall be remote mounted separate from sensor.

2. Sensor shall be mounted as high as possible in the room and at least within 6" below highest roof deck of space.

3. Provide cable and conduit between sensor and transmitter.

4. Provide raceway system and required cable per instrument sensor factory requirements between sensor junction box and remote mounted indicating/transmitter.

C. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents. Instruments may be shown on the PLANS, in the Specifications or both.

3.03 OPERATION AND MAINTENANCE TRAINING

A. Start-up Training: Provide required instruction to the OWNER's personnel during start-up period.

B. Special Training School: Provide services of a factory-trained instructor or instructors for each of the specified and installed Field Instrumentation and Sensing Devices for a total period of not less than Two (2) working days for the purpose of instructing the OWNER's personnel in the correct operating and maintenance procedures for all the Field Instrumentation and Sensing Devices specified under this Section of the Specifications and installed in this project. This is in addition to the training requirements defined in other Sections of Division 17 of the Specifications. The date of this school shall be scheduled with the OWNER, but will be after the entire instrument and control system is in operation and respective Operation and Maintenance Manuals have been submitted and revised per ENGINEER comments. Also, refer to the additional training requirements defined in other Sections of Division 17 of the Specifications.

1. Provide one (1) month prior notice to schedule class events with OWNER.

2. Submit detailed listing of class curriculum including, as a minimum, with the following at least four (4) months prior to class:
   a. Specific topics for each instrument, including but not limited to, general trouble-shooting, calibration, wiring, and general set-up/configuration.
   b. Anticipated duration of class for each instrument type.
   c. Names of instructor(s) for each specific instrument.
   d. Refer to instrument by Instrument Type Code as listed in this specification section where applicable.

3.04 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this Section. All costs are included in the Base Bid.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. Furnish all labor, materials, equipment, and incidentals required, and shall install complete, ready for operation, and test the distributed control system, hereinafter termed the System as shown on the PLANS and as specified.

B. The Instrument and Control System Contractor (ICS) shall provide equipment, materials, software, calibrations, training, startup assistance and system check-out, and other services that are required to successfully interface and interconnect the System and associated equipment that are specified or designated in PLANS or provisions of these specifications for the purpose of providing a fully integrated and functional control system as specified.

C. The ICS shall be responsible for furnishing and installing the Communication System for the Distributed Control System "DCS" shown on the PLANS (installation and testing of the fiber optic cable, Media Converters and validation of communication system), and as specified hereinafter.

D. The ICS shall be responsible for all modifications to the Owner's existing distributed control system as also shown on the PLANS.

E. Refer to the PLC Input/Output Schedule and wiring schematics on the PLANS and other subsections of this Specification Section for requirements related to the PLC Input/Output.

1.02 DISTRIBUTED CONTROL SYSTEM DESCRIPTION

A. General:

1. The Distributed Control System (DCS) as shown on the PLANS and specified herein, includes, but is not limited to, the following:
    a. Programmable Logic Controllers Subsystem (PLCs),
    b. Communication System Application and System Software,.
    c. PLC networking/data communications over existing and proposed Ethernet TCP/IP network as well as Modbus Plus network
    d. Interface with Power Monitoring Units, Protective Relays, and other devices as shown on the PLANS.
    e. Interface with process/mechanical equipment having packaged control systems as shown on the PLANS.

1.03 RELATED SPECIFICATIONS

A. Refer to Section 17100.

B. This Section covers work related to the Distributed Control System DCS and its Subsystems. Note that this Section does not stand-alone. Many key technical definitions, functional requirements, training, submittals, etc. requirements for the DCS are given in Section 17100 "Process Instrumentation and Control Systems (PICS)".

1.04 DISTRIBUTED CONTROL SYSTEM (DCS) SUBMITTALS

A. General: Submit the following in accordance with the Section 01300 of the Specifications.

B. Hardware:

1. Shop drawings, product data, bill of materials
2. Control system architecture block diagram,
3. Wiring diagrams
4. Spare parts listing.

C. Fiber-Optic Cable Plant Design: Submit fiber-optic cable types, installation procedure, and fiber flux budget/gain margin calculations.

D. Fiber Optic and Ethernet System Copper Cable Testing Submittal: Provide a complete set of cable test results for the testing required under subsection 3.02 "Fiber-Optic System and Ethernet System Copper Cable – Source Quality Control", this Section of the Specifications. Format and quantity of reports shall be per the requirements of Section 01300 of the Contract Specifications Provide the OWNER with a typewritten results of all tests, including a description of the equipment tested, the date and time of day tested, test values, results. Test reports shall be signed by the ICS representative

E. PLC I/O "Host Pack Template" Spreadsheets:

1. The Owner has standard Excel spreadsheet templates, termed the "Host Pack Template" of enumerating information about the I/O points for the installation of the system. Upon completion of the system installation and PAT, the Owner shall supply to the ICS the Host Pack Template in Excel format for the contractor to complete.
2. The Contractor is to complete and submit in Excel format the Owner provided Host Pack Template.

F. Operations and Maintenance O&M Manuals:

1. Hardware: As minimum, provide the following:
   a. Final approved versions of all shop drawing submittals.

b. Component Manufacturers' O&M Manuals including manuals to cover installation, operation, maintenance, troubleshooting, and calibration.

c. List of spare parts and expendables provided and list of spare parts recommended.

G. Training Submittals: Submit not less than 4 weeks prior to the time that the associated training is to be provided. Submit per Section 17100.

H. Additional submittals as required by Specifications Section 17100, Section 01300 and Section 01730 of the Contract Specifications.

I. Refer to the requirements of Specifications Section 17100.

J. Configuration System Submittal per subsection 2.09, this Section of the Specifications.

1.05 SPARE PARTS

A. Provide the following spare parts at minimum:

1. Provide the following SPARE equipment, complete with all accessories:
   a. PLC processor units (CPU Modules): Two (2) of each type used
   b. PLC power supply units: Ten Percent (minimum of 2) of the number required for each type of PLC used
   c. PLC RIO Head module: Ten Percent (minimum of 2) of the number required for each type of PLC used
   d. PLC RIO Drop Module: Ten Percent (minimum of 2) of the number required for each type of PLC used
   e. PLC I/O Module (AI, AO, DI, DO): Ten Percent (minimum of 2) of the number of each type used.
   f. PLC rack: One (1) of each type used.
   g. PLC rack extender module complete with all accessories: One (1) of each type used.
   h. Local Area Network (LAN) system component (converter, modem, transceiver, etc.): Ten percent (minimum of 2) of each type provided
   i. Ethernet NOE module: Ten Percent (minimum of 2) of the number required for each type of PLC used.
   j. One (1) ethernet switch complete will all modules for each type used
   k. One (1) spare Type 1 OIU complete with all accessories.
   l. All spare parts shall be of the same manufacturer, model, and software revision as the installed component, and shall be provide complete with all accessories.

PART 2 - PRODUCTS

2.01 GENERAL

A. Refer to Section 17100.

B. General Requirements:

1. Power source parameters:
   a. 120 volts A.C., plus or minus 10 percent, 60 Hertz
   b. Regulators and power supplies required for compliance with the above shall be provided.
2. Materials and equipment used shall be U.L. approved wherever such approved equipment and materials are available.
3. All components and interconnecting wiring shall be provided as required to satisfy the functional and operational requirements of this Specification.
4. All equipment to be installed in a control panel or on a rack, including switches, etc., shall be tagged according to the guidelines outlined in Section 17200 “Instrumentation and Control Cabinets and Associated Equipment”, of these Specifications.
5. Unless otherwise specified, tag each outlet face plate with white Label with black lettering of minimum height ¼” where label is TTP Continuous polyester thermal transfer label as manufactured by Tyco, or approved equal, with ribbon and printer by label manufacturer.
6. Communication Cables: Provide all cables for interconnection between all components of the DCS inside the and/or in duct/conduit banks, as applicable. These cables shall include cables to the various PLCs I/O racks, power supplies, central processing units, patch panels, ethernet switches, computers, etc. All cables shall be tagged per Section 17200 “Instrumentation and Control Cabinets and Associated Equipment”.
7. All equipment cabling, including copper Ethernet cable, all patch cords, etc., shall be tagged according to the guidelines and tagging labeling system outlined in Section 17200 “Instrumentation and Control Cabinets and Associated Equipment”, of these Specifications. For tagging of cables with manufacturer pre-connected cable ends, e.g. patch cords, power cords, etc., furnish and install SP self-laminating polyester labels (minimum 2” long along length of cable) with thermal transfer printable, low profile translucent polyester film with a permanent acrylic adhesive as manufactured by Tyco, or approved equal, with respective printer and ribbon type by label manufacturer. Tag all S.O. type power cords with the tag of the equipment served.

2.02 PROGRAMMABLE LOGIC CONTROLLERS (PLCS)

A. General:

1. Provide all hardware and software features required to make the PLCs totally operational.

2. The PLCs shall include, but not be limited to, the equipment components called for on the PLANS and in these specifications. Capacities and/or quantities shown are minimum. Provide additional capacity or units as necessary to meet the functional requirements.

3. Availability:
   a. Subsystem Availability Calculation: The Subsystem availability (A) for the PLC's is defined as average of the individual PLC availabilities (Ai) times the nonspecific availability (NA). That is, A = NA*(Al*A2*A3 ... *An)/n, where n is the number of PLC's.

   b. Availability Requirements: The PLC's availability shall be at least 99 percent.

   c. Component and Backup Definitions: For purposes of the availability calculations, each PLC, each PLC power supply, its process I/O, and data highway interface is considered to be an individual component. There are no backup components.

4. Communications:
   a. Failure of any PLC or DCS component connected to the communications system network shall not affect the ability of the remaining components on the network to communicate with each other.

   b. Data Highway DH Link Requirements:

      1) Fast Ethernet (100BaseFX), as minimum

      2) Minimum operating distance: 10,000 feet

      3) Rate: 10/100 Mbps.

   c. The remote I/O shall be single channel, Ethernet, in a ring network topology. All remote I/O cabling and installation shall be in accordance to the Modicon M580 System Planning Guide.

   d. Fiber Optic Link Requirements:

      1) Minimum gain margin: 4 dB. The Flux Budget/Gain margin is the difference between the system gain of the fiber-optic transmitter/receiver and the calculated loss budget of the fiber-optic link (fiber-optic cable, connectors, patch cords, and splices) when both are expressed in decibels (dB)).

   e. All copper Ethernet cables shall have a category 6A RJ-45 connector and category 6A cable. The connector end shall be the Boot type connector and preinstalled by the Ethernet patch cable manufacturer.

f. Modbus and Modbus Plus shall be in accordance to the Square D standard for cable pin out and cable type, as well as the end devices to be interconnected. The cables shall be shielded. Refer to the Square D Modicon Hardware Reference Guide for Modbus serial cable pin out and guidelines. Furnish and install ruggedized taps and terminators were available from the manufacturer.

B. Type 1 Programmable Logic Controllers (PLCs):

1. Each programmable logic controller shall consist of central processor, process controller, power supply, memory, input/output, interconnecting cables, and optional items as specified.

2. Power Supply:
   a. Manufacturer: MODICON M580 Automation Series model number BMX CPS 3500, No Equal.

   b. Accessories: Provide screw clamp type removable terminal blocks, Modicon M580 model number BMX XTS CPS10 No Equal.

3. Central Processor:
   a. Memory: 65535 Kbytes, at minimum

   b. Ports: 1 mini B Universal Serial Bus (USB) port, 1 Ethernet service port, and 2 Ethernet Modbus TCP/IP port

   c. Accessories: Provide a 4 GB SD Memory Card, as manufactured by the CPU manufacturer.

   d. Manufacturer: Schneider Electric MODICON M580 BME P58 4040, No Equal.

4. Discrete Input Module DI:
   a. Manufacturer: MODICON M580 Automation Series Model number BMX DAI 1604 No Equal.

5. Discrete Output DO:
   a. Manufacturer: MODICON M580 Automation Series model number BMX DRA 0805 No Equal.

6. Analog Input Module AI:
   a. Manufacturer: MODICON M580 Automation Series model number BMX AMI 0810 No Equal. With each module, furnish and install cage clamp terminal block Modicon Model BMXFTB2800, No Equal.

7. Analog Output Modules AOs:
   a. Manufacturer: MODICON M580 Automation Series model number BMX AMO 0410 No Equal

8. Network Option Ethernet (NOE):

a. Manufacturer: Modicon M580 Automation Series model number BME NOC 0311 Module, No Equal.

9. PLC Racks
   a. X bus and Ethernet Bus interface. Manufacturer: MODICON M580 Automation Series model number BME XBP 1200 No Equal

10. PLC Rack Extender Module:
    a. Accessories:
       1) Provide X bus extender cord, length as required per PLANS, manufactured by Extender Module manufacturer, model number BMX XBC series No Equal.
       2) Provide line terminator for extender module located at each end of the daisy chain, manufactured by the Extender Module manufacturer, model number TSXTLYEX, No Equal.
    b. Manufacturer: MODICON M580 Automation Series model number BMX XBE 1000 No Equal

11. Remote I/O Drop Module:
    a. Manufacturer: MODICON M580 Automation Series model number BME CRA 31210 No Equal.

12. Accessories:
    a. Unless specified otherwise, provide 20-way screw clamp type removable terminal block with each module, Modicon Model BMXFTB2010, no equal.

C. Type 2 Programmable Logic Controllers (PLCs):

1. Each programmable logic controller shall consist of central processor, process controller, power supply, memory, input/output, interconnecting cables, and optional items as specified

2. Power Supply:
   a. Manufacturer: MODICON M340 Automation Series model number BMX CPS 3500, No Equal
   b. Accessories: Provide screw clamp type removable terminal blocks, Modicon M340 model number BMX XTS CPS10 No Equal.

3. Central Processor:
   a. Memory: 4096 Kbytes, at minimum
   b. Ports: 1 mini B Universal Serial Bus (USB) port, 1 Modbus communication port, and 1 Ethernet Modbus TCP/IP port
   c. Accessories: Provide a 16 MB FLASH Memory Card, as manufactured by the CPU manufacturer.

d. Manufacturer: Schneider Electric MODICON M340 BMX P34 2020, No Equal

4. Discrete Input Module DI:
   a. Manufacturer: MODICON M340 Automation Series Model number BMX DAI 1604 No Equal

5. Discrete Output Module DO:
   a. Manufacturer: MODICON M340 Automation Series model number BMX DRA 0805 No Equal

6. Analog Input Module AI:
   a. Manufacturer: MODICON M340 Automation Series model number BMX AMI 0810 No Equal

7. Analog Output Module AO
   a. Manufacturer: MODICON M340 Automation Series model number BMX AMO 0410 No Equal

8. Network Option Ethernet (NOE)
   a. Manufacturer: Modicon M340 Automation Series model number BMX NOE 0100 Module, No Equal

9. PLC Racks:
   a. Manufacturer: MODICON M340 Automation Series model number BMX XBP 1200 No Equal

10. PLC Rack Extender Module:
    a. Accessories: Provide extender cord, length as required per PLANS, manufactured by Extender Module manufacturer, model number BMX XBC series No Equal.
    b. Manufacturer: MODICON M340 Automation Series model number BMX XBE 1000 No Equal

11. Accessories:
    a. Provide 20-way screw clamp type removable terminal block with each module, Modicon Model BMXFTB2010, no equal.

2.03 LAPTOP PROGRAMMING COMPUTER

A. Mother Board

1. A minimum of Intel Intel Core i7-7820HQ (Quad Core 2.90GHz, 3.90GHz Turbo, 8MB 45W, w/Intel HD Graphics 630)
2. 16GB, DDR4-2400MHz SDRAM, 1 DIMMS

B. Hard Drive (HDD)

1. Minimum 500GB Solid State Hard Drive.
2. The hard drive shall be partitioned with the NTFS file system type

C. Pointing Device and Keyboard

1. Keyboard
   a. Anti-microbial keyboard with number pad and backlight feature
2. The laptop shall consist of integrated dual pointing device
   a. Touchpad pointer and stick pointer
   b. Multi-touch touchpad with three buttons

D. Graphics Display

1. The integrated laptop display type shall be 15.6" UltraSharp FHD(1920x1080) Wide View Anti-Glare LED-backlit, non-touch

E. Peripheral Ports

1. 1 x SD Card Reader (SD, SDHC, SDXC, supporting up to 2TB);
2. 1 x Thunderbolt ® 3
3. 4 x USB3.0 with PowerShare;
4. 1 x mDP 1.4;
5. 1 x HDMI 1.4;
6. 1 x Headphone and microphone combo jack;
7. 1 x SmartCard Reader

F. Video

1. Minimum of Nvidia Quadro M1200 w/4GB GDDR5
2. The Computer shall have a special function key that enables the video card signal to be sent to the Laptop's LCD display, the HDMI output port, or both

G. Audio

1. The laptop shall consist of a minimum of Stereo: 20-bit stereo-digital to analog and 18-bit stereo analog to digital 16 bit integrated audio card
2. Dual integrated high quality speakers

H. Communication

1. The laptop shall at minimum have the following communication devices
   a. Intel WiFi Link 8265 Card (802.11ac + Bluetooth 4.2), 2x2
   b. Integrated 10/100/1000 BASE-TX Gigabit Ethernet communication with RJ-45 port interface

2. All communication drivers for each communication device shall be installed on the laptop.

I. Battery

1. The Laptop battery shall be user accessible and replaceable
2. Minimum 91Whr long life cycle Ion Polymer battery
3. The laptop is to have a charging unit to fully charge the battery while providing full power to the laptop.
4. The charging means shall also be a means of providing power to the laptop in the event that the battery is fully discharged.

J. Software

1. Each software installed on the laptop shall be legally licensed to the owner.
2. Operating System
   a. Microsoft Windows® 10 Professional, 64-bit, with service packs and media
3. Drivers and Laptop Maintenance utilities
   a. All drivers and Laptop maintenance and diagnostic utilities including battery percent charged, estimate of laptop remaining operation time when powered only by the battery source, shall be Windows 10 Professional compatible.
   b. Drivers for the following shall be installed on Windows 10 Professional system are:
      1) Network Communications
      2) Audio card
      3) Video card
      4) Battery time of operation estimation and battery percent charged
      5) Laptop suspend (sleep) mode
4. Provide the media (DVD-ROM or USB) and installation guide for all software, including the operating system and all media for complete system recovery to the Laptop system state as initially provided out of the package by the Laptop manufacturer.

K. USB Flash Drives

1. Provide two (2) 128 gigabyte USB 3.0 removable Flash Drive Units.

L. Backpack Case

1. Provide Nylon Deluxe back pack case sufficiently large to house the Laptop unit

2. The case should have additional pouches/pockets for storage of cables, CD-R disks, etc.

M. The Laptop shall include a five (5) year manufacturer's warranty covering parts and labor and next business day on site support as well as ProSupport and 3 Year CompleteCare Accidental Damage Protection

N. The Laptop shall be manufactured by Dell and shall be the most current version of the Dell model Precision Workstation series laptops.

O. Each laptop shall have a USB-C type port with Thunderbolt version 3 or later for interconnection to docking station. The Laptop ports for docking station shall be configured for direct interconnection with the Dual USB-C Thunderbolt docking cable without any modification to the docking station's manufacturer's docking cable connectors.

P. For each Laptop, furnish docking station to be connected to laptop with the included docking cable. Docking station shall be manufactured by the same manufacturer as Laptop manufacturer. At minimum, the docking station shall have the following features:

1. Docking Cable: Docking cable shall interconnect docking station to Laptop. The docking cable shall have interface with Dual USB-C Thunderbolt Dock for interconnection to Laptop without any modification to cable connectors. Furnish one docking cable per docking station.
2. Support a Minimum of three (3) displays at full HD (1920 x 1080 p) each.
3. Minimum 210W AC adapter, rated for 120VAC, 60Hz. primary power.
4. The docking station shall, at minimum, have the following ports
   a. Minimum 2 x USB 2.0 - 4 pin USB Type A
   b. Minimum 2 x USB 3.0 - 9 pin USB Type A
   c. Minimum 1 x display / video - HDMI - 19 pin HDMI Type A
   d. Minimum 1 x display / video - DisplayPort - 20 pin DisplayPort
   e. Minimum 1 x display / video - Mini DisplayPort
   f. Minimum 1 x network - Ethernet 1000 - RJ-45
   g. Minimum 1 x headset - output - mini-phone 3.5 mm
   h. Minimum 1 x audio - output - mini-phone 3.5 mm
   i. Minimum 1 x video - VGA - 15 pin D-Sub (DB-15)
   j. Minimum 1 x Thunderbolt 3 - Thunderbolt - 24 pin USB-C port.

2.04 TYPE 1 OPERATOR INTERFACE UNIT

A. General: The OIU shall effectively be a Graphical front end to the local PLC network and have complete read/write access to all registers of the local PLC network to which the OIU is connected.

1. Communication:
   a. The OIU shall utilize Ethernet communication protocols to communicate to other peripheral devices, including PLC's, as shown in the contract drawings.
   b. The ICS shall provide the necessary cabling for communicating with the OIU for programming and configuration purposes with a personal computer. The program cabling shall be USB and minimum of 12 feet in length.
   c. The ICS shall install the necessary cabling, connectors, and termination for communication between the OIU Ethernet interface and the Ethernet network.

2. Software:
   a. Operating System: Magelis Operating system, with latest service Pack, preinstalled by the OIU manufacturer.
   b. Software: Vijeo Designer run time software, preinstalled by the OIU manufacturer.
   c. All additional necessary software, software drivers, etc. complete will all licenses, as necessary for the proper operation of the OIU.

3. Mounting:
   a. Mount in control panel door as shown on the Drawings. All communication ports shall be accessible with OIU installed in the control panel.
   b. Provide mounting hardware as required and install OIU according to manufacturer's instructions and requirements. Provide trim accessories to seal the gap between the OIU and control panel door.

4. Accessories:
   a. 1 Gigabyte secure digital (SD) card, manufactured by the OIU manufacturer.
   b. All necessary cables, connectors, and terminators. Minimum cable length shall be 12 feet

B. Display Module:

1. Type: Flat Color Active Matrix (TFT) LCD display type, with touch screen capability
2. Size: 15" diagonal

3. Minimum Resolution: 1024 x 768 pixels,
4. Colors: 16,000,000 colors
5. Power Input: 24 volts DC.
6. Communication Ports:
   a. One (1) USB 2.0 Type A port,
   b. One (1) USB 2.0 Mini-B port
7. Physical Environment:
   a. Ambient Air Temperature: +32° to +140° Fahrenheit
   b. Ambient Air Humidity: 10% to 90% Relative Humidity Non-condensing
   c. Free of corrosive gases
8. Cooling Method: Natural air circulation
9. Enclosure: NEMA 4X rated
10. Manufacturer: Schneider Electric Magelis GTU HMIDT732, No Equal.

C. Box Module:

1. Power Input: 24 volts DC.
2. Memory:
   a. System Card: SD Card 1 GB
   b. Internal Memory: 256 MB RAM
   c. Backup Memory: 512 kB NVRAM
3. Communication Ports:
   a. Two (2) RJ-45 Ethernet ports,
   b. Two (2) USB 2.0 Type A ports,
   c. One (1) USB 2.0 Mini-B port,
   d. One (1) RJ-45 RS-485 serial port,
   e. One (1) 9 pin RS-232/422/485 serial port,
   f. Two (2) SD card slots [one (1) system and one (1) storage]
4. Communication Protocol: Ethernet, Modbus TCP/IP
5. Output Interface:
   a. One (1) 300 mW speaker output,
   b. One (1) 24 VDC auxiliary alarm output
6. Physical Environment:
   a. Ambient Air Temperature: +32° to +140° Fahrenheit
   b. Ambient Air Humidity: 10% to 90% Relative Humidity Non-condensing

c. Free of corrosive gases

7. Cooling Method: Natural air circulation

8. Manufacturer: Schneider Electric Magelis GTU HMIG3U, No Equal.

2.05 TYPE 2 OPERATOR INTERFACE UNIT

A. General: The OIU shall effectively be a Graphical front end to the SCADA network and have complete read/write access to all registers of the plant SCADA network to which the computer is connected.

B. Display screen:

1. Type: Flat Color Active Matrix (TFT) LED display type, with touch screen capability

2. Size: 19" diagonal

3. Minimum Resolution: 1920 x 1080 pixels

4. Colors: 32 bit color

5. Accessories:
   a. Pop up window for numeric keypad and alphanumeric keypad displays

   b. Touch sensitive protective film harsh environment coating

C. Hardware:

1. Communication Ports:
   a. Two (2) RS-232 ports

   b. Four (4) USB 3.0 ports

   c. Three (3) 10/100/1000 Base Tx Ethernet port. Ports may be obtained by use of Ethernet module installed in PCI slot

2. Enclosure: Stainless steel, NEMA 4 rated

3. Power Input: 24 volts DC

4. Hard Drive: Minimum of 256 GB solid state disk

5. Processor: Intel i7 processor with minimum 3 GHz clock speed

6. Memory: 8 GB RAM, at minimum.

D. Communication:

1. The OIU shall utilize Ethernet communication protocols to communicate to other peripheral devices, including PLC's, as shown in the contract drawings.

2. The ICS shall install the necessary cabling, connectors, and termination for communication between the OIU Ethernet interface and the Ethernet network.

E. Software:

1. Operating System: Windows 10 Professional, 64 bit Operating system, with latest service Pack, preinstalled by the OIU manufacturer.
2. Latest version of GE Proficy IFix runtime client license, key, and software media. Furnish for installation by the Owner.
3. All additional necessary software, software drivers, etc. complete with all licenses, as necessary for the proper operation of the OIU.

F. Keyboard:

1. Sealed to Nema 4X standards, heavy duty industrial type keyboard suitable for harsh environment.
2. 113-key functionality (includes a separate numeric keypad and 20 function keys) Integrated Button Pointer.
3. Key Material - Industrial silicone rubber
4. Key Travel: 0.098", 0.45 lb. nominal actuation force, 10 million cycle life
5. Three year warranty
6. Full-Travel Wall Mount Keyboard with Button Pointer Model KB-R2-WMT-BLK-4-USB as manufactured by Hope Industrial.
7. Mount Keyboard on front of panel door below OIU using keyboard vendor provided mounting hardware and template. Mount keyboard such that the typing surface of the keyboard is 38” above finished floor (floor on which user is standing to face OIU), inclusive of housekeeping concrete pad height. Mount keyboard such that it is horizontally centered on the door.

G. Mounting:

1. Mount OIU on face of control panel at door shown on the Drawings. All communication ports shall be accessible with OIU installed on the control panel.
2. Provide mounting brackets and hardware as required and install OIU and all accessories according to manufacturer’s instructions and requirements.

H. Accessories:

1. All necessary cables, connectors, and terminators. Minimum cable length shall be 12 feet
2. Keyboard Bracket.
3. Panel mountable, gasketed, Nema 4X rated split cable gland kit for all cables connecting to OIU through control panel door. Split cable gland kit shall be as manufactured by Icotek Kel-ER, or approved equal.
4. Nema 4X gasketed cable grommets for final cable connection to OIU per the OIU manufacturer’s recommendations.

I. Manufacturer: Noax Technologies Steel Series S19 complete with specified accessories, No Equal.

2.06 ETHERNET MEDIA CONVERTER

A. Ethernet Media Converter: The Ethernet Media Converter shall be used for the conversion of Ethernet protocol between fiber optic and copper media. The Media Converter shall be as follows:

1. 24VDC power input rating.
2. DIN Rail mountable
3. Port types on the media converter shall be 100Mb/s or 1000Mb/s, depending on use of the media converter. For fiber interconnection whose other fiber end is a switch uplink SFP module, then the 1000Mb/s shall be used, otherwise the 100Mb/s shall be used.
4. Ports (100Mb/s):
   a. one (1) 100Base-FX Single-Mode fiber port, with SC-Duplex connector
   b. one (1) RJ45 10/100Base-TX copper port
5. Ports (1000Mb/s):
   a. One SFP Module slot:
      1) Furnish and install 1000BASE-LX/LH SFP module shall be as identified in this section of the specifications.
   b. one (1) RJ45 10/100/1000Base-TX copper port
6. Class 1 Div 2 Rating
7. Operating temperature range: -40°C to 75°C
8. The Media Converter shall have DIP switches for features as follows and shall be set as follows:
   a. 100Mb/s
      1) Port Alarms Disabled
      2) Link pass through Enabled
      3) Fiber Full Duplex Enabled
      4) Converter Mode Enabled
   b. 1000Mb/s
      1) SFP - Enable Auto Negotiation for the SFP
      2) Copper - Enable Auto Negotiation for the copper
      3) Link pass through Enabled
9. Lifetime warranty

10. The Media Converter shall be the industrially hardened type as manufactured by Transition Networks, the SISTG10xx-211-LRT-B series for 1000Mb/s, and the SISTF101x-211-LRT series for the 100Mb/s, where xx and x are substituted as needed to meet the specifications.

B. Modbus TCP/IP to RS-485 Converter: Where shown on the PLANS, furnish and install Modbus TCP/IP to RS-485 converter. The converter shall convert between Modbus TCP/IP Ethernet protocol and Modbus RTU serial RS-485 protocol. The converter shall be as follows:

1. 24VDC power input rating.
2. DIN Rail mountable
3. Ports:
   a. One (1) RJ45 10/100Base-TX copper port.
   b. One (1) RJ-45 port for serial configuration of converter
   c. RS-485 connector terminal strip, 4-wire capable
4. Operating temperature range: -25°C to 70°C
5. The Media Converter shall have DIP switches for setting serial connection Bias, Termination, and 2-wire / 4-wire jumper
6. Furnish the following accessories:
   a. RS232 serial to Ethernet port configuration kit model (TCSEAK0100) as manufactured by Schneider Electric
7. The Modbus TCP/IP to RS-485 Converter shall be the PowerLogic EGX100 as manufactured by Schneider Electric.

2.07 ETHERNET SWITCHES

A. General:

1. Provide and install Ethernet switches for the Distributed Control System DCS. The ICS shall schematically design the routing and specify component make and model. The components herein shall be provided as minimum for bidding purposes. It is anticipated that Ethernet Switch technology will advance over time and the latest model of Ethernet switch having the features specified hereinafter as a minimum shall be furnished and installed.
2. All switches shall be provided with the latest firmware from the manufacturer, where applicable. Switches to be stacked must be supplied with the same feature set, IP LAN, IOS, etc. Contractor shall furnish Ethernet switch stack cabling for switches capable of being stacked. Owner shall install Ethernet switch stack cabling.
3. All switches shall be supplied with the manufacturer's support contract for the duration of two years starting from final completion of the project. At minimum switches manufactured by Cisco shall have the Cisco SMART NET for a

minimum of two (2) years starting from final completion of the project and registered in the name of the Owner.

4. SFP Module: Each SFP module shall be the 1000BASE-LX/LH Long Haul module with duplex LC single mode connector. All SFP modules shall be as manufactured by Cisco.

5. Should the specified switch be designated as "End of Life" and/or discontinued by its manufacturer, contractor shall furnish and install an alternate switch, whose specifications meet or exceed the specified switch, by the same manufacturer and that is not designated as "End of Life" and/or discontinued by the switch manufacturer.

B. Type 1 Ethernet Switches:

1. Power Input: 120 volts A.C., 60 Hz

2. Port Quantity and Type: 24 10/100/1000BaseTx ports, and modular uplink module to support 4 sockets for SFP 1G/10G modules. Note: The previously specified quantity of ports shall be provided even if the PLANS show lesser quantity of ports.

3. Module: Furnish and install minimum four (4) 1000BaseLX/LH SFP modules in each switch. All SFP modules shall be the 1000BASE-LX/LH Long Haul module with duplex LC single mode connector.

4. Manufacturer: Cisco Catalyst C9200-24T-A, or approved equal.

C. Type 2 Ethernet Switches:

1. Provide Type 1 Ethernet Switch, this Section of the Specifications, with the exception that the copper Port Quantity shall be 48 10/100/1000BaseTx ports and that only two SFP modules are required.

2. Furnish and install second, redundant power supply for this switch.

D. Type 3 Ethernet Switches:

1. Provide Type 1 Ethernet Switch, this Section of the Specifications, with the exception that the SFP modules are not required.

E. Type 4 Ethernet Switches:

1. Power Input: 120 volts A.C., 60 Hz.

2. Port Quantity and Type: minimum 24 10/100/1000Base TX ports, 4 of which are dual purpose ports which the user may elect to use as a 10/100/10000Base TX port or as a socket for an SFP module.

3. Module: Provide minimum one (1) 1000BaseLX/LH SFP modules with each switch. All SFP modules shall be the 1000BASE-LX/LH Long Haul module with duplex LC single mode connector.

4. Mounting: 19-inch rack mounting with necessary kit. Refer to the PLANS.

5. Accessories:

a. LAN Base image

b. For each Ethernet switch, furnish and install 120VAC Ethernet Switch power supply, model PWR-RGD-AC-DC-250 by Cisco.

6. Manufacturer: Cisco Industrial Ethernet Switch IE-4010-4S24P.

F. Type 5 Ethernet Switches:

1. Power Input: 24 volts D.C.
2. Port Quantity and Type: Eight (8) 10/100 BaseTx Ethernet ports
3. Switch shall be the unmanaged type and without power over Ethernet
4. Operating Temperature Range: -40 degrees Celsius to 85 degrees Celsius
5. Accessories: 2 year support contract with the manufacturer, to begin from the time that the system is commissioned and turned over to the Owner.
6. Manufacturer: N-Tron 508TX, or approved equal

G. Type 6 Ethernet Switches:

1. Power Input: 24 volts D.C.
2. Port Quantity and Type: Five (5) 10/100 BaseTx Ethernet ports
3. Switch shall be the unmanaged type and without power over Ethernet
4. Operating Temperature Range: -40 degrees Celsius to 85 degrees Celsius
5. Accessories: 2 year support contract with the manufacturer, to begin from the time that the system is commissioned and turned over to the Owner.
6. Manufacturer: N-Tron 405TX, or approved equal.

H. Type 7 Ethernet Switches:

1. Power Input: 120 volts A.C., 60 Hz
2. Port Quantity and Type: Eight (8) 10/100/1000 BaseTx Ethernet ports and 2 combo ports. Each combo port shall consist of one (1) SFP based Gigabit Ethernet port.
3. Module: Provide minimum two (2) 1000BaseLX/LH SFP modules with each switch. All SFP modules shall be the 1000BASE-LX/LH Long Haul module with duplex LC single mode connector.
4. Enclosure: Sealed, rated NEMA 4X
5. Mounting: DIN rail mount or 19-inch rack mounting with necessary kit, as applicable. Refer to the PLANS.
6. Software: LAN Base manufacturing license
7. Accessories:
   a. Provide a one year support contract with the manufacturer, to begin from the time that the system is commissioned and turned over to the OWNER

b. For each Ethernet switch where shown to be installed on 19" rack in PLANS, furnish and install 19-inch DIN-rail adapter for rack mounting, model STK-RACK-DINRAIL= by Cisco, or approved equal.

c. For each Ethernet switch, furnish and install 120VAC Ethernet Switch power supply, model PWR-IE170W-PC-AC= by Cisco, or approved equal.

8. Manufacturer: Cisco Industrial Ethernet IE-4000-16GT4G-E, or approved equal.

I. Accessories:

1. Furnish and install mounting brackets and hardware as required to install each Ethernet Switch according to manufacturer's instructions and requirements

2. Furnish and install all necessary cables, connectors, and terminators as required for a complete and functional installation

2.08 FIBER-OPTIC CABLES AND CONNECTORS AND HARDWARE GENERAL SPECIFICATIONS REQUIREMENTS

A. General: Provide and install fiber-optic cables, connectors, panels, cords, and enclosures for the Distributed Control System DCS. The ICS shall schematically design the routing and specify component make and model. The components specified herein shall be provided as minimum for bidding purposes.

B. Each fiber cable, as depicted on the PLANS, represents a minimum of two (2) fiber strands. A loose tube fiber cable, as depicted on the PLANS, represents the quantity of fiber strands equal to the loose tube fiber strand count as specified in this section of the specifications.

C. Fiber-Optic Cables:

1. Multiple types of fiber optic cable are required for this project as hereinafter specified. Unless specifically shown otherwise on the PLANS, all fiber optic cable shall be Type 1.

2. Type 1 Fiber Optic Cable:
   a. Cable shall be Communication System Data Highway "DH" Fiber-Optic Cable. Each link external to/outside the respective Building/Room containing the Main Control Panels MCPs and the PLC Cabinets shall consist of loose tube fiber-optic cables (one cable for primary data highway communications, and another for secondary/backup data communication highway DH).

   b. Cable shall consist of 72 strands of Single Mode fiber.

3. Type 2 Fiber Optic Cable:

   a. Cable shall be Security System Data Highway cable as well as Telephone System Data Highway cable. Each link external to the respective Building/Room containing the Security System Control Panels

and the Telephone System Control Panels shall consist of loose tube fiber-optic cables as shown on the PLANS.

b. Hybrid Multi Mode and Single Mode fiber type.

c. Cable shall consist of 18 strands of Single Mode fiber and 18 strands of Multi Mode fiber.

4. Type 3 Fiber Optic Cable:

a. Cable shall be Security System Data Highway cable. The cable shall be loose tube fiber-optic cable.

b. Multi Mode fiber type.

c. Cable shall consist of 6 strands of Multi Mode fiber.

5. General Requirements for all types of Fiber Optic Cables:

a. All fiber optic cable shall be Loose tube fiber cable

b. Construction: Loose tube construction, allowing for thermal expansions and free movement of the fiber within the protective container.

c. Protective Coverings: Continuous and be of the same material, free from holes, splices, blisters, and other imperfections.

d. Flooding Compound: Applied into the interior of the fiber buffer tubes.

e. Strength members:

1) Integral part of the cable construction

2) Sufficient to support the stress of installation and to protect the cable in service.

f. Outer cable jacket: polyethylene (PE), except for the fiber that is run inside a building.

g. Additional Requirements:

1) Lightning resistant.

2) Fully water blocked.

h. Manufacturer: ALTOS loose tube type Fiber-Optic cable as manufactured by Corning Cable Systems LLC, or approved equal.

6. Each fiber optic cable shall be routed in a conduit that is dedicated only to that cable, and shall contain no other cable, unless explicitly noted in the drawings.

7. Optical fibers:

a. Coated with a suitable material to preserve the intrinsic strength of the glass.

b. Protected by a protective tube, a jacketed strength member, and an exterior jacket.

8. Fibers that are multimode shall be graded index, solid glass waveguides with the following characteristics:
    a. Nominal core diameter: 62.5 microns.
    b. Outside clad diameter: 125 microns.
    c. Minimum ellipicity: 2.0 percent.
    d. Minimum Numerical Aperture (NA): 0.275.
    e. Maximum attenuation (850 nm): 2.7 db/Km.
    f. Minimum bandwidth (850 nm): 800 MHz/Km.
    g. Maximum attenuation (1300 nm): 1.0 db/Km.
    h. Minimum bandwidth (1300 nm): 800 MHz/Km.
9. Fibers that are single-mode shall be solid glass waveguides with the following characteristics:
    a. Nominal core diameter: 8.3 microns.
    b. Outside clad diameter: 125 microns.
    c. Maximum attenuation (1310 nm): 0.5 db/Km
    d. Maximum attenuation (1550 nm): 0.4 db/Km
10. Glass cladding: Nominally concentric with the fiber core.
11. Each fiber shall be continuous with no factory splices

D. Fiber Optic Cable Terminations:

1. All fibers in all loose tube, fiber-optic cable ends shall be “fanned-out’ using a Buffer Tube Fan-Out Kit for the respective cable to allow direct connectorization of the fiber-optic cable. Thereafter, all fibers shall be attached to a connector, of the respective type for that patch panel adapter in which the fiber is installed and of the same fiber mode as that of the cable.
2. In addition to the Buffer Tube Fan-Out, the fiber optic termination shall be accompanied by a furcation Unit and Loose tube Cable End kits. The Loose Tube Cable End terminates the cable jacket and aids in cable water blocking, as well as buffer tube strain relief. Furnish and install single mode kits and multi-mode kits corresponding to the type of fiber optic cable terminated.
3. Provide a minimum 20.0-foot coil of spare fiber in each manhole throughout the cable length as well as at each patch panel.
4. Do not splice or terminate Fiber-Optic cable in underground electrical manholes and/or handholes. Also do not splice Fiber-Optic cables in any location other than Main Instrument Control Panels, PLC cabinets, and or Patch panels located in indoor climate controlled environment.
5. All fiber optic cables shall be tested for performance and loss after termination and installation to verify that at least a 4dB power safety margin is obtained between all transmitters and receivers. Test data for each fiber and safety margin

calculations for each fiber path shall be provided to the Owner and Engineer after installation to verify conformance with this specification.

6. Additional Requirements:
   a. Provide a minimum 20.0-foot coil of spare fiber in each manhole throughout the cable length as well as at each patch panel.
   b. Terminate fiber optic cable only at the low voltage control panel and motor control center as shown on the PLANS. Do not splice fiber optic cables elsewhere.
   c. Terminate all strands of a loose tube fiber optic cable in one, and only one, spider fan out kit.
   d. All fiber optic cables shall be tested for performance and loss after termination and installation to verify that at least a 4dB power safety margin is obtained between all transmitters and receivers. Test data for each fiber and safety margin calculations for each fiber path shall be provided to the OWNER and ENGINEER after installation to verify conformance with this specification.

E. Fiber Optic Connectors:

1. The fiber-optic device and the fiber cable end shall use the same type connectors.
2. All fiber strands associated with a Loose tube fiber cable shall be have an SC single mode connector at both ends of the strand.
3. An “SC-Duplex” connector is two (2) SC connectors abutted next to each other. Hence, a single “SC-Duplex” connector shall carry two fibers. Similarly, a single “SC-Duplex” adapter shall accept two fibers:
4. All outdoor Fiber Optic Cable shall be connectorized, at each end of the cable, to a patch panel located inside the building to which the cable is routed.
5. All fiber strands at both ends of each Fiber strand of a Fiber Optic Cable shall be terminated with a single mode SC connector, where two such connectors are joined together to form a single mode “SC-Duplex” Connector. Where fiber strand terminates directly to a fiber/optic communication device (e.g., security camera device), connector type shall be the type as required to mate with connector(s) on device.
6. Use fusion splice-on type connectors, except for those patch cords which are to be preconnectorized by the manufacturer. The connector shall be factory pre-polished connector and shall have a factory terminated pre-cleaved fiber strand pigtail that is suitable for machine aligned fusion splicing. The connector shall have a ceramic ultra PC polish Zirconia ferrule, color coded buffer, cleave protector, splice protection boot, and dust protection cap. Connectors shall be manufactured by “FIS Cheetah Splice-On Connector”, or approved equal. The connector shall conform to the following:
   a. Single-mode insertion loss (typical/maximum): 0.2db/0.3db. Multi-mode insertion loss (typical/maximum): 0.4db/0.5db.

b. The Insertion loss is the db loss across two (2) connectors, of the same type, which are mated with each other using a fiber optic adapter of that same type.

c. Durability: < 0.2 db per 500 reconnects.

d. All connectors shall have a ceramic zirocnia ferrule and shall be Ultra PC polished.

F. Fiber-Optic Patch Panels:

1. General Requirements For Each Patch Panel:

a. Each port on a fiber optic patch panel, as depicted on the PLANS, represents an interconnection to a minimum of two (2) fiber strands. Those ports depicted on the PLANS connected to a loose tube fiber cable represents an interconnection to a minimum of the number of fiber strands within the loose tube fiber optic cable, in accordance to the loose tube fiber strand count as specified in this section of the specifications.

b. All Fiber Optic Cables shall be attached to connectors that are then manually inserted into adapters on the patch panel. The fiber optic may be attached by a means that is removable in the future, e.g., wire ties.

c. Labeling:

1) In addition to the device/wire tagging requirements described in Section 17200 “Instrumentation and Control Cabinets and Associated Equipment”, provide additional labels as described below.

2) Overall Connector Panel Labels: Printed on the patch panel case by the Manufacturer. Provide unique, alphanumeric designation.

3) Connector Panel Adapter Label: Each adapter on each Connector Panel shall have clearly labeled, printed, alphanumeric designation that is unique to that Connector Panel and printed on the connector panel by the Manufacturer.

d. Each patch panel shall be accompanied with a typed patch panel schedule with the following columns: Adapter ID, Cable Side, User Side, described as follows:

1) adapter ID: The adapter ID shall be of the form XX-YY, where:

a) XX is the Connector Panel identifier shown by the panel manufacturer

b) YY shall represent the adapter number within the Connector Panel.

2) Cable Side:

a) Indicate the source of the fiber optic strands. Use the “patch panel tag”-XX-YY designation where applicable.

3) User Side:

a) Indicates the device (PLC, patch panel, etc.) connected to the adapter.

4) A Hard Copy print out of each Patch Panel Schedule shall be provided to the OWNER and ENGINEER. A soft copy on CD-R media of the patch panel schedule shall also be provided to the OWNER and ENGINEER.

e. Employ consistent and uniform application of identifier and adapter numbering assignment to individual fiber strands along the entire span and route of each fiber optic cable.

2. Each Type 1 Fiber Optic Patch Panel shall be as follows:
   a. Mounting: 19" rack mountable, with necessary brackets. Refer to the PLANS
   b. Capacity: Up to 12 connector panels
   c. Connector Panels: Minimum of six (6) connector panels, with six (6) SC-Duplex single mode adapters of ceramic type. Furnish and install additional connector panels as required to terminate all fiber strands of cables terminated to patch panel. Refer to PLANS. Unused slots of patch panel shall be covered with blank panels. Commence termination of panels from the left side of patch panel (when viewing front/user accessible side of panel), and leave right most panels un-terminated, where applicable, as spare
   d. All unused fiber optic connector ports shall be covered with a dust protector covering provided by manufacturer of connector
   e. Manufacturer: Corning Cable Systems LLC, Model CCH-04U, or approved equal.

3. Each Type 2 Fiber Optic Patch Panel shall be as follows:
   a. Mounting: Wall mounted with necessary mounting bracket kit and any additional accessories.
   b. Capacity: Up to two (2) connector panels
   c. Connector Panels: Two (2) connector panel, with six (6) SC-Duplex single mode adapters of ceramic type per connector panel.
   d. All unused fiber optic connector ports shall be covered with a dust protector covering provided by manufacturer of connector.
   e. Manufacturer: Corning Cable Systems LLC, Model WCH-02P, or approved equal.

4. Each Type 3 Fiber Optic Patch Panel shall be as follows:
   a. Mounting: 19" rack mountable, with necessary brackets. Refer to the PLANS
   b. Capacity: Up to 4 connector panels

c. Connector Panels: Minimum of two (2) connector panels, with six (6) SC-Duplex single mode adapters of ceramic type. Furnish and install additional connector panels as required to terminate all fiber strands of cables terminated to patch panel. Refer to PLANS. Unused slots of patch panel shall be covered with blank panels. Commence termination of panels from the left side of patch panel (when viewing front/user accessible side of panel), and leave right most panels un-terminated, where applicable, as spare

d. All unused fiber optic connector ports shall be covered with a dust protector covering provided by manufacturer of connector

e. Manufacturer: Corning Cable Systems LLC, Model CCH-02U, or approved equal.

5. Each Type 4 Fiber Optic Patch Panel shall be as follows:
   a. Mounting: Wall mounted with necessary mounting bracket kit and any additional accessories.

   b. Capacity: Up to six (6) connector panels

   c. Connector Panels: Six (6) connector panel, with six (6) SC-Duplex single mode adapters of ceramic type per connector panel.

   d. All unused fiber optic connector ports shall be covered with a dust protector covering provided by manufacturer of connector.

   e. Manufacturer: Corning Cable Systems LLC, Model WCH-06P, or approved equal.

6. Fiber-Optic Patch Cords:
   a. General:

      1) Use for indoor runs of fiber cable between a fiber-optic device and a fiber-optic patch panel, between adapters on the user side of two patch panels, or between two fiber optic devices

      2) All fiber patch cords shall not consist of any splices of the fiber strands

      3) Each fiber in each patch cord shall be placed in individual tight thermoplastic buffer tubes and protected with kevlar strength members and enclosed with a thermoplastic jacket with an outer diameter of at least 2.5mm

      4) Each patch cord shall consist of at least two (2) fibers, according to the fiber count requirements of the communication devices the cable is interconnecting

      5) Each patch cord shall be pre-connectorized with the appropriate type connector by the manufacturer

      6) Provide minimum length of six feet. Provide additional length as required for the application

7) Patch cords shall be selected with connector ends to mate/match the equipment/device/patch panel connector to which they interconnect. Duplex devices/patch panel connectors shall interconnect with duplex patch cords. Patch cord mode type (single mode or multi mode) shall be the same as that of device mode type and fiber patch panel connector connected fiber strand mode type with which patch cord is interconnecting

8) Patch cord Connectors: connectors on each end of fiber optic patch cord shall mate/match that of the device/patch panel connector to which it is interconnecting on that respective end. All connectors shall have ceramic zerconia ferrule. All single mode connecters shall be Ultra PC Polish. The connector mode type (single mode or multi mode) shall be the same as that of the fiber strand of the patch cord.

   a) In particular, single mode SC-Duplex to LC-Duplex Single Mode Patch Cords shall have SC-Duplex connector on one end of the patch cord and LC-Duplex with spring on the other. The SC-Duplex connectors shall be single mode, with ceramic zirconia ferrule and Ultra PC polish. The LC-Duplex connectors shall be single mode, with ceramic zirconia ferrule, with an integrally mounted spring, and Ultra PC polish

   b) In particular, single mode SC-Duplex to SC-Duplex Single Mode Patch Cords shall have SC-duplex connectors on both ends of the patch cord. SC-duplex connectors shall be single mode, with Ultra PC polish ceramic zirconia ferrule.

9) Single Mode Fiber Optic Patch Cords:

   a) Diameter: 8.3/125 micron

   b) Type: Single Mode Fiber

   c) Features: Adhere to the attenuation and bandwidth parameters as previously specified for fiber-optic cable and connectors as described in these specifications.

10) Manufacturer: Corning Cable Systems LLC, Model Zipcord cables, or approved equal.

2.09 ETHERNET COPPER CABLES AND CONNECTORS AND HARDWARE GENERAL SPECIFICATIONS REQUIREMENTS

A. General:

1. Provide and install copper cables, connectors, patch panels, and cords for the Distributed Control System DCS. The ICS shall schematically design the routing

and specify component make and model. The components herein shall be provided as minimum for bidding purposes.

2. Ethernet Copper Connectors: All copper Ethernet cables shall have a Category 6A boot type RJ-45 connector.

3. The installed Ethernet copper media system (including cable, data outlets, connectors, patch cords, patch panels, etc.) shall at minimum meet the TIA/EIA-568-C.2-10 Category 6A standards.

B. Ethernet Copper Patch Cords:

1. The Ethernet Copper Patch Cord shall be used to connect a communication device with a patch panel or Ethernet Copper Data Outlet. The Ethernet Copper Patch Cord shall also be used to connect devices directly to one another. At minimum, furnish and install copper patch cords for all Ethernet cabling between devices or between device and patch panel within the same cabinet. Refer to PLANS for required interconnections

2. Each patch cod connector end shall be RJ-45 and shall be the Boot type connector. The connectors at each end shall be preinstalled by the Ethernet patch cord manufacturer

3. The Patch Cord shall be unshielded twisted pair and shall be rated Category 6A

4. The Ethernet copper cable outer jacket shall be Blue.

C. Patch panels:

1. General:
   a. Approvals: Meet or exceed requirements for Category 6A per TIA/EIA-568-C.2-10

   b. In addition to the device/wire tagging requirements described in Section 17200 “Instrumentation and Control Cabinets and Associated Equipment”, provide additional labels as described below:

      1) Overall Connector Panel Labels: Printed on the patch panel case by the Manufacturer. Provide unique, alphanumeric designation

      2) Connector Panel Adapter Port Label: Each adapter port on each Connector Panel shall have clearly labeled, printed, alphanumeric designation that is unique to that Connector Panel port and printed by the patch panel manufacturer

      3) Terminate copper cabling to patch panel in accordance to TIA/EIA-568-C.2-10 standards

      4) Label each port of each patch panel. Furnish and install TTP Continuous polyester thermal transfer label as manufactured by Tyco, with ribbon and printer by label manufacturer. Label shall be white with black lettering of minimum height ¼”

c. Each patch panel shall be accompanied with a typed patch panel schedule with the following columns: Adapter ID, Cable Side, User Side, described as follows:

1) adapter ID: The adapter ID shall be of the form XX-YY, where:

a) XX is the Connector Panel identifier shown by the panel manufacturer

b) YY shall represent the adapter number within the Connector Panel

2) Cable Side: Indicate the source of the cable. Use the "patch panel tag"-XX-YY designation where applicable

3) User Side: Indicates the device (PLC, patch panel, etc.) connected to the adapter

4) A Hard Copy print out of each Patch Panel Schedule shall be provided to the OWNER and ENGINEER. A soft copy on CD-R media of the patch panel schedule shall also be provided to the OWNER and ENGINEER

5) Employ consistent and uniform application of identifier and adapter numbering assignment to Ethernet Copper cables along the entire span and route of each copper cable.

2. Each Type 1 patch panel shall be as follows:

a. Construction: Metal, primed and painted with manufacturer's standard black finish.

b. Quantity of Ports: minimum 24.

c. Miscellaneous: Color coded front port labeling.

d. Mounting: 19" rack mountable. Mount on 19" rack, with all necessary brackets and hardware. Refer to the PLANS.

e. Manufacturer: Siemon, Panduit, Hubbell, CommScope, or approved equal.

f. Mounting Bracket: Where patch panel is to be mounted to a wall or back panel, furnish and install 1U Hinged Wall-Mount 19" rack Patch Panel Mounting Bracket for wall mounting the patch panel:

1) Bracket shall be rated for minimum 8 kg (17 lbs.) weight capacity

2) Bracket shall offset patch panel from wall by a minimum distance of 5.5".

3) Bracket shall allow for wall or back panel mounting a patch panel while providing hinged access to the back of the patch panel to facilitate installation of Ethernet connectors and Ethernet cable termination.

4) Bracket shall have mounting holes spaced 16" apart

5) Bracket shall be painted steel hardware, minimum 14 gauge thickness, mounted with 316 stainless steel screws.

3. Each Type 2 patch panel shall be as follows:
   a. Construction: Plastic, fully enclosed type,
   b. Quantity of ports: Minimum 2
   c. Mounting: Surface mounted. Secure patch panel to backpanel with screws.
   d. Manufacturer: "Panduit", Model Mini-Com #CBXJ2IW-A, with "Mini-Com TX6A" UTP Coupler Module Model CJ6X88TGIW and blank cover plates, or approved equal.

4. Each Type 3 patch panel shall be as follows:
   a. Construction: Plastic, fully enclosed type,
   b. Quantity of ports: Minimum 12
   c. Mounting: Surface mounted. Secure patch panel to backpanel with screws.
   d. Manufacturer: "Panduit", Model Mini-Com # CBXF12IW-AY, with "Mini-Com TX6A" UTP Coupler Module Model CJ6X88TGIW and blank cover plates, or approved equal.

5. Each Type 4 patch panel shall be as follows:
   a. Construction: Plastic, fully enclosed type,
   b. Quantity of ports: Minimum 4
   c. Mounting: Surface mounted. Secure patch panel to backpanel with screws.
   d. Manufacturer: "Panduit", Model Mini-Com #CBXJ4IW-A, with "Mini-Com TX6A" UTP Coupler Module Model CJ6X88TGIW and blank cover plates, or approved equal.

D. Copper Ethernet Data Communication Cabling:

1. Copper Ethernet Communication Cabling shall be used to interconnect copper patch panels with each other, or to interconnect Ethernet data outlets to copper patch panels.
2. The copper Ethernet cabling shall be unshielded, twisted pair, rated Category 6A cabling.
3. Agency Compliance: TIA/EIA-568-C.2, TIA/EIA-568-C.2-10 Category 6A, IEEE 802.3an 10GBASE-T Ethernet, UL Listed
4. Number of Pairs: Four
5. Wire: #23 AWG Bare Copper
6. Type of Conductors: Solid copper conductors, twisted

7. Individual Conductor Insulation: Minimum 300 volt polyolefin
8. Individual Conductor Insulation Color: White/Blue Stripe, Blue, White/Orange Stripe, Orange, White/Green Stripe, Green, White/Brown Stripe, Brown
9. Overall Jacket: PVC, include ripcord
10. Overall Jacket Color: Blue
11. Manufacturer: Belden 10GX32, or approved equal.

2.10 CONFIGURATION SYSTEM

A. Provide a configuration system, including hardware necessary to allow Engineer configuration of and programming of the PLC system. PLCs equipment provided as part of the Configuration System shall be fully compatible with the DCS equipment provided for this system.

B. Ship and temporarily install the Configuration System at the Engineer's designated facility.

C. Include at least the following components for the Configuration System:

1. All proposed Programmable Logic Controllers (PLCs), including all racks, power supplies, microprocessor modules, I/O modules, communication modules, remote I/O modules, etc.
2. All proposed OIUs.
3. All proposed Remote I/O units, including all racks, power supplies, I/O modules, communication modules, remote I/O modules, etc.
4. All Communications interface hardware, cabling, and fiber optics electronics for PLC-to-PLC interface, and PLCs to programmer PC interface, OIU interface, etc.
5. All necessary cabling to interconnect the equipment at the engineer's site as follows:
   a. The programming cabling between the PLC and the Engineer's computer shall, at minimum, consist of four (4) USB programming cables, each of 12 foot length minimum
6. Provide the following per specifications, to be included with the configuration system (These units may be counted amongst the spare units):
   a. One (1) GE Multilin EPM 9700 (Transducer Module) with advanced software option complete with three line LED combination display and keypad Model P40NPLUS. Furnish and install all required cabling to power the units and to interconnect display with EPM unit
7. Provide all Ethernet Switches
8. One (1) Type 1 OIU complete with all accessories
9. One (1) Type 2 OIU Computer complete with all accessories and software

10. One (1) laptop complete with all accessories and software

11. Provide 19" rack(s) and install PLC racks and other configuration equipment on 19" rack(s). For each 19" rack, secure rack to base with four (4) lockable, caster wheels that shall allow the cabinet to be pushed/carted forward, backward, and rotated at least 90 degrees. Overall rack assembly height shall not exceed 60".

12. Prior to assembly and delivery of configuration system, submit to engineer a drawing detailing the front and back elevations of proposed arrangement of PLC equipment on 19" rack(s). Upon approval of submittal, contractor is to then configure rack according to approved submittal and ship configuration system to Engineer's location.

13. When directed by the Engineer, recreate and ship Configuration System from the Engineer's designated facility to Owner's facility.

14. Provide property and shipping insurance and include the Engineer and Owner as insured. Insure against fire and all-risk for physical loss and damage. The Owner and Engineer will not provide insurance for the Configuration System.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

A. The ICS shall furnish labor, materials, equipment, and incidentals required to install the system in accordance with specification section 17100 and 17600.

B. The ICS shall be responsible for ensuring that field wiring for power and signal circuits is correct and wired in accordance with best industry practice. Also, the ICS shall be responsible for providing all necessary system grounding to insure a satisfactory functioning installation.

3.02 FIBER-OPTIC SYSTEM AND ETHERNET SYSTEM COPPER CABLING- SOURCE QUALITY CONTROL

A. Fiber Optic Splice-on Connector Termination:

1. The specified splice-on connectors shall be terminated using a fusion splicer and splicing oven with fiber holders to ensure the fiber cables are machine aligned prior to splicing. The splicing oven shall be the Fujikura 12S Fusion Splicer, or approved equal. Splicer and oven shall be compatible with the splice-on connectors. The loss of the fusion splice shall be no greater than 0.1 dB.

B. Fiber Optic On-Site Testing:

1. General: The ICS shall provide all equipment, instrumentation, and supplies necessary to perform all testing. The OWNER/ENGINEER shall have the option to witness and participate actively in the On-Site tests performed by the ICS firm.

2. Cables shall be tested with an Optical-Time-Domain Reflectometer "OTDR", as described hereinafter. The OTDR shall be designed to test the type of cable required for the project and shall include a laser light source used for transmitting test signals through the fiber under test. Contractor shall use launch cables of minimum length of 500 feet and tail cords (receiver cables) when performing testing with the OTDR. OTDR test wavelengths shall be as follows:
   a. Single-mode cable: 1310 nm and 1550 nm
   b. Multi-mode cable: 850nm and 1300nm.

3. OTDR test results shall include the following, at minimum:
   a. Cable tested
   b. Fiber number
   c. Direction of test
   d. Wavelength
   e. Reference power reading,
   f. Total length of fiber
   g. Attenuation of the fiber
   h. Power loss (in dB) across the length of fiber cable. The results shall also show the individual numerical dB loss values of the loss across each connector, each splice, and each fiber cable.
   i. OTDR traces, legibly plotted The traces shall be displayed on a trend chart with size 7" long and 5" high. The trace shown should be zoomed/scaled so that it spans the area of the displayed chart, and the vertically and horizontal axis labels adjusted accordingly.
   j. Additional information as necessary to determine insertion loss across the connectors and cables.

4. Pre-installation testing: Prior to the physical placement of the fiber optic cable, each fiber shall be OTDR tested on-Site, while on the spool. Submit test results for approval prior to cable installation.

5. Post-installation Testing:
   a. Separate OTDR tests shall be performed on all installed fibers (both used and unused fibers) as follows, with all test results submitted accordingly:
      1) Cable after connectorization. Perform test from both ends of the cable, at each patch panel connector attached to the cable's fiber strands.
   b. Fiber end-to-end attenuation testing
      1) Fiber end-to-end attenuation testing shall be performed on all installed fibers (both used and unused fibers) after connectorization from both ends of the cable.

2) These tests shall utilize a stabilized light source and optical power meter. The attenuation tests shall be performed at wavelengths of 1310 nm and 1550 nm for Single Mode cable and 850nm and 1300nm for Multi-Mode cable. Documented results to be provided shall include the cables tested, fiber number, direction of tests, wavelength, the power loss (in dB) across the length of fiber cables tested, and reference power reading.

c. Fiber device-to-device attenuation testing

1) This testing shall be performed after all necessary patch fiber patch cords have been installed in the system.

2) This test shall be performed on all renovated fiber optic links between fiber optic devices. The test shall be conducted only after all necessary patch cords to be used in the final system to create the link between devices are properly installed. The tests shall be performed from both ends of the link. The test should include all installed patch cords in the link, including the end patch cords that are to connect to the switches themselves.

3) These tests shall utilize a stabilized light source and optical power meter as well as OTDR. The attenuation tests shall be performed at wavelengths of 1310 nm and 1550 nm for Single Mode cable and 850nm and 1300nm for Multi-Mode cable. Documented results to be provided shall include the cables tested, fiber number, direction of tests, wavelength, the power loss (in dB) across the length of fiber cables tested, and reference power reading and OTDR results, as identified in these specifications.

C. Copper Ethernet Cable System Testing:

1. After installation of Copper Ethernet Cable System, ICS shall perform testing of the cable system to assure compliance of the installed system with the TIA/EIA-568-C.2-10 Category 6A requirements. Testing shall be performed for all installed copper cable systems, including used and unused links, from end-to-end, including all data outlets, connectors, patch panels, patch cords, etc

2. Copper Ethernet Cable System Test reports shall be submitted to the engineer and owner for review and approval. The test report shall document, for each copper data link, description of the link and components therein, the testing method used, test results, and demonstrate compliance with TIA/EIA-568-C.2-10 of the link. If any installed link does not meet the TIA/EIA-568-C.2-10 Category 6A requirements, ICS shall repair/modify link to assure it is compliant with TIA/EIA-568-C.2-10 Category 6A standard at no additional cost to the owner.

3.03 TESTS (GENERAL)

A. Refer to Section 17100.

3.04 INITIAL ON-SITE SYSTEM DEMONSTRATION TESTS

A. Programmable Logic Controllers PLCs:

1. Test all loop-specific functions and demonstrate all I/O Points.

2. Test all non-loop-specific functions including, but not limited to, the following:
   a. Failure Mode and Backup Procedures: Power failure, auto restart, retentive outputs.

3. Refer to Section 17100 for additional test requirements.

3.05 OPERATIONAL READINESS TEST (ORT) AND PERFORMANCE ACCEPTANCE TESTS (PAT)

A. Refer to Section 17100.

PART 4 - TRAINING

4.01 GENERAL

A. Provide a training program for the OWNER's personnel to address all equipment provided. The training program shall meet the specific needs of the OWNER and include the following subjects, at a minimum:

1. Hardware
   a. Specific training for the actual hardware configuration provided

   b. Test, adjustment, calibration, troubleshooting, and component replacement procedures.

2. Software:
   a. Operate the equipment on a day-to-day basis.

   b. Make programming changes for all aspects of programming/configuration/functionality.

   c. Configuration, troubleshooting, software installation procedures.

   d. Assist the hardware maintenance technicians in diagnosing problems with the equipment.

   e. Classes shall be designed for students having the equivalent of a one-semester class on personal computers, but no professional programmable controller programming experience, OIU programming experience, or Ethernet switch configuration experience.

B. Additional training program requirements:

1. Training duration:

a. Hardware: A minimum of two (2) days, each of eight (8) normal working hours.

b. Software: Provide a minimum of one (1) week, 40 consecutive normal working hours for each of the following:

1) Modicon Unity Pro XL, for PLC's. Provide at minimum the following courses: Schneider course PLCUTY13 (Unity Pro Programming Level 1), and Schneider course PLCUTY23 (Unity Pro Programming Level 2).

c. Cisco Ethernet switches/routers: Provide a minimum of one (1) week, 40 consecutive normal working hours for ethernet switches/router training. The training shall be performed in Austin, Texas and shall be a private training session exclusively for the personnel designated for this project by the Owner. It should be clarified that this training class is intended for the students to have hands on knowledge to troubleshoot, configure, and maintain the installed Cisco equipment and not necessarily to obtain Cisco certification. Provide training by New Horizons Worldwide, Inc, or Global Knowledge, Inc., course ICND1 or approved equal. For the Ethernet Switch configuration provide, at least, the following training:

1) How to remotely manage/configure the Ethernet switch/router with an IBM PC compatible computer from:

a) Serial/USB communication port

b) terminal telnet session

c) web browser

2) How to change the configuration settings of the switch, including its name, IP address, user passwords using commands at the command prompt via serial communication or terminal sessions, as well as graphically from a browser.

3) Overview of the Ethernet switch hardware provided.

4) Overview of Ethernet switch configuration settings, as well as guidelines and examples, configured by using commands at the command prompt via serial communication or terminal sessions, as well as graphically from a browser.

5) Provide emphasis and show actual settings for all configuration settings of the switches used in the plant, in particular those settings relating to setting of VLAN's, VLAN truncking, STP and RSTP setup.

6) Provide training on Cisco management tools that provide overview, from a web browser, of all the switches in the network, link status, and port status, as well as how to configure such a management tool, and viewing logs of system events, such as network link failures, internal diagnostic failures, modules failures, etc.

7) Provide training for upgrading the onboard software of an Ethernet switch

8) Provide training for how to store settings from the switch to a file, as well as how to store settings to a switch from a file.

9) Provide this training for both command based as well as browser-based configuration via direct connection to the switch (console port) as well as from the switch management tool.

10) Diagnostic and Troubleshooting: Capabilities, usage, and interpretation of results.

d. Provide additional time as required by the OWNER.

2. Training Location: OWNER's designated facility located in Austin, Texas. Include all associated expenses.

3. Shift Quantity: Total of one shift, at minimum, with a minimum ten (10) of the Owners personnel for each shift. Provide the training coordinated with the OWNER's schedule.

4. Personnel attending the training will be technical, managerial, administrative, engineers, and maintenance type personnel. The training shall accommodate instruction methods and materials accordingly.

4.02 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this Section. All costs are included in the Base Bid.

END OF SECTION

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