ARIZONA SCHOOL FACILIITES BOARD

Mobile Elementary School Well Equipping Project

Wilson Engineers Project No. 15-009

TECHNICAL SPECIFICATIONS

September 2015

WILSON ENGINEERS

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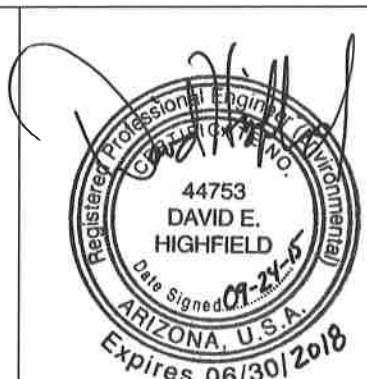
SPECIFICATIONS
FOR
MOBILE ELEMENTARY SCHOOL WELL EQUIPPING PROJECT

DIVISION 1 - GENERAL REQUIREMENTS

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SECTION 01010

SUMMARY OF WORK

PART 1 - GENERAL

1.1 SUMMARY

A. The Work to be accomplished under these Contract Documents consists of furnishing all labor, materials, and equipment for the equipping of the Mobile Elementary School Potable Well and installation of a tablet chlorination system, complete and ready for use in accordance with the Contract Documents. In addition the work includes abandonment of the existing potable well after the new well is online.

B. The CONTRACTOR shall be responsible for site and personnel safety during all phase and all aspects of construction.

C. The Work includes, but is not limited to, the following Principal Unit Processes and Structures:
   1. Site fence and other site improvements as shown and specified in the Contract Documents.
   2. Underground piping as shown and specified in the Contract Documents.
   3. Aboveground piping as shown and specified in the Contract Documents.
   4. Potable water submersible well pump, motor, piping, valves, concrete, and appurtenances as shown and specified in the Contract Documents.
   5. Tablet Chlorination System and appurtenances as shown in the Contract Documents.
   6. Electrical equipment, instrumentation, conduit, wiring, and appurtenances as shown and specified in the Contract Documents.
   7. All notifications to governmental and public agencies.
   8. Application for and securing of all construction related permits.
   9. Prepare As-Built Contract Documents to accurately reflect the final state of construction.
   10. Prepare Operation and Maintenance Manuals as specified herein.
   11. Prepare and maintain construction schedules.
   12. Provide one year warranty on all warranted materials and labor.
   13. Provide one year warranty on start-up assistance.
   14. Provide on-site, hands-on, operator training.
   15. Videotape all operator training sessions.
   16. All other miscellaneous items of Work specified in the Contract Documents.

1.2 ACCESS TO AND FROM THE SITE

A. The CONTRACTOR'S personnel shall ingress and egress the Mobile Elementary School Potable Well site as directed by the OWNER.

B. Work Hours: CONTRACTOR’s personnel shall restrict construction activities to the hours posted by the OWNER.

1.3 DESCRIPTION OF SITES

A. The Mobile Elementary School Potable Well site is located northeast of the intersection of 99th avenue and Arizona Highway 238.
   1. The address for the Mobile Elementary School Potable Well is 42798 S 99th Avenue, Goodyear Arizona 85239.

1.4 COORDINATION WITH EXISTING UTILITIES

A. Various utilities including but not limited to potable and non-potable water pipes, septic tank and leach filed, electrical duct banks, communications cables, drainage and irrigation channels and associated structures are in the area and on adjoining properties.

B. Where required by the Contract Documents, the CONTRACTOR shall make connection to proposed or existing utilities.

C. The CONTRACTOR shall connect to existing utilities without disrupting or interrupting the operation of the services of the existing utilities.

D. The existing utilities shall be assumed to be in service at the time the CONTRACTOR makes connection.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01013

ENGINEERING SERVICES

PART 1 - GENERAL

1.1 SUMMARY

A. The Work to be accomplished under these Contract Documents has been designed for the OWNER by a registered Professional Engineer, retained by the OWNER for this purpose. It is understood that normal engineering for the purpose of interpretation of the Contract Documents is provided by the OWNER. Should any services of the ENGINEER be required to assist in the corrections of errors or omissions in construction by the CONTRACTOR, or services of the ENGINEER be required because of changes in structure or equipment where the CONTRACTOR has requested approval of substitute methods or materials, those services will be provided by the ENGINEER at the standard hourly rates previously negotiated with the OWNER and shall be paid for by the CONTRACTOR. Other services shall be described further in this Section.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 ENGINEERING SERVICES

A. The ENGINEER shall be reimbursed by the CONTRACTOR for the ENGINEER'S additional services to the Project through no fault of the OWNER or ENGINEER including, but not limited to, the following conditions:
   1. Additional Shop Drawing review(s) by the ENGINEER as described in Section 01300, Submittals.
   2. Additional site visits, investigations, inspections, design work and/or reports by the ENGINEER which are required due to damages to existing facilities or completed Work caused by the CONTRACTOR in his performance, the CONTRACTOR'S negligence, or the CONTRACTOR'S Work which is rejected as defective or as failing to conform to the Contract Documents.
   3. All retesting required due to the failure of the CONTRACTOR'S Work to meet the requirements of the Contract Documents shall be at the CONTRACTOR'S expense. All standby and travel time by the OWNER'S testing lab or ENGINEER due to CONTRACTOR'S inability to be prepared for testing at the agreed upon time or inability of CONTRACTOR to meet performance requirements shall be at the CONTRACTOR'S expense. An

hourly rate of three times the direct labor cost, but not less than $150/hour, will be charged to the CONTRACTOR for every hour of engineering or testing lab personnel time plus the cost of any retesting on a per test basis.

4. The ENGINEER shall bill the OWNER for additional Engineering Services performed as described in these Documents. The OWNER shall withhold payment for this from the CONTRACTOR'S final payment. A Change Order shall be executed deleting the amount due from the Contract sum and final payment.

END OF SECTION

SECTION 01025

MEASUREMENT AND PAYMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Payment for Work performed by the CONTRACTOR under these Contract Documents shall be made at the approved Contract agreement lump sum price for each of the Items listed in the Bid Schedule and further broken down as listed in the Schedule of Values. Such payment shall compensate the CONTRACTOR for all materials and labor incorporated into the Work in accordance with the Drawings and other Contract Documents.

B. The Items listed in the Bid Schedule and the Schedule of Values constitutes all of the Bid Items for the completion of the Work. No direct or separate payment will be made for providing miscellaneous or temporary works, testing, safety, shop and Record Drawings, and the removal of waste. Compensation for all such services and materials shall be included in the prices stipulated for the lump sum and unit pay items listed in the Schedule of Values.

C. The lowest bidder will be determined based on the total bid amount for all Bid Schedule Items (1 through 10 listed on the Bid Schedule).

1.2 MEASUREMENT

A. Measurements of the completed Work will be made in place, with no allowance for waste.

B. Measurements of distances will be made in a horizontal plane, unless otherwise stated.

C. Widths of pavement removal areas and trenching will be measured based on Maricopa County Association of Governments (MAG) limits, regardless of the construction techniques used.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 BID FORM DESCRIPTION

A. The following are descriptions of the Items listed on the bid form.

1. Bid Item No. 1 - "General Requirements" for Mobile Elementary School Potable Well Replacement shall be paid for at the Contract lump sum price and shall include compensation for mobilizing and demobilizing the CONTRACTOR'S construction equipment and personnel, and shall include compensation for all of the temporary facilities required to complete the Project including the CONTRACTOR'S storage yard, construction photographs, permits, insurance, bonds, coordination, utility services, cleanup, Record Drawings, Progress Schedules, and all other incidental and appurtenant work not specifically specified in the other paragraphs of this Section.
2. Bid Item No. 2 - "Survey, Staking, and Verification of Field Measurements and Utility Locations" for Mobile Elementary School Potable Well Replacement shall be paid for at the Contract lump sum price and shall include compensation for the cost for all surveying, TBM placement, necessary work to properly stake all pipeline, roadway, perimeter wall, landscaping, and all other surveying responsibilities involved with the Project, and verification of the depth, location and size of buried utilities and other work shown on the Plans, identified by blue staking or evident from surface features, and all incidental and appurtenant work to complete the item as specified and indicated on the Drawings.
3. Bid Item No. 3 - "Potable Water Well Equipping" for Mobile Elementary School Potable Well shall be paid for at the Contract lump sum price and shall include all costs in connection with the furnishing and installation of the submersible pump, motor, column pipes, valves, flow meters, header piping, fittings, painting, and all incidental and appurtenant work to complete the item as specified and indicated on the Drawings.
4. Bid Item No. 4 - "Concrete Pads and Supports" for Mobile Elementary School Potable Well Replacement shall be paid for at the Contract lump sum price and shall include compensation for all costs associated with the installation of all concrete pads, concrete pipe supports, and all other incidental and appurtenant work required to complete the item as indicated on the Drawings.
5. Bid Item No. 5 - "Below Grade Piping, Valves, and Accessories" for Mobile Elementary School Potable Well Replacement shall be paid for at the Contract lump sum price and shall include all costs in connection with open trenching, discovery, and protection of subsurface obstructions, removal and replacement of surface obstructions, shoring and bracing as required, concrete encasement, pipe bedding, trench backfill, trench stabilization, over excavation, disposal of surface and waste material at approved locations, furnishing and installing all below grade pipe and fittings, valves, testing, disinfection, connections, and all incidental and appurtenant work to complete the item as specified and indicated on the Drawings.

6. Bid Item No. 6 - "Above Grade Piping, Valves, and Accessories" for Mobile Elementary School Potable Well Replacement shall be paid for at the Contract lump sum price and shall include all costs in connection with furnishing and installing all above grade pipe and fittings, valves, chlorinator, testing, disinfection, connections, and all incidental and appurtenant work to complete the item as specified and indicated on the Drawings.
7. Bid Item No. 7 - "Chain Link Fence" for Mobile Elementary School Potable Well Replacement shall be paid for at the Contract lump sum price and shall include all costs in connection with furnishing and installing all fencing and all incidental and appurtenant work to complete the item as specified and indicated on the Drawings.
8. Bid Item No. 8 - "Electrical" shall be paid for at the Contract lump sum price for the completed work. This item shall include all costs in connection with all electrical panels, connections and wiring, switches, lighting, and all incidental and appurtenant work to complete the item as specified and as shown on the Drawings.
9. Bid Item No.9 – "Existing Well Abandonment" shall be paid for at the Contract lump sum price and shall include all costs to discontinue the existing well which is 8-inch in diameter with a depth of approximately 450 feet. The existing pump and all associated equipment shall be salvaged and turned over to the school. The existing well shall be abandoned with cement grout from its total depth to the land surface in accordance with the ADWR well abandonment handbook.
10. Bid Item No. 10 - "Miscellaneous Work Items and Other Prices not Included in the Above Items" and necessary to complete the Work shall be paid for at the Contract lump sum price and shall include compensation for all costs associated with installing all miscellaneous work items shown on the Drawings and specified herein and not specifically included in the previous bid items, but necessary to complete the Work identified on the Drawings and specified herein.

END OF SECTION

SECTION 01040

COORDINATION

PART 1 - GENERAL

1.1 SUMMARY

A. The CONTRACTOR will be required to coordinate his activities with the pertinent utilities, OWNER'S staff, subcontractors and equipment suppliers in order not to delay the CONTRACTOR'S Project Schedule.

1.2 RELATED SECTIONS

A. Section 01300, Submittals.

B. Section 01310, Progress Schedule.

1.3 SEQUENCING AND SCHEDULING

A. CONTRACTOR shall submit to the ENGINEER and OWNER a construction schedule in accordance with Section 01310, Progress Schedule.

B. The CONTRACTOR shall be responsible for coordinating in a timely manner with pertinent utility companies to avoid delays in the installation of their facilities.

C. The CONTRACTOR shall receive approval of the construction schedule prior to commencement of Work.

D. The CONTRACTOR shall be responsible for coordinating Work among all subcontractors as necessary.

E. The CONTRACTOR shall be responsible for all construction coordination necessary so that the Project may remain on schedule.

F. The CONTRACTOR shall coordinate the following with the OWNER and ENGINEER:
   1. Testing.
   2. Inspections.
   3. Starting of Systems.
   4. Operations and Maintenance Training.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01050

FIELD ENGINEERING/SURVEYING

PART 1 - GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall hire a surveyor licensed in the State of Arizona to topographically survey the Project site to confirm the baseline conditions. It is also the CONTRACTOR'S responsibility to notify the ENGINEER of any discrepancy found between the topographic survey provided and the baseline conditions provided in the Contract Documents within 14 days of the Notice to Proceed. The CONTRACTOR further takes the responsibility to correct any discrepancies not reported to the ENGINEER within the specified construction schedule as part of the finished grading required as part of this Project at no cost to the OWNER.

B. The licensed surveyor shall also fulfill construction staking requirements and responsibilities as specified in the General Conditions.

C. The CONTRACTOR shall provide competent, qualified personnel and materials required to perform all construction layout staking of the Work and will protect and preserve the established reference points and will make no change or relocations without the prior written approval of the OWNER.

D. The CONTRACTOR will report to the OWNER whenever any reference point is lost or destroyed or requires relocation because of necessary changes in grades or locations. The CONTRACTOR will replace and accurately relocate all reference points so lost, destroyed, or moved.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01090

REFERENCE STANDARDS/ABBREVIATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section lists many of the construction industry organizations, professional and technical associations, societies and institutes, and government agencies issuing, promoting, or enforcing standards to which references may be made in the Contract Document along with the abbreviations commonly used for those references. Also included are certain general requirements for the use of industry standards specified and for application of the standards in quality control.

1.2 USE OF REFERENCE STANDARDS

A. Work specified by reference to the published standard or specification of a government agency, technical association, trade association, professional society or institute, testing agency, or other organization shall conform to or surpass the minimum standards of quality for materials and workmanship established by the designated standard or specification.

B. Where so specified, products or workmanship shall also conform to the additional prescriptive or performance requirements included within the Contract Documents to establish a higher or more stringent standard of quality than that required by the referenced standard.

C. Where the specific date or issue of the standard is not included with the reference to the standard, the edition, including all amendments published and available on the first published date of the Invitation to Bid, shall apply.

D. Where two or more standards are specified to establish quality, the product and workmanship shall conform to or surpass the requirements of both.

E. In case of conflict between referenced standards, the more stringent shall apply.

F. Where both a standard and a brand name are specified for a product in the Contract Document, the proprietary product named shall conform to or surpass the requirements of the specified reference standard. The listing of a trade name in a Contract Document shall not be construed a warranting that such product conforms to the respective reference standard.

G. Copies of Standards:
   1. Copies of applicable referenced standards have not been bound in this Contract Document.
   2. Where copies of standards are needed by the CONTRACTOR for superintendence and quality control of the Work, obtain a copy or copies directly from the publication source and maintain in an orderly manner at the job site, available to the CONTRACTOR'S personnel, subcontractors, OWNER, and ENGINEER.
   3. Submittals: Submit for approval the requests to use products conforming to printed standards or publications with a different publication date from that effective under the Contract. Clearly indicate the changes in product or workmanship quality involved in the proposed change, if any, and reasons for the request.

1.3 ABBREVIATIONS

A. Abbreviations for trade organizations and government agencies. The following is a list of construction industry organizations and government agencies to which references may be made in the Contract Document with abbreviations used.

AA	Aluminum Association
AAMA	American Architectural Manufacturers Association
AAMA	Architectural Aluminum Manufacturers' Association
AASHTO	American Association of State Highway and Transportation Officials
ABPA	Acoustical and Board Products Association
ACI	American Concrete Institute
ADA	Americans With Disabilities Act
ADEQ	Arizona Department of Environmental Quality
ADHS	Arizona Department of Health Services
AFBMA	Anti-Friction Bearing Manufacturers' Association
AGA	American Gas Association
AGC	Associated General Contractors
AGMA	American Gear Manufacturers' Association
AHC	Architectural Hardware Consultant
AI	Asphalt Institute
AIA	American Institute of Architects
AIA	American Insurance Association
AIEE	American Institute of Electrical Engineers
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
ALS	American Lumber Standards
AMCA	Air Moving and Conditioning Association
AMG	Arizona Masonry Guild
ANSI	American National Standards Institute

APA	American Plywood Association
API	American Petroleum Institute
AREA	American Railway Engineering Association
ARI	Air Conditioning and Refrigeration Institute
ARMA	Asphalt Roofing Manufacturers Association
ASAE	American Society of Agricultural Engineers
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc.
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWI	Architectural Woodwork Institute
AWPA	American Wood Preservers' Association
AWPB	American Wood Preservers Bureau
AWPI	American Wood Preservers' Institute
AWS	American Welding Society
AWSC	American Welding Society Code
AWI	Architectural Woodwork Institute
AWWA	American Water Works Association
BHMA	Builders Hardware Manufacturers' Association
BIA	Brick Institute of America
CBMA	Certified Ballast Manufacturers' Association
CDA	Copper Development Association
CGA	Compressed Gas Association
CISPI	Cast Iron Soil Pipe Institute
CLFMI	Chain Link Fence Manufacturer's Institute
CMAA	Crane Manufacturers' Association of America
CRA	California Redwood Association
CRSI	Concrete Reinforcing Steel Institute
CS	Commercial Standards
CSI	Construction Specifications Institute
CTI	Cooling Tower Institute
FGMA	Flat Glass Manufacturer's Association
FIA	Factory Insurance Association
FM	Factory Mutual
FS	Federal Specification
FTI	Facing Tile Institute
GA	Gypsum Association
HI	Hydraulic Institute
HMI	Hoist Manufacturers' Institute

ICBO	International Conference of Building Officials
ICEA	Insulated Cable Engineers' Association
IEEE	Institute of Electrical and Electronics Engineers, Inc.
IES	Illuminating Engineering Society
ISA	Instrument Society of America
JIC	Joint Industry Conferences of Hydraulic Manufacturers
LIA	Lead Industries Association
MAG	Maricopa Association of Governments
MIA	Marble Institute of America
MIA	Masonry Institute of America
MLMA	Metal Lath Manufacturers Association
MS	Military Specifications
MMA	Monorail Manufacturers' Association
NAAMM	National Association of Architectural Metal Manufacturers
NBFU	National Board of Fire Underwriters
NBHA	National Builders' Hardware Association
NBS	National Bureau of Standards
NCMA	National Concrete Masonry Association
NEC	National Electrical Code
NEMA	National Electrical Manufacturers' Association
NESC	National Electric Safety Code
NFPA	National Fire Protection Association
NFPA	National Forest Products Association
NGA	National Glass Association
NHLA	National Hardwood Lumber Association
NKCA	National Kitchen Cabinet Association
NLMA	National Lumber Manufacturers' Association
NMWIA	National Mineral Wool Insulation Association
NTMA	National Terrazzo and Mosaic Association
NWMA	National Woodwork Manufacturers' Association
OECI	Overhead Electrical Crane Institute
OSHA	Occupational Safety and Health Administration (both Federal and State)
PCA	Portland Cement Association
PCI	Pre-cast Concrete Institute
PDI	Plumbing Drainage Institute
PEI	Porcelain Enamel Institute
PS	Product Standards Section - U.S. Department of Commerce

RLM	RLM Standards Institute, Inc.
RMA	Rubber Manufacturers' Association
SAE	Society of Automotive Engineers
SDI	Steel Deck Institute
SDI	Steel Door Institute
SIGMA	Sealed Insulating Glass Manufacturing Association
SJI	Steel Joist Institute
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SSPC	Steel Structures Painting Council
SWI	Steel Window Institute
TEMA	Tubular Exchanger Manufacturers' Association
TCA	Tile Council of America
TIMA	Thermal Insulation Manufacturers Association
TPI	Truss Plate Institute
UBC	Uniform Building Code
UFC	Uniform Fire Code
UL	Underwriters' Laboratories, Inc.
USDA	United States Department of Agriculture
USPS	United States Postal Service
VI	Vermiculite Institute
WCLA	West Coast Lumberman's Association
WCLB	West Coast Lumber Bureau
WCLIB	West Coast Lumber Inspection Bureau
WIA	Woodwork Institute of Arizona
WPOA	Western Plumbing Officials Association
WWPA	Western Wood Products Association

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01201

PRE-CONSTRUCTION CONFERENCE

PART 1 - GENERAL

1.1 SUMMARY

A. Date, Time and Location: Conference will be held after execution of the Contract and before construction is started at the site. OWNER will fix the date, time, and location of the meeting.

B. The ENGINEER shall prepare agenda, preside at meeting, and prepare and distribute a transcript of proceedings to all parties.

C. The CONTRACTOR shall provide data required, contribute appropriate items for discussion, and be prepared to discuss all items on agenda.

1.2 REQUIRED ATTENDANCE

A. The CONTRACTOR and major subcontractors.

B. The OWNER'S representative.

C. The ENGINEER.

D. Representatives of government agencies having any degree of control or responsibility, if available.

E. Representatives of utility companies having any degree of control or responsibility, if available.

1.3 AGENDA

A. Agenda will include, but will not necessarily be limited to, the following:
   1. Designation of responsible personnel.
   2. The subcontractors.
   3. Contract time.
   4. Coordination and cooperation with other contractors.
   5. Progress Schedule.
   6. Processing of Shop Drawings and distribution of Submittals.
   7. Processing of field decisions and Change Orders.
   8. Requirements for copies of Contract Documents.
   9. Insurance in force.

10. Schedule of Values.
11. Processing and Schedule of Payments.
12. Use of premises.
13. The CONTRACTOR'S responsibility for safety and first aid procedures.
14. Security.
15. Housekeeping.
16. Field offices.
17. Record Drawings.
18. Letter of Notice to Proceed.
19. Operation and Maintenance Manuals.
20. Meetings.
21. Temporary utilities.
22. Permits.
23. Emergency telephone numbers.
24. Any other Project related items.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01202

PROGRESS MEETINGS

PART 1 - GENERAL

1.1 GENERAL

A. Date and Time:
   1. Regular weekly meetings for the duration of construction or as designated by ENGINEER/OWNER.
   2. Other Meetings: On call.

B. Place: Mobile Elementary School (42798 S 99th Avenue, Goodyear Arizona 85239) or mutually agreed upon location.

C. ENGINEER shall prepare agenda, preside at meetings, and prepare and distribute a transcript of proceedings to all parties.

D. CONTRACTOR shall provide data required and be prepared to discuss all items on agenda.

1.2 MINIMUM ATTENDANCE

A. CONTRACTOR, subcontractors and suppliers as required, representatives present for each party shall be authorized to act on their behalf.

B. ENGINEER.

C. Others as appropriate.

1.3 AGENDA

A. Agenda will include, but will not necessarily be limited to, the following:
   1. Transcript of previous meeting.
   2. Progress since last meeting.
      a. CONTRACTOR.
      b. Subcontractors.
   3. Planned progress for next period.
   4. Shop Drawings.
   5. Problems, conflicts, and observations.
   6. Change Orders.
   7. Applications for payment.
   8. Quality standards and control.

9. Schedules, including status of off-site fabrication and delivery schedules. Corrective measures required.
10. Coordination between parties.
11. Safety concerns.
12. Other business.
13. Next meeting date.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01300

SUBMITTALS

PART 1 - GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall include a completed transmittal form for all submittals. Transmittal forms will be furnished to CONTRACTOR by ENGINEER at the pre-construction conference. Submittals shall be sent to the ENGINEER.

1.2 SECTION INCLUDES

A. Shop Drawings.

B. Material and Equipment Record.

C. Samples.

D. Operation and Maintenance (O&M) Manuals.

E. Progress Schedule.

F. Progress Reports.

G. Daily Reports.

H. Testing Results.

I. Construction Photographs.

J. Record Drawings.

1.3 DATA REFERENCE SYMBOLS AND DESCRIPTIONS

A. The Submittal data required for Shop Drawings and operations manuals shall contain, but not necessarily be limited to, that data and material as defined by the coded legend set forth below. The Submittal data required shall be as indicated and specified under various headings of the Specifications.

LEGEND
DATA REFERENCE SYMBOLS AND DESCRIPTIONS

Symbol	Description
A	Letters of Certification of Compliance on materials, equipment, etc.
B	Samples.
C	Final Certified Drawings showing outline dimensions, foundation layout or mounting information, and other pertinent dimensions.
D	Field erection instructions, assembly drawings and/or diagrams, detailed reference drawing lists, and lists of erection details.
E	Shop detail drawings showing individual sub-assemblies and fabricated pieces with material specifications and other applicable data.
F	Installation instructions, operating and/or service manuals, and all other data pertinent to operating or servicing the complete apparatus. Preventative maintenance instructions and recommended frequency.
G	Schematic and wiring diagrams of power, control, and piping systems. A detailed description of operation shall be included for each diagram to describe all modes of operation of the system indicated. Where the integrated system requires interlocking and control of other components in normal operation, these components shall be included in the description of operation.
H	General bulletins and catalog cuts describing complete apparatus including operating principles and fundamentals.
I	Service data sheets showing design performance, utility requirements, etc., as applicable to the specific duty for which the equipment is furnished.
J	Head capacity curves for pumps. Impeller size furnished and maximum size available shall be noted on these data sheets.
K	Curves and/or data for overall range of operation from minimum to maximum capacity or load, showing capacity or load, utilities motive medium required, total or incremental differential head, and other pertinent information applicable to the equipment or its component assemblies.
L	Materials of construction of all components.
M	Renewal parts list with diagrammatic or cross-section drawings showing part identification. Material analysis or trades designation for each significant part is to be noted on parts lists or on a separate sheet.
N	Stuffing box sizes; packing sizes; Specifications and arrangement; and mechanical seal details, Specifications, etc., if furnished in equipment.

Symbol	Description
O	Bearing manufacturer's standard identification and/or interchangeable number for all anti-friction bearings in the equipment proper and its accessory items.
P	Material gradation, design mix, job mix formula, and/or material analysis.

B. Each Shop Drawing Submittal shall include a hard copy of the relevant Specification Section. Each and every paragraph of the Specification Section shall be clearly marked to indicate whether the requirements for equipment and/or services in the Specification Section are met. If clarifications are needed to any of the paragraphs in the Specification Section, they shall be addressed next to the paragraph as such and explained further with any additional information necessary. If any exceptions and/or deviations are proposed to any of the Specifications, they shall be clearly noted as such in the Submittal, and an explanation of any deviation and/or exception shall be provided. The CONTRACTOR shall furnish equipment and/or services as specified if an exception and/or deviation is rejected.

1.4 SHOP DRAWINGS

A. A minimum of nine copies of Shop Drawings are required for Submittal. Disposition of the Shop Drawings will be in accordance with the following schedule:

Action by ENGINEER	Retained by ENGINEER	Returned to CONTRACTOR	No. Required for Resubmittal
No Exceptions Noted	6	3	0
Exceptions Noted	6	3	0
Revise and Resubmit	1	8	9
Rejected	1	8	9
No Action Taken	1	8	0

1. ENGINEER shall return Shop Drawings to CONTRACTOR within 35 days of receipt by ENGINEER.

B. Only one copy of "Revise and Resubmit" and "Rejected" Shop Drawings will be stamped.

C. If the CONTRACTOR requires more than three copies of "No Exceptions Noted" or "Exceptions Noted" Shop Drawings, additional copies shall be included in original Submittal.

D. The CONTRACTOR may request Submittals be reviewed up to two times for each equipment or construction material item, regardless of manufacturer or supplier, by the ENGINEER. For additional reviews, CONTRACTOR will reimburse ENGINEER for additional labor as specified in Section 01013, Engineering Services.

E. The CONTRACTOR will be held responsible for any delay in progress of the Work due to resubmittal of Shop Drawings. Time for completion of the Contract will not be extended due to his failure to promptly submit complete and acceptable Shop Drawings, product data and samples.

F. Do not execute Work required by Shop Drawings until accepted Shop Drawings are received from ENGINEER.

G. Before submitting Shop Drawings for review, CONTRACTOR shall check Shop Drawings for accuracy, ascertain that all Work contiguous with and having bearing on other Work shown on Shop Drawings is accurately drawn, and that Work shown is in conformity with Contract requirements. The CONTRACTOR is responsible for all Submittals from subcontractors and suppliers.

H. All such Drawings and details, when submitted, must bear the stamp of approval of CONTRACTOR, bearing checked data, as evidence that such Drawings and details have been checked by him. Said "stamp" shall clearly state that the CONTRACTOR has checked the Drawings and, by his signature, he so certifies. Any Drawings submitted without such executed stamp of approval, or whenever it is evident (despite the stamp) that the Drawings have not been checked, they will be returned to the CONTRACTOR for re-submission and will not be considered. In such event, it will be deemed that CONTRACTOR has not complied with this provision and the CONTRACTOR shall bear risk of all delays to the same extent as if no Drawings or details had been submitted.

I. The CONTRACTOR shall prepare composite drawings and installation layouts, when required to solve tight field conditions. Such Drawings shall consist of dimensioned plans and elevations, and must give complete information particularly as to size and location of sleeves, inserts, attachments, openings, conduits, ducts, boxes, structural interferences, etc. These composite drawings and installation layouts shall be coordinated in the field by the CONTRACTOR and his subcontractors for proper relationship to the Work of other trades, based on field conditions, and shall be checked and approved by them before submission to the ENGINEER for his final review. The CONTRACTOR shall have competent technical personnel readily available for such coordinating and checking, as well as for supervision of field installation of Work as per the Drawings and installation layouts, which have been previously determined by him to be correct and carry the ENGINEER'S review stamp.

J. Submission of Shop Drawings (in either original submission or when resubmitted with corrections) constitute evidence that the CONTRACTOR has checked all information thereon, and that he accepts and is willing to perform the Work as shown in a workmanlike manner and in accordance with best standard practice.

K. Cost of any changes in construction due to improper checking and coordination by the CONTRACTOR shall be paid for by the CONTRACTOR, and the CONTRACTOR shall be responsible for all additional costs, including coordination.

L. Shop Drawings shall clearly delineate the following information:
   1. ENGINEER'S name and Project number, Project name and address.
   2. Drawing title, number, date, and scale.
   3. Names of CONTRACTOR, subcontractor, and fabricator.
   4. Working and erection dimensions.
   5. Arrangements and sectional views.
   6. Necessary details, including complete information for making connections with other Work.
   7. Kinds of materials and finishes.
   8. Show descriptive names of materials and equipment, classified item numbers, and locations at which materials or equipment are to be installed in the Work. Use same reference identification as shown on Contract Drawings.
   9. The ENGINEER shall provide the CONTRACTOR with a form to accompany the Shop Drawings.

M. If Shop Drawings show variations from Contract Documents because of standard shop practice or other reasons, make specific mention of such variations in transmittal form.

N. Shop Drawing review will be general. It shall not relieve the CONTRACTOR of responsibility for accuracy of such Shop Drawings, nor proper fitting, construction of Work, furnishing of materials, or Work required by Contract Documents and not indicated on Shop Drawings. Shop Drawing review shall not be construed as approving departures from Contract Documents.

O. Review of Shop Drawings and schedules shall not relieve the CONTRACTOR from responsibility for any violation indicated on such Drawings or schedules of local, County, State or Federal laws, rules, ordinances, or rules and regulations of commissions, boards or other authorities or utilities having jurisdiction.

P. When product data, consisting of manufacturer's printed literature, is required to be submitted to ENGINEER, it shall be submitted in original form. Any fading type of reproduction will not be accepted.

1.5 MATERIAL AND EQUIPMENT RECORD

A. The CONTRACTOR shall maintain an up-to-date record of all materials and equipment furnished by him and any subcontractors to be incorporated in the Work.

B. The ENGINEER will furnish the CONTRACTOR a master of the materials and equipment form. The CONTRACTOR shall maintain the records on reproductions of this form in the field office.
   1. The CONTRACTOR shall provide the following information on these forms.
   2. The Specification Paragraph and Section number where material or equipment are called for.
   3. Date ordered.
   4. Date required.
   5. CONTRACTOR'S purchase order number.
   6. Supplier's purchase order number.
   7. Date promised.
   8. Date received.
   9. Supplier's name and address.
   10. Remarks.
   11. Shop Drawings and samples with approval date.
   12. Physical dimensions and ratings.
   13. Other items that shall be submitted with the material and equipment record include performance curves for all pumps and fans. Where Submittal sheet describes items in addition to that item being submitted, the submitted item shall be clearly marked on the sheet and superfluous information shall be crossed out.

C. Three copies of the materials and equipment record shall be submitted to the ENGINEER with each application for payment. If the current record has not been submitted, the application shall not be reviewed and shall be returned to the CONTRACTOR as incomplete.

D. The CONTRACTOR shall permit free access to these records; including information on items recently received and not yet posted to the record, by the ENGINEER or authorized representative of the OWNER at any time.

1.6 SAMPLES

A. Deliver no material to the building site prior to receipt of ENGINEER'S written approval. Furnish materials equal in every respect to approved samples and execute Work in conformity therewith. Samples shall be provided with respective Shop Drawings.

B. The approval or acceptance of samples will not preclude the rejection of any material upon the discovery of defects in same prior to the Final Acceptance of the completed Work.

C. After a material has been approved, no change in brand or make will be permitted unless satisfactory written evidence is presented to, and approved by the ENGINEER that the manufacturer cannot make scheduled delivery of approved material, or that material delivered has been rejected and substitution of suitable material is an urgent necessity, or that other conditions are apparent which indicate approval of such substitute materials to be in best interest of OWNER.

D. All samples of materials requiring laboratory tests shall be submitted to laboratory for testing not less than 90 days before such materials are required to be used in the Work. Submit all other samples for approval within 30 days after signing of the Contract.

E. Submit samples in duplicate, except where greater or lesser number is specifically required by these Specifications. Submittal shall be made only by the CONTRACTOR, unless he has authorized his subcontractor to submit them and has notified the ENGINEER to this effect. Ship all samples prepaid.

F. Samples shall be submitted along with Shop Drawings. Each sample shall be accompanied by a Shop Drawing form and an itemized transmittal form. The transmittal shall contain list of samples, Project, CONTRACTOR, manufacturer, brand, quarry, quality, etc.; also Project number, Specifications reference, ASTM number (if any) and material being furnished. Enclose copies of transmittal with samples. Any deviation from Contract requirements shall be so stated in the transmittal.

G. Label each sample by a securely attached label giving the Project, CONTRACTOR, subcontractor or supplier, manufacturer's name, product trade name and number, material type, Specification Section and paragraph reference etc.; also Project name and number and ASTM number (if any).

H. Samples shall be of adequate size to permit proper evaluation. The samples submitted shall show the full range of colors, textures and dimensions, and other variable characteristics expected. Samples of different items that must match or whose finish relates shall be delivered at the same time to facilitate coordination.

I. Samples which are rejected by the ENGINEER must be resubmitted as soon as possible after notification of rejection, and shall be marked "Resubmitted Sample" in addition to other information required.

J. The right is reserved to require submission of samples of any material or any material lists whether or not specifically specified in the Specifications.

1.7 OPERATION AND MAINTENANCE MANUALS

A. Five copies of an Operations and Maintenance (O&M) Manual containing the following items, in addition to any instructions packed with the equipment, are required for each individual item of equipment:
   1. Specifications.
   2. Drawings.
   3. Description of each individual item of equipment.
   4. Manufacturer name, model number, and serial numbers.
   5. Name address and phone number of both the manufacturer's customer service department and the local manufacturer's representative.
   6. Installation instructions.
   7. Operation and maintenance instructions, including lubrication schedule and lubricant specification.
   8. Parts list.
   9. Additional data to be included in the manual shall be as required in these Specifications.
   10. Temporary storage recommendations.

B. These manuals are to be submitted to the ENGINEER upon delivery of the equipment to the site. Overall Project substantial completion will not be scheduled until all manuals are approved.

C. The respective manuals for the individual items of equipment shall be combined into bound volumes covering the complete operating installation with individual equipment items tabled separately. Information for equipment subassemblies not manufactured by the major supplier shall also be included with the respective equipment item.

D. The volumes of manuals shall be bound in a substantial three-ring binder hardback covers. Labels on the cover and spine of the binders shall indicate the equipment items to be addressed, each manufacturer's name, Project name, and the year of purchase. Manuals for particular items of equipment which are in the same area (i.e., mechanical bar screens and screenings conveyor) should be bound in the same volume where practicable.

E. Upon completion of the installation of each item of equipment, the CONTRACTOR shall provide Drawings of the local control panel to be added to the O&M Manual. Manuals for particular items of equipment that are in the same area (i.e., belt press, belt press feed pumps, and conveyors) should be bound in the same volume where practicable.

F. All final O&M Manuals shall be scanned and placed into a .pdf document. All .pdf shall be placed onto compact discs and inserted into the O&M Manual.

1.8 PROGRESS SCHEDULE

A. Progress Schedule as defined in Section 01310, Progress Schedule.

1.9 DAILY REPORTS

A. The CONTRACTOR will provide the ENGINEER a daily report on a form provided indicating the Work in progress, Work completed, equipment used, numbers and category of personnel, and such other pertinent information as applicable. The daily reports shall be compiled and submitted monthly with the application for payment. The application for payment will not be reviewed and shall be returned to the CONTRACTOR as incomplete if the reports do not accompany it.

1.10 TESTING RESULTS

A. CONTRACTOR shall furnish to ENGINEER copies of all testing results for all tests required in the Specifications.

1.11 CONSTRUCTION PHOTOGRAPHS

A. Construction photographs as defined in Section 01380, Construction Photographs.

1.12 RECORD DRAWINGS

A. Record Drawings as defined in Section 01700, Contract Closeout. CONTRACTOR shall update Record Drawings monthly and submit updated Record Drawings to ENGINEER monthly for review with the pay application. Failure of CONTRACTOR to maintain updated Record Drawings shall be justification for refusal of pay application.

1.13 SUBMITTALS

A. All additional Submittals as required by the Contract Documents.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01310

PROGRESS SCHEDULE

PART 1 - GENERAL

1.1 GENERAL

A. To assure completion of the Work within the Contract times established, all activities of the CONTRACTOR shall be scheduled and monitored by use of a Critical Path Method (CPM) Schedule. The CONTRACTOR shall provide a CPM Schedule for Work done under this Contract in accordance with the requirements of this Section and the General Conditions.

B. The CONTRACTOR shall employ or retain services of at least one person experienced in CPM Scheduling for the duration of the Contract. This person shall cooperate with the ENGINEER and shall update the CONTRACTOR'S schedule as required by these Specifications.

C. A preliminary CPM Schedule for the entire Project shall be submitted to the ENGINEER at the pre-construction conference in bar chart forms. The bar chart shall be referenced to time.

D. At the Pre-construction Conference, the CONTRACTOR shall furnish to the ENGINEER a detailed preliminary CPM Schedule in bar chart form showing the CONTRACTOR'S proposed operations for the first four months of the Contract period.

E. The CONTRACTOR shall submit, at the pre-construction conference, a projection of estimated monthly payments through the life of the Contract. Initial projections shall be correlated with and provided at the same time as the Schedule of Values. Projections shall be updated when requested by the ENGINEER.

1.2 DEFINITIONS

A. Unless otherwise noted, terms shall be defined for this Project as follows:
   1. Activity - means a component step or operation in the construction of Work.
   2. Event - means a point in time during construction of the Work.
   3. Network or Network Diagram - means a flow diagram which is a symbolic representation of activities and events that must be performed in accordance with the Contract and which shows the order and interdependence of activities and the sequence in which Work is to be accomplished as planned by the CONTRACTOR.
   4. Earliest Start Date - means the earliest date on which an activity can start.

5. Earliest Finish Date - means the earliest date on which an activity can finish without changing the Contract duration.
6. Latest Start Date - means the latest date on which an activity can start without changing the Contract duration.
7. Latest Finish Date - means the latest date on which an activity can finish without changing the Contract duration.
8. Latest Free Start Date - means the latest date on which an activity can start without affecting the scheduling of any other activities.
9. Latest Free Finish Date - means the latest date on which an activity can finish without affecting the scheduling of any other activities.
10. Total Float - means the number of calendar days by which an activity can be delayed without necessarily extended a pertinent Contract Time. Total Float is by definition at least equal to Contract Float.
11. Contract Float - If the schedule anticipates early completion of all or any part of the Work, Contract Float is the number of calendar days between CONTRACTOR'S anticipated date for early completion of all or any such part of the Work and the corresponding specified Contract Time.
12. Free Float - means the amount of time in calendar days by which an activity can be delayed without affecting the scheduling of any other activity.
13. Duration - means the amount of time in consecutive calendar days required to perform an activity from the date on which Work commences on the activity to the date on which the activity is complete.
14. Milestone - means a significant event such as date of Notice to Proceed, substantial completion, final completion and specified mandatory completion dates when portions of the Work or site are to be turned over to the OWNER or other contractors.
15. Critical Path - means the continuous sequence of activities and events throughout the network that comprises the longest time path through the network from start to finish.
16. Critical Activity - means an activity that cannot be delayed without altering the Contract Times.
17. Mandatory Date - means the date specified for completion of a Work activity or when other contractors must be permitted to start Work.
18. Sub-network - means a network relating to a particular phase, portion, or subdivision of the Work.
19. Arrow Method - means that method of network diagram construction in which activities are represented by arrows.
20. Lag - means the amount of time between the commencement of an activity and the commencement of an activity that immediately follows it, expressed in the number of calendar days.
21. Lag Factor - means the amount of time between the commencement of an activity and the commencement of an activity that immediately follows it, expressed as a percentage of the duration of the first activity.

1.3 SUBMITTALS

A. All CPM Schedules (both original and revisions) submitted shall be one reproducible mylar and four copies. Each CPM Schedule Submittal shall bear CONTRACTOR'S stamp or written indication of approval as representative to OWNER that CONTRACTOR has determined or verified all data on that CPM Schedule, and that CONTRACTOR and the subcontractors and suppliers have reviewed and coordinated the sequences in that CPM Schedule with the requirements of the Work.

B. At the pre-construction conference, the CONTRACTOR shall submit to the OWNER and ENGINEER sufficient descriptive information about the CPM software the CONTRACTOR has chosen to employ to comply with the requirements of this Section.

C. Neither the OWNER'S or ENGINEER'S review of a CPM Schedule, nor a statement of "Resubmittal Not Required", will relieve the CONTRACTOR from responsibility for complying with the Contract Times and those sequences of Work indicated in or required by the Contract Documents, or completing any Work omitted from that Progress Schedule within the Contract Times. The CONTRACTOR shall make appropriate adjustments or corrections in a CPM Schedule returned as "Revise and Resubmit" and shall submit to the ENGINEER the corresponding CPM Schedule resubmittal as required herein. CPM Schedule resubmittals shall use the same revision number followed by the letters "A", "B", etc., as applicable.
   1. CONTRACTOR shall submit to ENGINEER with the first Application for Payment, the initial Progress Schedule, and the schedule of Shop Drawing and sample Submittals. CONTRACTOR shall correct all schedules returned for revision and resubmission, taking into account comments made by OWNER and ENGINEER and shall resubmit any schedule if directed by ENGINEER. The final revision of the schedule shall be the As Planned Schedule from which subsequent schedules revisions shall be developed and used by CONTRACTOR when making proposals or claims for adjustments in Contract Time or Contract Price.
   2. Early dates in the Progress Schedule shall be based on proceeding with all or part of the Work exactly on the date when the corresponding Contract Time commences to run. Late dates shall be based on completing all or part of the Work exactly on the corresponding Contract Time, regardless of whether CONTRACTOR anticipates early completion. If sequences of Work are imposed by the Contract Documents, the Progress Schedule shall show in detail CONTRACTOR'S approach to conforming with those sequences.
   3. Progress Schedule Revisions submitted shall:
      a. Adequately depict CONTRACTOR'S current approach to remaining Work.
      b. Report on progress or schedule recovery actions.
      c. Facilitate evaluation of Progress Payments.

d. Accurately depict the progress and sequence of the Work to date.

1.4 WEATHER DAYS ALLOWANCE

A. Include as a separate identifiable activity on the critical path, an activity labeled "Weather Days Allowance". Insert this activity at the end of the schedule.

B. Weather Days:

1. The CONTRACTOR shall suspend the Work wholly or in part for such period as he may deem necessary due to unsuitable weather or to such other conditions as are considered unfavorable for the suitable prosecution of the Work.
2. In case of suspension of Work from any cause whatsoever, the CONTRACTOR shall be responsible for all materials and shall store them properly if necessary and shall provide suitable drainage and erect temporary structures where necessary.
3. In setting the Contract Time, it has been assumed that up to 10 business days may be lost as a result of weather conditions which will slow down the normal progress of Work; therefore, no extensions in Contract Time will be allowed for the first 10 business days lost due to bad weather conditions. High temperature shall not be considered as a weather condition that will slow down the normal progress of Work.
4. Should the CONTRACTOR prepare to begin Work at the regular starting time of any day on which inclement weather, or the conditions resulting from the weather, or the condition of Work, prevents the Work from beginning at the usual starting time and the crew is dismissed as a result thereof and the CONTRACTOR does not proceed with at least 75% of the normal labor and equipment force engaged in the current controlling operation or operations for at least 60% of the total daily time being currently spent on the controlling operation or operations, the CONTRACTOR will not be charged for a business day whether or not conditions should change thereafter during said day and the major portion of the day could be considered to be suitable for such construction operations.
5. The current controlling operation or operations is to be construed to include any feature of the Work (e.g., an operation or activity, or a settlement or curing period) considered at the time by the ENGINEER and the CONTRACTOR, which, if delayed or prolonged, will delay the time of completion of the Contract.
6. Determination that a day is a lost business day by reason of inclement weather or conditions resulting immediately there from, shall be made and agreed upon in accordance with Article 12 of the General Conditions, during such day by conference between the ENGINEER and the CONTRACTOR. In the event of failure to agree, the CONTRACTOR will be allowed 10 days to file a written protest setting forth in what respects he differs from the ENGINEER, otherwise the decision of the ENGINEER shall be deemed to have been accepted by the CONTRACTOR as correct. The ENGINEER will furnish the CONTRACTOR a weekly statement showing the number of days

charged to the Contract for the preceding week, the number of days of time extensions being considered or approved, the number of days originally specified for the completion of the Contract, and the number of days remaining to complete the Contract and the extended date for completion.

C. Insert an activity in critical path to reflect weather day occurrences when weather days are experienced and approved by ENGINEER. Identify this activity as a weather delay.

D. Reduce duration of Weather Days Allowance activity as weather delays are experienced and inserted into the Schedule. Remaining weather days in Weather Day Allowance at completion of Project is considered float.

1.5 ADJUSTMENT OF CONTRACT TIME

A. Contract Time shall be adjusted only for causes specified in Contract Documents.

B. Submit justification, construction schedule data, and supporting evidence with each request for Contract Time adjustment.

C. Submit Proof That the Contract Completion Date Has Been Affected By:
   1. Inserting new activities associated with change orders or OWNER-caused delays into the schedule.
   2. Revising activity logic.
   3. Revising activity durations.

D. When a delay to the Project as a whole can be avoided by revising preferential sequencing, and the CONTRACTOR chooses not to implement the revisions, the CONTRACTOR will be entitled to a time extension and no compensation for extended overhead.

E. Indicate clearly that the CONTRACTOR has used, in full, all the Contract Float available for the Work involved in the request, including any float that may exist between the CONTRACTOR'S planned completion date and the Contract completion date. Utilize the latest version of the Progress Schedule accepted at the time of the alleged delay, and all other relevant information, to determine the adjustment of the Contract Time.

F. Contract Float shall be for the mutual benefit of the OWNER and the CONTRACTOR. Adjustment of the Contract Time will be granted only when the Contract Float has been fully utilized and only when the revised date of completion of the Work has been pushed beyond the Contract completion date. Adjustment of the Contract Time will be made only for the number of days that the planned completion of the Work has been extended.

G. Actual delays in activities which do not affect the critical path work or which do not move the CONTRACTOR'S planned completion date beyond the Contract completion date, will not be the basis for an adjustment to the Contract Time.

H. The CONTRACTOR shall not be entitled to job site or home office overhead beyond the CONTRACTOR'S originally planned occupancy of the site if completion of the Project occurs within the specified Contract Time.

I. When an adjustment of the Contract Time is requested due to OWNER-requested changes to the Project, include as part of each Change Order proposal that portion of the latest version of the accepted Progress Schedule which illustrates logic revisions, duration changes, and other impacts to the Progress Schedule due to the proposed Change Order work in question.

J. Notify ENGINEER for a request for Contract time adjustment. Submit request in accordance with General Conditions, Article 5.05 Claims, Paragraph G. In cases where the CONTRACTOR does not submit a request for Contract time adjustment for a specific change order, delay, or CONTRACTOR request within the specified period of time, then it is mutually agreed that the particular change order, delay, or CONTRACTOR request has no time impact on the Contract completion date and no time extension is required.

K. The ENGINEER will, within 15 days after receipt of a Contract Time adjustment, request any supporting evidence, review the facts, and advise the CONTRACTOR in writing therefore.

L. The new Progress Schedule data, if accepted by the ENGINEER, shall be included in the next monthly updating of the Schedule.

M. When the ENGINEER has not yet made a final determination as to the adjustment of the Contract Time, and the parties are unable to agree as to the amount of the adjustment to be reflected in the Progress Schedule, reflect that amount of time adjustment in the Progress Schedule as the ENGINEER may accept as appropriate for such interim purpose. It is understood and agreed that any such interim acceptance by the ENGINEER shall not be binding and shall be made only for the purpose of continuing to schedule the Work, until such time as a final determination as to any adjustment of the Contract Time acceptable to the ENGINEER has been made. Revise the Progress Schedule prepared thereafter in accordance with the final decision.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 MONTHLY PROGRESS REPORTS

A. On the first working day (or as otherwise scheduled) of each month, the CONTRACTOR shall meet with the ENGINEER and present, in duplicate, a report of his operations during the preceding month, including actual starting and ending dates on activities shown on the network diagram. Where such starting or ending dates were delayed beyond those required by the CPM schedule, the CONTRACTOR shall describe the action he is taking to regain lost time, and state the anticipated completion dates of subsequent activities affected by the delayed items. He shall also point out known or anticipated delays on continuing activities and outline the action he is taking to regain lost time, or avoid future delays, and state the anticipated completion dates of subsequent activities affected by the delayed items. On the basis of the reports presented at the meeting, the CONTRACTOR will develop a revised mathematical analysis, bar chart, and narrative report, and will furnish eight copies thereof to the ENGINEER not later than the fifth working day of the month. The updated bar chart shall detail one month window in the CPM Schedule. Each activity covering Work at the site shall reflect the Work of a specific crew, span 15 business days or less, and indicate which CPM Schedule Activity includes the same Work. Activities covering Submittals and the procurement of items of materials or equipment shall segregate the time required for preparation of Submittals, review and return of Submittals, and fabrication and delivery, as applicable, and shall not combine items furnished by separate suppliers (first and second tiers).
   1. Updated mathematical analyses shall include the information included in the initial Submittal and the following additional information.
   2. Actual start date of activities that have been started by calendar date.
   3. Actual finish date of activities that have been completed by calendar date.
   4. Actual number of days worked on activities that have been completed.
   5. Percentage completion of activities that have been started.
   6. Actual dates on which attained Milestones were achieved.
   7. Additions or deletions of activities or events since the previous report.
   8. Changes in sequence or estimated duration of activities.
   9. Where progress along any path is behind schedule such that activities lying on the path are delayed by an amount greater than their initial Total Float, the Total Float shall show as a negative value.

B. The updated bar chart shall be a revision of the initial accepted bar chart based upon the updated mathematical analysis and shall show changes from the initial bar chart.

C. The updated narrative report shall be based upon the initial narrative report and shall describe in detail any revisions, either current or forecast, to information submitted with the initial narrative reports, together with a description of current and anticipated problems and delaying factors affecting progress of the Work, their impact on progress of the Work, and an explanation of corrective actions taken or proposed. The narrative shall, at a minimum, compare current Late

Dates vs. Contract Times and Milestone Times; provide sufficient detail to allow objective verification of the progress of the Work; identify the assumptions made and activities affected in incorporating Work involved in Change Orders; describe actual or potential delays and their extent, related causes and the steps taken or anticipated to mitigate their impact; and itemize any revisions, and their bases, made in CPM Schedule Activities and sequences.

3.2 REVISION OF NETWORK DIAGRAM

A. Unless the ENGINEER direct otherwise, the network diagram shall be revised every month during the duration of the Project to reflect departures and changes from the previous network diagram. The revised network diagram shall be furnished to the ENGINEER with the corresponding Application for Payment. Each Submittal shall consist of the required copies of the updated CPM Schedule narrative, and floppy disk data.
   1. Schedule Revisions shall be solely for the purpose of showing how the CONTRACTOR'S planning, scheduling, and execution of Work remaining demonstrate continued compliance with the Contract Times and those sequences of Work indicated in or required by the Contract Documents, and preparing schedule recovery plans. CPM Schedule Revisions shall accurately represent all changes, adjustments or updates in the sequencing and timing of Work remaining made or required to be made by the CONTRACTOR.
   2. Schedule Revisions shall accurately portray how completed Work was performed and any delays and any other significant events experienced since the previous CPM Schedule Revision.
   3. Schedule Revisions shall incorporate changes in Activities and sequence agreed upon in previously authorized Change Orders.
   4. The CONTRACTOR shall ensure that the CPM Schedule diagram accurately reflects for each activity the "as-built" information shown on the pertinent documents, such as daily reports and Submittal logs (and in the later case, reflect dates for resubmissions and re-reviews). As a minimum, schedule as-built data shall include actual start dates (discounting early starts not representing true as-built conditions), remaining days of Work, percent complete, and actual finish dates (when the activities were completed so that dependent Work could proceed).
   5. The ENGINEER will return a CPM Schedule Revision Submittal with comments limited to the unprogressed portion within 20 days. If a resubmittal of a CPM Schedule Revision is required, the CONTRACTOR shall, within 10 days, submit the required copies of a corrected and adjusted CPM Schedule Revision. Once an issue of a CPM Schedule Revision is returned to the CONTRACTOR as "Resubmittal Not Required", with or without comments, it shall represent the most current CPM Schedule as of the date of the Revision, and it shall be the basis for monitoring of the CONTRACTOR'S performance and progress against late dates.

6. Each CPM Schedule Revisions Submittal shall include a statement signed by the CONTRACTOR certifying that the CONTRACTOR has not, as of the cut-off date of that CPM Schedule Revision, been delayed by any actions, or failure to act by the OWNER or ENGINEER, except as otherwise specifically stated.

3.3 REPORTS

A. CPM Schedule reports shall include cost updates, written narratives, network logic diagrams, graphic bar tabular printouts, and graphic bar charts, in both detailed and summary format.

B. Network Diagrams shall legibly show the order and interdependence of activities, and the sequence in which the Work is to be accomplished as planned by the CONTRACTOR.

C. Tabular printouts shall show one activity per line along with appropriate data for the purpose intended including various combinations of the following:
   1. Activity ID.
   2. Activity description.
   3. Preceding and succeeding activity IDs and descriptions.
   4. Original duration (in calendar days).
   5. Revised duration (in calendar days).
   6. Days remaining (in calendar days).
   7. Percent complete.
   8. Earliest start date (by calendar date).
   9. Earliest finish date (by calendar date).
   10. Latest start date (by calendar date).
   11. Latest finish date (by calendar date).
   12. Actual start date (by calendar date).
   13. Actual finish date (by calendar date).
   14. Total Float.
   15. Free Float.

D. Activities shall include in addition to the construction activities, the Submittal, review, and approval of samples, manufacturers' data, and Shop Drawings, the procurement of materials and equipment, installation and testing.

E. Bar charts will be required for summary purposes to compare actual progress with baseline As-Planned Schedule.

F. The network diagram shall be made to a time schedule and shall show the order and interdependence of activities and sequence in which the Work is to be accomplished as planned by the CONTRACTOR. The diagram shall show how the start of a given activity is dependent upon completion of preceding activities

and how its completion restricts the start of following activities. Float need not be shown on the network diagram.

1. The diagram shall be constructed in such a manner that sub-networks relating to particular phases or portions of the Work can be readily extracted or revised as required. Each sub-network shall show time allocations for Shop Drawing review and Fabrication Time in addition to Work Time. The network diagram shall show the following information related to the activities:
    a. Activity number or label if the precedence method of diagramming is being used or the preceding and following event numbers if the arrow method of diagramming is used.
    b. A brief description of the activity.
    c. Estimated duration, in consecutive calendar days, of each activity.
    d. If the precedence method of diagramming is being used, lags or lag factors may be used at the CONTRACTOR'S option.
    e. All activities relating to the furnishing and performance of the Work shall be shown. Activities which are interdependent because of restrictions of available manpower or construction equipment shall be so shown.
    f. In addition to construction activities, the diagram shall show the date of the Work authorization and mandatory completion dates.
    g. Detail of information shall be such that duration times of activities shall span 40 calendar days or less with not over 2% of the activities exceeding these limits. The activities which comprise separate portions of the Work shall be separately identifiable by coding.
    h. The network diagram shall be drawn on 24-inch by 36-inch size sheets with flow of activities generally from left to right. Printing shall be suitable for half size and microfilm reproduction. No lettering or numbering shall be less than 1/8-inch in height (for capitals and numbers). The critical path shall be clearly marked. Wherever possible, activities relating to a particular sub-network shall be grouped together on a single sheet.

G. Mathematical analysis of the network diagram shall be based on the network diagram and shall be a computer printout tabulating each activity and showing the following information for each activity:
    1. Activity number or label if the precedence method of diagramming is being used or the preceding and following event numbers if the arrow method is being used.
    2. Activity description.
    3. Estimated duration, in consecutive calendar days, or each activity.
    4. Earliest start date by calendar date.
    5. Earliest finish date by calendar date.
    6. Latest start date by calendar date.
    7. Latest finish date by calendar date.
    8. Latest free start date by calendar date.

9. Latest free finish date by calendar date.
10. Total Float.
11. Free Float.
12. Critical activities and activities on critical path shall be marked.
13. Earliest start and finish dates shall be regarded as the CONTRACTOR'S scheduled start and finish dates.

H. The bar chart shall be based on the network diagram and mathematical analysis. Related activities may be grouped together into a single item. However, the completed bar chart shall consist of not less than 50 items. The length of each bar shall correspond to the net aggregate durations of activities represented by the bar. Portions of bars that represent critical activities shall be marked. Bars shall be broken during extended periods of no Work such as shutdowns for inclement weather.
   1. The bar chart shall be drawn on 24-inch by 36-inch size sheets showing the total Contract duration in months. Printing shall be suitable for half size and microfilm reproduction. No lettering or numbering shall be less than 1/8-inch in height (for capitals and numbers). Bars representing related activities for any given portion of the Work shall be grouped together and a descriptive title shall be shown for each bar. A list of all activities represented by each bar shall be included with the bar charts.

I. The narrative report shall describe in detail, but not be limited to, the CONTRACTOR'S proposed methods of carrying out each phase or portion of the Work together with the number of personnel, number of shifts, hours per shift, work week, and the number, size and type of major pieces of construction equipment required for the Work. The report shall include a charge showing the CONTRACTOR'S estimated monthly earnings and accumulated earnings.

J. Except where directed in writing by the OWNER, the CONTRACTOR shall promptly take appropriate action to recover schedule whenever the CONTRACTOR fails to achieve a Contract Time or Milestone Time or perform activities within the late dates in the most current revision of the CPM Schedule, or the CONTRACTOR'S progress falls behind that required to comply with that Contract Time, Milestone Time, or late dates. The CONTRACTOR shall submit with the Application for Payment following recognition of the problem a schedule recovery plan describing the cause of schedule slippage or delayed progress and the actions taken to correct them within the shortest reasonable time.
   1. Appropriate schedule recovery actions may include, but not be limited to, assignment of additional labor, subcontractors, or construction equipment, Work during other than normal working hours (subject to the requirements of Article 8 of the General Conditions), expediting of Submittals or deliveries, or any combination of any of them. Overlapping or re-sequencing of Activities to increase activity concurrence shall be appropriate only if properly substantiated in the schedule recovery plan.
   2. The CONTRACTOR'S failure, refusal or neglect to:

a. Submit a schedule recovery plan furnishing sufficient and convincing evidence that the CONTRACTOR can recover schedule within the shortest reasonable time acceptable to the OWNER or take appropriate schedule recover action, shall be reasonable evidence that the CONTRACTOR is not prosecuting the Work with all due diligence and shall give sufficient basis to the OWNER to demand adequate, written assurance of performance under the General Conditions, withhold from any payment an amount based on the OWNER'S estimate of the liquidated damages that would become due because of the actual or anticipated late completion, and in the OWNER'S sole discretion, order alternate schedule recovery actions.

3. An extension in Contract Time or an increase in Contract Price arising from delays which postpone, extend or in any other manner alter the schedule or completion of all or part of the Work will not be granted unless the CONTRACTOR, through an analysis of a schedule reflecting data as of the date prior to the origination of the delay, as designated in Paragraph 3.2.A.4 demonstrations that conditions justifying extensions in Contract time or increases in Contract price as provided in Articles 8 and 11 of the General Conditions, have been met, and that analysis by the CONTRACTOR is verifiable by objective evaluation.
4. A Version of the As-Planned Schedule Shall Accurately Show:
   a. All Work progress (by the cut-off date) and any delays and any other significant events experienced before the cut-off date.
   b. Any changed in activities and sequences agreed upon in previously authorized Change Orders considering the proper records and all valid data provided under the requirements of Paragraphs 3.2.A.2. and 3.2.A.3., respectively. Any such As-Planned Schedule shall purposely exclude all activity and sequencing changes initiated by the CONTRACTOR that affect Work after the cut-off date (whenever incorporated into any contemporaneous CPM Schedule Revisions under the requirements of Paragraph 3.2.A.1. or otherwise), until the timing and sequences suggested by those changes actually take place.

K. The ENGINEER may refuse to recommend any part of the payment if, in the ENGINEER'S judgment, the CONTRACTOR'S failure, refusal or neglect to provide the required CPM Schedule information precludes a proper evaluation of the CONTRACTOR'S progress. The OWNER may withhold a set-off from any payment recommended by the ENGINEER, if in the OWNER'S judgment, the CONTRACTOR'S failure, refusal or neglect to provide the required CPM Schedule information precludes a proper evaluation of whether the CONTRACTOR is prosecuting the Work, or any separable part of the Work, with all due diligence or not.

END OF SECTION

SECTION 01380

CONSTRUCTION PHOTOGRAPHS

PART 1 - GENERAL

1.1 SUMMARY

A. Pre-construction Video:
   1. The CONTRACTOR shall furnish a pre-construction video recording of the entire Project site showing the condition of the site, grading, and other site features. The pre-construction video shall be in color DVD format. Two copies of the DVD shall be submitted to the ENGINEER and approved prior to mobilization or initiating any construction activities. The CONTRACTOR shall notify the ENGINEER at least 48 hours prior to making the recording so that the ENGINEER may accompany the recorder.

B. Ground Level Construction Photographs:
   1. The CONTRACTOR shall furnish a minimum of 30 digital progress photographs of the Project with each application for payment. The photographer selected by the CONTRACTOR shall be approved by the ENGINEER and shall be either a commercial photographer or an individual experienced and equipped for such photography. The CONTRACTOR shall submit to the ENGINEER three representative prints of photos taken by the selected photographer for approval of the photographer's qualifications prior to taking the first photographs.
   2. Digital camera shall have 3.0 megapixel resolution minimum. Photos shall be recorded at high resolution and printed at a minimum resolution of 1,600 by 1,200 dots per inch. Photos shall be printed two per sheet on 8-1/2-inch by 11-inch glossy photo-quality paper. Labels shall be on the front of each sheet immediately below each photo. Provide two copies of the digital files on CD of the photographs with each pay application. The digital file of each photo shall include the label. If the current photographs do not accompany the application for payment, it shall not be reviewed and shall be returned to the CONTRACTOR as incomplete. At least 30 photographs shall be taken per each Application of Payment (approximately 15 photos per two week period).
   3. The photographs shall be taken at regular intervals, which provide a step-by-step progress of each process area.
   4. The CONTRACTOR shall furnish a three-ring binder for storage of the photos each of the two sets of photos. Photo albums shall be labeled as to Project title and OWNER'S Project number.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PROCEDURES

A. Requirements: Photographic exposures shall be taken during the construction period. The ENGINEER may vary the specified frequency so that significant progress or changes can be recorded on the photographs. Approximately 15 ground level construction photographs will be required every two weeks through the construction period.

B. The ground level construction photographs shall be of aesthetic composition and shall depict the progress of the Work from the beginning of construction through and including the finished product and shall include, but not be limited to, the items listed in Section 01010, Summary of Work.

C. Ground level construction photographs shall be submitted with each Application for Payment. The Application for Payment shall not be reviewed and shall be returned to the CONTRACTOR as incomplete if the currently due photographs have not been submitted.

D. All buried piping above 4-inches shall be photographed prior to backfill. One photograph shall be taken at every 40 feet of length. These shall be in addition to the 15 photographs per two week period.

END OF SECTION

SECTION 01400

QUALITY CONTROL

PART 1 - GENERAL

1.1 RELATED SECTIONS

A. Section 01300, Submittals.

B. Section 01640, Materials and Equipment.

1.2 QUALIFICATIONS

A. Installation of materials and equipment shall be performed in a workmanlike manner by mechanics skilled in their particular trade.

B. The determination for the performance qualification is the responsibility of CONTRACTOR and each welder or welding operator shall be qualified by tests using equipment, procedures and a base metal and electrode or filler wire from the same compatible group number that will be encountered in the applicable procedure. Welders or welding operators who make acceptable procedure qualification test welds will be considered performance qualified for the welding procedures used. Performance qualification shall be determined in accordance with Section IX of the ASME Boiler and Pressure Vessel Code. Welders and welding operators qualified by another employer may be accepted as permitted by ANSI B31.1. ENGINEER shall be notified 24 hours in advance as to the time and place of tests and wherever practical, the tests shall be performed at the Work site. ENGINEER shall be furnished a listing of the names and identification symbol as noted on the performance qualification test records to be used to identify the Work performed by the welder or welding operator who after completing a welded joint shall identify it as his Work by applying his assigned symbol for permanent record.

1.3 REGULATORY REQUIREMENTS

A. Unless indicated or specified otherwise, all materials and workmanship for the mechanical trades shall conform to the editions of the various standards, codes, manuals, and Specifications in effect on the date of advertisement for bids.

1.4 CERTIFICATIONS

A. Submittals of certifications of compliance from the CONTRACTOR or manufacturer required as specified for equipment in these documents shall be submitted to the ENGINEER as specified in Section 01300, Submittals.

1.5 FIELD TESTING

A. All testing called for in the Specifications shall be the responsibility of the CONTRACTOR. All retesting required due to the failure of the CONTRACTOR'S Work to meet the requirements of the Contract Documents shall be at the CONTRACTOR'S expense.

1.6 SUPERVISION OF INSTALLATION BY MANUFACTURER

A. As required in the individual equipment specifications, an experienced, competent, and authorized factory representative of the equipment manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation, and shall be present when the equipment is placed in operation. The equipment supplier's representative shall revisit the job site as often as necessary until any trouble is corrected and the equipment installation and operation is satisfactory to ENGINEER. The equipment supplier's representative shall furnish to ENGINEER, through CONTRACTOR a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; has been operated under full load conditions and that it operated satisfactorily.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 DEMONSTRATION

A. The CONTRACTOR shall demonstrate as, specified in Section 01650, Starting of Systems, to the satisfaction of the ENGINEER, OWNER and manufacturer's representative that all newly installed equipment operates in a satisfactory manner.

END OF SECTION

SECTION 01451

TESTING LABORATORY SERVICES FURNISHED BY THE CONTRACTOR

PART 1 - GENERAL

1.1 DESCRIPTION

A. The CONTRACTOR will employ and pay for an independent testing laboratory to perform the specified services.

B. Inspection, sampling, and testing shall be as specified in the individual Sections. These include, but are not limited to:
   1. Section 02200, Earthwork.
   2. Section 03305, Concrete.

C. The CONTRACTOR will pay for the testing listed above, including repeat testing which results from CONTRACTOR'S negligence or his repeated failure to meet Contract Document requirements.

D. CONTRACTOR shall pay for:
   1. Tests not listed above.
   2. Tests made for CONTRACTOR'S convenience.
   3. Repeat tests required because of CONTRACTOR'S negligence or repeated failure, three or more tests for the same item, to meet Contract Document requirements.

E. The testing laboratory is not authorized to approve or accept any portion of the Work; rescind, alter, or augment the requirements of the Contract Documents; or perform any duties of CONTRACTOR.

1.2 QUALIFICATIONS OF LABORATORY

A. Where applicable, the testing laboratory will meet "Recommended Requirements for Independent Laboratory Qualification", latest edition, published by American Council of Independent Laboratories, and the basic requirements of ASTM E329 "Standards of Recommended Practice for Inspection and Testing Agencies for Concrete and Steel as Used in Construction".

B. Testing equipment used by the laboratory will be calibrated at maximum 12 month intervals by devices of accuracy traceable to either National Bureau of Standards or accepted values of natural physical constants.

C. CONTRACTOR shall submit a written description of the proposed soils testing agency giving qualification of personnel, equipment, and other information which may be required by ENGINEER.

1.3 LABORATORY DUTIES

A. The Testing Laboratory shall:
   1. Cooperate with CONTRACTOR and provide qualified personnel promptly on notice.
   2. Perform specified inspections, sampling, and testing of materials and methods of construction; comply with applicable standards; and ascertain compliance with requirements of Contract Documents.
   3. Promptly notify ENGINEER and CONTRACTOR of irregularities or deficiencies of Work that are observed during performance of services.
   4. Promptly submit five copies of reports of inspections and tests to ENGINEER, including:
      a. Date issued.
      b. Project title and number.
      c. Testing laboratory name and address.
      d. Date of inspection or sampling.
      e. Record of temperature and weather.
      f. Date of test.
      g. Identification of product and Specification Section.
      h. Location in Project.
      i. Type of inspection or test.
      j. Results of tests and observations regarding compliance with Contract Documents.
   5. Perform additional tests and services as required by OWNER.

1.4 CONTRACTOR'S RESPONSIBILITIES

A. CONTRACTOR shall:
   1. Cooperate with laboratory personnel and provide access to Work and to manufacturer's operations.
   2. Provide to laboratory preliminary representative samples of materials to be tested, in required quantities.
   3. Furnish copies of product test reports.
   4. Provide to the laboratory the preliminary design mix proposed for concrete and other material mixes that require testing by the testing laboratory.
   5. Furnish labor and facilities:
      a. To provide access to Work to be tested.
      b. To obtain and handle samples at the site.
      c. To facilitate inspections and tests.
      d. For laboratory's exclusive use for storage and curing of test samples.
      e. Forms for preparing concrete test beams and cylinders.

6. Notify laboratory and ENGINEER sufficiently in advance of operations to allow for assignment of personnel and scheduling of tests.
7. Arrange with laboratory and pay for additional samples and tests required for CONTRACTOR'S convenience.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01500

CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Temporary utilities required during construction.

B. Requirements for security and protection of facilities and property.

C. Requirements for access to the Work.

D. Temporary controls for protection of environment.

1.2 SUBMITTALS

A. Temporary Utility Submittals:
   1. Electric power supply and distribution plans.
   2. Temporary water supply and distribution plans.
   3. Copies of approvals of local utility companies for CONTRACTOR'S intended temporary utility plans.

B. Temporary Construction Submittals:
   1. Access roads and parking area plans.
   2. Security guard shack and storage building plans, including gravel surfaced area.
   3. Fencing and protective barrier locations and details.
   4. Staging area plan and notification of any obstructions encountered during mobilization.

1.3 STAGING AREA

A. Use the area designated for CONTRACTOR'S temporary facilities as shown on the Drawings.

B. Notify ENGINEER of obstructions not shown or not readily apparent by visual inspection of the staging area. Do not remove obstructions without OWNER'S prior consent.

1.4 TEMPORARY UTILITIES

A. Costs after Final Acceptance:

1. Upon acceptance of the Work or a portion of the Work defined and certified as complete by ENGINEER, and OWNER commences full-time successful operation of the facility or portion thereof, the OWNER will bear the cost for utilities used for OWNER'S operation. In the event the OWNER has not accepted all portions of the Work, CONTRACTOR shall continue to pay for temporary utilities used until all Work has been accepted, except as provided herein.

B. Electric Power:
   1. Temporary electrical service shall be provided by CONTRACTOR until Final Acceptance of the Work. The CONTRACTOR shall make arrangements with Arizona Public Service (APS) for obtaining temporary electric power service, metering equipment, and pay all costs for the electric power used till final completion.
   2. Provide power for testing, checking, initial start-up of equipment and commissioning.
   3. Maintain installation throughout construction period to provide continuous service and to provide safe working conditions.
   4. Temporary electric power installations shall meet construction safety requirements of OSHA, State, and other governing agencies.
   5. Completely remove temporary materials and equipment after permanent installation is in use.

C. Water:
   1. CONTRACTOR shall pay costs of temporary water service, including costs of installation, maintenance and removal of pipe and equipment. CONTRACTOR shall pay costs for water used by all trades.
   2. CONTRACTOR shall provide water source by connecting to existing utility mains at locations designated by OWNER. CONTRACTOR shall provide all facilities necessary to convey the water from the OWNER designated source to the points of use in accordance with the requirements of the Contract Documents. CONTRACTOR shall provide backflow prevention devices, where required. Hydrants cannot be taken out of service.
   3. The CONTRACTOR shall not make connection to or draw water from any other water system without first obtaining permission from the OWNER or the authority having jurisdiction over the use of the said water system. For each water system connection, the CONTRACTOR shall first attach to the water system a valve and a meter. The size and type of valve and meter shall be acceptable to OWNER or jurisdictional authority.
   4. Before final acceptance of the Work, all temporary connections to the said water system shall be entirely removed. All affected improvements shall be restored to their original condition or better, to the satisfaction of the ENGINEER and to the OWNER or jurisdictional authority.
   5. All potable water used by CONTRACTOR'S employees, subcontractor's employees and the temporary construction facilities during construction shall be furnished by the CONTRACTOR and shall be bottled water or water

furnished in approved metal dispensers. Notices shall be posted conspicuously throughout the site warning temporary piped water may be contaminated.

D. Sanitation:
   1. Provide and maintain sanitary facilities for CONTRACTOR'S employees and subcontractors' employees that comply with regulations of local and State health departments.
   2. Provide chemical toilets of suitable types and maintain them in a sanitary condition at all times conforming to code requirements and acceptable to health authorities. They shall be of watertight construction so that no contamination of the area can result from their use. The CONTRACTOR shall make arrangements for frequent emptying of toilets. Upon completion of Work, CONTRACTOR shall remove toilets and restore area to original condition.
   3. Use of OWNER'S existing sanitary facilities by construction personnel will not be allowed.

E. Communications:
   1. The CONTRACTOR shall provide and maintain, at all times during the progress of the Work, not less than one cellular phone in good working order.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 SECURITY

A. The CONTRACTOR shall provide security to prevent unauthorized persons from entering the construction site and a secured storage area for materials and equipment.

B. The CONTRACTOR shall safely guard all Work, materials, equipment, and property from loss, theft, damage, and vandalism. The CONTRACTOR'S duty to safely guard property shall include the OWNER'S property and other private property from injury or loss in connection with the performance of the Contract.

C. The CONTRACTOR may make no claim against the OWNER for damage resulting from trespass.

D. Party responsible for security shall make good all damage to property of the OWNER and others, arising from failure to provide adequate security.

E. The CONTRACTOR shall provide and maintain temporary security fencing in a manner satisfactory to the ENGINEER and OWNER.

F. Security measures taken by the CONTRACTOR shall be at least equal to those usually provided by the OWNER to protect his existing facilities during normal operation.

G. Maintain security program throughout construction until final acceptance and occupancy precludes need for the CONTRACTOR'S security program.

H. All costs for security as specified in this Section shall be borne by the CONTRACTOR.

I. CONTRACTOR hereby acknowledges and agrees to limit access to the site to those persons cleared by OWNER. In furtherance thereof, all employees, agents, and invitees of CONTRACTOR shall be subject to a background check prior to entry on to the site. CONTRACTOR expressly acknowledges OWNER'S right to deny or limit entry to the site to any person(s) that OWNER deems to be a security risk based on the results of the background check conducted, and to forward the results thereof to those law enforcement agencies that OWNER deems appropriate.

3.2 TEMPORARY CONSTRUCTION FACILITIES

A. Access Roads and Parking:
   1. Construct temporary construction access roads and detours as necessary to execute the Work and as approved by the OWNER. Maintain in good condition until no longer needed, then remove the temporary roads and leave the area in a condition satisfactory to the OWNER. Construction traffic shall use the construction access road to enter and exit the staging and trailer areas. Construction traffic shall not use the plant's main entrance.

B. Storage Yards and Buildings:
   1. Construct temporary storage yards for the storage of products that are not subject to damage by weather conditions. Materials such as pipe, reinforcing, and structural steel shall be stored on pallets or racks, off the ground, and in a manner to allow ready access for inspection and inventory. Temporary gravel surfacing of storage yards must be approved by the OWNER.
   2. Erect or provide temporary storage buildings of various sizes needed to protect mechanical and electrical equipment and other materials, as recommended by manufacturers of such equipment and materials.
      a. Provide environmental control systems that meet recommendations of manufacturers of equipment and materials stored in the buildings.
      b. Buildings shall be of sufficient size.
      c. Arrange or partition buildings to provide security for their contents and ready access for inspection and inventory.

d. At or near completion of the Work, temporary storage buildings shall be dismantled, removed from the site, and remain the property of the CONTRACTOR.

3. Store combustible materials (paints, solvents, fuels, etc.), in a well ventilated building remote from other buildings.

C. Fencing and Barricades:
1. Barricades: Provide barricades as necessary to prevent unauthorized entry to construction areas, both inside and outside of fenced area. Also, provide barricades to protect existing facilities and adjacent properties from potential damage.

3.3 EXAMINATION OF EXISTING FACILITIES

A. General:
1. After the Contract is awarded and before the commencement of Work, CONTRACTOR and ENGINEER shall make a thorough examination of all existing buildings, structures, and other improvements in the vicinity of the Work, as applicable, which might be damaged by construction operations.
2. Periodic examinations of existing buildings, structures, and other improvements in the vicinity of the Work shall be made jointly by authorized representatives of the CONTRACTOR, ENGINEER, and the OWNER. The scope of the examination shall include cracks in structures, settlement, leakage, and similar conditions.
3. Records in triplicate of all observations shall be prepared by the CONTRACTOR and each copy of every document shall be signed by the authorized representative of the OWNER and of the CONTRACTOR. Photographs, as requested by the OWNER, shall be made by the CONTRACTOR and signed in the manner specified above. One signed copy of every document and photograph will be kept on file in the office of the ENGINEER.
4. These records and photographs are intended for use as indisputable evidence in ascertaining whether and to what extent damage occurred as a result of the CONTRACTOR'S operations, and are for the protection of the adjacent property owners, the CONTRACTOR, and the OWNER.

3.4 SAFETY REQUIREMENTS

A. General:
1. CONTRACTOR shall do whatever Work is necessary for safety and be solely and completely responsible for conditions of the job site, including safety of all persons (including employees) and property during the Contract period. This requirement shall apply continuously and not be limited to normal working hours.
2. Safety provisions shall conform to Federal and State Departments of Labor Occupational Safety and Health Act (OSHA), and other applicable Federal,

State, County, and local laws, ordinances, codes, requirements set forth herein, and regulations that may be specified in other parts of these Contract Documents. Where these are in conflict, the more stringent requirement shall be followed. CONTRACTOR shall become thoroughly familiar with governing safety provisions and shall comply with the obligations set forth therein.

3. CONTRACTOR shall develop and maintain for the duration of the Contract, a safety program that will effectively incorporate and implement required safety provisions. CONTRACTOR shall appoint a qualified employee who is authorized to supervise and enforce compliance with the safety program.
4. ENGINEER'S duty to conduct construction review of the CONTRACTOR'S performance is not intended to include a review or approval of the adequacy of CONTRACTOR'S safety supervisor, safety program, or safety measures taken in, on, or near the construction site.
5. As part of safety program, CONTRACTOR shall maintain at its office or other well known place at the job site, safety equipment applicable to the Work as prescribed by the governing safety authorities, and articles necessary for giving first-aid to the injured. Establish procedures for the immediate removal to a hospital or a doctor's care of persons who may be injured on the job site.
6. CONTRACTOR shall do all Work necessary to protect the general public from hazards, including, but not limited to, surface irregularities or unramped grade changes in pedestrian sidewalk or walkway, and trenches or excavations in roadway. Barricades, lanterns, and proper signs shall be furnished in sufficient amount to safeguard the public and the Work.
7. Construct and maintain satisfactory and substantial temporary chain-link fencing, solid fencing, railing, barricades, steel plates, as applicable, at all openings, obstructions, or other hazards in streets, sidewalks, floors, roofs, and walkways. Such barriers shall have adequate warning lights as necessary or required for safety.
8. Comply with OWNER'S safety rules while on OWNER'S property.
9. If death or serious injuries or damages are caused, the accident shall be reported immediately by telephone or messenger to the ENGINEER and OWNER. In addition, CONTRACTOR shall promptly report in writing all accidents whatsoever arising out of, or in connection with, the performance of the Work whether on or adjacent to the site, giving full details and statements of witnesses.
10. If claim is made by anyone against CONTRACTOR or any subcontractor on account of accident, CONTRACTOR shall promptly report the facts in writing, giving full details of the claim.

B. Traffic Safety and Access:
   1. Comply with rules and regulations of the City, State, and County authorities regarding closing or restricting the use of public streets or highways. No public or private road shall be closed except by written permission of the

proper authority. Assure the least possible obstruction to traffic and normal commercial pursuits.

2. Where traffic will pass over backfilled trenches before they are paved, maintain top of trench to allow normal vehicular traffic to pass over. Provide temporary access driveways where required. Cleanup operations shall follow immediately behind backfilling.
3. When flagmen and guards are required by regulation or when deemed necessary for safety, furnish them with approved orange wearing apparel and other regulation traffic control devices.
4. Traffic control procedures and devices used on all local rights-of-way shall meet the requirements of the applicable current laws and regulations for traffic control.
5. Notify the fire department and police department, and obtain required permits before closing any street or portion thereof. Notify said departments when the streets are again passable for emergency vehicles. Do not block off emergency vehicle access to consecutive arterial crossings or dead-end streets in excess of 300 linear feet without written permission from the fire department. Conduct operations with the least interference to fire equipment access, and at no time prevent such access.
6. CONTRACTOR shall leave its night emergency telephone number or numbers with the police department, so that contact may be made easily at all times in case of barricade and flare trouble or other emergencies.
7. Maintain postal service facilities in accordance with the requirements of the U.S. Postal Service. Move mailboxes to temporary locations designated by the Service, and on completion of Work in each area replace them in their original location and in a condition satisfactory to the service.

C. Fire Prevention:
   1. Perform all Work in a fire safe manner. Furnish and maintain on the site adequate firefighting equipment capable of extinguishing incipient fires. Comply with applicable Federal, State, and local fire prevention regulations. Where these regulations do not apply, follow applicable parts of the National Fire Prevention Standard for Safeguarding Building Construction Operations (NFPA No. 241).

D. Protection of Work and Property:
   1. General:
      a. CONTRACTOR shall employ such means and methods necessary to adequately protect public property and property of the OWNER against damage. In the event of damage to such property, immediately restore the property to a condition equal to its original condition and to the satisfaction of the ENGINEER and the OWNER of said property, and bear all costs therefore.
      b. Protect stored materials and other items located adjacent to the proposed Work.
   2. Finished Construction:

a. General Construction CONTRACTOR shall assume the responsibility for protection of finished construction and shall repair and restore any and all damage to finished work to its original or better condition.
b. Prevent wheeling of loads over finished floors, either with or without plank protection, except in rubber-tired wheelbarrows, buggies, or dollies. Protect finished floors and concrete floors exposed as well as those covered with composition tile or other applied surfacing. All finished floors shall be protected from stains due to spillage of oil, paint, or any other construction-related materials. Any such stains that are allowed to occur shall be removed, if necessary by removing and replacing the floor, at the CONTRACTOR'S expense.
c. At such time temporary facilities and utilities are no longer required for the Work, notify ENGINEER of intent and schedule for their removal. Remove temporary facilities and utilities from the site as CONTRACTOR'S property and leave the site in such condition as specified, as shown on the Drawings, or as directed by the ENGINEER.
d. In unfinished areas, leave the site evenly graded, seeded, or planted as necessary, in a condition that will restore original drainage and with an appearance equal to or better than original.

3.5 ENVIRONMENTAL CONTROLS

A. General:
1. The CONTRACTOR, in executing the Work, shall maintain affected areas within and outside Project boundaries free from environmental pollution that would be in violation of Federal, State, or local regulations.
2. Do not impair operation of existing sewer systems. Prevent construction material, pavement, concrete, earth, volatile and corrosive wastes, and other debris from entering sewers, pump stations, or other sewer structures. Maintain original site drainage wherever possible.

B. Waste Material Disposal:
1. The OWNER will make available areas to dispose of excess excavated material within two miles of each site. Excess excavated material not suitable for backfill, and other waste material, must be disposed of in licensed landfills. However, a site is exempt from licensing where only earth containing less than 25% by volume of concrete and building stone is disposed. The CONTRACTOR shall submit the proposed haul route(s) for each site intended to be used.
2. Unacceptable disposal sites include, but are not limited to, sites within a wetland or critical habitat and sites where disposal will have a detrimental effect on surface water or groundwater quality.
3. In lieu of the foregoing, CONTRACTOR may make his own arrangements for disposal subject to submission of proof that the owner(s) of the proposed site(s) has a valid fill permit issued by the appropriate governmental agency. Submit intended haul route plan, including a map of the proposed route(s).

Provide watertight conveyance for liquids, semi-liquids, or saturated solids that tend to bleed during transport.

4. Maintain areas covered by the Contract and affected public properties free from accumulations of waste, debris, and rubbish caused by construction operations. Remove excavated materials from the site.
5. Cleaning and disposal shall comply with local ordinances and pollution control laws. Do not burn or bury rubbish or waste materials on the Project site. Do not dispose of volatile wastes such as mineral spirits, oil, chemicals, or paint thinner in storm or sanitary drains. Disposal of wastes into streams or waterways is prohibited. Provide acceptable containers for collection and disposal of waste materials, debris, and rubbish.

C. Air Pollution Control:
   1. CONTRACTOR shall comply with Maricopa County's requirements regarding dust control.
   2. Minimize air pollution likely to occur from construction operations by wetting down bare soils during windy periods, requiring proper combustion emission control devices on construction vehicles and equipment, and by shutdown of motorized equipment not in use. Trash burning will not be permitted on the construction site.
   3. Operations of dumping rock and of carrying rock away in trucks shall be conducted to cause a minimum of dust. Give unpaved streets, roads, detours, or haul roads used in the construction area a dust-preventive treatment, or periodically water to prevent dust. Strictly adhere to applicable environmental regulations for dust prevention.

D. Noise Control:
   1. Minimize noise by executing Work using appropriate construction methods and equipment. Provide acoustical barriers so noise emanating from tools or equipment will not exceed legal noise levels.
   2. Submit plans to mitigate construction noise impacts and to comply with noise control ordinances including method of construction, equipment to be used, and acoustical treatments.
   3. If piles are required, use spudding or drilling techniques to penetrate through fill and overburden. Penetrate intermediate hard layers to minimize noise impact by minimizing the number of piledriver hammer blows. Use only piledriver hammers with mufflers capable of reducing noise, and use barriers or shielding techniques to comply with applicable noise criteria.

E. Pest and Rodent Control:
   1. Comply with local health requirements for pest and rodent control. Cooperate with agencies and companies authorized to spray or provide other treatments to prevent insect outbreaks.
   2. Maintain closures of means of entry into finished buildings by rodents. Inspect for rodents during cleaning, remove debris, and treat infested areas to OWNER'S satisfaction.

END OF SECTION

SECTION 01640

MATERIALS AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall furnish all materials and equipment and perform all operations required to completely install and place in operation the various mechanical apparatus and systems indicated on the Drawings and as specified herein. It is not the intention to mention herein each and every item required. However, all installations shall be complete and operable in the methods intended. These general equipment requirements apply, in general, to all equipment. They shall supplement the detailed equipment specifications, but in case of conflict, the equipment specifications shall govern.

1.2 RELATED SECTIONS

A. Section 01300, Submittals.

PART 2 - PRODUCTS

2.1 GENERAL

A. Materials and equipment shall be of new, of first quality and best grade, essentially the standard catalog products of reputable manufacturers, and shall be of the type, size, and capacity, and for the type of service specified. It is the intent of these Specifications that the highest quality equipment shall be provided for the intended service. Units proposed shall be carefully matched to the particular hydraulic and mechanical requirements for each installation, and the CONTRACTOR shall submit complete hydraulic and mechanical data for approval of the ENGINEER. Where two or more units of the same class of equipment are required, these units shall be the products of a single manufacturer; however, the component parts of the system need not be the products of the same manufacturer unless otherwise specified.

1. Materials and Workmanship: Materials used in the manufacture of the equipment shall be of the best quality used for the purpose in commercial practice. Materials shall be suitable for service conditions. Iron castings shall be tough, close-grained gray iron free from blowholes, flaws, or excessive shrinkage, and shall conform to ASTM A48. Except where otherwise specified, structural and miscellaneous fabricated steel used in items of equipment shall conform to the Standards of the American Institute of Steel Construction. All structural members shall be considered as subject

to shock or vibratory loads. Unless otherwise specified, all steel which will be submerged, all or in part, during normal operation of the equipment shall have a minimum nominal thickness of 1/4-inch. Equipment shall be installed in accordance with the recommendations of the manufacturer and the best standard practice for each type of equipment.

2. Approval of Materials, Equipment, and Shop Drawings: Detailed Shop Drawings shall be prepared for the equipment to be furnished under this Project. General drawings for equipment will not be acceptable. Approval of equipment under this provision shall not be construed as authorizing any deviations from the Specification unless the attention of the ENGINEER has been directed to the specific deviation.
    a. The decision of the ENGINEER on any questions concerning the acceptability of materials, equipment, or installation shall be final and binding. The Shop Drawing material required for the various submittals shall be in accordance with the coded legend set forth in Section 01300, Submittals, and as indicated and specified under various headings of these Specifications.
3. Nameplates: Equipment shall be furnished with nameplates of bronze, monel, or stainless steel. Aluminum will not be acceptable. Each nameplate shall include pertinent hydraulic and mechanical data. Information shown shall be permanently stamped or cast into each nameplate and shall include the manufacturer's name and model number.
4. ASME Stamp: Where materials and equipment are specified to be constructed in accordance with the standard of the American Society of Mechanical Engineers (ASME) Code for Unfired Pressure Vessels, the CONTRACTOR shall submit proof that the items furnished under this Section of the Specifications conform to such requirements. The ASME stamp, label, or listing will be acceptable as sufficient evidence that the items conform to these requirements and shall be provided on all pressure vessels falling within the ASME Code jurisdiction.

B. Electric Motors:
1. General: Unless otherwise required by the detailed equipment specifications, motors furnished with equipment shall be rated for continuous duty at 50° C ambient temperatures with a 1.15 service factor. Motors designated for use with variable speed drives and where indicated shall be derated to accommodate the application. Where frequent starting occurs, motors shall be designed for frequent starting duty equivalent to the duty service required by the driven equipment. The horsepower rating of each motor shall be as required to drive the equipment under full load, including all losses in speed reducers and power transmission, and to be non-overloading over the entire range of equipment head capacity curves without the use of motor service factors. It is the intent of this general specification to allow the manufacturer's standard motor on integrally constructed motor driven equipment such as appliances, hand tools, etc., that is specified by model number in which a redesign of the complete unit would be required for a

motor with other features as may be specified herein. All motors furnished under these Specifications shall be of recognized manufacture, of adequate capacity for the loads involved, and wound to the current characteristics noted. All motors shall conform to the standards of manufacture and performance of the National Electrical Manufacturers Association as shown in their latest publications.

2. Enclosures: Unless otherwise required by the detailed equipment specifications, the enclosures for motors shall be as indicated below:
   a. Motors installed outdoors shall be totally enclosed or totally enclosed fan-cooled except that vertically mounted motors may be weather protected Type I.
   b. Motors installed indoors may be open drip-proof, unless otherwise indicated.
3. Motor horsepower requirements in the equipment specifications are estimated. If the horsepower requirements for the equipment furnished vary from the estimated horsepower, the CONTRACTOR shall be responsible for making all necessary revisions to wiring, conduit, motor starters, circuit breaker, and other electrical equipment at no additional cost to OWNER.
4. Anchor Bolts: Equipment suppliers shall furnish suitable anchor bolts of specified metallurgy for each item of equipment. Anchor bolts, together with templates or setting drawings, shall be delivered sufficiently early to permit setting the anchor bolts when the structural concrete is placed. Two nuts shall be furnished for each bolt. Unless otherwise shown or specified, anchor bolts for items of equipment mounted on baseplates shall be long enough to permit 1-1/2-inch of grout beneath the base plant and to provide adequate anchorage into structural concrete.
5. Equipment Bases: A cast iron or welded steel baseplate shall be provided for each pump and other item of equipment that is to be installed on a concrete base. Each baseplate shall support the unit and its drive assembly, and shall be of a neat design with pads for anchoring the units. Baseplates shall be anchored to the concrete base with suitable anchor bolts and grouted in place.

C. Equipment Guards: All belts or chain drives, fan blades, couplings, and other moving or rotating parts shall be covered on all sides by a safety guard. All safety guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water.

D. Special Tools and Accessories: Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

E. Standard specifications prepared by recognized organizations mentioned elsewhere shall govern except as provided otherwise by these Specifications and/or its accompanying Drawings. Special care shall be exercised in requests for

quotations and in orders, to refer to the standard specifications and to all modifications thereof.

F. Standard Codes, Regulations, and Specifications: Unless indicated or specified otherwise, all materials and workmanship for the mechanical trades shall conform to the editions of the various standards, codes, manuals, and specifications in effect on the date of advertisement for bids, which are referred to in the various Sections herein.

PART 3 - EXECUTION

3.1 PROTECTION OF EQUIPMENT

A. General: All equipment shall be boxed, crated, or otherwise completely enclosed and protected during shipment, handling, and storage. All equipment shall be protected from exposure to the elements and shall be kept thoroughly dry at all times.

B. Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage. All painted surfaces that are damaged prior to acceptance of equipment shall be repainted to the satisfaction of the ENGINEER.

C. Electrical equipment, controls, and insulation shall be protected against dust, moisture, or water damage.

3.2 INSTALLATION

A. Installation of materials and equipment specified herein shall be performed in a workmanlike manner by mechanics skilled in their particular trade. Piping and equipment shall be installed square and plumb and accessible for proper operation and service. Installations shall be consistent in completeness and appearance whether enclosed or exposed. Any item that does not present a neat and workmanlike appearance shall be replaced without additional cost to OWNER.

3.3 ELECTRIC WIRING

A. The CONTRACTOR shall do all electric wiring of every type for both power supply and for instrumentation and control in accordance with the provisions specified herein, except for such items as are normally wired at their point of manufacture and so delivered, and unless specifically noted to the contrary herein. The CONTRACTOR shall erect all motors and shall mount all starters and controls, furnishing the supporting structures.

3.4 GUARANTEE

A. The CONTRACTOR shall Guarantee All Equipment Against:

1. Faulty or inadequate design.
2. Improper assembly or erection.
3. Defective workmanship or materials.
4. Leakage, breakage, or other failure.
5. The guarantee period shall be as defined in the General Conditions.

END OF SECTION

SECTION 01650

STARTING OF SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Disinfection:
   1. CONTRACTOR shall disinfect the well with a chlorine concentration of 50 mg/l (the standard concentration) in accordance with ADEQ Bulletin 8. In addition, all new portions of the Project that will be in contact with potable water shall be disinfected in accordance with AWWA C653.
      a. The CONTRACTOR shall provide all chemicals, materials, equipment, and utilities to perform the disinfection.
      b. The CONTRACTOR shall obtain an OWNER approved lab to pull a BAC-T test sample from the well and have it analyzed. The CONTRACTOR shall make each well site available for sampling and shall operate equipment when the OWNER approved lab acquires the sample. The CONTRACTOR shall not place the equipment into operation for testing or otherwise until the BAC-T test has passes local standards.

B. Equipment Start-up:
   1. The CONTRACTOR, in the presence of OWNER and ENGINEER, shall place the newly installed equipment and facilities into operation and test, observe, and adjust all items until the units are properly adjusted and operating in accordance with the requirements of the manufacturer's data and the Contract Documents. After the new equipment has been put into operation, CONTRACTOR, ENGINEER, and operator shall go over in detail the standard operating procedures of the equipment. The Work performed by CONTRACTOR shall include, but not be limited to, the following items:
      a. Marking and numbering all valves, gates, and equipment which have been numbered in the Contract Documents. All valves and gates shall be labeled with the appropriate equipment identification tag as shown on the Drawings.
      b. Labeling switches.
      c. Testing of pumps and equipment for proper operation and verifying alignment and capacity.
      d. Checking all electrical, electronic, and remotely controlled equipment for proper operation as specified under Section 01400, Quality Control.
      e. Marking all new and existing exposed pipelines for identification as specified in Section 09900, Painting, and as labeled on the Drawings for pipe material, size, service, and direction of flow.
      f. Testing of unit processes for proper operations.

g. Making all equipment adjustments required.

2. The CONTRACTOR shall place temporary piping, valves, and fittings as needed to fully test the equipment. To fully test the equipment, the well site will not be allowed to discharge from the site and into the raw water pipeline. To complete the testing a temporary discharge pipe shall be routed, from downstream of the flowmeter, to the pump to waste catch basin. The discharge pipe shall include all of the necessary fittings and back pressure devices to simulate actual pressure conditions. Once the temporary pipe system is no longer needed, as determined by the ENGINEER and OWNER, it shall be removed from the site and all of the permanent fittings installed. The pipeline shall be flushed and disinfected as needed during the testing operation to ensure a complete and functional well system.

C. Supervision of Installation and Start-up by Manufacturer:

1. An experienced, competent, and factory-employed representative of the equipment manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation and shall be present when the equipment is placed in operation. The equipment manufacturer's representative shall revisit the job site as often as necessary until any trouble is corrected and the equipment installation and operation is satisfactory to the OWNER. The equipment manufacturer's representative shall furnish to OWNER a written report certifying that the equipment:
   a. Has been properly installed and lubricated.
   b. Is in accurate alignment.
   c. Is free from any undue stress imposed by connecting piping or anchor bolts.
   d. Has been operated under full load conditions and that it operated satisfactorily.
2. A resume of each factory personnel assigned to supervise installation and train OWNER'S personnel shall be submitted to the ENGINEER for approval prior to scheduling training and installing the equipment.

D. Training:

1. The CONTRACTOR shall provide experienced, competent manufacturers' representatives to train OWNER'S personnel in operation and maintenance procedures for equipment items specified below during the start-up period at no additional cost to OWNER. The lesson plans for these sessions shall be reviewed with the OWNER and the ENGINEER in one meeting prior to initiating training. Lesson plans shall be submitted to the ENGINEER not less than one week prior to this meeting. CONTRACTOR will video tape the manufacturers' training sessions and provide OWNER with professional quality DVDS of the training sessions. The representatives shall present training programs and on-site demonstrations designed to fully acquaint plant personnel with all equipment features, routine scheduled maintenance procedures, alternative operational modes, emergency procedures, spare parts inventories, and demonstrate performance requirements of the specifications.

Representatives shall remain on-site to observe operation of the equipment and further advise plant personnel for a minimum number of days as specified below, unless specified otherwise in equipment specifications. The following table is not a complete list of equipment training. See individual Specifications for additional training.

Equipment	Additional Training Days (Day = 8 hrs min.)
11295, Hydraulic Valves	1/2
11310, Submersible Pumps	1/2
Division 16 & 17, Electrical & Instrumentation	1

2. A complete schedule of representatives and dates for operator training shall be submitted to OWNER prior to commencement of the start-up period. This schedule shall be prepared to accommodate the plant staff's work schedules, including training on all shifts and staffs' flex time.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01700

CONTRACT CLOSEOUT

PART 1 - GENERAL

1.1 SUMMARY

A. Tasks listed under this Section shall be completed prior to Contract closeout and approval of the CONTRACTOR'S final pay request.

1.2 RELATED SECTIONS

A. Section 01300, Submittals.

B. Section 01650, Starting of Systems.

1.3 CONTRACT CLOSEOUT SUBMITTALS

A. The following documents are to be submitted as specified to the ENGINEER prior to approval of the CONTRACTOR'S final pay request:
   1. Record Drawings shall be furnished by the CONTRACTOR. One set of blacklines annotated to show all changes shall be delivered by the CONTRACTOR to the ENGINEER. The Record Drawings shall reflect all changes made by Change Order, Addenda, Field Order, Work Directive, and any other changes made and approved during the course of the Work.
   2. Certification of final completion.
   3. Evidence of Payment and Release of Labor and Material Liens as outlined in the Conditions of the Contract. These documents shall be furnished by the CONTRACTOR and all subcontractors.
   4. Release of claims as outlined in the conditions of the Contract.
   5. Copies of written warranties shall be furnished for each individual item of equipment. The names, addresses, and phone numbers of the manufacturer's representatives shall be included.
   6. Operation and Maintenance Manuals shall be furnished for each individual item of equipment as specified in Section 01300, Submittals.
   7. Evidence of Compliance with requirements of governing authorities, including Certificate of Occupancy and Certificates of Inspection.
   8. Equipment manufacturer's start-up reports shall be furnished as specified in Section 01400, Quality Control.
   9. The CONTRACTOR shall submit all maintenance stock items, spare parts, and special tools.
   10. Two copies of all training video tapes made in accordance with Section 01650, Starting of Systems.

1.4 SITE CONDITIONS

A. Prior to approval of the CONTRACTOR'S final pay request and after Work has been completed, the CONTRACTOR shall dispose of all waste material.

B. All areas shall be restored to a condition equal to or better than the original.

C. Site grading shall be performed to the lines and grades as shown or conforming to adjacent contours.

1.5 MAINTENANCE AND GUARANTEE

A. The CONTRACTOR shall comply with the maintenance and guarantee requirements contained in the General Conditions.

B. Replacement of earth fill or backfill, where it has settled below the required finish elevations, shall be considered as a part of such required repair work, and any repair or resurfacing constructed by the CONTRACTOR which becomes necessary by reason of such settlement shall likewise be considered as a part of such required repair work unless the CONTRACTOR shall have obtained a statement in writing from the affected private owner or public agency releasing the OWNER from further responsibility in connection with such repair or resurfacing.

C. The CONTRACTOR shall make all repairs and replacements promptly upon receipt of written order from the OWNER. If the CONTRACTOR fails to make such repairs or replacements promptly, the OWNER reserves the right to do the Work and the CONTRACTOR and his surety shall be liable to the OWNER for the cost thereof.

1.6 BOND

A. The CONTRACTOR shall provide a bond to guarantee performance of the provisions contained in Paragraph 1.5 and the General Conditions.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01710

CLEANING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section outlines requirements for cleaning of the Project Work. This Section is complementary to the General Conditions and nothing herein shall be considered to waive any requirements of the General Conditions.

1.2 REQUIREMENTS OF REGULATORY AGENCIES

A. Safety and Insurance Standards: Maintain Project in accordance with the following safety and insurance standards:
   1. State Industrial Commission of Arizona (OSHA).

B. Fire Protection: Store volatile waste in covered metal containers and remove from premises daily.

C. Pollution Control: Conduct cleanup and disposal operations to comply with local ordinances and anti-pollution laws. Burning or burying of rubbish and waste material on the Project site is not permitted. Disposal of volatile fluid waste (such as mineral spirits, oil, or paint thinner) in storm or sanitary sewer systems or into streams or waterways is not permitted.

PART 2 - PRODUCTS

2.1 CLEANING MATERIAL

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

PART 3 - EXECUTION

3.1 DURING CONSTRUCTION

A. During the construction period, the material to be used in the Work shall be kept in an orderly manner, neatly stacked or piled.

B. Clean up frequently (at least weekly) all refuse, rubbish, scrap materials, and debris caused by operations, to the end that at all times the site of the Work shall present a neat, orderly, and workmanlike appearance. Sprinkle dusty debris with water.

C. Provide for the disposal of all waste products, trash, debris, etc., and make necessary arrangement for legal disposal of same off the site. Never throw rubbish from windows or other parts of building. Lower waste materials in a controlled manner with as few handling as possible.

D. Remove all surplus material, falsework, temporary structures, including foundations thereof, plant of any description and debris of every nature resulting from operations and put the site in a neat, orderly condition.

E. Vacuum clean interior building areas when ready to receive finish painting and continue vacuum cleaning on an as-needed basis until building is ready for acceptance.

F. Schedule cleaning operation so that dust and other contaminants resulting from cleaning process will not fall on wet, newly painted surfaces.

G. General CONTRACTOR shall provide trash gondolas or containers for use by all trades.

3.2 FINAL CLEANING

A. Use experienced workmen or professional cleaners for final cleaning. Provide adequate ventilation during use of volatile or noxious substances.

B. Besides general broom cleaning, do following special cleaning for all trades at completion of Work:
   1. Remove putty stains from glass; wash, polish same inside and outside. Exercise care not to scratch glass.
   2. Remove marks, stains, fingerprints, other soil, dirt from painted, decorated, or stained work.
   3. Clean and polish hardware for removal of stains, dust, dirt, paint, and the like.
   4. Clean fixtures, equipment; remove stains, paint, dirt, dust.
   5. Remove temporary floor protections.
   6. Clean all floors.
   7. Remove all temporary protections at the site.
   8. Clean exterior and interior metal surfaces including doors and windows of oil, stains, dust, dirt, paint, and the like.

C. Make buildings ready for occupancy in all respects. Lay heavy building paper in main circulation areas to protect the floors until final inspection and acceptance.

D. All existing improvements, inside or outside the property that are disturbed, damaged, or destroyed by the Work under the Contract shall be restored to the condition in which they originally were, or to the satisfaction of the ENGINEER.

END OF SECTION

SECTION 02100

SITE PREPARATION

PART 1 - GENERAL

1.1 SUMMARY

A. CONTRACTOR shall hire a surveyor licensed in the State of Arizona to perform a topographical survey of the Project site to confirm the baseline conditions per Section 01050, Field Engineering/Surveying. The CONTRACTOR shall notify the ENGINEER and perform the required site work necessary to match the baseline conditions to correct any discrepancies.

B. Prepare the construction site for new construction.

1.2 SECTION INCLUDES

A. Protection of certain existing trees and vegetation.

B. Clearing and grubbing.

C. Removing below-grade improvements (including stumps).

D. Installing and maintaining barricades and warning signs.

E. All other miscellaneous items of Work required to completing the site preparation.

1.3 RELATED SECTIONS

A. Section 02200, Earthwork.

1.4 PROJECT CONDITIONS

A. Traffic: Conduct site clearing operations to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities. Do not close or obstruct streets, walks, or other occupied or used facilities without permission from authorities having jurisdiction.

B. Protection of Existing Improvements: Provide protection as necessary to prevent damage to existing improvements indicated to remain in place.
   1. Protect improvements on adjoining properties and OWNER'S property.

2. Restore damaged improvements to their original condition, as acceptable to OWNER.

C. Protection of Existing Trees and Vegetation:
   1. Existing vegetation in the field not scheduled for removal shall be undisturbed by the CONTRACTOR. The CONTRACTOR shall **NOT** remove from the site any plants unless specifically approved by the ENGINEER.
   2. Protect existing trees and vegetation indicated to remain against unnecessary cutting, breaking or skinning of roots, skinning or bruising of bark, smothering of trees by stockpiling construction materials or excavated materials within drip line, excess foot or vehicular traffic or parking of vehicles within the drip line. Prior to initiating site clearing activities, the CONTRACTOR shall mark the limits of the disturbance areas either by placing lime, flags, or survey stakes at the limits shown on the Plans.
   3. Do not destroy vegetation that may be naturally located in the periphery of proposed disturbed areas (within a zone ± 5 feet from the limits of construction). The ENGINEER shall be notified if existing plants are located within the fringes of the construction limits. The ENGINEER shall issue instructions at that time.
   4. Adjustments may be made in the limits of construction to protect the affected plants based on a field review of the staked limits. The adjusted construction limits shall be considered the permanent construction limits for the duration of the Project. If the ENGINEER recommends that construction limits be adjusted to preserve existing plants, the CONTRACTOR, at his own option, may elect to clear the subject vegetation and revegetate with like-kind size and species as required herein and by Landscape Drawings at no additional cost to the OWNER. The CONTRACTOR shall be entirely responsible for removal, storage, and replanting of such vegetation.
   5. During the course of the Work the CONTRACTOR shall:
      a. Water trees, shrubs, and other vegetation to remain within limits of Contract Work as required to maintaining their health during the course of construction operations.
      b. Provide protection for roots over 1-1/2-inches in diameter that are cut during construction operations. Temporarily cover exposed roots with wet burlap to prevent the roots from drying out; cover with earth as soon as possible.
      c. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations in a manner acceptable to the ENGINEER.
      d. Trees to be protected in place shall not be pruned unless limbs are damaged, or at the direction of the ENGINEER. Employ a licensed arborist to repair damaged trees and shrubs. Replace trees that cannot be repaired and restored to full-growth status, as determined by the arborist.

D. Provide a temporary construction fence/barrier to protect trees and vegetation at the limits reviewed and approved by the ENGINEER. The barrier shall be installed and remain in place for the duration of the Project or as directed by the ENGINEER.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Fencing: Any fencing removed as obstructions shall be restored to match existing.

B. Barricades, warning signs, and related equipment shall be placed as required.

C. Tree Protection Fence/Barrier: Shall be a commercially available product acceptable to the ENGINEER for its intended purpose. The barrier shall be similar to a nylon woven material or woven wire fence such as TENAX Nordic Snow Fence, or approved equal, with approved stakes approximately 36-inches in height. Submit material sample and Shop Drawings for barrier installation to the ENGINEER for approval prior to use.

PART 3 - EXECUTION

3.1 PREPARATION

A. Site Clearing:
   1. General: Remove trees, shrubs, grass and other vegetation, improvements or obstructions, as required, to permit installation of new construction. Remove similar items elsewhere on-site or premises as specifically indicated. Removal includes digging out and off-site disposal of stumps and roots.
      a. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
   2. Clearing and Grubbing: Within the limits of Work, clear site of trees, shrubs and other material, except for those indicated to be left standing.
      a. Completely remove stumps, roots, and other debris protruding through the ground surface. Stump removal and backfilling of holes is required for trees indicated on the Plans to be removed.
      b. Use only hand methods for grubbing inside drip line of trees indicated to remain.
      c. Fill depressions caused by clearing and grubbing operations with satisfactory soil material, unless further excavation or earthwork is indicated.

d. Place fill material in horizontal layers not exceeding 6-inches loose depth, and thoroughly compact each layer to a density equal to adjacent original ground.

3. Disposal of Waste Material:
   a. Burning on OWNER'S Property: Burning is not permitted on OWNER'S property.
   b. Removal from OWNER'S Property: Remove waste materials from OWNER'S property at no additional cost to the Project.
4. All miscellaneous items not specifically mentioned or designated on the Drawings as removal items, but required for the completion of the Work, shall be removed. All such items removed shall be hauled from the site.

B. Barricades and Warning Signs:
   1. Construction sites shall be properly barricaded with appropriate warning signs affixed to prevent unauthorized access to the construction site.

END OF SECTION

SECTION 02200

EARTHWORK

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. Preparing and grading subgrades for each well site.
   2. Excavating and backfilling for buildings and structures.
   3. Subbase course for walks and pavements.
   4. Excavating and backfilling trenches within building lines.
   5. Excavating and backfilling for underground mechanical and electrical utilities and appurtenances.

B. Related Section: The following Section contains requirements that relate to this Section.
   1. Section 03305, Concrete, for concrete encasings, cradles, and appurtenances for utility systems.

1.3 DEFINITIONS

A. Excavation consists of the removal of material encountered to subgrade elevations and the reuse or disposal of materials removed.

B. Subgrade: The uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.

C. Borrow and Export: Soil material will be provided by OWNER for all additional fill needed. Excess soil can be exported to borrow site.

D. Subbase Course: The layer placed between the subgrade and base course in a paving system or the layer placed between the subgrade and surface of a pavement or walk.

E. Base Course: The layer placed between the subbase and surface pavement in a paving system.

F. Unauthorized excavation consists of removing materials beyond indicated subgrade elevations or dimensions without direction by the ENGINEER. Unauthorized excavation, as well as remedial work directed by the ENGINEER, shall be at the CONTRACTOR'S expense.

G. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below ground surface.

H. Utilities include on-site underground pipes, conduits, ducts, and cables, as well as underground services within building lines.

1.4 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract and Division General Requirements, Specification Sections.

B. Product Data for the following:
   1. Each type of plastic warning tape.

C. Test Reports: In addition to test reports required under field quality control, submit the following:
   1. Laboratory analysis of each soil material proposed for fill and backfill from on-site and borrow sources.
   2. One optimum moisture-maximum density curve for each soil material.

1.5 QUALITY ASSURANCE

A. Codes and Standards: Perform earthwork complying with requirements of authorities having jurisdiction.

B. Pre-installation Conference: Before commencing earthwork, meet with representatives of the governing authorities, OWNER, ENGINEER, consultants, Geotechnical Engineer, independent testing agency, and other concerned entities. Review earthwork procedures and responsibilities including testing and inspection procedures and requirements. Notify participants at least three working days prior to convening conference. Record discussions and agreements and furnish a copy to each participant.

C. Soils Testing Service: CONTRACTOR shall employ, at his own expense, an independent testing agency, certified in the State of Arizona, to perform all testing services specified herein. Selection of the testing agency is subject to ENGINEER'S approval. Submit a written description of the proposed soils testing agency giving qualifications of personnel, equipment, and other information which may be requested by ENGINEER.

1.6 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt existing utilities serving facilities occupied by the OWNER or others except when permitted in writing by the ENGINEER and then only after acceptable temporary utility services have been provided.
   1. Provide a minimum 48 hours notice to the ENGINEER and receive written notice to proceed before interrupting any utility.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide approved borrow soil materials from off-site when sufficient approved soil materials are not available from excavations.

B. Site Soils: The granular site soils may be used as fill in all areas of the site. The clayey sand site soils may be used in all areas, provided these soils are placed and compacted at moisture contents at or above optimum in exterior slab and facility areas. All materials shall be free of organics, debris, and rubble.

C. Imported Soils: Additional fill required at the site shall be provided. Soils are to meet the following requirements:
   1. Maximum Particle Size: 6-inches.
   2. Maximum Swell Potential: 1.5% based on a sample which is remolded to 95% of the ASTM D698 maximum dry density at a moisture content of 2% below optimum placed under a surcharge of 100 psf and wetted.
   3. Maximum Percent Passing No. 200 Sieve: 40.

D. Backfill and Fill Materials: Site soils as described above.

E. Subbase and Base Material: Maricopa Association of Governments (MAG) Specification Section 702 for Select (subbase) Type A or B and aggregate base (base).

F. Engineered Fill: Site soils as describe above subbase or base materials or aggregate base course (ABC) according to MAG Standard Specification Section 702.

G. Bedding Material: Subbase or base materials with 100% passing a 1-inch sieve and not more than 8% passing a No. 200 sieve.
   1. If on-site material can be used as bedding material, the CONTRACTOR shall take necessary steps to separate the suitable bedding material from the sandy clay and sandy silt found on site. The bedding material must meet all

requirements of this Specifications Document and MAG Standard Specification Section 601.

2. If on-site material does not meet the bedding material requirements, the CONTRACTOR shall supply the specified bedding material at no additional cost to the OWNER.

H. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, 6-inches wide and 4 mils thick, continuously inscribed with a description of the utility.

1. Tape Colors: Provide tape colors to utilities as follows:
   a. Red: Electric.
   b. Yellow: Gas, oil, steam, and dangerous materials.
   c. Orange: Telephone and other communications.
   d. Blue: Water systems.
   e. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect subgrades and foundation soils against freezing temperatures or frost. Provide protective insulating materials as necessary.

B. Provide erosion control measures following the most current City of Goodyear Best Management Practices (BMP) to prevent erosion or displacement of soils and discharge of soil-bearing water runoff per the National Discharge Elimination System (NPDES) or airborne dust to adjacent properties and walkways.

3.2 DEWATERING

A. Prevent surface water and subsurface or groundwater from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

3.3 EXCAVATION

A. Explosives: Do not use explosives.

B. Unclassified Excavation: Excavation is unclassified and includes excavation to required subgrade elevations regardless of the character of materials and obstructions encountered.

C. Classified Excavation: Excavation is classified and includes excavation to required subgrade elevations. Excavation will be classified as earth excavation or rock excavation as follows:
   1. Earth excavation includes excavation of obstructions visible on surface; underground structures, utilities, and other items not indicated that we are required to be demolished and removed; together with soil and other materials encountered that are not classified as rock or unauthorized excavation.
      a. Intermittent drilling, blasting, or ripping to increase production and not necessary to permit excavation of material encountered will be classified as earth excavation.

3.4 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of ± 0.10 feet. Extend excavations a sufficient distance from structures for placing and removing concrete formwork, installing services and other construction, and for inspections. Structure excavation, backfilling, and compaction shall be as specified in MAG Section 206.
   1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other Work.
   2. Excavation for Storage Tanks, Basins, and Mechanical or Electrical Appurtenances: Excavate to elevations and dimensions indicated within a tolerance of ± 0.10 feet. Do not disturb bottom of excavations intended for bearing surface.

3.5 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated cross sections, elevations, and grades.

B. Pavement excavation, backfilling and compaction shall be as specified in MAG Section 205.

3.6 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated slopes, lines, depths, and invert elevations.

B. Trench excavation, backfilling, and compaction shall be as specified in MAG Section 601.

3.7 APPROVAL OF SUBGRADE

A. Notify the ENGINEER when excavations have reached required subgrade.

B. When the ENGINEER determines that unforeseen unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
   1. Unforeseen additional excavation and replacement material will be paid according to the Contract provisions for changes in Work.

C. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by the ENGINEER.

3.8 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending indicated bottom elevation of concrete foundation or footing to excavation bottom, without altering required top elevation. Lean concrete fill may be used to bring elevations to proper position when acceptable to the ENGINEER.
   1. Fill unauthorized excavations under other construction as directed by the ENGINEER.

B. Where indicated widths of utility trenches are exceeded, provide stronger pipe that may require higher strength pipe than specified or different pipe material depending on the limits of unauthorized excavation. Special installation procedures maybe required by the ENGINEER.

3.9 STORAGE OF SOIL MATERIALS

A. Stockpile excavated materials acceptable for backfill and fill soil materials, including acceptable borrow materials. Stockpile soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent wind-blown dust.
   1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.10 BACKFILL

A. Backfill excavations promptly, but not before completing the following:
   1. Acceptance of construction below finish grade including, where applicable, damp proofing, waterproofing, and perimeter insulation.

2. Surveying locations of underground utilities for record documents.
3. Testing, inspecting, and approval of underground utilities.
4. Concrete formwork removal.
5. Removal of trash and debris from excavation.
6. Removal of temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

3.11 UTILITY TRENCH BACKFILL

A. Place and compact bedding course on rock and other unyielding bearing surfaces and to fill unauthorized excavations. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

B. Concrete backfill trenches that carry below or pass under footings and that are excavated within 18-inches of footings. Place concrete to level of bottom of footings.

C. Provide 4-inch thick concrete base slab support for piping or conduit less than 2 feet 6-inches below surface of roadways. After installation and testing, completely encase piping or conduit in a minimum of 4-inches of concrete before backfilling or placing roadway subbase.

D. Place and compact initial backfill of satisfactory soil material or subbase material, free of particles larger than 1-inch, to a height of 12-inches over the utility pipe or conduit.
   1. Carefully compact material under pipe haunches and bring backfill evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of utility system.

E. Coordinate backfilling with utilities testing.

F. Fill voids with approved backfill materials as shoring and bracing, and sheeting is removed.

G. Place and compact final backfill of satisfactory soil material to final subgrade.

H. Install warning tape directly above utilities, 12-inches below finished grade, except 6-inches below subgrade under pavements and slabs.

3.12 FILL

A. The following apply to the areas within and extending 5 feet beyond the footprint of the facilities and exterior slabs.

1. Clear and grub the site by removing and disposing of all vegetation, debris, rubble, and remnants of former developments.
2. Strip the area of all stockpiled fill zones, loose backfill zones, and unstable soils. During stripping observe the surface for evidence of buried debris, vegetation or disturbed materials that shall require additional removal. If encountered, these materials should be removed. Areas steeper than 5H to 1V shall be benched and any depressions widened to accommodate compaction equipment.
3. Prepare the ground surface in fill areas and in areas cut to grade by scarifying, moisture conditioning, and compacting the exposed surface soils to a depth of 8-inches.
4. Moisture condition and place all fill and backfill materials to achieve specified grades. Fill materials shall be moisture conditioned, placed, and compacted in horizontal lifts.

B. Place fill material in layers to required elevations for each location listed below.
1. Under grass, use satisfactory excavated or borrowed soil material.
2. Under walks and pavements, use subbase or base material, or satisfactory excavated or borrow soil material.
3. Under steps and ramps, use subbase material.
4. Under building slabs, use drainage fill material.
5. Under footings and foundations, use engineered fill.

3.13 MOISTURE CONTROL

A. The moisture content of soil and base materials at the time of compaction shall be:

Type	Area of Use	Moisture Content
On-site Granular	Structure, Exterior Slab	Optimum ± 3%
On-site Clayey Soils	Structure, Exterior Slab	Optimum to Optimum + 3%
On-site Soils	Pavement	2% Below Optimum or Lower
Imported Soils	Structure, Exterior Slab, Pavement	Optimum ± 3%
Base Material	Structure, Pavement	Optimum ± 3%

3.14 COMPACTION

A. Place backfill and fill materials in layers not more than 8-inches in loose depth for material compacted by heavy compaction equipment, and not more than 4-inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill materials evenly on all sides of structures to required elevations. Place backfill and fill uniformly along the full length of each structure.

C. Compact subgrade, fill, backfill, subbase fill or base material to the following minimum percent compaction of the ASTM D698 maximum dry density in each lift:

Material	**Minimum Percent Compaction**
Soil	
Below foundations and pavement sections (fill thickness less than 5 feet):	95
Below foundations (fill thickness greater than 5 feet):	100
Below concrete floor slabs (above footings):	90
Subsurface wall backfill:	95
Base Material (Subbase and Base Courses)	
Below concrete floor slabs:	95
Below pavement surfacing:	100
Backfill (Not adjacent to structures and beyond exterior slab areas.):	90
Well Site (Not adjacent to structures.):	90

3.15 GRADING

A. General: Uniformly grade areas to a smooth surface, free from irregular surface changes. Comply with compaction requirements and grade to cross-sections, lines, and elevations indicated.
   1. Provide a smooth transition between existing adjacent grades and new grades.
   2. Cut out soft spots, fill low spots, and trim high spots to conform to required surface tolerances.

B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
   1. Lawn or Unpaved Areas: ± 0.10 feet.
   2. Walks: ± 0.10 feet.
   3. Pavements: ± 1/2-inch.

B. Grading Inside Building Lines: Finish subgrade to a tolerance of 1/2-inch when tested with a 10 foot straightedge.

3.16 SUBBASE AND BASE COURSES

A. Under pavements and walks, place subbase course material on prepared subgrades. Place base course material over subbases to pavements.
   1. Shape subbase and base to required crown elevations and cross-slope grades.
   2. When thickness of compacted subbase or base course is 6-inches or less, place materials in a single layer.
   3. When thickness of compacted subbase or base course exceeds 6-inches, place materials in equal layers, with no layer more than 6-inches thick or less than 3-inches thick when compacted.

B. Pavement Shoulders: Place shoulders along edges of subbase and base course to prevent lateral movement. Construct shoulders at least 12-inches wide of acceptable soil materials and compact simultaneously with each subbase and base layer.

3.17 FIELD QUALITY CONTROL

A. Testing Agency Services: Allow testing agency to inspect and test each subgrade and each fill or backfill layer. Do not proceed until test results for previously completed work verify compliance with requirements.
   1. Perform field in-place density tests according to ASTM D1556 (sand cone method), ASTM D2167 (rubber balloon method), or ASTM D2937 (drive cylinder method), as applicable.
      a. Field in-place density tests may also be performed by the nuclear method according to ASTM D2922, provided that calibration curves are periodically checked and adjusted to correlate to tests performed using ASTM D1556. With each density calibration check, check the calibration curves furnished with the moisture gages according to ASTM D3017.
      b. When field in-place density tests are performed using nuclear methods, make calibration checks of both density and moisture gages at beginning of Work, on each different type of material encountered, and at intervals as directed by the ENGINEER.
   2. Footing Subgrade: Footing subgrades to be reviewed and approved by a representative of the Geotechnical Engineer, prior to placement of reinforcing steel.
   3. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, perform at least one field in-place density test for every 2,000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.

4. Foundation Wall Backfill: In each compacted backfill layer, perform at least one field in-place density test for each 100 feet or less of wall length, but no fewer than two tests along a wall face.
5. Trench Backfill: In each compacted initial and final backfill layer, perform at least one field in-place density test for each 150 feet or less of trench, but no fewer than two tests.
6. Well Site: At subgrade and at each compacted fill and backfill layer, perform at least one field in-place density test for every 2,000 sq. ft. or less, but in no case fewer than three tests.

B. When testing agency reports that subgrades, fills, or backfills are below specified density, scarify and moisten or aerate, or remove and replace soil to the depth required, recompact and retest until required density is obtained.

3.18 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and re-establish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or lose compaction due to subsequent construction operations or weather conditions.
1. Scarify or remove and replace material to depth directed by the ENGINEER; reshape and recompact at optimum moisture content to the required density.

C. Settling: Where settling occurs during the Project correction period, remove finished surfacing, backfill with additional approved material, compact, and reconstruct surfacing.
1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to the greatest extent possible.

3.19 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Surplus satisfactory soil can be disposed of to OWNER’s borrow pile.

B. Remove waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off the OWNER'S property.

END OF SECTION

SECTION 03305

CONCRETE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install concrete, reinforcement, and related materials.
   2. The Work includes:
      a. Providing concrete consisting of Portland cement, fine and coarse aggregates, water, and approved admixtures; combined, mixed, transported placed, finished, and cured.
      b. Fabrication and placement of reinforcement, including ties and supports.
      c. Design, erection, and removal of formwork.
      d. Building into the concrete all sleeves, frames, anchors, inserts, and other items required to be embedded in the concrete.
      e. Providing openings in the concrete as required to accommodating Work under this and other Sections.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed in the concrete.

C. Classifications of Concrete:
   1. Type "1" concrete shall be steel reinforced and includes all concrete, unless indicated otherwise.
   2. Type "2" concrete shall be placed without forms or with simple forms, with little or no reinforcing and includes the following:
      a. Concrete fill.
      b. Duct banks.
      c. Unreinforced encasements.
      d. Curbs and gutters.
      e. Sidewalks.
      f. Thrust blocks.

1.2 QUALITY ASSURANCE

A. Source Quality Control:
   1. Concrete Testing Service:
      a. Employ acceptable testing laboratory to perform materials evaluation, testing, and design of concrete mixes.

b. OWNER will employ a separate testing laboratory to perform field quality control sampling and testing on concrete delivered to and placed at the site. Full access shall be provided by CONTRACTOR to personnel of OWNER'S testing laboratory to Work and shall provide all assistance, including labor and equipment, necessary to facilitate testing and sampling.

2. Certificates, signed by concrete producer and CONTRACTOR, may be submitted in lieu of material testing when acceptable to ENGINEER.
3. OWNER'S testing laboratory will perform field quality control sampling and testing during concrete placement, as follows:
   a. Sampling: ASTM C172.
   b. Slump: ASTM C143, one test for each load at point of discharge.
   c. Air Content: ASTM C231.
   d. Compressive Strength: ASTM C39, one set of compression strength specimens for each 50 cubic yards or fraction thereof or for each 2,500 square feet of surface area or fraction thereof for each class of concrete placed in any one day.
      1) Test one specimen at seven days and two specimens at 28 days.
      2) When the total quantity of concrete is less than 50 cubic yards, the strength tests may be waived by ENGINEER following review and acceptance of submitted field experience indicating evidence of satisfactory strength.
      3) Slump and air content testing shall be conducted on each sample from which compressive strength specimens are taken.
4. Report test results in writing to ENGINEER on same day tests are made.

B. Standard Specifications and Details:
   1. Conform to all applicable requirements of Sections Nos. 505, 725 and 726 of the Uniform Standard Specifications for Public Works Construction by the Maricopa Association of Governments (MAG) as supplemented by the City of Goodyear. Where there is a conflict between MAG Standard Specifications as supplemented by the City of Maricopa and this Specification, provisions of this Specification shall govern.

C. Reference Standards: Comply with applicable provisions and recommendations of the latest editions of the following, except as otherwise shown or specified.
   1. ACI 224, Control of Cracking in Concrete Structures.
   2. ACI 301, Specifications for Structural Concrete.
   3. ACI 304, Guide for Measuring, Mixing, Transporting, and Placing Concrete.
   4. ACI 305, Hot Weather Concreting.
   5. ACI 306, Cold Weather Concreting.
   6. ACI 309, Guide for Consolidation of Concrete.
   7. ACI 315, Details and Detailing of Concrete Reinforcement.
   8. ACI 318, Building Code Requirements for Structural Concrete.
   9. ACI 347, Guide to Formwork for Concrete.
   10. ACI SP-66, ACI Detailing Manual.

11. ASTM A82, Specification for Steel Wire, Plain, for Concrete Reinforcement.
12. ASTM A185, Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
13. ASTM A307, Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
14. ASTM A615, Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
15. ASTM C33, Specification for Concrete Aggregates.
16. ASTM C39, Test Method for Compressive Strength of Cylindrical Concrete Specimens.
17. ASTM C94, Specification for Ready-Mixed Concrete.
18. ASTM C143, Test Method for Slump of Hydraulic Cement Concrete.
19. ASTM C150, Specification for Portland Cement.
20. ASTM C172, Practice for Sampling Freshly Mixed Concrete.
21. ASTM C231, Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
22. ASTM C260, Specification for Air-Entraining Admixtures for Concrete.
23. ASTM C309, Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
24. ASTM C494, Specification for Chemical Admixtures for Concrete.
25. ASTM C579, Test Method for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings and Polymer Concretes.
26. ASTM C920, Specification for Elastomeric Joint Sealants.
27. ASTM D1752, Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
28. ASTM E154, Test Method for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover.
29. CRD-C 572, U. S. Army Corps of Engineers Specification for Polyvinylchloride Waterstops.
30. Concrete Reinforcing Steel Institute (CRSI) 1MSP, Manual of Standard Practice.

1.3 SUBMITTALS

A. Samples: Submit samples of materials as specified and as otherwise may be requested by ENGINEER, including names, sources, and descriptions.

B. Submit the following Shop Drawings:
   1. Manufacturer's specifications with application and installation instructions for proprietary materials and items, including admixtures and bonding agents.
   2. Concrete placement plans showing the location and type of all joints.
   3. Drawings for fabrication, bending and placement of concrete reinforcement. Comply with ACI 315 and ACI SP-66. For walls, show elevations to a minimum scale of 1/4-inch to 1 foot. Show bar schedules, stirrup spacing, splice

lengths, diagrams of bent bars, arrangements and assemblies, as required for the fabrication and placement of concrete reinforcement.

4. List of concrete materials and concrete mix designs proposed for use. Include the results of all tests performed to qualify the materials and to establish the mix designs in accordance with ACI 301, Section 4. Submit written report to ENGINEER for each proposed concrete mix at least 15 days prior to start of Work. Do not begin concrete production until mixes have been reviewed and are acceptable to ENGINEER. Mix designs may be adjusted when material characteristics, job conditions, weather, test results, or other circumstances warrant. Do not use revised concrete mixes until submitted to and accepted by ENGINEER.

C. Laboratory Test Reports: Submit copies of laboratory test reports for concrete cylinders, materials and mix design tests. ENGINEER'S review will be for general information only. Production of concrete to comply with specified requirements is the responsibility of CONTRACTOR.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver concrete reinforcement materials to the site bundled, tagged and marked. Use metal tags indicating bar size, lengths, and other information corresponding to markings shown on placement diagrams.

B. All materials used for concrete must be kept clean and free from all foreign matter during transportation and handling and kept separate until measured and placed in the mixer. Bins or platforms having hard clean surfaces shall be provided for storage. Suitable means shall be taken during hauling, piling, and handling to ensure that segregation of the coarse and fine aggregate particles does not occur and the grading is not affected.

C. Store concrete reinforcement materials to prevent damage and accumulation of foreign material including dirt and excessive rust. Store on framework or blocking such that no materials come in contact with ground. Space framework or blocking supports to prevent excessive deformation of stored materials.

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

A. Portland Cement: ASTM C150, Type II.
B. Aggregates: ASTM C33.
   1. Fine Aggregate: Clean, sharp, natural sand free from loam, clay, lumps or other deleterious substances. Dune sand, bank run sand, and manufactured sand are not acceptable.

2. Coarse Aggregate: Clean, uncoated, processed aggregate containing no clay, mud, loam, or foreign matter, as follows:
   a. Crushed stone, processed from natural rock or stone.
   b. Washed gravel, either natural or crushed. Use of slag and pit or bank run gravel is not permitted.

C. Coarse Aggregate Size: ASTM C33, Nos. 57 or 67, unless permitted otherwise by ENGINEER.

D. Water: Clean, potable.

E. Air-Entraining Admixture: ASTM C260.

F. Water-Reducing Admixture: ASTM C494, Type A. Only admixtures which have been tested and accepted in mix designs shall be used.

G. Water Reducing and Set Adjusting Admixtures: ASTM C494, Type D and E. Only admixtures which have been tested and accepted in mix designs shall be used.

H. High Range Water-Reducing Admixture: ASTM C494, Type F/G. Only admixtures which have been tested and accepted in mix designs shall be used.

I. Calcium Chloride or admixtures containing chloride ions shall not be used.

2.2 CONCRETE MIX

A. General:
   1. Normal weight: 145 pounds per cubic foot.
   2. Use air-entraining admixture in all concrete: provide not less than four percent nor more than eight percent entrained air for concrete exposed to freezing and thawing, and from three percent to five percent for other concrete.

B. Proportioning and Design of Type “1” Mix:
   1. Minimum compressive strength at 28 days: 4,000 psi.
   2. Maximum water cement ratio by weight: 0.45.
   3. Minimum cement content: 564 pounds per cubic yard.

C. Proportioning and Design of Type “2” Mix:
   1. Minimum compressive strength at 28 days: 3,000 psi.
   2. Maximum water cement ratio by weight: 0.50.
   3. Minimum cement content: 517 pounds per cubic yard.

D. Proportioning and Design of Type “3” Mix:
   1. The requirements for Type “1” concrete shall be met except that slump shall be increased by the use of a high range water-reducer.

E. Slump Limits:
   1. Proportion and design mixes to result in concrete slump at the point of placement of not less than 1-inch and not more than 4-inches.
   2. Where high range water reducers are used, slump prior to addition of admixture shall not exceed 3-inches. Slump after addition of admixture shall not exceed 8-inches at point of placement.

F. Adjustment to Concrete Mixes:
   1. Concrete mix design adjustments may be requested by CONTRACTOR when warranted by characteristics of materials, job conditions, weather, test results, or other similar circumstances.
   2. Laboratory test data for adjusted concrete mix designs, including compressive strength test results, shall be submitted to ENGINEER for review.
   3. Adjusted mix designs shall be implemented only with the approval of the ENGINEER.
   4. Adjustments to the concrete mix designs shall result in no additional costs to the OWNER.

2.3 FORM MATERIALS

A. Provide form materials with sufficient stability to withstand pressure of placed concrete without bow or deflection. Responsible for design of the formwork system to resist all applied loads including pressures from fluid concrete and construction loads.

B. Smooth Form Surfaces: Acceptable panel-type to provide continuous, straight, smooth, as-cast surfaces as required by ACI 301.

C. Unexposed Concrete Surfaces: Material to suit project conditions.

D. Provide 3/4-inch chamfer at all external corners. Not required at re-entrant corners, unless indicated otherwise.

E. Form Ties:
   1. Provide factory-fabricated, removable or snapoff metal form ties, designed to prevent form deflection, and to prevent spalling of concrete surfaces upon removal. Materials used for tying forms will be subject to approval of ENGINEER.
   2. Unless otherwise shown, provide ties so that portion remaining within concrete after removal of exterior parts is at least 1.5-inches from the outer concrete surface. Unless otherwise shown, provide form ties that will leave a uniform, circular hole no larger than 1-inch diameter in the concrete surface when removed.

3. Ties for exterior walls, below grade walls, and walls subject to hydrostatic pressure shall have waterstops.
4. Wire ties are not acceptable.

2.4 REINFORCING MATERIALS

A. Reinforcing Bars: ASTM A615, Grade 60 deformed bars.

B. Welded Wire Fabric: ASTM A185.

C. Steel Wire: ASTM A82.

D. Supports for reinforcement including bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcement in place.
   1. Use wire bar-type supports complying with CRSI, "Manual of Standard Practice," recommendations, except as specified below. Do not use wood, brick, or other unacceptable materials.
   2. For slabs on grade, use precast concrete blocks (4-inches square minimum with compressive strength equal to or greater than the surrounding concrete) or supports with sand plates or horizontal runners where base materials will not support chair legs.
   3. For all concrete surfaces, where legs of supports are in contact with forms, provide supports having either hot-dip galvanized, plastic protected or stainless steel legs complying with the requirements of CRSI, "Manual of Standard Practice".
   4. Provide precast concrete supports over waterproof membranes.

E. Drilled Dowels:
   1. Adhesive material for drilled dowels shall be a vinylester resin, epoxy resin, urethane methacrylate or vinyl urethane resin specifically formulated for the application, moisture condition, application temperature, and orientation of the hole to be filled. Polyester resins shall not be used. The resin shall be a high modulus, moisture insensitive type packaged in a cartridge dispensing system with a mixing nozzle.
   2. The adhesive system shall be certified by test to develop a pullout resistance in the specified concrete equal to 125 percent of the yield strength of the dowel bar when embedded to the manufacturer's recommended depth. Drilled dowels shall be embedded a minimum of 12 times the nominal bar diameter into sound concrete.
   3. Products and Manufacturers: Provide one of the following:
      a. HIT HY150, by Hilti.
      b. HSE 2421 System, by Hilti.
      c. Epcon System Ceramic 6 or Acrylic 7, by ITW Ramset/Redhead.
      d. Power-Fast, by Powers/Rawl Fastening System.
      e. Or equal.

2.5 RELATED MATERIALS

A. Waterstops:
   1. Polyvinyl Chloride Waterstops:
      a. Waterstops shall meet the requirements of CRD-C 572. No reclaimed or scrap material shall be used.
      b. Minimum Thickness: 3/8-inch.
      c. Provide waterstops with a minimum of seven ribs equally spaced at each end on each side with the first rib located at the edge. Each rib shall be a minimum 1/8-inch in height.
      d. Construction Joints: Waterstops shall be 6-inch wide flatstrip type.
      e. Expansion Joints: Waterstops shall be 9-inch wide centerbulb type.
      f. Products and Manufacturers: Provide one of the following:
         1) W.R. Meadows, Inc.
         2) A.C. Horn, Inc.
         3) Or equal.
   2. Hydrophilic Waterstops:
      a. Hydrophilic waterstop materials shall be Bentonite-free and shall expand by a minimum of 80 percent of dry volume in the presence of water to form a watertight joint seal without damaging the concrete in which it is cast.
      b. Waterstop material shall be composed of resins and polymers which absorb water and cause a completely reversible and repeatable increase in volume.
      c. Waterstop material shall be dimensionally stable after repeated wet-dry cycles with no deterioration of swelling potential.
      d. Select material in accordance with manufacturer's recommendations for the type of liquid to be contained.
      e. Minimum cross-sectional dimensions: 3/16-inch by 3/4-inch.
      f. Location of the hydrophilic waterstops shall be as shown on the Drawings or where approved by the ENGINEER.
      g. Products and Manufacturers: Provide one of the following:
         1) Duroseal Gasket, by BBZ USA, Inc.
         2) Adeka Ultraseal MC-2010M, by Asahi Denka Kogyo K.K.
         3) Or equal.
      h. Hydrophilic Sealant shall adhere firmly to concrete, metal and PVC in dry or damp condition and be indefinitely elastic when cured.
         1) Products and Manufacturers: Provide one of the following:
            a) Duroseal Paste, by BBZ USA, Inc.
            b) Adeka Ultraseal P-201, by Asahi Denka Kogyo K.K.
            c) SikaSwell S, by Sika Corp.
            d) Or equal.

B. Moisture Barrier: Minimum 8 mil thick clear polyethylene membrane meeting the requirements of ASTM E 154. Provide moisture barrier as shown on the Drawings. Provide minimum 9-inch overlaps at joints.

C. Liquid Chemical Floor Hardener: Provide a clear chemical hardener of the fluorosilicate family.
   1. Products and Manufacturers: Provide one of the following:
      a. Lapidolith, by Sonneborn ChemRex, Inc.
      b. Hornolith by A.C. Horn, Inc.
      c. Or equal.

D. Membrane-Forming Curing compound: ASTM C309, Type I.

E. Epoxy Bonding Agent:
   1. Two-component epoxy resin bonding agent.
   2. Products and Manufacturers: Provide one of the following:
      a. Sikadur 32, Hi-Mod LPL, by Sika Corp.
      b. Eucopoxy LPL, by the Euclid Chemical Company.
      c. Or equal.

F. Epoxy-Cement Bonding Agent:
   1. Three component blended epoxy resin-cement bonding agent.
   2. Products and Manufacturers: Provide one of the following:
      a. Sika Armatec 110 EpoCem, by Sika Corp.
      b. Corr-Bond, by the Euclid Chemical Company.
      c. Or equal.

G. Joint Fillers, Sealant and Backer Rod:
   1. Preformed Expansion Joint Filler: ASTM D 1752, Type II Cork.
   2. Joint Sealant: Where expansion joints are indicated to be subject to being submerged by water, joint sealant shall be a two part polyurethane type sealant conforming to the requirements of ASTM C 920, Type M, Class 25. The sealant shall be formulated for use in continuously submerged conditions and shall be used only with the manufacturer's recommended primer.
      a. Products and Manufacturer's: Provide one of the following:
         1) Permapol RC-270 Reservoir Sealant by Products Research and Chemical Corp.
         2) Sikaflex-2c by the Sika Corp.
         3) Or Equal.
   3. Backer Rod: Extruded closed-cell polyethylene foam rod compatible with the sealant material. The backer rod shall be 1/8-inch larger in diameter than the joint width for joints less than 3/4-inch wide and 1/4-inch larger in diameter than the joint width for joints 3/4-inch wide and wider.

2.6 GROUT

A. Non-shrink Grout:

1. Prepackaged, non-metallic, cementitious grout requiring only the addition of water at the job site.
2. Minimum 28-day compressive strength: 7000 psi.
3. Products and Manufacturers: Provide one of the following:
   a. NS Grout by the Euclid Chemical Company.
   b. Set Grout by Master Builders, Inc.
   c. NBEC Grout by Five Star Products, Inc.
   d. Or equal.

B. Epoxy Grout:
1. Prepackaged, non-shrink, non-metallic, 100 percent solids, solvent-free, moisture-insensitive, three-component epoxy grouting system.
2. Minimum seven-day compressive strength: 14,000 psi, when tested in accordance with ASTM C 579.
3. Products and Manufacturers: Provide one of the following:
   a. Euco High Strength Grout by the Euclid Chemical Company.
   b. Sikadur 42, Grout Pak by the Corp.
   c. Five Star Epoxy Grout by Five Star Products, Inc.
   d. Or equal.

C. Cement-Sand Grout:
1. Grout mix shall consist of cement, fine and coarse aggregates, water and admixtures meeting the requirements previously specified for similar materials in concrete.
2. Proportion and mix grout as follows:
   a. Minimum cement content: 564 pounds per cubic yard.
   b. Maximum water-cement ratio: 0.45.
   d Maximum coarse aggregate size: 1/2-inch, unless indicated otherwise.
   e. Minimum 28-day compressive strength: 4,000 psi.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the substrate and the conditions under which Work is to be performed and notify ENGINEER, in writing, of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 FORMWORK

A. Construct formwork in accordance with ACI 347 such that concrete members and structures are of correct size, shape, alignment, elevation and position.

B. Provide openings in formwork to accommodate Work of other trades. Accurately place and securely support items required to be built into formwork.

C. Clean and adjust forms prior to concrete placement. Apply form release agents or wet forms, as required. Retighten forms during and after concrete placement if required to eliminate cement paste leaks.

D. Removal of Formwork:
   1. Conform to the requirements of ACI 301 and ACI 347, except as otherwise specified.
   2. Formwork or shoring shall not be removed until supported concrete members have acquired a minimum of 90 percent of specified compressive strength. Results of suitable quality control tests of field cured specimens may be submitted to ENGINEER for review as evidence that concrete has attained sufficient strength for removal of supporting formwork and shoring prior to removal times indicated herein.
   3. Removal time for all formwork will be subject to approval of ENGINEER.
   4. Form tie holes shall be repaired following the requirements of ACI 301.

3.3 REINFORCEMENT, JOINTS, AND EMBEDDED ITEMS

A. Comply with the applicable recommendations of specified codes and standards, and CRSI "Manual of Standard Practice", for details and methods of reinforcement placement and support.

B. Clean reinforcement to remove loose rust and mill scale, earth, ice and other materials which act to reduce or destroy bond with concrete.

C. Position, support, and secure reinforcement against displacement during formwork construction or concrete placement. Locate and support reinforcing by means of metal chairs, runners, bolsters, spacers and hangers, as required.
   1. Place reinforcement to obtain the minimum concrete coverages as shown and as specified in ACI 318. Arrange, space, and securely tie bars and bar supports together with 16 gage wire to hold reinforcement accurately in position during concrete placement operations. Set with ties so that twisted ends are directed away from exposed concrete surfaces.
   2. Reinforcement shall not be secured to formwork with wire, nails or other ferrous metal. Metal supports subject to corrosion shall not be in contact with formed or exposed concrete surfaces.

D. Provide sufficient numbers of supports of strength required to carry reinforcement. Do not place reinforcement more than 2-inches beyond the last leg of any continuous bar support. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.

E. Splices: Provide standard reinforcement splices by lapping ends, placing bars in contact, and tying tightly with wire. Comply with requirements shown for minimum lap of spliced bars.

F. Install welded wire fabric in as long lengths as practical, lapping adjoining sections a minimum of one mesh.

G. Concrete shall not be placed until the reinforcement is inspected and permission for placing concrete is granted by ENGINEER. All concrete placed in violation of this provision will be rejected. Notify ENGINEER a minimum of two working days prior to proposed concrete placement.

H. Joints:
   1. Provide construction, isolation, expansion, and control joints as indicated or required. Locate construction joints so as to not impair the strength and appearance of the structure. Place isolation and control joints in slabs-on-grade to stabilize differential settlement and random cracking.
   2. In walls locate joints at a maximum spacing of 40 feet and approximately 12 feet from corners.
   3. In foundation slabs and slabs-on-grade locate joints at a spacing of approximately 40 feet.
   4. In mats and structural slabs and beams, locate joints in compliance with ACI 224.
   5. The location of all joints shall be as approved by the ENGINEER.
   6. Where construction joints are indicated to be roughened, intentionally roughen surfaces of previously placed concrete to a full amplitude of 1/4-inch.

I. Installation of Embedded Items: Set and build into the Work anchorage devices and embedded items required for other Work that is attached to, or supported by cast-in-place concrete. Use setting diagrams, templates and instructions provided under other Sections for locating and setting. Refer also to Paragraph 1.1.B, above. Uncoated aluminum items shall not be embedded in concrete. Where aluminum items come in contact with concrete surfaces, coat aluminum to prevent direct contact with concrete.

J. Drilled Dowels
   1. Drilled dowels shall consist of reinforcing dowels set in an epoxy adhesive in a hole drilled into hardened concrete.
   2. Holes shall be drilled to the epoxy manufacturer's recommended diameter and depth to develop the required pullout resistance but shall not be greater in diameter than 1/4-inch more than the nominal bar diameter nor less than 12 times the nominal bar diameter in depth.
   3. The hole shall be drilled by methods which do not interfere with the proper bonding of epoxy.

4. Existing reinforcement in the vicinity of proposed holes shall be located prior to drilling. The location of holes to be drilled shall be adjusted to avoid drilling through or nicking any existing reinforcement. Adjusted hole locations shall be subject to ENGINEER'S approval.
5. The hole shall be cleaned using a non-metallic fiber bristle brush and blown out with clean, dry compressed air to remove all dust and loose particles.
6. Epoxy shall be injected into the hole through the injection system-mixing nozzle (and any necessary extension tubes) placed to the bottom of the hole. The discharge end shall be withdrawn as epoxy is placed but kept immersed to prevent formation of air pockets. The hole shall be filled to a depth that ensures that excess material is expelled from the hole during dowel placement.
7. Dowels shall be twisted during insertion into the partially filled hole so as to guarantee full wetting of the bar surface with epoxy. The bar shall be inserted slowly enough to avoid developing air pockets.
8. Drill holes, install epoxy and dowels and cure epoxy in accordance with epoxy manufacturer's recommendations and using epoxy manufacturers standard tools and accessories.

3.4 CONCRETE PLACEMENT

A. Job-Site Mixing: Use drum type batch machine mixer, mixing not less than 1-1/2 minutes for one cubic yard or smaller capacity. Increase mixing time a minimum of 15 seconds for each additional cubic yard or fraction thereof.

B. Ready-Mixed Concrete: Comply with the requirements of ASTM C94.

C. Concrete Placement:
   1. Place concrete in a continuous operation within planned joints or sections complying with the requirements of ACI 304.
   2. Do not begin placement until work of other trades affecting concrete is completed.
   3. Wet concrete and subgrade surfaces to a saturated surface dry condition immediately prior to placement of concrete.
   4. Deposit concrete as near its final location as practical to avoid segregation due to re-handling or flowing.
   5. Take care to avoid separation of the concrete mixture during transportation and placement. Concrete shall not be permitted to free fall for a distance greater than four feet during placement.
   6. Concrete placement shall be completed within 90 minutes of the addition of water to the dry ingredients.

D. Consolidate placed concrete in accordance with ACI 309 using mechanical vibrating equipment supplemented with hand rodding and tamping, such that concrete is worked around reinforcement and other embedded items and into all parts of formwork. Insert and withdraw vibrators vertically at uniformly spaced locations. Do

not use vibrators to transport concrete within the formwork. Vibration of formwork or reinforcement shall not be permitted.

E. Protect concrete from physical damage or reduced strength due to weather extremes during mixing, placement, and curing.
   1. In hot weather comply with the requirements of ACI 305.
   2. In cold weather comply with the requirements of ACI 306.

3.5 QUALITY OF CONCRETE WORK

A. Make all concrete solid, compact, smooth and free of laitance, cracks and cold joints.

B. All concrete for liquid retaining structures, and all concrete in contact with earth, water or exposed directly to the elements shall be watertight.

C. Cut out and properly replace to the extent directed by ENGINEER, or repair to the satisfaction of ENGINEER, surfaces which contain cracks or voids, are unduly rough or are in any way defective. Patches or plastering will not be acceptable.

D. Repair, removal and replacement of defective concrete as ordered by ENGINEER shall be at no additional cost to OWNER.

3.6 CURING

A. Begin initial curing as soon as free water has disappeared from exposed surfaces. Where possible, keep continuously moist for not less than 72 hours. Continue curing by use of moisture-retaining cover or membrane-forming curing compound. Cure formed surfaces by moist curing until formwork is removed. Provide protection as required to prevent damage to exposed concrete surfaces. The total curing period shall not be less than seven days. Curing methods and materials shall be compatible with scheduled finishes.

3.7 FINISHES

A. Slab Finish:
   1. After placing concrete slabs, do not work the surface further until ready for floating. Begin floating when the surface water has disappeared or when the concrete has stiffened sufficiently. Use a wood float only. Check and level the surface plane to a tolerance not exceeding 1/4-inch in ten feet when tested with a ten foot straightedge placed on the surface at not less than two different angles. Cut down high spots and fill all low spots. Uniformly slope surfaces to drains. Immediately after leveling, re-float the surface to a uniform, smooth, granular texture. All slab surfaces shall receive a float finish. Provide additional trowel finishing as required below.

2. After floating, begin the first trowel finish operation using a power-driven trowel. Begin final troweling when the surface produces a ringing sound as the trowel is moved over the surface.
3. Consolidate the concrete surface by the final hand troweling operation. Finish shall be free of trowel marks, uniform in texture and appearance, and with a surface plane tolerance not exceeding 1/8-inch in ten feet when tested with a ten foot straight edge. Grind smooth surface defects which would telegraph through applied floor covering system.
4. Use trowel finish for the following:
    a. Interior exposed slabs, unless otherwise shown or specified.
    b. Apply non-slip broom finish, after troweling, to exterior concrete slab and elsewhere as shown on the Drawings.

B. Apply chemical floor hardener to exposed interior concrete floor areas when cured and dry, in accordance with manufacturer's instructions.

C. Formed Finish:
1. Provide a smooth form concrete finish at all exposed surfaces. Use largest practical form panel sizes to minimize form joints. Exposed surfaces also include all interior water bearing surfaces of tanks, whether directly visible or not. All surfaces shall be considered as exposed, unless buried or covered with a permanent structural or architectural material. After form removal, patch all form tie holes and defects in accordance with the requirements of ACI 301. Remove all fins exceeding 1/8-inch in height. Where surface is to be coated or to receive further treatment, remove all fins flush with concrete surface.
2. Provide rough form finish at all unexposed surfaces. After form removal, patch all form tie holes and defects in accordance with the requirements of ACI 301. Remove all fins exceeding 1/2-inch in height.

3.8 GROUT PLACEMENT

A. Place grout as shown and in accordance with manufacturer's instructions. If manufacturer's instructions conflict with the specified requirements do not proceed until ENGINEER provides clarification.

B. Dry-packing will not be permitted, unless indicated otherwise.

C. Manufacturers of proprietary products shall make available upon 72 hours notification the services of qualified, full-time employee to aid in assuring proper use of the product under job conditions.

D. Placing grout shall conform to the temperature and weather limitations described in Article 3.4, above.

3.9 MISCELLANEOUS CONCRETE ITEMS

A. Temporary Openings:
   1. Openings in concrete walls and/or slabs required for passage of Work or installation of equipment and not shown on the Drawings shall be provided, but only with approval of the ENGINEER.
   2. All temporary openings made in concrete shall be provided with waterstop in below grade or water retaining members. Continuity of required reinforcement shall be provided in a manner acceptable to the ENGINEER.
   3. Temporary openings left in concrete structures shall be filled with concrete after the Work causing the need for the opening is in place, unless otherwise shown or directed. Mix, place and cure concrete as specified herein, to blend with in-place construction. Provide all other miscellaneous concrete filling shown or required to complete the Work.

B. Equipment Bases:
   1. Unless specifically shown otherwise, provide concrete bases for all pumps and other equipment. Coordinate and construct bases to the dimensions shown, or as required to meet manufacturers; requirements and Drawing elevations. Where no specific elevations are shown, bases shall be 6-inches thick and extend 3-inches outside the metal equipment base or supports. Bases shall have smooth trowel finish, unless a special finish such as terrazzo, ceramic tile or heavy duty concrete topping is required. In those cases, provide appropriate concrete finish.
   2. Include all concrete equipment base work not specifically included under other Sections.
   3. In general, place bases up to 1-inch below the metal base. Properly shim equipment to grade and fill 1-inch void with non-shrink grout as specified herein.

C. Curbs:
   1. Provide monolithic finish to interior curbs by stripping forms while concrete is still green and steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
   2. Exterior curbs shall have rubbed finish for vertical surfaces and a broomed finish for top surfaces.

D. Steel Pan Stairs:
   1. Provide concrete fill for steel pan stair treads and landings and associated items. Screed, tamp, and finish concrete surfaces as shown.
      a. Cast-in safety inserts and accessories as shown.

E. Slabs/Foundations:
   1. All mechanical pipe and electrical conduit penetrations through concrete slabs must be sleeved.

END OF SECTION

SECTION 05500

METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. All specialty metal items required to completing the Work in accordance with the intent of the Drawings and Specifications shall be furnished and installed, regardless of whether or not specifically shown or described. Such items include loose or embedded items of structural shapes, plates and bars, welded plate inserts, fabrications and similar items. Bolts, expansion shields, and other fastening devices, which may or may not be provided with the indicated or specified items, shall also be furnished and installed as required for attachment and support.

1.2 SECTION INCLUDES

A. Pipe supports and brackets.

B. Anchor bolts.

C. Stainless steel rods, nuts, bolts, and washers.

D. Fasteners for aluminum.

E. Anodizing.

F. Fasteners.

G. Corrosion protection.

1.3 RELATED SECTIONS

A. Not Applicable.

1.4 SUBMITTALS

A. Descriptive submittals shall be made in accordance with the Data Reference Symbols defined in Section 01300, Submittals.

1. | Item | Shop Drawings |
|---|---|
| Pipe Supports & Brackets | A,C,D,E,H,L,P |
| Anchor Bolts | A,C,D,E,H,L,P |
| Stainless Steel Rods, Nuts, Bolts & Washers | A,C,D,E,H,L,P |
| Fasteners for Aluminum | A,C,D,E,H,L,P |
| Anodizing | A,C,D,E,H,L,P |

B. Shop Drawings shall be provided for all metal fabrications and shall indicate all shop and erection details, including cuts, copes, connection, holes, threaded fasteners, rivets, and welds.
   1. All welds, both shop and field, shall be indicated by AWS Welding Symbols.
   2. Show all types of paints.
   3. Submit certified copies of the qualifications records of each welder prepared within six months of time of Contract award.

C. The CONTRACTOR shall submit Shop Drawings for all proposed pipe supports, hangers, and brackets.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel Plates, Shapes and Bars: ASTM A36.

B. Aluminum:
   1. Alloy and Temper: Provide alloy and temper as shown on the Drawings or specified, or as otherwise recommended by the aluminum producer or finisher.
   2. Extruded Shapes and Tubes: ASTM B221.
   3. Plate and Sheet: ASTM B209.
   4. Bars, Rods and Wire: ASTM B211.

C. Stainless Steel Plates, Sheets and Bars: ASTM A240 or A276, Type 304L or Type 316 stainless steel.
   1. Submerged or Intermittently Submerged: Type 316 stainless steel.
   2. Non-Submerged: Type 304L stainless steel.

D. Stainless Steel Fasteners and Fittings: ASTM A320.

2.2 PIPE SUPPORTS AND BRACKETS

A. Piping:
   1. All piping shall be supported as detailed on the Drawings and specified herein. Piping includes, but is not limited to, the following:
      a. Ductile iron pipe.
      b. PVC pipe.
   2. All pipe supports and brackets shall be as manufactured by B-Line systems, Grinnell, or Unistrut as detailed on the Drawings. Supports for stainless steel piping shall be Type 316 stainless steel.
   3. All appurtenances required for proper installation of the pipe supports and brackets shall be supplied by the manufacturer.

4. Anchor bolts for pipe supports and brackets shall be of the sizes as recommended by the manufacturers of the pipe supports, hangers, and brackets. Anchor bolt type and materials shall be as specified under Paragraph 2.3 of this Specification.

2.3 ANCHOR BOLTS

A. Cast-In-Place Bolt-Type Anchors:
   1. Cast-in-place anchor bolts, nuts and washers shall be ANSI Type 316 stainless steel, which meet the requirements of ASTM F593 and ASTM A666.
   2. Cast-in-place anchor bolts shall have a bent shank or flat plate configuration.

B. Adhesive (Epoxy) Anchors:
   1. Adhesive anchors shall consist of all-thread anchor rod, nut, washer, and adhesive capsule. Anchor rods shall be manufactured from ASTM A666 AISI Type 316 stainless steel that meets the requirements of ASTM F593. The adhesive capsules shall contain a vinylester resin as supplied in the Hilti HEA adhesive capsules or approved equal.
   2. Anchors shall be installed per manufacturer's recommendations.

2.4 STAINLESS STEEL RODS, NUTS, BOLTS, AND WASHERS

A. Stainless steel rods, nuts, bolts, and washers shall be ASTM A666, Type 316. Only non-gall lubricants shall be used on stainless steel rods, nuts, and bolts.

2.5 FASTENERS FOR ALUMINUM

A. Unless otherwise specified, all nuts, bolts, screws, washers, and other fastener material for aluminum handrails, stairs, gratings, and other aluminum fabrications shall be Type 316 stainless steel.

2.6 ANODIZING

A. Anodizing for aluminum, unless otherwise indicated, shall be 200RI finish.

2.7 FASTENERS

A. Unless otherwise specified or required, all fasteners provided for this Project shall be at a minimum Grade 5, ASTM A449 Type 1, SAE J429, zinc-plated. Grade marking shall appear on all bolts and nuts.

2.8 CORROSION PROTECTION

A. Corrosion Protection: Prepare and coat all concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:

1. Surface must be clean, dry and free of oil, grease, and other contaminants. Surface preparation with SSPC-SP7 brush-off abrasive blast cleaning. Apply two coats of Tnemec Series 20 Pota-Pox, or approved equal; each coat shall be 3 to 5 mils. Coating must be NSF 61 approved.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install items plumb and level, accurately fitted, free from distortion or defects.

B. All bolting holes provided in equipment, valves, gates, pipe supports and hangers, handrails, ladders, and other items that require mounting shall be used as specified and intended.

C. Allow for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.

D. Field weld components indicated on Drawings.

E. Perform field welding in accordance with AWS D1.1.

F. ENGINEER approval prior to site cutting or making adjustments not scheduled.

END OF SECTION

SECTION 09900

PAINTING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, services and incidentals required to furnish and install all painting work for aluminum and ferrous metals, masonry surfaces, fiberglass, CPVC, PVC, galvanized metals, and other surfaces as specified herein, or as indicated on the Drawings.
   2. The extent of painting Work is specified and/or shown.
   3. The Work includes the painting and finishing of all items and surfaces throughout the Project included in the Specifications.
      a. Surface preparation, priming, and coats of paint specified are in addition to shop priming and surface treatment specified under other Sections of the Work.
   4. The term "paint" as used herein means all coating systems materials, which includes pretreatments, primers, emulsions, enamels, stain, sealers and fillers, and other applied materials whether used as prime, intermediate or finish coats.
   5. Paint all exposed surfaces whether or not colors are designated in any schedule, except where the natural finish of the material is specifically noted as a surface not to be painted. The term "exposed" as used herein means all items not covered with concrete. Ducts, conduits, and other materials with corrosion resistant surfaces which are in chases, above finished ceilings, or other inaccessible areas shall not require field painting, unless otherwise specified or otherwise shown. Where items or surfaces are not specifically mentioned, paint these the same as adjacent similar materials or areas.
   6. Structural and miscellaneous metals covered with concrete shall only receive a primer compatible with the covering material.
   7. Pre-applied coatings to all items delivered to the job site and not requiring field sand blasting shall be done in accordance with the approved painting submittal under this Section. All items delivered to the job site with pre-applied coatings will be inspected by the ENGINEER and shall be repaired by the CONTRACTOR if, in the judgment of the ENGINEER, the coating is damaged. The CONTRACTOR shall then apply a final coat of the approved protective coating to the equipment in the field.
   8. Where required in these Specifications, ferrous metal surfaces to be painted including above ground and below ground piping, fittings, valves, etc., supplied under Division 15, Mechanical, shall be prepared by field blast cleaning as specified herein.
   9. Pipe markers, as specified.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be field painted in this Section.
   2. Coordinate the painting of areas that are inaccessible once equipment has been installed.
   3. Ensure pre-applied prime coats not to be sand blasted are done in accordance with the approved painting submittals under this Section. CONTRACTOR shall be responsible to ensure all coating systems are provided in accordance with the approved painting and protective coating submittals under this Section.
   4. Provide finish coats which are compatible with the prime paints used. Review other Sections of these Specifications in which prime paints are to be provided to ensure compatibility of the total coatings system for the various substrates. CONTRACTOR shall be responsible for the compatibility of all shop primed and field painted items. Furnish information on the characteristics of the finish materials proposed to use, to ensure that compatible prime coats are used. Provide barrier coats over incompatible primers or remove and re-prime as required. Notify ENGINEER, in writing, of anticipated problems using the coating systems as specified with substrates primed by others.

C. Related Sections that shall apply to all equipment, materials, labor, and services furnished under this Section shall include, but not be limited to, the following:
   1. Section 01300, Submittals.
   2. Division 5, Metals.
   3. Division 11, Equipment.
   4. Division 15, Mechanical.
   5. Division 16, Electrical.

D. Painting Not Included: The following categories of Work are not included as part of the field-applied finish work or are included in other Sections of these Specifications.
   1. Shop Priming: Unless otherwise specified, shop priming of structural metal, miscellaneous metal fabrications, other metal items and such fabricated components as shop-fabricated or factory-built heating and ventilating, instrumentation and electrical equipment or accessories shall conform to applicable requirements of Section 09900, Painting, but is included under the appropriate Sections of this Specification.
   2. Pre-Finished Items:
      a. Items furnished with factory finishes, such as baked-on enamel, porcelain, polyvinyl fluoride or other similar finishes, where specified, or noted on the Drawings.
   3. Concealed Surfaces:
      a. Nonmetallic wall or ceiling surfaces in concealed from view areas and generally inaccessible areas, such as furred areas, pipe spaces and duct shafts, as applicable to this Project.

4. Metal surfaces of anodized aluminum, stainless steel, chromium plate, bronze, and copper will not require finish painting, unless shown or specified otherwise.
5. Operating Parts and Labels:
    a. Do not paint over any code-required labels, such as UL and Factory Mutual, or any equipment identification, performance rating, name, or nomenclature plates.
    b. Remove all paint, coating or splatter inadvertently placed on these surfaces.
6. Sealants.
7. Protective coating of concrete.

1.2 QUALITY ASSURANCE

A. Applicator Qualifications:
    1. CONTRACTOR shall submit to the ENGINEER the name and experience record of the painting subcontractor. Include a list of utility or industrial installations painted, responsible officials, ARCHITECT'S, or ENGINEER'S concerned with the Project and the approximate Contract Price.
    2. Painting subcontractors whose submissions indicate that they have not had the experience required to perform the Work shall not be approved. Qualifying experience shall include at least three previous water well projects of similar magnitude and complexity to this Project that have been completed not less than three years prior to submission of qualifications to ENGINEER.

B. All materials specified by name, brand, or manufacturer shall be delivered unopened to the job in their original containers. The paint shall be applied in strict accordance with the recommendations of the manufacturer using equipment approved for the duty.

C. Source Quality Control:
    1. Certify long-term compatibility of all coatings with all substrates.

D. Reference Regulations: Surface preparation and application of coatings shall be performed by the CONTRACTOR in compliance with all applicable Federal, State and local occupational safety, health and air pollution control regulations. The CONTRACTOR shall obtain and comply with all safety precautions recommended by the paint manufacturer in printed instructions or special bulletins, and as required by applicable regulations. The CONTRACTOR shall provide forced ventilation in all areas where inadequate ventilation exists.

1.3 SUBMITTALS

A. Submittals shall be done in accordance with the Section 01300, Submittals, and as specified below. The CONTRACTOR shall be required to submit his proposed protective coating systems prior to any other equipment, piping, or hardware

submittals that require protective coatings. After review of the protective coating submittals by the ENGINEER to indicate no further submittals are required, the CONTRACTOR shall be required to furnish only the approved protective coatings throughout the Project.

B. Shop Drawings: Submit for approval the following:
   1. Copies of manufacturer's technical information, including paint label analysis and application instructions for each material proposed for use.
   2. Copies of CONTRACTOR'S proposed protection procedures in each area of the Work.
   3. List each material and cross-reference to the specific paint and finish system and application. Identify by manufacturer's catalog number and general classification.
   4. Copies of manufacturer's complete color charts for each coating system.
   5. Maintenance Manual: Upon completion of the Work, furnish copies of a detailed Maintenance Manual including the following information:
      a. Product name and number.
      b. Name, address and telephone number of manufacturer and local distributor.
      c. Detailed procedures for routine maintenance and cleaning.
      d. Detailed procedures for light repairs such as dents, scratches, and staining.

C. Applicator Qualifications: In accordance with Paragraph 1.2.A of this Section.

D. Manufacturer Qualifications: In accordance with Paragraph 2.2 of this Section.

E. Certification: In accordance with Paragraph 1.2.C of this Section.

F. Application Techniques: In accordance with Paragraph 2.3.H of this Section.

G. Test Results: In accordance with Paragraph 3.8 of this Section.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Delivery of Materials: Deliver all materials to the job site in original, new and unopened packages and containers bearing manufacturer's name and label, and the following information.
   1. Name or title of material.
   2. Manufacturer's stock number and date of manufacture.
   3. Manufacturer's name.
   4. Contents by volume, for major pigment and vehicle constituents.
   5. Thinning instructions where recommended.
   6. Application instructions.
   7. Color name and number.

B. Storage of Materials:
   1. Store only acceptable Project materials on Project site.
   2. Store in a suitable location approved by ENGINEER. Keep area clean and accessible.
   3. Restrict storage to paint materials and related equipment.
   4. Comply with health and fire regulations including the Occupational Safety and Health Act of 1970.

C. Handling of Materials:
   1. Handle materials carefully to prevent inclusion of foreign materials.
   2. Do not open containers or mix components until necessary preparatory Work has been completed and application Work will start immediately.

1.5 JOB CONDITIONS

A. Existing Conditions:
   1. Before painting is started in any area, it shall be broom cleaned and excessive dust shall be removed.
   2. After painting operations begin in a given area, broom cleaning will not be allowed; cleaning shall then be done only with commercial vacuum cleaning equipment.

B. Environmental Requirements:
   1. Apply water-base paints only when the temperature of surfaces to be painted and the surrounding air temperatures are between 55° F and 90° F, unless otherwise permitted by the paint manufacturer's printed instructions.
   2. Apply other paints only when the temperature of surfaces to be painted and the surrounding air temperatures are between 65° F and 95° F and the temperature is 5° F above the dew point, unless otherwise permitted by the paint manufacturer's printed instructions and approved by the ENGINEER.
   3. Do not apply paint in rain, fog, or mist; or when the relative humidity exceeds 80%; or to damp or wet surfaces.
   4. Painting may be continued during inclement weather only if the areas and surfaces to be painted are enclosed and heated within the temperature limits specified by the paint manufacturer during application and drying periods.
   5. Adequate illumination and ventilation shall be provided in all areas where painting operations are in progress.
   6. Surface preparation and application of coatings shall be performed by the CONTRACTOR in compliance with all applicable Federal, State and local occupational safety, health and air pollution control regulations. The CONTRACTOR shall obtain and comply with all safety precautions recommended by the paint manufacturer in printed instructions or special bulletins.
   7. Install piping markers only after all painting and finish Work has been completed.

C. Protection: Cover or otherwise protect finished Work of other trades and surfaces not being painted concurrently or not to be painted.

D. Spent abrasive containing lead and/or chromate paint resulting from the blasting of the "affected surfaces" may be classified as a hazardous waste. "Spent abrasive" shall be understood to mean the abrasive generated during the blasting operation, including the spent water imposed over the abrasive flow, paint residue, and any other debris.

E. Care shall be exercised to prevent spent abrasive, water or dust from falling on surrounding buildings, unprotected vegetation, walkways, soils, structures and equipment by covering these areas with non-tearing tarps. Spent abrasive collecting on the ground shall be vacuumed regularly to prevent it from becoming wind blown. The site shall at all times be kept as clean as possible. At the end of the Work day, all spent abrasive shall be thoroughly vacuumed and the site left with a neat appearance.

F. Spent abrasive resulting from the blasting of the "affected surfaces" shall be captured. Non-tearing tarps or plastic sheathing, platforms, partial or total enclosures, temporary barriers or structures, or similar containment methods may be employed for this purpose. These methods must be reviewed by the ENGINEER prior to start of Work. A detailed procedure describing the proposed blast cleaning operation, abrasive capture, and containment techniques, and safety measures to avoid the contamination of the natural environment or surrounding structures.

G. Spent abrasive resulting from the blasting of the "affected surfaces" shall be collected and legally disposed of by the CONTRACTOR in a legal and responsible manner. Such disposal shall also be in conformance with all applicable codes, ordinances, and regulations for hazardous waste disposal. All other waste, including spent abrasive generated by the blasting of non-affected surfaces, shall be disposed by the CONTRACTOR.

H. All materials, including painting equipment, shall be stored in accordance with local, State, and Federal requirements for paints, toxic materials, and hazardous materials. All rags shall be removed from the premises. All possible precautions shall be taken to prevent spontaneous fires.

I. All reasonable care shall be taken to protect against paint splatter and over spray. CONTRACTOR shall be responsible for any damage incurred to surrounding property resulting from his Work.

J. Signs shall be posted, as required, to alert the public of any risks associated with sandblasting debris, painting over spray, etc. All efforts shall be made to prevent debris from becoming wind blown.

K. CONTRACTOR shall be responsible for obtaining any and all permits required to perform the Work.

L. Spent water, resulting from the cleaning operation of "affected surfaces" due to wet sandblasting, may contain hazardous particulates.

PART 2 - PRODUCTS

2.1 MATERIAL QUALITY

A. Provide manufacturer's best grade of the various types of coatings suitable for use in projects as regularly manufactured by acceptable paint materials manufacturers. Materials not displaying the manufacturer's identification as a standard, best-grade product will not be acceptable.

B. Provide primers produced by the same manufacturer as the finish coats. Use only thinners recommended by the paint manufacturer, and use only to manufacturer's recommended limits.

C. Provide paints, and pipe markers of durable and washable quality. Use materials which will withstand normal washing as required to remove grease, oil, chemicals, etc., without showing discoloration, loss of gloss, staining, or other damage.

D. Product and Manufacturer: Provide one of the following:
   1. Tnemec Company, Incorporated.
   2. Or approved equal.

2.2 SUBSTITUTIONS

A. No products shall be considered that decrease the film thickness, the number of coats, percent solids, the surface preparation or the generic type and formulation of coating(s) specified.

B. All "or approved equal" products shall be submitted with direct comparison to products specified, including information on durability, color and gloss retention, percent solids, VOCs per gallon and recoatability after curing.

C. Approved manufacturers shall furnish the same color selection as the manufacturers specified, including intense chroma and custom pigmented colors in all painting system.

2.3 COLORS AND FINISHES

A. Surface treatments and finishes are specified under "Painting Systems" below. All substrates referenced under "Painting Systems" shall be painted whether or

not shown, or scheduled, unless an item is specifically scheduled as not requiring the painting system scheduled below.

B. Color Selection:
   1. A maximum of 20 different colors shall be selected for the Project, in addition to color coding of all piping and ducts. Provide colors that match existing substrate colors as closely as possible where Work is performed adjacent to existing substrates to remain.
   2. ENGINEER reserves the right to select non-standard colors for all paint systems specified within the ability of the manufacturer to produce such non-standard colors. Selection of non-standard colors shall not be cause for CONTRACTOR rejecting ENGINEER'S color selections and CONTRACTOR shall provide such colors at no additional expense to OWNER.

C. After approval of submittals and prior to beginning Work, ENGINEER will select color schedules for surfaces to be painted listed in the painting systems below.

D. Piping and Sign Color Coding: In general, and unless otherwise specified, all color coding of piping, ducts and equipment shall comply with applicable standards of ANSI A13.1 and OSHA 1910.144.

E. Alternate color bands on piping shall be spaced every 2 feet along the length of the pipeline.

F. Use representative colors when preparing samples for ENGINEER'S review.

G. Color Pigments: Pure, non-fading, applicable types to suit the substrates and service indicated.
   1. All color pigments shall be lead free.

H. Submit proposed application techniques to ENGINEER and submit proof of acceptability, of technique proposed, by the paint manufacturer selected with the required submittals.

2.4 PAINTING SYSTEMS

A. Concrete Block Walls: Interior:
   1. Surface Preparation: Remove grease, oil and all foreign matter as specified in Paragraph 3.2.E.
   2. Product and Manufacturer: Provide one of the following:
      a. Tnemec:
         1) Primer: 54-660 Block Filler - one coat, 10.0 dry mils, pinhole free.
         2) Finish: 69 H.B. Epoxoline II - two coats, 4-5 dry mils per coat.
      b. Or approved equal.

B. Ferrous Metals including all Structural Steel, Miscellaneous Ferrous Metals, and all Ferrous Piping; Interior Non-submerged:
   1. Surface Preparation: SSPC-SP6 Commercial Blast Cleaning as specified in Paragraph 3.2.B and/or as required in accordance with Paragraph 3.2.C.
   2. Interior non-submerged applies to areas that are housed within a building and/or within a non-process, enclosed structure.
   3. Product and Manufacturer: Provide one of the following:
      a. Tnemec:
         1) Shop Primer: 66 H.B. Epoxoline - two coats, 2-3 dry mils per coat.
         2) Field Primer or Field Touchup: 66 H.B. Epoxoline - one coat, 2-3 dry mils per coat.
         3) Finish: 69 H.B. Epoxoline II - two coats, 4-5 dry mils per coat.
      b. Or approved equal.

C. Ferrous Metals, Including all Ferrous Piping; Exterior Non-submerged:
   1. Surface Preparation: SSPC-SP6 Commercial Blast Cleaning as specified in Paragraph 3.2.B and/or as required in accordance with Paragraph 3.2.C.
   2. Exterior non-submerged applies to areas that are not housed within a building or structure, and that are not located within process and/or water carrying structures or tanks.
   3. Product and Manufacturer: Provide one of the following:
      a. Tnemec:
         1) Primer: 66 H.B. Epoxoline - two coats, 2-3 dry mils per coat.
         2) Intermediate: 69 H.B. Epoxoline II - one coat, 4-5 dry mils.
         3) Finish: 75 Endura-Shield - two coats, 1.5-2 dry mils per coat.
      b. Or approved equal.

D. Galvanized Metal and Non-Ferrous Metal; Interior Non-Submerged:
   1. Surface Preparation: SSPC-SP 1 Solvent Cleaning, as specified in Paragraph 3.2.D and Paragraph 3.2.F.
   2. Interior non-submerged applies to areas that are housed within a building and/or within a non-process, enclosed structure.
   3. Product and Manufacturer: Provide one of the following:
      a. Tnemec:
         1) Primer: 66 H.B. Epoxoline - one coat, 3-4 dry mils.
         2) Finish: 69 H.B. Epoxoline II - one coat, 4-5 dry mils.
      b. Or approved equal.

E. All Aluminum in Contact with Dissimilar Materials:
   1. Surface Preparation: Remove all foreign matter.
   2. Product and Manufacturer: Provide one of the following:
      a. Tnemec:
         1) 66 H.B. Epoxoline - two coats, 2.0-3.0 dry mils per coat.
      b. Or approved equal.

F. PVC Piping, CPVC Piping, Fiberglass, Fiberglass Insulation Covering; Exterior:

1. Surface Preparation: Sand as specified in Paragraph 3.2.G.
2. Exterior applies to areas that are not housed within a building and/or within an enclosed structure.
3. Product and Manufacturer: Provide one of the following:
    a. Tnemec:
        1) Primer/Intermediate: 66 H.B. Epoxoline - one coat each, 2.0-3.0 dry mils per coat.
        2) Finish: 75 Endura-Shield - one coat, 3.0 dry mils.
    b. Or approved equal.

G. PVC Piping, CPVC Piping, Fiberglass, Fiberglass Insulation Covering; Interior Non-Submerged:
1. Surface Preparation: Sand, as specified in Paragraph 3.2.G.
2. Product and Manufacturer: Provide one of the following:
    a. Tnemec:
        1) Primer/Intermediate/Finish: 66 H.B. Epoxoline - one coat each, 2.0-3.0 dry mils per coat.
    b. Or approved equal.

H. Steel and Galvanized Steel Pipe; Buried Exterior:
1. Surface Preparation: SSPC-SP 10, Near-White Blast, as specified in Paragraph 3.2.D.
2. Product and Manufacturer: Provide one of the following:
    a. Tnemec:
        1) Primer: 66-1211 Epoxoline - two coats, 3-4 dry mils per coat.
        2) Field Primer or Field Touchup: Surface preparation as specified.
        3) Finish: 46-413 Tneme-Tar - two coats, 10.0 dry mils per coat.
    b. Or approved equal.

I. Submerged or Intermittently Submerged Ferrous Metals; Interior and Exterior:
1. Definition: Submerged shall apply to all metals below the maximum water surface elevation in open top structures unless otherwise noted or otherwise shown; and to all metals within liquid or residual solids carrying structures that are covered, including all metals on the underside of the covers, unless otherwise noted or otherwise shown; and to all metals within an enclosed process structure. This shall apply to all metals whether intermittently or continuously submerged.
2. Surface Preparation: SSPC-SP 10 Near-White Blast Cleaning as specified in Paragraph 3.2.D.
3. Product and Manufacturer: Provide one of the following:
    a. Tnemec:
        1) Primer: 69-1211 Epoxoline II - two coats, 3-4 dry mils per coat.
        2) Intermediate: 69 H.B. Epoxoline II - two coats, 5 dry mils per coat.
        3) Finish: 69 H.B. Epoxoline II - two coats, 5 dry mils per coat.
    b. Or approved equal.

J. Special Requirements for Aluminum:
   1. Aluminum surfaces bearing in or embedded in concrete and faying surfaces of bolted aluminum joints, except anchor bolts, shall be given two coats of 66 H.B. Epoxoline Primer, or approved equal. The primer shall be allowed to dry between coats and before concrete is poured against it.
   2. Where aluminum metals are placed in contact with or fastened to ferrous or stainless steel metals, the contact surfaces of each shall receive the protective coating specified for that metal and a gasket shall be placed between the two contact surfaces. The gasket material shall be non-conductive commercial grade neoprene, 60 durometer, 0.03-inch in thickness unless otherwise specified. Bolts shall be isolated using one piece non-conductive sleeves and washers as manufactured by PSI Products, Inc., Burbank, California; Parker Seal Col, Culvert City, California; or approved equal.

K. Galvanizing: All galvanizing, where called for in the Contract Documents shall be hot-dip process conforming to ASTM A123.

L. Gypsum Wallboard and Stucco:
   1. Surface Preparation: Remove grease, oil and all foreign matter as specified in Paragraph 3.2.I.
   2. Product and Manufacturer: Provide one of the following (semi-gloss or flat as scheduled):
      a. Tnemec:
         1) Primer: 151 Elasto-Grip - one coat, 1.0-2.5 dry mils.
         2) Finish: 156 Enviro-Crete - one coat, 4.0-8.0 dry mils.
      b. Or approved equal.

2.5 PIPING MARKERS

A. General:
   1. For Pipes Over 3/4-inch Outside Diameter: Provide painted pipe markers.
   2. For Pipes Under 3/4-inch Outside Diameter: Provide stainless steel tags and tag chains, 1/2-inch diameter, with depressed 1/4-inch high black filled letters above 2-inch high black filled numbers.
   3. Each painted marker shall consist of at least one legend descriptive of the function of the pipe, and a directional arrow. The legend descriptive and direction arrow shall be stenciled on the pipe utilizing stencils as manufactured by Seton Name Plate Co., or approved equal.
   4. The size of lettering and marker shall conform to ANSI A13.1.
   5. Location of Markers:
      a. Adjacent to each valve and "T" connection.
      b. At each branch and riser takeoff.
      c. At each pipe passage through a wall, floor, and ceiling.
      d. On all horizontal and vertical pipe runs at 25 foot intervals.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR and his painting subcontractor (applicator) and the manufacturer shall examine the areas and conditions under which painting work is to be performed and notify ENGINEER, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected by the CONTRACTOR.

B. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions otherwise detrimental to the formation of a durable paint film.

C. Quality Assurance: Surface preparation shall be based upon comparison with: "Pictorial Surface Preparation Standards for Painting Steel Surfaces", SSPC-Vis 1 ASTM Designation D220, NACE Standard TM-01-70, and as described below. Anchor profile for prepared surfaces shall be measured by using a nondestructive instrument such as a Keane-Tator Surface Profile Comparator or Testix Press-O-Film System. Temperature and dewpoint requirements noted herein shall apply to all surface preparation operations, except minimum temperature shall be 40° F. To facilitate inspection, the CONTRACTOR shall on the first day of abrasive blasting operations, abrasively blast metal panels furnished by CONTRACTOR to the standard specified. These panels shall be equivalent to plates or structural stock used in facility with minimum measurements of 8-1/2-inches by 11-inches, or nearest multiple for structural shapes. After agreeing a specific panel meets the requirements of the Specification, the panel shall be initialed by the CONTRACTOR and ENGINEER and coated with a clear non-yellowing finish. Panels shall be utilized for inspection purposes throughout the duration of abrasive blasting operations.

3.2 SURFACE PREPARATION

A. General:
   1. Perform all preparation and cleaning procedures as specified herein and in strict accordance with the paint manufacturer's instructions for each particular substrate and atmospheric condition.
   2. When required, prepare existing substrates to be painted under this Section as specified for new substrates. Where other methods of preparing existing substrates are proposed by the CONTRACTOR they shall be submitted to the ENGINEER for approval. ENGINEER'S approval of alternate substrate preparation shall not relieve the CONTRACTOR of his required performance under this Section.
   3. Remove all hardware, hardware accessories, machined surfaces, plates, lighting fixtures, and similar items in place and not to be finish painted, or provide surface applied protection prior to surface preparation and painting operations. Remove, if necessary, for the complete painting of the items and

adjacent surfaces. Following completion of painting of each space or area, reinstall the removed items by workmen skilled in the trades involved.

4. Clean surfaces to be painted before applying paint or surface treatments. Remove oil and grease with clean cloths and cleaning solvents prior to mechanical cleaning. Program the cleaning and painting so that dust and other contaminants from the cleaning process will not fall in wet, newly painted surfaces.
5. All surfaces which were not shop painted or which were improperly shop painted, and all abraded or rusted shop painted surfaces, which are to be painted, as determined by ENGINEER, shall be prepared, as specified below.
6. With the exception of motors, gears, and other equipment that might be damaged by sandblasting, and unless specified otherwise, shop applied protective coatings shall be completely removed at the job site by sandblasting.
7. All equipment and/or materials to be painted at the job site shall be placed on raised supports at least 2 feet above the ground. The prime coat shall be applied as quickly as possible after blasting. In no case shall bare metal surfaces be left overnight before applying the prime coat. Each coat of the paint shall be applied at proper consistency and shall be sprayed or brushed evenly and be free of brush marks, pin holes, sags, and runs with no evidence of poor workmanship. Care shall be exercised to prevent paint from being spattered on surfaces that are not to be painted, and if paint is dropped or spattered on surfaces not to be painted the paint shall be removed as directed by the ENGINEER. All equipment nameplates, valve stems, and areas not to be painted shall be masked prior to painting.
8. Multiple coats shall be applied in conformance with the paint manufacturer's recommendations for minimum drying time and maximum curing time between coats. The surface preparation and each coat of a multiple-coat system shall be of different colors (as selected by the ENGINEER) and inspected by the ENGINEER before subsequent coats are applied.
9. If thinning is required for proper application of a coating, it shall be done only in accordance with the recommendations of the paint manufacturer and only to the manufacturer's recommended limits.

B. Ferrous Surfaces:
   1. Ferrous metal surfaces to be painted including above and below ground piping, fittings, etc., supplied under Division 15, Mechanical, shall be prepared by field blast cleaning as specified below, unless described otherwise elsewhere in the Specifications.
   2. Prior to blast cleaning, the CONTRACTOR shall ensure that all rough welds are ground smooth and sharp steel edges ground to approximately 1/8-inch radius. Weld spatter shall be removed. Paint, mill scale, rust, flux, fume, and slag from weld deposits shall be removed by blast cleaning. Any grease or oil shall be removed by steam or solvent cleaning.
   3. Surfaces to be blast cleaned shall be dry blast cleaned to a commercial blast cleaned surface finish conforming to Section 310.-2.5 "Blast Cleaning" of the

SSPWC and SSPC-SP6. Surface profile for surfaces not subject to submergence shall be 1.5 to 1.9 mils. Surface profile for surfaces subject to submergence shall be 3.0 to 4.0 mils.

4. All dust shall be removed by brushing, vacuum, or air blast. The prime coat shall be applied as soon as possible after blasting. In no case shall bare metal surfaces be left overnight before applying the prime coat.
5. Sandblasting and painting shall not be performed concurrently in the same area. No sandblasting will be allowed in areas adjacent to equipment that might be damaged by sandblasting.
6. Heavy deposits of grease or oil shall be removed from all surfaces to be coated using the paint manufacturer's specified cleaner prior to any other surface preparation. Any chemical contamination shall be neutralized and/or flushed off prior to any other surface preparation.
7. In addition to the limitations imposed in Section 310-1 of the SSPWC, no surface preparation or coating shall be performed during periods of excessive wind, which in the opinion of the ENGINEER, would affect the quality of the Work, or produce nuisance conditions in adjacent areas. All coatings shall be applied in strict conformance with the manufacturer's printed recommendations regarding minimum and maximum allowable air and surface temperatures. No coatings shall be applied when the relative humidity is higher than 80% or when the temperature is less than or approved equal to 5° F above dew point. No coatings shall be applied if any moisture is detectable on the surface to be coated.

C. Equipment That Cannot be Sandblasted:

1. Equipment that could be damaged by sandblasting, typically including motors, gear reducers, switchboards, and similar equipment, shall receive the shop coatings and finish coatings. The CONTRACTOR shall be solely responsible for ensuring that shop coating is done in conformance with the specifications and the approved paint submittal, and for repair or replacement of any shop coating that is determined to be inadequate by the ENGINEER. All components shall have a finish color to match the plant color scheme. Color samples shall be submitted for review and selection by the ENGINEER.
2. Shop-applied coatings shall be inspected and evaluated at the job site and shall be evenly applied and free of brush marks, sags, nicks, scratches, runs, holidays or other evidence of poor workmanship or damage. Shop coatings which are of good quality shall be solvent cleaned, and lightly sanded as directed by the ENGINEER and finish coated as specified. All bearings and openings shall be masked to prevent damage during sanding and painting. Color shall be as specified above. Prior to application, the CONTRACTOR shall perform spot testing to determine if the shop-applied paint is of the same manufacturer as the specified finish coats. If, in the opinion of the ENGINEER, the paints are not as specified, the CONTRACTOR shall apply a suitable paint to act as a barrier or "tie coat" between the shop-applied and field-applied finishes. Materials and application procedures for the "tie-coat"

shall be subject to review and approval by the ENGINEER. "Tie coats" shall be applied at no increase in Contract price. It shall be the CONTRACTOR'S sole responsibility to determine if shop applied primers and finishes are as specified and he shall be totally responsible for the entire coating system warranty.

3. Shop-applied coatings which show evidence of poor materials or workmanship, or have been damaged, shall be repaired or replaced in the field as directed by the ENGINEER. Nicks and scratches or other small imperfections in the finish shall be repaired by wire brushing to a bright metal, primed with a universal primer and finish coated as specified. Universal primer shall be Amercoat 185, 37-77H Kem Prime, Koppers Pug Primer, or approved equal, to a minimum dry film thickness of 2 mils. An epoxy primer may be used as a universal primer if a test patch is applied to check adhesion, and the ENGINEER approves. After repair, the equipment shall be solvent cleaned, lightly sanded, and painted as specified above for equipment with a good quality shop finish. If, in the opinion of the ENGINEER, the shop coating is of such poor quality that repair is not warranted, he may elect to either:
    a. Require the CONTRACTOR to return the equipment to the factory for refinishing.
    b. Require the CONTRACTOR to completely remove the existing coating, prepare the surface for repainting and repaint the equipment using the applicable paint system as specified herein. All Work shall be done in a manner which will prevent damage to the equipment. Costs incurred for repair or replacement of shop-applied coatings shall be the sole responsibility of the CONTRACTOR at his expense.

D. Galvanized Surfaces:
    1. Where coatings for galvanized surfaces are called for by the Specifications, the CONTRACTOR shall prepare the galvanized surfaces as follows.
    2. All surfaces shall be inspected jointly by the CONTRACTOR and the ENGINEER to determine the condition of existing surfaces. The ENGINEER shall then designate the surface condition and cleaning shall be performed as noted below. Any areas overlooked during the joint inspection shall not relieve the CONTRACTOR from completely preparing surfaces.
    3. First, all oily or greasy surface contaminants shall be removed by wiping the contaminated area with a clean rag wetted with degreasing solution in accordance with Steel Structures Painting Council Specification SSPC-SP1 (Solvent Cleaning).
    4. Next, surface contaminants not easily removed by the previous step and complete surfaces shall be additionally cleaned in conformance with Steel Structures Painting Council Specification SSPC-SP7 (Brush-off Blast Cleaning).
    5. Next, all rusting, scaling, or damaged areas shall be blast cleaned in conformance with Steel Structures Painting Council Specification SSPC-SP10 (Near-White Blast Cleaning). Remaining galvanized surface shall be

firmly bonded to the substrate with sandblast edges feathered. Extreme care shall be exercised to insure remaining galvanized surfaces are not damaged by cleaning operations.

E. Masonry/Concrete Block Surfaces:
   1. Prepare surfaces of concrete block to be painted by removing all efflorescence, chalk, dust, dirt, grease, oils, with soap and water.
   2. Determine the alkalinity and moisture content of the surfaces to be painted by performing appropriate tests. If the surfaces are found to be sufficiently alkaline to cause blistering and burning of the finish paint, correct this condition before application of paint. Provide ENGINEER with suitable testing materials in order to carry out alkalinity and moisture tests.
   3. Do not paint over surfaces where the moisture content exceeds 8%, unless otherwise permitted in the manufacturer's printed directions.
   4. Concrete block surfaces that cannot be adequately cleaned by soap and water shall be acid etched.
   5. Remove loose or incompatible existing finish coats as recommended by the paint manufacturer for full product responsibility. Brush blast to clean all residues and create uniform rough texture.

F. Non-Ferrous Metal Surfaces: Clean non-ferrous metal surfaces in accordance with the coating system manufacturer's instructions for the type of service, metal substrate, and application required.

G. PVC, CPVC Piping, and Fiberglass: Lightly sand and clean all surfaces to be painted.

H. Covering on Pipe: Clean free of oil and surface contaminants as recommended by the coating manufacturer for substrate and application required. Do not cut or damage the insulation in any way.

I. Gypsum Wallboard:
   1. Patch, sand and seal all rough spots before prime coat.
   2. Touch up all suction spots and hot spots with primer before application of finish coats.

3.3 MATERIALS PREPARATION

A. General:
   1. Mix and prepare painting materials in strict accordance with the manufacturer's directions.
   2. Do not mix coating materials produced by different manufacturers, unless otherwise permitted by the manufacturer's instructions.
   3. Store materials not in actual use in tightly covered containers. Maintain containers used in storage, mixing, and application of paint in a clean condition, free of foreign materials and residue.

4. Stir all materials before application to produce a mixture of uniform density, and as required during the application of the materials. Do not stir any film that may form on the surface into the material. Remove the film and, if necessary, strain the material before using.
5. Mixing:
    a. Mix only in containers placed in suitably sized non-ferrous or oxide resistant metal pans to protect concrete floor from splashes or spills, which could stain exposed concrete or react with subsequent finish floor material.
    b. Mix and apply paint only in containers bearing accurate product name of material being mixed or applied.

3.4 APPLICATION

A. General:
1. Apply paint by brush, roller, air spray, or airless spray in accordance with the manufacturer's directions and recommendations of Paint Application Specifications No. 1 in SSPC Vol. 2, where applicable. Use brushes best suited for the type of material being applied. Use rollers of carpet, velvet back, or high pile sheep's wool as recommended by the paint manufacturer for material and texture required. Use air spray and airless spray equipment recommended by the paint manufacturer for specific coating system specified. Submit a list of application methods proposed, listing paint systems and location.
2. The paint film thickness required is the same regardless of the application method. Do not apply succeeding coats until the previous coat has completely dried.
3. Apply additional coats when undercoats, stains, or other conditions show through the final coat of paint, until the paint film is of uniform finish, color, and appearance. This is of particular importance regarding intense primary accent colors. Ensure that all surfaces, including edges, corners, crevices, welds, and exposed fasteners receive a film thickness equivalent to that of flat surfaces.
4. Multiple coats shall be applied in conformance with the paint manufacturer's recommendations for minimum drying time and maximum curing time between coats. The surface preparation and each coat of a multiple-coat system shall be of different colors (as selected by the ENGINEER) and inspected by the ENGINEER before subsequent coats are applied. The CONTRACTOR shall provide forced ventilation in areas where inadequate ventilation exists. If thinning is required for proper application of a coating, it shall be done only in accordance with the recommendations of the paint manufacturer and with the written approval of the ENGINEER.
5. Surfaces not exposed to view do not require color coding but require the same coating system specified for exposed surfaces.
    a. "Exposed to view surfaces" is defined as those areas visible when permanent or built-in fixtures convector covers, covers, covers for

finned tube radiation, grilles, etc., are in place in areas scheduled to be painted.

6. Paint interior surfaces of ducts, where visible through registers or grilles, with a flat, non-specular black paint as specified, before final installation of equipment.
7. Paint aluminum parts in contact with dissimilar materials as specified with appropriate primer and isolation gasket material.
8. Omit field primer on metal surfaces that have been shop primed touch-up paint shop prime coats only when approved by ENGINEER.
9. Paint the backs of access panels, and removable or hinged covers to match the exposed surfaces.
10. Paint all exposed pipes and pipe fittings according to the Pipe Painting Schedule at the end of this Specification.

B. Heating, Ventilating, Air Conditioning, and Electrical Work:
   1. Heating, ventilating, and air conditioning items to be painted include, but are not limited to, the following:
      a. Piping, pipe hangers, and supports.
      b. Heat exchangers.
      c. Tanks.
      d. Duct work and insulation.
      e. Motors, mechanical equipment, and supports.
      f. Accessory items.
   2. Electrical items to be painted include, but are not limited to, the following:
      a. Conduit and fittings.
      b. Switchgear, panels, junction boxes, motor control centers, motors and accessories.

C. Minimum Coating Thickness:
   1. Apply each material at not less than the manufacturer's recommended spreading rate, and provide total dry film thickness as specified.
   2. Apply extra coat if required to obtain specified total dry film thickness.

D. Scheduling Painting:
   1. Apply the first coat material to surfaces that have been cleaned, pretreated or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
   2. Allow sufficient time between successive coatings to permit proper drying. Do not recoat until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and the application of another coat of paint does not cause lifting or loss of adhesion of the undercoat.

E. Prime Coats: Recoat primed and sealed walls and ceilings where there is evidence of suction spots or unsealed areas in first coat, to assure a finish coat with no burn-through or other defects caused by insufficient sealing.

F. Pigmented (Opaque) Finishes: Completely cover to provide an opaque, smooth surface of uniform finish, color, appearance, and coverage.

G. Transparent (Clear) Finishes:
   1. On exposed to view portions, use multiple coats to produce glass-smooth surface film continuity of even matt luster. Provide a finish free of laps, cloudiness, color irregularity, runs, brush marks, orange peel, nail holes, or other surface imperfections.
   2. Provide satin finish for final coats, unless otherwise indicated.

H. Brush Application:
   1. Brush-out and work all brush coats onto the surfaces in an even film. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable. Neatly draw all glass and color break lines.
   2. Brush apply all primer or first coats, unless otherwise permitted to use mechanical applicators.

I. Mechanical Applicators:
   1. Use mechanical methods for paint application when permitted by governing ordinances, paint manufacturer, and approved by ENGINEER. If permitted, limit to only those surfaces impracticable for brush applications.
   2. Limit roller applications, if approved by ENGINEER, to interior wall finishes for second and third coats. Apply each roller coat to provide the equivalent hiding as brush-applied coats.
   3. Confine spray application to metal framework, siding, decking, wire mesh, and similar surfaces where hand brushwork would be inferior and to other surfaces specifically recommended by paint manufacturer.
   4. Wherever spray application is used, apply each coat to provide the equivalent hiding of brush-applied coats. Do not double back with spray equipment for the purpose of building up film thickness of two coats in one pass.

J. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint Work not in compliance with specified requirements as required by ENGINEER.

3.5 PROTECTION

A. Protect work of other trades, whether to be painted or not, from the Work of this Section. Leave all such work undamaged. Correct all damages by cleaning, repairing or replacing, and repainting, as acceptable to ENGINEER.

B. Provide "Wet Paint" signs as required to protect newly painted finishes. Remove all temporary protective wrappings provided for protection of this Contract and other contracts after completion of painting operations.

C. All equipment and/or materials to be painted at the job site shall be placed on raised supports at least 2 feet above the ground. The prime coat shall be applied as quickly as possible after blasting. In no case shall bare metal surfaces be left overnight before applying the prime coat. Each coat of the paint shall be applied at proper consistency and shall be sprayed or brushed evenly and be free of brush marks, pinholes, sags, and runs with no evidence of poor workmanship. Care shall be exercised to prevent paint from being spattered on surfaces that are not to be painted and, if paint is dropped or spattered on surfaces not to be painted, the paint shall be removed as directed by the ENGINEER. All equipment nameplates, valve stems and areas not to be painted shall be masked prior to painting.

D. In addition to the limitations imposed in Section 310-1 of the SSPWC, no surface preparation or coating shall be performed during periods of excessive wind, which in the opinion of the ENGINEER, would affect the quality of the Work, or produce nuisance conditions in adjacent areas. All coatings shall be applied in strict conformance with the manufacturer's printed recommendations regarding minimum and maximum allowable air and surface temperatures. No coatings shall be applied when the relative humidity is higher than 80% or when the temperature is less than or equal to 5° F above dew point. No coatings shall be applied if any moisture is detectable on the surface to be coated.

E. The CONTRACTOR shall be responsible for containing all over spray. Any over spray on any item of equipment, piping, structures, paving, or others including vehicles shall be removed by the CONTRACTOR. If removal is not possible, the CONTRACTOR shall be responsible at CONTRACTOR'S cost for repainting the entire damaged item, to the satisfaction of the ENGINEER.

F. Any component of any system, the operation or maintenance of which has, in the opinion of the ENGINEER, been negatively impacted due to painting shall be returned to satisfactory condition through replacement or repair at no additional cost to the OWNER.

3.6 CLEANUP

A. During the progress of the Work, remove from the site all discarded paint materials, rubbish, cans, and rags at the end of each Work day.

B. Upon completion of painting work, clean all paint-spattered surfaces. Remove spattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces.

C. At the completion of Work of other trades, touch-up and restore all damaged or defaced painted surfaces as determined by ENGINEER.

3.7 WARRANTY

A. Warranty inspection shall be conducted during the eleventh month following completion of the Work. All defective work shall be repaired by the CONTRACTOR in accordance with this Specification and to the satisfaction of the ENGINEER and at the CONTRACTOR'S expense.

B. Any location where paint has peeled, bubbled, or cracked and any location where rusting is evident shall be considered to be a failure of the system. The CONTRACTOR shall make repair at all points where failures are observed by removing the deteriorated paint, cleaning the surface, and recoating or repainting with the same system. If the area of failure exceeds 25% of the total coated or painted surface, the entire coating, or paint system may be required to be removed and repainted in accordance with this Specification as determined by the ENGINEER.

C. All costs for CONTRACTOR'S inspection, manufacturer's inspection, and all costs for repair shall be borne by the CONTRACTOR.

3.8 COATING SYSTEMS SCHEDULE (FINISH SCHEDULE)

A. Specific coatings, colors, and finishes for equipment, piping, and other items which are painted are specified in the following coating schedule.

FINISH SCHEDULE

Surface	Color
Equipment, non-immersed unless otherwise specified.	As Selected by the OWNER
Electrical switchgear panels, unit substations, motor control centers, power transformers, distribution centers, and relay panels.	As Selected by the OWNER
Ferrous, non-ferrous and galvanized piping, and appurtenant hangers and supports, metal shade canopies, non-immersed, unless otherwise specified.	As Selected by the OWNER
Conduit, outlet and junction boxes, lighting transformers, lighting and small power panels, control stations, appurtenant hangers, clamps, and supports on coated surfaces unless otherwise specified.	Match Background Color
Access Gate Frames	As Selected by the OWNER

PIPING AND SIGN COLOR CODE SCHEDULE

Piping Water	Piping Color	Lettering Color	Background Color
Potable	As Selected by OWNER	Black	Lt. Blue
Non-Chlorinated Water	As Selected by OWNER	Black	Lt. Blue

END OF SECTION

SECTION 11295

HYDRAULIC VALVES AND HYDRANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install all valves, hydrants, and accessories for water, as indicated on the Plans and as specified herein, including all appurtenances required for a complete and operational installation.

1.2 SECTION INCLUDES

A. Gate valves.

B. Ball valves.

C. Air/vacuum valves.

D. Backflow preventers.

E. Solenoid control valves.

F. Pump control valves.

G. Yard hydrant.

H. Butterfly valve.

I. Non-slam check valve.

1.3 RELATED SECTIONS

A. Section 01300, Submittals.

B. Section 01640, Materials and Equipment.

C. Section 01650, Starting of Systems.

D. Section 05500, Metal Fabrications.

E. Section 09900, Painting.

1.4 REFERENCES

A. ANSI/AWWA C500, Gate Valves.

B. ANSI/AWWA C509, Resilient-Seated Gate Valves.

C. ANSI B16.1.

D. ANSI B46.1.

E. ASTM A126.

F. ASTM A269.

G. ASTM A48.

H. ASTM A536.

I. ASTM A582.

J. ASTM B271.

K. ASTM D429.

L. ASTM D1784.

M. ASTM D2000.

N. ASTM F439.

O. All other applicable ASTM and ANSI Standards.

1.5 SUBMITTALS

A. Descriptive submittals shall be made in accordance with the Data Reference Symbols defined in Section 01300, Submittals.

1. Item	Shop Drawings	O&M Manuals
All Valves and Hydrants	C,D,E,F,H,I,L, M,N,O	C,D,E,F,H,I,L, M,N,O

PART 2 - PRODUCTS

2.1 GATE VALVES

A. Valves shall meet or exceed the applicable requirements of ANSI/AWWA C509 with wall thicknesses which exceed the minimum requirements of ANSI/AWWA C153/A21.53.

B. Rated for 250 psi working pressure.

C. Satisfactory for application involving operation after long periods of inactivity.

D. Above Ground Type: Resilient seated, rising stem OS&Y. Below Ground Type: Resilient seated, non-rising stem suitable for buried service.

E. Above Ground Operator: Handwheel. Below Ground Operator: Extension stem and 2-inch operating nut.

F. Flanged ends in accordance with ANSI/AWWA C110/A21.10 (ANSI B16.1, Class 125).

G. Internal and External Coating: Fusion bonded epoxy coating, which meets or exceeds requirements of ANSI/AWWA C550.

H. All gate valves shall be as manufactured by Mueller Company; U.S. Pipe & Foundry; Henry Pratt Company; or approved equal.

2.2 BALL VALVES

A. Bronze Ball Valves:
   1. Approved valves shall have bottom loaded pressure retaining stems, virgin TFE seats and full port. Valve shall be pressure rated at 400 psi WOG (non-shock), 125 psi saturated steam.
   2. Each valve shall be tested, air under water, in the opened and closed position by the manufacturer. Valve must conform to Federal Specification WW-V-35B, Type II, Class A, Style 3, End Connection A. Watts Regulator Company Series B-6080, or approved equal.

2.3 AIR/VACUUM VALVES

A. The air/vacuum valve allows large volumes of air to escape out the large orifice when filling a pipeline and closes when liquid enters the air and vacuum valve.

B. Air/vacuum valves shall be fitted with a bronze ball valve to isolate from pressure piping.

C. Air/vacuum valve shall be ARI Model D-062HFNS. No equal.

2.4 VACUUM RELIEF VALVE

A. Normally closed valve that opens when the system pressure becomes negative.

B. Vacuum valve shall have a bronze ball valve to isolate from pressure piping.

C. Vacuum valve shall be APCO 1502T, or approved equal.

2.5 BACKFLOW PREVENTER

A. Backflow preventer shall be the reduced pressure zone type assembly and shall be Watts Series U-909-S-QT or approved equal.

B. Size: 1-inch

C. Accessories:
   1. Integral body unions.
   2. Bronze strainer.
   3. Two bronze ball valves, lever actuator, 1/4 turn, full port, resilient seated.

D. Backflow preventers shall be tested and certified in accordance with AWWA C506 by a third party inspector.

2.6 SOLENOID CONTROL VALVES

A. General:
   1. Solenoid control valve shall control the pump flow to the transmission line via a pilot control system, which utilizes the solenoid valve to open or close the diaphragm. The solenoid control valve shall have provisions within the pilot control system to accept a high-pressure potable water source to assist in the actuation of the valve due to low transmission main pressures. The solenoid control valve shall have pressure-sustaining and check features.

B. Type:
   1. Flanged globe style, hydraulically operated, and diaphragm actuated.

C. Manufacturer:
   1. Cla-Val, Model No. 636G-03BCDFSYKCX.
   2. Approved equal.

D. Pilot System:
   1. 2-way solenoid and a high capacity 3-way pilot valve, designed to operate on 120 volt AC current and have a manual operator installed.
   2. Cock isolation valves.
   3. Adjustable closing speed control needle valve.
   4. Adjustable opening speed control needle valve.
   5. "Y" strainer.
   6. Utilize independent operating pressure.
   7. The control valve pilot system shall have a check feature that will close the valve upon pressure reversal.

8. Solenoid shall be NEMA 4 rated for outdoor installation.
9. Accurately maintains a constant, preset upstream pressure regardless of changing upstream potential and/or system demand (flow rate).

E. Materials of Construction shall be as follows:
1. Body and Cover: Ductile iron, ASTM A536.
2. Valve Disc Seat, Cover Bearing: Type 304 stainless steel.
3. Disc: EPDM rubber.
4. Diaphragm: Nylon reinforced Buna-N rubber.
5. Stem, Nut, and Spring: Type 304 stainless steel.
6. Pilot Control Valves: Bronze or stainless steel.
7. Pilot Control System Tubing and Fittings: stainless steel fittings or.
8. Rated for a working pressure of 250 psi.
9. 150 lb flange.
10. Valve to include stainless steel metal tag with manufacturer's information stamped.

F. Special Options:
1. Each valve shall have a limit switch for open and closed indication. The switch shall be weatherproof, single-pole, double throw. The limit switch shall be the Cla-Val manufactured standard, supplied with the valve.
2. NSF 60 and 61 approved fusion bonded epoxy coating.
3. Apply epoxy coatings in accordance with AWWA C550-90.
4. A direct factory representative shall be made available for start-up service, inspection, and necessary adjustments. Representative will be required to provide one, eight hour day of start-up service to the OWNER.
5. Provide and install heat-tracing and insulating pipe wrap for all pilot tubing and fittings to prevent freezing. Pipe wrap shall be aluminum foil backed foam insulation. Foil backing shall be exterior to the pipe wrap to prevent UV deterioration. Pipe wrap shall be firmly installed to prevent unraveling and premature failure.

2.7 PUMP CONTROL VALVES

A. General:
1. Pump control valve shall control the pump flow to the dry well via a pilot control system, which utilizes the valve to open or close the diaphragm. The pump control valve shall have provisions within the pilot control system to accept a high-pressure potable water source to assist in the actuation of the valve due to low transmission main pressures.
2. CONTRACTOR shall provide and install pump control valves and solenoid control valves by the same manufacturer for both wells.

B. Type:
1. Flanged globe style, hydraulically operated, and diaphragm actuated.

C. Manufacturer:
   1. Cla-Val, Model No. 661G-02KCX.
   2. Approved equal.

D. Pilot System:
   1. Two 3-way solenoid operated pilot valves, designed to operate on 120 volt AC current and have a manual operator installed.
   2. Cock isolation valves.
   3. Adjustable closing speed control needle valve.
   4. Adjustable opening speed control needle valve.
   5. "Y" strainer.
   6. Utilize independent operating pressure.
   7. Solenoid shall be NEMA 4 rated for outdoor installation.

E. Materials of Construction shall be as follows:
   1. Body and Cover: Ductile iron, ASTM A536.
   2. Valve Disc Seat, Cover Bearing: Type 304 stainless steel.
   3. Disc: Buna-N rubber.
   4. Diaphragm: Nylon reinforced Buna-N rubber.
   5. Stem, Nut, and Spring: Type 304 stainless steel.
   6. Pilot Control Valves: Bronze or stainless steel.
   7. Pilot Control System Tubing and Fittings: Copper with brass fittings or stainless steel.
   8. Rated for a working pressure of 250 psi.
   9. 150 lb. flange.
   10. Valve to include stainless steel metal tag with manufacturer's information stamped.

F. Special Options:
   1. Each valve shall have a limit switch for open and closed indication. The switch shall be weatherproof, single-pole, double throw. The limit switch shall be the Cla-Val manufactured standard, supplied with the valve.
   2. NSF 60 and 61 approved fusion bonded epoxy coating.
   3. Apply epoxy coatings in accordance with AWWA C550-90.
   4. A direct factory representative shall be made available for start-up service, inspection and necessary adjustments. Representative will be required to provide one, eight hour day of start-up service to the OWNER.
   5. Provide and install insulating pipe wrap for all pilot tubing and fittings to prevent freezing. Pipe wrap shall be aluminum foil backed foam insulation. Foil backing shall be exterior to the pipe wrap to prevent UV deterioration. Pipe wrap shall be firmly installed to prevent unraveling and premature failure.

2.8 YARD HYDRANT

A. Manufacturer: Woodford Model No. W34.

B. Type:
   1. Non-freeze, self-draining type.
   2. Cast aluminum housing 3/4-inch NPT inlet, 3/4-inch brass male hose thread outlet with a 1-inch hose adapter.
   3. 4 foot minimum depth of bury.
   4. Pad lockable lever handle.

2.9 BUTTERFLY VALVES

A. Butterfly valves shall be AWWA C504 approved tight-closing, rubber-seat type with rubber seats that are securely fastened to the valve body or valve disc. No metal-to-metal seating surfaces shall be permitted. Valves shall be bubble-tight at rated pressures with flow in either direction and shall be satisfactory for applications involving valve operation after long periods of inactivity. Valve disc shall rotate 90 degrees from the full open position to the tight shut position. The hand wheel operators shall be traveling nut, self-locking type and shall be designed to hold the valve in any intermediate position between fully open and fully closed without creeping or fluttering. Valve operators shall be equipped with mechanical stop-limiting devices to prevent over-travel of the disc in the open and closed positions. Valves shall close with a clockwise rotation. Operators shall conform to the requirements of AWWA C504.

B. Valve bodies shall be constructed of cast iron ASTM A48 Class 40 or ASTM A126 Class B. Two trunnions for shaft bearings shall be integral with each valve body. Minimum body shell thicknesses shall be in strict accordance with AWWA Standard C504.

C. Valve disc shall be constructed of ductile iron ASTM A536, Grade 65-45-12, or cast iron ASTM A48 Class C.

D. Shafts of all valves shall be turned, ground and polished. Valve shafts shall be constructed of 18-8 Type 316 stainless steel. Shaft diameters must meet minimum requirements established by AWWA Standard C504 for Class 150B.

E. Valve seats shall be Buna-N for water and EPDM for air. Valves shall have seats that are bonded or mechanically retained to the valve body or valve disc.

F. Valves shall be fitted with sleeve-type bearings. Bearings shall be corrosion resistant and self-lubricating. Bearing load shall not exceed 20% of the compressive strength of the bearing or shaft material. Bearings shall be high temperature for air valves.

G. Packing shall be Chevron V-type adjustable for above ground service and non-adjustable wear compensating for submerged or buried service.

H. Valves will be provided with torque tube pedestal assemblies where indicated on the Plans. Assemblies shall consist of a torque tube extension or a pedestal.

Torque tubes shall be designed for a maximum deflection of no more than 0.75 degrees when measured at the disc edge. The pedestal shall be made of high-strength cast iron and shall support the full weight of the extension rod by use of corrosion resistant thrust bearings located in the pedestal. Torque tube shall be made of carbon steel. Design of a torque tube shall allow ± 2-inches of free movement along the tube longitudinal axis. Pedestal or torque tube extension shall have a height of 3 feet above the operating floor. Torque tube or pedestal assemblies shall be factory assembled as integral units where applicable.

I. All aboveground butterfly valves shall have hand wheel/lever/t-handle geared operators or electric actuators as specified in the Valve Schedule and as shown on the Drawings. All buried valves shall be equipped with valve box and extension stem and either a hand wheel and pedestal, actuator and pedestal, or with operating nut as specified in the valve schedule and as shown on the Drawings. Valves specified with an operating nut shall be installed with a ground level valve position indicator.

J. All buried butterfly valves shall be side mounted with a buried service gear operator and extended nut, as specified in this Section.

K. Certified drawing and material specifications shall be furnished by the manufacturer through the CONTRACTOR covering all items included in Sections 1 and 2 of AWWA C504. Butterfly valves shall be as manufactured by Henry Pratt Company; Mueller; DeZurick; or equal.

2.10 NON-SLAM CHECK VALVE

A. Manufacturer:
   1. Series 6000 as manufactured by APCO.
   2. Model A-2606-6-01 as manufactured by Mueller.
   3. Approved equal.

B. Type:
   1. Swing check valves shall be of weighted lever, air-cushioned, non-slamming type.
   2. Valves shall have a weighted level mounted to the side of the valve connected to a pneumatic cylinder.
   3. Pneumatic cylinder shall have adjustable opening and closing speeds.

C. Materials of Construction:
   1. Body, Cover: Ductile iron, ASTM A126, Grade B.
   2. Disc, Disc Arm: Ductile iron, ASTM A536.
   3. Seat: Stainless steel, ASTM B148.
   4. Disc Seat: Buna-N.
   5. Pivot Shaft: Stainless steel, Type 304.

2.11 SHOP PAINTING

A. The manufacturer shall paint all valves and hydrants as follows:
   1. Clean and remove oil, grease, dirt, loose mill scale, and other foreign substances from un-galvanized ferrous-metal surfaces.
   2. Solvent scrub with stiff bristle brush followed by brush-off abrasive blast cleaning to a minimum surface profile depth of 1.5 mils.
   3. Valves and hydrants shall have prime coat per Section 09900, Painting.

B. CONTRACTOR shall provide finished coat per Section 09900, Painting. ENGINEER shall approve final color selection prior to application.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Workmanship shall be of the highest grade throughout and in accordance with the best standard practice for this type of equipment.

B. Valves of the various types and pattern shall be installed at the respective locations as shown on the Drawings. All appurtenances required for operation and control of the valves shall be included. Joints and connections shall be made in accordance with applicable requirements for pipeline or pipe joints. Valve stems shall be plumb and vertical unless otherwise specifically shown. Each valve shall be adjusted for smooth and easy operation and shall be watertight when placed in operation under maximum working pressure.

END OF SECTION

SECTION 15050

PIPING SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: This Section specifies systems of process piping and general requirements for piping systems. Detailed Specifications for the components listed on the piping system Specification sheets are found in other Sections of Division 15, Mechanical. This Section shall be used in conjunction with those Sections.

B. Related Sections:
   1. Section 02200, Earthwork.
   2. Section 09900, Painting.
   3. Section 11295, Hydraulic Valves.
   4. Section 15051, Buried Piping Installation.
   5. Section 15052, Exposed Piping Installation.

1.2 QUALITY ASSURANCE

A. This Section contains references to the following documents. They are a part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued, or replaced.

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REFERENCE	TITLE
AASHTO M36/M36M	Metallic (Zinc or Aluminum) Coated Corrugated Steel Culverts and Underdrains
ANSI A13.1	Scheme for the Identification of Piping Systems
ANSI B1.20.1	Pipe Threads, General Purpose (Inch)
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800
ANSI B16.3	Malleable Iron Threaded Fittings Class 150 and 300
ANSI B16.5	Pipe Flanges and Flanged Fittings
ANSI B16.9	Factory Made Wrought Steel Buttwelding Fittings
ANSI B16.11	Forged Steel Fittings, Socket Welding and Threaded
ANSI B16.12	Cast Iron Threaded Drainage Fittings
ANSI B16.22	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ANSI B16.26	Cast Copper Alloy Fittings for Flared Copper Tubes
ANSI B31.1	Power Piping
ANSI B31.3	Chemical Plant and Petroleum Refinery Piping
ASME Section IX	Boiler and Pressure Vessel Code; Welding and Brazing Qualifications
ASTM A47	Malleable Iron Castings
ASTM A74	Cast Iron Soil Pipe and Fittings
ASTM A105/A105M	Forgings, Carbon Steel, for Piping Components
ASTM A106	Seamless Carbon Steel Pipe for High Temperature Service
ASTM A126	Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A197	Cupola Malleable Iron
ASTM A234/A234M	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM A312/A312M	Seamless and Welded Austenitic Stainless Steel Pipe
ASTM A403/A403M	Wrought Austenitic Stainless Steel Piping Fittings
ASTM A536	Ductile Iron Castings
ASTM A570/A570M	Hot Rolled Carbon Steel Sheet and Strip, Structural Quality
ASTM B88	Seamless Copper Water Tube
ASTM C76	Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C443-REV A	Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
ASTM C564	Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM D1248	Polyethylene Plastics Molding and Extrusion Materials
ASTM D1784	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds

REFERENCE	TITLE
ASTM D1785	Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR)
ASTM D2513	Thermoplastic Gas Pressure Pipe, Tubing, and Fittings
ASTM D2665	Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D2996	Filament Wound Reinforced Thermosetting Resin Pipe
ASTM D3034	Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3261	Butt Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D4174	Cleaning, Flushing, and Purification of Petroleum Fluid Hydraulic Systems
ASTM D4101	Propylene Plastic Injection and Extrusion Materials
ASTM F441	Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
AWWA C105	Polyethylene Encasement for Ductile Iron Piping for Water and Other Liquids
AWWA C110	Ductile Iron and Gray Iron Fittings, 3" Through 48", for Water and Other Liquids
AWWA C111	Rubber Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings
AWWA C115	Flanged Ductile Iron and Gray Iron Pipe with Threaded Flanges
AWWA C151	Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids
AWWA C200	Steel Water Pipe 6" and Larger
AWWA C205	Cement Mortar Protective Lining and Coating for Steel Water Pipe - 4" and Larger - Shop Applied
AWWA C206	Field Welding of Steel Water Pipe
AWWA C207	Steel Pipe Flanges for Waterworks Services - Sizes 4" Through 144"
AWWA C208	Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C209	Cold Applied Tape Coating for Special Sections, Connections, and Fittings for Steel Water Pipelines
AWWA C210	Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipe
AWWA C214	Tape Coating Systems for the Exterior of Steel Water Pipelines
AWWA 301	Pre-stressed Concrete Pressure Pipe, Steel Cylinder Type, for Water and Other Liquids
AWWA C303	Reinforced Concrete Pressure Pipe, Steel Cylinder Type, Pre-tensioned, for Water and Other Liquids

REFERENCE	TITLE
AWWA C600	Installation of Ductile Iron Water Mains and Their Appurtenances
AWWA C651	Disinfecting Water Mains
AWWA C900	Polyvinyl Chloride (PVC) Pressure Pipe, 4" Through 12", for Water
AWWA M11	Steel Pipe - A Guide for Design and Installation
CISPI 301	Specification Data for Hubless Cast Iron Sanitary System with No-Hub Pipe and Fittings
FEDSPEC L-C-530B(1)	Coating, Pipe, Thermoplastic Resin, or Thermosetting Epoxy
MIL-H-13528B	Hydrochloric Acid, Inhibited, Rust Removing
MIL-STD-810C	Environmental Test Methods
SAE J1227	Assessing Cleanliness of Hydraulic Fluid Power Components and Systems
UPC	Uniform Plumbing Code

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Unless otherwise specified, piping materials, including pipe, gaskets, fittings, connection and joint assemblies, linings and coatings, shall be selected from those listed on the piping system specification sheets.

B. Piping materials shall conform to detailed specifications for each type of pipe and piping appurtenance specified in other Sections of Division 15, Mechanical.

C. All piping shall be compatible with the fluid to which it is exposed.

2.2 PIPING IDENTIFICATION

A. Pipe Coding:
   1. Refer to Section 09900, Painting, for pipe identification in above ground installations.

B. Plastic Tracer Tape:
   1. Tracer tape shall be per MAG Section 616, colored the same as the background colors, as specified in Table A, Paragraph 3.5 of this Section.
   2. Tape shall be capable of stretching to twice its original length and shall be as manufactured by Allen Systems, W. H. Brady Co., Seton Name Plate Corporation, Marking Services, Inc., or approved equal.

3. The message shall read **"CAUTION CAUTION CAUTION _____ PIPE BURIED BELOW"**, with bold letters approximately 2-inches high. The blank shall be filled with the particular system fluid, such as chlorine, potable water line, or storm sewer line. All lines shall have tracer tape.

C. Locator Tape:
   1. Detectable locator tape shall be per MAG Section 616. Locator tape shall be used for non-potable lines.

2.3 VALVES

A. Valves of the same size and service shall be provided by a single valve manufacturer. Packing shall be non-asbestos material. Actual length of valves shall be within 1/16-inch (±) of the manufacturer's specified length. Flanges shall meet the requirement of ANSI B16.5. Push-on and mechanical joints shall meet the requirements of AWWA C111. Refer to Section 11295, Hydraulic Valves, Sampling Stations, and Hydrants, for additional requirements.

2.4 SUBMITTALS

A. Descriptive submittals shall be made in accordance with the Data Reference Symbols defined in Section 01300, Submittals

1. Item	Shop Drawings	O&M Manuals
All Piping	A,C,D,E	A,C,D,E

B. Shop Drawings shall also include the following information for all piping systems:
   1. Product Technical Data, Including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Copies of manufacturer's written directions regarding material handling, delivery, storage and installation.
      c. Separate schedule sheet for each piping system scheduled in this Section showing compliance of all system components. Attached technical product data on gaskets, pipe, fittings, and other components.
   2. Qualifications:
      a. Qualifications of lab performing disinfection analysis on water systems.
   3. Test Reports:
      a. Copies of pressure test results on all piping systems.
      b. Reports defining results of dielectric testing and corrective action taken.
      c. Disinfection test report.
      d. 24 hour notification of time and date prior to conducting piping pressure tests.

C. All additional Submittal information shall be included with this submittal information as noted in the Division 15, Mechanical, Pipe Material Specifications.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Location:
   1. Piping shall be provided as specified, except for adjustments, to avoid architectural and structural features, and shall be coordinated with electrical construction.

B. Piping Sizes:
   1. Where the size of piping is not specified, the CONTRACTOR shall provide piping of the sizes required by UPC. Unless specified otherwise, small piping (less than 1-inch in diameter) required for services not described by UPC shall be 1/2-inch.

C. Pipe Support, Anchorage, and Seismic Bracing:
   1. Piping shall be supported by anchor brackets, guides, saddles, or hangers.
   2. Acceptable types of supports, guides, saddles, hangers, and structure attachments for general pipe support, expansion/contraction, and for seismic bracing, as well as anchorage details, are shown on the Drawings.
   3. Minimum spacing shall be as specified for supports and for seismic bracing.
   4. Where a specific type of support or anchorage is indicted on the Drawings, only that type shall be used there.
   5. Piping shall be vertically supported by anchor brackets, guides, saddles, or hangers and shall be seismically braced where indicated to resist lateral load.
   6. Supports shall be provided on each run at each change of direction.
   7. Pipe supports shall be hot-dip or mechanically galvanized.
   8. Unless otherwise specified, existing pipes and supports shall not be used to support new piping.

D. Anchorage for Buried Piping:
   1. All plugs, caps, tees, and bends in buried pressure piping systems shall be anchored by means of restrained joints as specified.
   2. Bedding and backfill for all pipe shall conform with Section 02200, Earthwork.
   3. All piping 4-inches in diameter and larger, at a minimum, shall be backfilled with a 4-inch thick bedding layer to a height equal to 1 foot above the top of the pipe.
   4. All piping less than 4-inches in diameter, at a minimum, shall be backfilled with a 4-inch thick bedding layer to a height equal to 1 foot above the top of the pipe.

5. The bedding and backfill operations shall, at a minimum, follow the County's and City of Goodyear's infrastructure development guidelines.

3.2 PIPING IDENTIFICATION

A. Pipe Coding:
   1. After application of the specified coating and insulation systems, exposed piping, interior and exterior, and piping in ceiling spaces, pipe trenches, pipe chases, and valve boxes shall be identified with pipe markers, as specified in Paragraph 2.2.A of this Section.
   2. Legend markers and directional arrows shall be located at each side of walls, floors, and ceilings, at one side of each piece of equipment, at piping intersections, and at approximately 50 foot centers.

B. Plastic Tracer Tape:
   1. A single line of tape, as specified in Paragraph 2.2.B of this Section, shall be provided 2-1/2 feet above the centerline of buried pipe.
   2. For pipelines buried 8 feet or greater below finished grade, CONTRACTOR shall provide a second line of tape 12-inches below finished grade, above and parallel to each buried pipe.
   3. Tape shall be spread flat with message side up before backfilling.

C. Locator Tape:
   1. Detectable pipe locating tape, as specified in Paragraph 2.2.C of this Section, shall be installed per MAG Section 616.5.

3.3 TESTING

A. General:
   1. Upon completion of piping, but prior to application of insulation on exposed piping, the CONTRACTOR shall test the piping systems in accordance with the appropriate MAG and City Specifications. Pressures, media, and test durations shall be as specified in the PIPESPEC. Equipment which may be damaged by the specified test conditions shall be isolated. Testing shall be performed using calibrated test gauges and calibrated volumetric measuring equipment to determine leakage rates. Each test gage shall be selected so that the specified test pressure falls within the upper half of the gage's range. Unless otherwise specified, the CONTRACTOR shall notify the construction manager 24 hours prior to each test.
   2. Unless otherwise specified, testing, as specified herein, shall include existing piping systems that connect with new pipe systems. Existing pipe shall be tested to the nearest existing valve. Any piping that fails the test shall be repaired. Repair of existing piping will be considered and paid for as extra work.

B. Liquid Systems:

1. Pressure and leakage testing for water systems shall be in accordance with MAG Section 610. Unless otherwise specified, leakage from other buried liquid piping systems shall be less than 0.02 gallons per hour per inch diameter per 100 feet of buried piping.

3.4 CLEANING AND FLUSHING

A. General:
   1. Piping systems shall be cleaned following completion of testing and prior to connection to operating, control, regulating, or instrumentation equipment.
   2. Unless specified otherwise, piping 24-inches in diameter and smaller shall first be cleaned by pulling a tightly fitting cleaning ball or swab through the system.
   3. Piping larger than 24-inches in diameter may be cleaned manually or with a cleaning ball or swab.

B. Water Systems:
   1. Potable water piping systems shall be flushed and disinfected in accordance with AWWA C651, MAG Section 611, and City of Goodyear Infrastructure Development Guidelines.

3.5 PIPING SPECIFICATION SHEETS (PIPESPEC)

A. Piping and valves for groupings of similar plant processes or types of service lines are specified on individual piping specification sheets (PIPESPECS). Piping services are grouped according to the chemical and physical properties of the fluid conveyed and/or by the temperature or pressure requirements. Piping services specified in the PIPESPECS and on the Drawings are alphabetically arranged by designated service symbols, as shown in Table A. Table A also indicates the system symbol, fluid category, and pipe marker background color of each service.

TABLE A - PIPING SERVICES

Symbol	Service	Fluid Category
PW	Potable Water	Liquid
RW	Raw Water	Liquid

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PIPING SYMBOL/SERVICE PW / POTABLE WATER, NCW / NON-CHLORINATED WATER, RW/RAW WATER

PIPING SYMBOL/SERVICE **PW / POTABLE WATER, NCW / NON-CHLORINATED WATER, RW/RAW WATER**

Test Requirements:

Medium:	Water; Ref. Spec. 15050, Paragraph 3.4.C.
Pressure:	200 psi for lines less than 16-inches in diameter and 150 psi for lines greater than and equal to 16-inches in diameter. All requirements of MAG and City of Goodyear Infrastructure Development Guidelines.
Duration:	2 hours.

Gasket Requirements:

Flange:	1/8-inch thick SBR red rubber gasket.
Push-on/Mech Cpl:	Nitrile or Neoprene.

Exposed Pipe and Valves:
(See Drawings for pipe size and valve type. See Remarks for insulation requirements.)

(3" and Smaller) Pipe:	Copper tube; ASTM B88, Type L, drawn. Ref. Spec. Section 15064. Copper Conn; Solder type with threaded or flanged adapters for valves. Copper Ftgs; Wrought copper or bronze, ANSI B16.22.
(2" and Smaller) Valves:	Ball; Ref. Spec. Section 11295.
(4" and Larger) Pipe:	Ductile iron; AWWA C151, with cement mortar lining. Ref. Spec. Section 15061. Conn; Flanged. Ftgs; Ductile iron per Spec. Section 15061; coating, lining, and ends to match pipe.
(2-1/2" and Larger) Valves:	Gate; Ref. Spec. Section 11295. Specialty Valves; Ref. Spec. Section 11295.

Buried and Encased Pipe and Valves:
(See Drawings for pipe size and valve type. See Remarks for insulation requirements.)

PIPING SYMBOL/SERVICE	**PW / POTABLE WATER, NCW / NON-CHLORINATED WATER, RW/RAW WATER**
(3" and Smaller) Pipe:	Copper tube; ASTM B88, Type K, annealed or drawn. Ref. Spec. Section 15064. Conn: Solder type, with threaded or flanged adapters for valves. Ftgs; Wrought copper or bronze, ANSI B16.22
(2" and Smaller) Valves:	Corporation Stop; Reference City of Goodyear Infrastructure Development Guidelines, with valve box and cover.
(4" and Larger) Pipe:	Ductile iron; AWWA C151, with cement mortar lining. Ref. Spec. Section 15061. Conn; Restrained push-on rubber gasket joint. Flanged adapters for valves and ends. Ftgs; Ductile iron per Spec. Section 15061; coating, lining, and ends to match pipe.
(2-1/2" and Larger) Valves:	Gate up to 16-inch; Same as exposed, with extension stem and valve box.

Remarks:

1. Potable water lines shall be disinfected in accordance with City of Goodyear Infrastructure Development Guidelines.
2. All piping, fittings, valves, and any other material that comes in contact with drinking water shall comply with NSF Standards 60 and 61.

END OF SECTION

SECTION 15051

BURIED PIPING INSTALLATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to install and test all buried piping, fittings and specials. The Work includes, but is not limited to, the following:
      a. All types and sizes of buried piping, except those specified under other Sections.
      b. Piping beneath structures.
      c. Supports, restraints and thrust blocks.
      d. Pipe encasements.
      e. Work on or affecting existing piping.
      f. Testing.
      g. Cleaning and disinfecting.
      h. Installation of all jointing and gasketing materials, specials, flexible couplings, mechanical couplings, harnessed and flanged adapters, sleeves, tie rods and all other Work required to complete the buried piping installation.
      i. Incorporation of valves, meters and special items shown or specified into the piping systems as required and as specified in the appropriate Division 15, Mechanical, Sections.
      j. Unless otherwise specifically shown, specified, or included under other Sections, all buried piping work required begins at the outside face of structures or structure foundations and extending away from structure.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate with the Work that is related to this Section.
   2. Section 15051, Buried Pipe Installation, specifies the installation of all buried piping materials specified in Sections of Division 15, Mechanical. Coordinate with these Sections.

C. Related Work Specified Elsewhere:
   1. Section 02200, Earthwork.
   2. Section 11295, Hydraulic Valves.
   3. Section 15050, Piping Systems.
   4. Section 15064, Copper Pipe.
   5. Section 15065, Thermoplastic Pipe and Accessories.

6. Section 15212, Piping Specialties and Accessories.

1.2 QUALITY ASSURANCE

A. CONTRACTOR shall conform to all applicable requirements of Parts 600 and 700 of the Uniform Standard Specifications for Public Work Construction by the Maricopa Association of Governments (MAG). If there is a conflict between MAG Standard Specifications and these Specifications, the provisions of these Specifications shall govern.

B. Requirements of Regulatory Agencies:
   1. Comply with requirements of NFPA Standard No. 24 for "Outside Protection" where applicable to water pipe systems used for fire protection.
   2. Comply with requirements of UL, FM, and other jurisdictional authorities, where applicable.
   3. Refer to the General and Supplementary Conditions regarding permit requirements for this Work.
   4. Applicable building codes.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ASTM D2321, Practice for Underground Installation of Flexible Thermoplastic Pipe.
   2. ASTM D2774, Practice for Underground Installation of Thermoplastic Pressure Piping.
   3. AWWA C105, Polyethylene Encasement for Ductile Iron Piping for Water and Other Liquids.
   4. AWWA C111, Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings.
   5. AWWA C104, Cement Mortar Protective Lining and Coating for Ductile Iron Pipe.
   6. AWWA C600, Installation of Ductile Iron Water Mains and Their Appurtenances.
   7. AWWA C606, Grooved and Shouldered Joints.
   8. AWWA C651, Disinfecting Water Mains.
   9. AWWA M23, PVC - Design and Installation.
   10. ASCE MOP No. 37, Design and Construction of Sanitary and Storm Sewers.

1.3 SUBMITTALS

A. Shall be in accordance with Section 15050, Piping Systems, Submittal information.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the site to ensure uninterrupted progress of the Work.

B. Handle all pipe, fittings, specials, and accessories carefully with approved handling devices. Do not drop or roll material off trucks. Do not otherwise drop, roll, or skid piping.

C. Store pipes and fittings on heavy wood blocking or platforms so they are not in contact with the ground.

D. Unload pipe, fittings, and specials opposite to or as close to the place where they are to be installed as is practical to avoid unnecessary handling. Keep pipe interiors completely free from dirt and foreign matter.

E. Inspect delivered pipe for cracked, gouged, chipped, dented or other damaged material and immediately remove defective pipe from site.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Required pipe materials are as shown on the detail drawings. Refer to applicable Sections for material specifications.

B. General:
   1. Marking Piping:
      a. Clearly mark each piece of pipe or fitting with a designation conforming to those as shown on the detail drawings.
      b. Cast or paint material, type, and pressure designation on each piece of pipe or fitting 4-inches in diameter and larger.
      c. Pipe and fittings smaller than 4-inches in diameter shall be clearly marked by manufacturer as to material, type, and rating.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
   1. Installation of all pipe, fittings, valves, specials, and appurtenances shall be subject to the review and/or approval of the ENGINEER.
   2. Install piping as shown, specified, and as recommended by the manufacturer and in conformance with referenced standards, and approved Shop Drawings.
   3. Request instructions from ENGINEER before proceeding if there is a conflict between the manufacturer's recommendations and the Contract Documents.

4. All piping shall be inspected by the ENGINEER prior to installation. ENGINEER'S inspection will not relieve CONTRACTOR or manufacturer from responsibility for damaged products.
5. All piping shall be carefully examined for cracks, damage, or other defects before installation. Any piping that is defective, including but not limited to, cracked, damaged, in poor condition, or with damaged linings or improper markings shall be rejected unless the product can be repaired in a manner acceptable to the manufacturer and ENGINEER. Any piping found to be broken or defective after it has been installed shall be removed, replaced or repaired at the CONTRACTOR'S expense.
6. Minimum earth cover over the piping shall be as shown on the Drawings, specified or directed by the ENGINEER, but in no case shall the earth cover be less than 4 feet for all piping, except drains.
7. Required earthwork shall be as specified in applicable Sections of Division 2, Sitework.
8. Present all conflicts between piping systems and equipment, structures or facilities to ENGINEER for determination of corrective measures before proceeding.
9. Take field measurements, where required, prior to installation to ensure proper fitting of Work. The CONTRACTOR shall uncover the existing pipelines sufficiently in advance of the proposed Work in order that the type and location of the existing pipes and joints and other information required to fabricate the proposed piping can be determined. It shall be the responsibility of the CONTRACTOR to obtain whatever information is required to complete the connections of the proposed pipelines to the existing pipelines. Refer to Paragraph 3.3 of this Section, as applicable.
10. Interior of all piping and mating surfaces shall be inspected and all dirt, gravel, sand, debris or other foreign material shall be completely removed from the interior and mating surfaces before installation. Measures shall be taken to maintain the interior of all piping clean until acceptance of the completed Work. Care shall be taken to prevent foreign matter from entering joint space. Bell and spigot mating surfaces shall be wiped clean immediately before piping is laid. For ductile iron pipe, the bell and spigot mating surfaces shall be thoroughly cleaned with a wire brush.
11. Install piping accurately to line and grade shown, specified or directed, unless otherwise approved by the ENGINEER. Accurate means of determining and checking the alignment and grade shall be used, which shall be subject to the approval of the ENGINEER. Any modifications to the Contract Documents to suit the pipe manufacturer's standard shall be approved by the ENGINEER. Remove and relay piping that is incorrectly installed at CONTRACTOR'S expense.
12. Do not lay piping in water, unless otherwise specified in these Specifications or approved by the ENGINEER. Ensure that the water level in the trench is at least 6-inches below the bottom of piping. Maintain a dry trench until

jointing and backfilling are complete, unless otherwise specified in these Specifications or approved by the ENGINEER.

13. Where unforeseen conditions will not permit the installation of piping as shown or specified, no piping shall be installed without approval of the ENGINEER. Do not modify structures or facilities without approval of the ENGINEER.
14. Start laying piping at lowest point and proceed toward the higher elevations, unless otherwise approved by the ENGINEER. Slope piping uniformly between elevations shown on the Drawings or as otherwise directed by the ENGINEER.
15. Place bell and spigot piping so that the bells face the direction of laying, unless otherwise approved by the ENGINEER.
16. Piping shall be installed so that the barrel of the piping, and not the joints, receives the bearing pressure from the trench bottom or other bedding condition.
17. No piping shall be brought into position until the preceding length, valve, fitting, or special has been bedded and secured in place.
18. Whenever pipe laying is not actively in progress, the open ends of the piping shall be closed by a temporary plug or cap to prevent soil, water, and other foreign matter from entering the piping.
19. Field cutting of metallic piping, where required for inserting valves, fitting, specials, and closures, shall be made with a machine specially designed for cutting piping and in accordance with the manufacturer's instructions. Cuts shall be carefully done, without damage to piping, so as to leave a smooth end at right angles to the axis of the piping. Cut end shall be tapered and sharp edges filed off smooth. Flame cutting shall not be permitted. Piping damaged by the CONTRACTOR by improper or careless methods of cutting shall be replaced or repaired at his expense.
20. Blocking under piping shall not be permitted, unless specifically approved by ENGINEER for special conditions.
21. Protective linings and coatings shall be touched up prior to installation, where required.
22. Except where bends, wyes, or similar fittings are used, changes in alignment and grade of the piping shall be made by deflecting joints or with beveled pipe. Permissible joint deflection shall not exceed 75% of the amount allowed by the manufacturer.
23. All joints shall be made in the presence of the ENGINEER, or his duly authorized representative, except as otherwise approved.
24. Special care shall be taken to ensure that each section of piping abuts against the next in such a manner that there will be not shoulder or unevenness of any kind along the piping invert.
25. Piping shall be rotated as required to place outlets in proper position.
26. Blind flanges and cleanouts shall be provided at locations shown on the Drawings, specified, or required. Cleanouts on buried piping shall include all pipe, fittings, and appurtenances required to bring cleanout to finished

grade and terminate in a flange and blind flange or suitably capped piping as shown. Cleanout piping shall be same as that specified for the main run.

27. All gravity lines shall pitch uniformly at the grade shown or as specified or approved.
28. Short pipe stubs, maximum 4 feet in length, shall be used at all manholes and other wall faces, except as otherwise specified.
29. Field painting shall be accomplished after joints are made.
30. All piping shall be plugged watertight with a suitable cap or plug securely fastened to the end of the piping at all contact interfaces.
31. CONTRACTOR shall notify ENGINEER in advance of backfilling operations.
32. On steep slopes, take measures acceptable to ENGINEER to prevent movement of the pipe during installation.
33. Thrust Restraint: During the installation of the pipe, thrust blocks, tied joints, or proprietary restrained joint systems shall be provided wherever required for thrust restraint. Thrust restraint shall conform to the applicable requirements of Paragraph 3.2 of this Section.
34. Exercise care to avoid flotation when installing pipe in cast-in-place concrete.

B. Separation of Sewers and Potable Water Pipe Lines:
   1. Conform to the requirements of all applicable requirements of the Uniform Standard Specifications for Public Work Construction by the Maricopa Association of Governments (MAG).

C. Plugs:
   1. Temporarily plug installed pipe at the end of each day's Work or other interruption to the installation of any pipe line. Plugging shall prevent the entry of animals, liquids, or persons into the pipe or the entrance or insertion of deleterious materials.
   2. Install standard plugs into all bells at dead ends, tees, or crosses. Cap all spigot ends.
   3. Fully secure and block all plugs and caps installed for pressure testing to withstand the specified test pressure.
   4. Where plugging is required for phasing of the Work or for subsequent connection of piping, install watertight, permanent type plugs.

D. Bedding Pipe: Bed pipe as specified below and in accordance with the details shown.
   1. Trench excavation and backfill and bedding materials shall conform to the requirements of Section 02200, Earthwork, as applicable.
   2. Excavate trenches below the pipe bottom by an amount specified. Remove all loose and unsuitable material from the trench bottom.
   3. Carefully and thoroughly compact all pipe bedding with hand held pneumatic compactors.

4. Do not lay pipe until the ENGINEER approves the bedding condition. If a conflict exists, obtain clarification from ENGINEER before proceeding.
5. No pipe shall be brought into position until the preceding length has been bedded and secured in its final position.

E. Laying Pipe:
1. Conform to manufacturer's instructions and requirements of the standards listed below, where applicable:
   a. Ductile Iron Pipe: AWWA C600, AWWA C105.
   b. Thermoplastic Pipe: ASTM D2774.
   c. ASCE Manual of Practice No. 37.

F. Polyethylene Encasement:
1. Provide polyethylene encasement for ductile iron piping to prevent contact between the pipe and surrounding bedding material and backfill.
2. Polyethylene may be supplied in tubes or in sheet material.
3. Polyethylene encasement materials and installation shall be in accordance with the requirements of MAG Section 610.5.

G. Jointing Pipe:
1. Ductile Iron Mechanical Joint Pipe:
   a. Wipe clean the socket, plain end and adjacent areas immediately before making joint. Make certain that cut ends are tapered and sharp edges are filed off smooth.
   b. Lubricate the plain ends and gasket with soapy water or an approved pipe lubricant, in accordance with AWWA C111, just prior to slipping the gasket onto the plain end of the joint assembly.
   c. Place the gland on the plain end with the lip extension toward the plain end, followed by the gasket with the narrow edge of the gasket toward the plain end.
   d. Insert the pipe into the socket and press the gasket firmly and evenly into the gasket recess. Keep the joint straight during assembly.
   e. Push gland toward socket and center it around pipe with the gland lip against the gasket.
   f. Insert bolts and hand tighten nuts.
   g. Make deflection after joint assembly, if required, but prior to tightening bolts. Alternately tighten bolts 180 degrees apart to seat the gasket evenly. The bolt torque shall be as follows:

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Pipe Size (inches)	Bolt Size (inches)	Range of Torque (ft-lbs.)
3	5/8	45-60
4-24	3/4	75-90
30-36	1	100-120
42-48	1-1/4	120-150

h. All bolts and nuts shall be heavily coated with two 10 mil minimum coats of coal-tar epoxy coating as manufactured by Koppers, Tnemec, or approved equal.

i. Restrained mechanical joints shall be in accordance with Section 15061, Ductile Iron Pipe.

2. Ductile Iron Push-On Joint Pipe:

a. Prior to assembling the joints, the last 8-inches of the exterior surface of the spigot and the interior surface of the bell shall be thoroughly cleaned with a wire brush, except where joints are lined or coated with a special protective lining or coating.

b. Rubber gaskets shall be wiped clean and flexed until resilient. Refer to manufacturer's instructions for procedures to ensure gasket resiliency when assembling joints in cold weather.

c. Insert gasket into joint recess and smooth out the entire circumference of the gasket to remove bulges and to prevent interference with the proper entry of the spigot of the entering pipe.

d. Immediately prior to joint assembly, apply a thin film of approved lubricant to the surface of the gasket that will come in contact with the entering spigot end of pipe. CONTRACTOR may, at his option, apply a thin film of lubricant to the outside of the spigot of the entering pipe.

e. For assembly, center spigot in the pipe bell and push pipe forward until it just makes contact with the rubber gasket. After gasket is compressed and before pipe is pushed or pulled all the way home, carefully check the gasket for proper position around the full circumference of the joint. Final assembly shall be made by forcing the spigot end of the entering pipe past the rubber gasket until it makes contact with the base of the bell. When more than a reasonable amount of force is required to assemble the joint, the spigot end of the pipe shall be removed to verify the proper positioning of the rubber gasket. Gaskets that have been scoured, or otherwise damaged, shall not be used.

f. Maintain an adequate supply of gaskets and joint lubricant at the site at all times when pipe jointing operations are in progress.

3. Proprietary Joints:

a. Pipe which utilizes proprietary joints such as Fastite, by American Cast Iron Pipe Company; Tyton by U.S. Pipe Incorporated; restrained joints described under Paragraph 3.2. of this Section; or other such joints

shall be installed in strict accordance with the manufacturer's instructions.

4. Thermoplastic Pipe Joints:
   a. Solvent Cement Joints:
      1) Bevel pipe ends and remove all burrs before making joints. Clean both pipe and fittings thoroughly. Do not attempt to make solvent cement joints if temperature is below 40° F or above 90° F when exposed to direct sunlight or in wet conditions.
      2) Use solvent cement supplied or recommended by the pipe manufacturer.
      3) Apply joint primer and solvent cement and assemble joints in strict accordance with the recommendations and instructions of the manufacturer of the joint materials and the pipe manufacturer.
      4) Observe safety precautions with the use of joint primers and solvent cements. Allow air to circulate freely through pipelines to permit solvent vapors to escape. Slowly admit water when flushing or filling pipelines to prevent compression of gases within pipes.
   b. Push-On Joints:
      1) Bevel all field-cut pipe, remove all burrs and provide a reference mark the correct distance from the pipe end.
      2) Clean the pipe end and the bell thoroughly before making the joint. Insert the O-ring gasket, making certain it is properly oriented. Lubricate the spigot well with an approved lubricant; do not lubricate the bell or O-ring. Insert the spigot end of the pipe carefully into the bell until the reference mark on the spigot is flush with the bell.
5. Copper Tubing Joints:
   a. Assemble copper tubing with soldered joints. Solder shall be 95-5 tin-antimony solder conforming to ASTM B32.
   b. Ream or file pipe to remove burrs.
   c. Clean and polish contact surfaces of joints.
   d. Apply flux to both male and female ends.
   e. Insert end of tube into full depth of fitting socket.
   f. Heat joint evenly.
   g. Form continuous solder bead around entire circumference of joint.
   h. Runs shall contain unions at connection to equipment and at reasonable distances along the lengths of runs to permit convenient disassembly of piping and removal of equipment.
6. Mechanical Coupling Joints:
   a. Prior to the installation and assembly of mechanical couplings, the joint ends shall be cleaned thoroughly with a wire brush to remove foreign matter. Following this cleaning, lubricant shall be applied to the rubber gasket or inside of the coupling housing and to the joint ends. After lubrication, the gasket shall be installed around the joint end of the previously installed piece and the joint end of the subsequent piece

shall be mated to the installed piece. The gasket shall be positioned and the coupling housing placed around the gasket and over the grooved or shouldered joint ends. The bolts shall be inserted and the nuts screwed up tightly by hand. The bolts shall then be tightened uniformly in order to produce an equal pressure on all parts of the housing. When the housing clamps meet metal to metal, the joint is complete and further tightening is not required.

H. Backfilling:
   1. Conform to the applicable requirements of Section 02200, Earthwork.
   2. Place backfill as construction progresses. Backfill by hand and use power tampers until pipe is covered by at least 1 foot of fill.

I. Connections to Valves and Hydrants:
   1. Install valves and hydrants as shown.
   2. Provide suitable adapters when valves or hydrants and piping have different joint types.
   3. Provide thrust restraint at all hydrants and at valves at pipeline terminations.

3.2 THRUST RESTRAINT

A. Provide thrust restraint on all pressure piping systems and where otherwise shown and specified. Pipe joints shall be restrained as specified in Paragraph 3.2.C of this Section.

B. Thrust restraint shall be accomplished by means of restrained pipe joints. Concrete thrust blocks shall be used only when specifically shown on the Drawings or as directed by the ENGINEER. Thrust restraints shall be designed for the axial thrust exerted by the test pressure given in Section 15050, Piping Systems, Paragraph 3.5.

C. Restrained Pipe Joints:
   1. Pipe joints shall be restrained by means suitable to the type of pipe being installed.
      a. Ductile iron push-on joints and mechanical joints shall be restrained utilizing a proprietary restrained joint system such as American Lok-Ring, Lok-Fast, Lok-Set, U.S. Pipe Field Lok Gasket, U.S. Pipe TR Flex System, lugs, and tie rods, or other system approved by ENGINEER.
      b. Thermoplastic and copper piping shall generally be installed with soldered, solvent weld, threaded, flanged, or similar type joints. Where push-on type or other non-restrained joints are provided, the CONTRACTOR shall provide tie rods or other suitable joint restraint system for these joints, subject to the approval of ENGINEER.
      c. Pipe thrust restraint shall be in accordance with the Schedule of Restrained Pipe Lengths and as noted on the Project Drawings.

2. Schedule of Restrained Pipe Lengths: Restrained pipe lengths shall conform to the requirements of AWWA M41 for ductile iron pipe and to AWWA M11 for steel pipe. Restrained pipe lengths shall be as shown on the construction plans.

D. Concrete Thrust Blocks:
   1. Thrust blocks shall be constructed of Class B concrete, conforming to the requirements of MAG.
   2. Blocks shall be placed against undisturbed soil as shown on Drawings or as directed by the ENGINEER. Concrete shall be placed so that pipe joints and fitting joints will be accessible for repair.
   3. Size of concrete thrust blocks shall be as shown on the Drawings or as directed and approved by ENGINEER.
   4. Concrete thrust blocks shall not be used for pipe restraint except where specifically shown on the Drawings or as approved by the ENGINEER.

3.3 WORK AFFECTING EXISTING PIPING

A. Location of Existing Piping:
   1. Locations of existing piping shown should be considered approximate.
   2. CONTRACTOR shall determine the true locations of existing piping to which work is to be performed, and locations of other facilities which could be disturbed during earthwork operations, or which may be affected by CONTRACTOR'S Work already installed.

B. Taking Existing Pipelines Out of Service:
   1. Do not take pipelines out of services, unless specifically provided for under this Project, or approved by ENGINEER.
   2. Notify ENGINEER at least 48 hours prior to taking pipeline out of service.

C. Work on Existing Pipelines:
   1. Cut or tap pipes as shown or required with machines specifically designed for this Work.
   2. Install temporary plugs to prevent entry of mud, dirt, water, and debris.
   3. Provide all necessary adapters, fittings, pipe, and appurtenances required to complete the Work.
   4. Existing pipelines that are cut and abandoned shall be adequately capped or filled with grout.

3.4 TESTING OF PIPING

A. General:
   1. Test all piping except as otherwise authorized by ENGINEER.
   2. Notify ENGINEER 48 hours in advance of testing.
   3. Provide all testing apparatus, including pumps, hoses, gages, and fittings.

4. Unless otherwise noted, pipelines shall hold specified test pressure for two hours.
5. Repair and retest pipelines that fail to hold specified test pressure or which exceed the allowable leakage rate.
6. Unless otherwise specified, test pressures required are at the lowest elevation of the pipeline section being tested.
7. Conduct all tests in the presence of ENGINEER.
8. Advise local authorities having jurisdiction if their presence is required during testing.
9. All testing shall conform to the MAG Standard Specifications and City of Maricopa Infrastructure Development Guidelines. In case of contradiction with these Specifications the CONTRACTOR shall notify the ENGINEER before proceeding with the testing.

B. Schedule of Pipeline Tests:
1. Test piping at the test pressures listed in Section 15050, Piping Systems, Paragraph 3.5, and respective pipe material specification.
2. All piping shall be water tested after installation, except as otherwise specified or directed by ENGINEER.
3. For piping not included in the Schedule, the ENGINEER will notify CONTRACTOR in writing of the test pressure to be used.

C. Pressure Test Procedure:
1. Complete backfill and compaction at least to the pipe centerline before testing, unless otherwise required or approved by ENGINEER.
2. Allow concrete for thrust blocks to reach design strength before testing.
3. Fill section to be tested slowly with water and expel all air. Install corporation cocks, if necessary, to remove all air.
4. Test only one section of pipe at a time.
5. Apply specified test pressure for two hours and observe pressure gage. Check carefully for leaks while test pressure is being maintained.

D. Leakage Testing:
1. Conduct leakage test for all liquid piping after satisfactory completion of pressure test.
2. Allow concrete pipe to stand full of water at least 12 hours prior to starting leakage test.
3. Maintain test pressure constantly for the minimum test period and accurately measure the amount of water which must be added to maintain the test pressure.
4. Allowable Leakage Rates (in gallons per hour per 1,000 feet per inch diameter):
    a. DIP Push-On or Mechanical Joints: 0.075.
    b. Copper, Steel, and Thermoplastic: None.
5. Leakage Test Procedure:

a. Examine exposed pipe, joints, fittings, and valves. Repair visible leakage or replace the defective pipe, fitting, or valve.
b. Refill the line under test to reach the required test pressure.
c. Provide a test container filled with a known quantity of water at the start of the test. Attach the test pump suction to the test container.
d. Pump water from the test container into the line with the test pump to hold the specified test pressure for the test period. Water remaining in the container shall be measured and the amount used during the test shall be recorded on the test report.
e. Perform all repair, replacement, and retesting required because of failure to meet testing requirements.
f. Leakage shall be less than rate specified above.

E. Required Tests for Storm Drains and Sanitary Sewer Connections:
1. CONTRACTOR shall use water test procedures only.
a. Tests shall be performed after backfilling is completed, but shall be performed before final cleanup and acceptance of Work.
b. Tests shall be performed prior to Final Acceptance.
1) Test all piping and manholes for leakage by means of the tests described below.
2) Test to be performed between adjacent manholes or as approved by the ENGINEER.
c. Prior to making tests, the CONTRACTOR shall submit details of his testing procedures, with a description of methods and equipment he proposes to use, to the ENGINEER for approval. The CONTRACTOR shall furnish all necessary labor, equipment, water, watertight bulkheads, rodding machine, generator, pumps, and all else necessary to carry out the required tests.
2. Water Test:
a. When water test is performed for reinforced concrete pipe, the test section shall be filled with water and allowed to stand for 24 hours. The water shall then be replenished and the test performed.
b. Insert test plugs and securely brace.
c. Fill the pipe and manhole with water to provide a positive differential head on the top of the pipe at the highest point of the pipeline under test of at least the test pressure specified in the Buried Piping Schedule.
d. The amount of water added to maintain this head shall be the leakage.
e. Test for a period of at least four hours.
f. Total leakage of any section tested shall not exceed the following rates:
1) Gravity Sewer: 0.5 gallons per hour per 100 feet of pipe per inch diameter of pipe.
2) Storm Drains: 2.0 gallons per hour per 100 feet of pipe per inch diameter of pipe.
g. If the leakage in the section tested exceeds the specified amount, the CONTRACTOR shall make the necessary repairs or replacements

required to reduce the leakage to within the specified limits and the test shall be repeated until the leakage requirements is met.

h. On steep grades it may be necessary to place plugs in the pipe between manholes to avoid excessive pressures in the pipe.

3. Visual Inspection:
   a. Prior to final acceptance, a visual inspection by ENGINEER of all appurtenant structures, e.g., manholes, chambers, etc., shall be required. Any visual leaks, regardless of their magnitude, shall be repaired by the CONTRACTOR.
4. Watertight Sewers:
   a. It is imperative that all sewers and appurtenant structures be constructed as watertight as practicable. The CONTRACTOR shall adhere rigidly to all requirements of the Contract Documents and follow all directions of the ENGINEER to secure a watertight sewer. If, during the Work or after its completion, any leaks are discovered, they shall be repaired in a satisfactory manner at the expense of the CONTRACTOR even though the pipe and appurtenant structures may have already successfully passed the leakage tests.

3.5 DISPOSAL OF WATER

A. CONTRACTOR shall provide suitable means for disposal of test and flushing water so that no damage results to facilities or waterways.

B. Means of disposal of test and flushing water shall be subject to the approval of ENGINEER, local governing authorities, and regulatory agencies.

C. CONTRACTOR shall be responsible for any damage caused by his water disposal operations.

3.6 CLEANING

A. Cleaning:
   1. Thoroughly clean all piping and flush prior to placing in service in a manner approved by ENGINEER.
   2. Piping 24-inches in diameter and larger shall be inspected from inside and all debris, dirt, and foreign matter removed.
   3. If piping that requires disinfection has not been kept clean during storage or installation, CONTRACTOR shall swab each section individually before installation with a 5% hypochlorite solution to ensure clean piping.

B. Disinfection:
   1. Disinfect all potable water piping.
   2. Disinfection shall conform to the requirements of MAG Section 611 and City of Goodyear Infrastructure Development Guidelines.

END OF SECTION

SECTION 15052

EXPOSED PIPING INSTALLATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to install and test all exposed piping, fittings, and specials. The Work includes, but is not limited to, the following:
      a. All types and sizes of exposed piping except those specified under other Sections.
      b. Piping embedded in concrete within a structure or foundation will be considered as exposed and included herein.
      c. Supports, restraints, and other anchors.
      d. Work on or affecting existing piping.
      e. Testing.
      f. Cleaning and disinfecting.
      g. Installation of all jointing and gasketing materials, specials, flexible couplings, mechanical couplings, harnessed and flanged adapters, sleeves, tie rods, and all other Work required to completing the exposed piping installation.
      h. Incorporation of valves, meters and special items shown or specified into the piping systems as required and as specified in the appropriate Division 15, Mechanical, Sections.
      i. Unless otherwise specifically shown, specified, or included under other Sections, all exposed piping work required, beginning at the outside face of structures or structure foundation and extending into the structure.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate with the Work that is related to this Section.
   2. Section 15052, Exposed Piping Installation, specifies the installation of all exposed piping materials specified in Division 15, Mechanical. Coordinate with these Sections.

C. Related Work Specified Elsewhere:
   1. Section 02200, Earthwork.
   2. Section 09900, Painting.
   3. Section 11295, Hydraulic Valves.
   4. Section 15050, Piping Systems.
   5. Section 15064, Copper Pipe.

6. Section 15212, Piping Specialties and Accessories.

1.2 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies:
   1. Comply with requirements of UL, FM, and other jurisdictional authorities, where applicable.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ANSI B16.3, Malleable-Iron Threaded Fittings, Classes 150 and 300.
   2. ANSI B16.4, Cast Iron Threaded Fittings, Classes 125 and 250.
   3. ANSI B16.5, Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys.
   4. ANSI B16.9, Factory-Made Wrought Steal Butt Welding Fittings.
   5. ANSI B16.11, Forged Steel Fittings, Socket-Welding and Threaded.
   6. AWWA C111, Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings.
   7. AWWA C206, Field Welding of Steel Water Pipe Joints.
   8. AWWA C600, Installation of Ductile Iron Water Mains and Their Appurtenances.
   9. AWWA C606, Grooved and Shouldered Type Joints.
   10. AWWA C651, Disinfecting Water Mains.
   11. AWWA M11, Steel Water Pipe Design and Installation.
   12. AWWA M23, PVC Piping.
   13. AWS D1.1, Structural Welding Code.
   14. AWS D10.7, Recommended Practices For Gas Shielded-Arc Welding of Aluminum and Aluminum Alloy Pipe.
   15. AWS D10.9, Standard for Qualification of Welding Procedures and Welders for Piping and Tubing.
   16. ASME Boiler and Pressure Vessel Code.
   17. Maricopa County Association of Government (MAG) Standard Specifications and Details.

1.3 SUBMITTALS

A. Shall be in accordance with Section 15050, Piping Systems, submittal information.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the site to insure uninterrupted progress of the Work.

B. Handle all pipe, fittings, and accessories carefully with approved handling devices. Do not drop or roll pipe off trucks. Do not otherwise drop, roll, or skid piping.

C. Store pipes and fittings on heavy wood blocking or platforms so they are not in contact with the ground.

D. Unload pipe, fittings, and specials opposite to or as close to the place where they are to be installed as is practical to avoid unnecessary handling. Keep pipe interiors completely free from dirt and foreign matter.

E. Inspect delivered pipe for cracked, gouged, chipped, dented, or other damaged material and immediately remove from site.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Required pipe materials are as indicated on the detail drawings. Refer to applicable Sections for material specifications.

B. General:
   1. Marking Piping:
      a. Clearly mark each piece of pipe or fitting with a designation conforming to that shown on the Shop Drawings.
      b. Cast or paint material, type, and pressure designation on each piece of pipe or fitting 4-inches in diameter and larger.
      c. Pipe and fittings smaller than 4-inches in diameter shall be clearly marked by manufacturer as to material, type, and rating.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
   1. Install piping as shown, specified, and as recommended by the manufacturer.
   2. If there is a conflict between manufacturer's recommendations and the Contract Documents, request instructions from ENGINEER before proceeding.

B. Manufacturer's Installation Specialist:
   1. Provide the services of a competent installation specialist of the pipe manufacturer when pipe installation begins for the following:
      a. Ductile iron pipe.
   2. Retain installation specialist at the site for a minimum of two days or until competency of the pipe installation crew has been satisfactorily demonstrated.

C. Piping Installation:

1. Install straight runs true to line and elevation.
2. Install vertical pipe truly plumb in all directions.
3. Install piping parallel or perpendicular to masonry walls. Piping at angles and 45 degree runs across corners will not be accepted unless specifically shown or approved.
4. Install small diameter piping generally as shown when specific locations and elevations are not indicated. Locate such piping as required to avoid other obstructions.
5. Install piping so as to leave all corridors, walkways, work areas, and like spaces unobstructed.
6. Protect and keep clean water pipe interiors, fittings, and valves.
7. Provide temporary caps or plugs over all pipe openings at the end of each days work, and when otherwise required or directed by ENGINEER.
8. Cutting: Cut pipe from measurements taken at site, not from Drawings.
9. Install dielectric unions wherever dissimilar metals are connected, except for bronze or brass valves in ferrous piping.
10. Provide a union downstream of each valve with screwed connections.
11. Provide screwed or flanged unions at each piece of equipment, where shown, and where necessary to install or dismantle piping.

D. Joints:
   1. General:
      a. Make joints in accordance with the pipe manufacturer's recommendations and the requirements below.
      b. Cut piping accurately and squarely and install without forcing or springing.
      c. Ream out all pipes and tubing to full inside diameter after cutting. Remove all sharp edges on end cuts.
      d. Remove all cuttings and foreign matter from the inside of pipe and tubing before installation. Thoroughly clean all pipe, fittings, valves, specials, and accessories before installing.
   2. Flanged Joints:
      a. Assemble flanged joints using 1/8-inch ring-type gaskets for raised face flanges. Use full-face gaskets for flat face flanges unless otherwise approved by ENGINEER. Gaskets shall be suitable for the service intended in accordance with the manufacturer's ratings and instructions. Gaskets shall be properly centered.
      b. Bolts shall be tightened in a sequence that will insure equal distribution of bolt loads.
      c. The length of bolts shall be uniform, and they shall not project beyond the nut more than 1/4-inch or fall short of the nut when fully taken up. The ends of bolts shall be machine cut so as to be neatly rounded. No washers shall be used.
      d. Bolt threads and gasket faces for flanged joints shall be lubricated prior to assembly.

e. Alternately tighten bolts 180 degrees apart to compress the gasket evenly.

3. Copper Tubing Joints:
   a. Assemble copper tubing with soldered joints. Solder shall be 95-5 tin-antimony conforming to ASTM B32.
   b. Ream or file pipe to remove burrs.
   c. Clean and polish contact surfaces of joints.
   d. Apply flux to both male and female ends.
   e. Insert end of tube into full depth of fitting socket.
   f. Heat joint evenly.
   g. Form continuous solder bead around entire circumference of joint.
   h. Runs shall contain unions at connections to equipment and at reasonable distances along the lengths of runs to permit convenient disassembly of piping and removal of equipment.

E. Installing Valves and Accessories:
   1. Provide supports for large valves, flow meters, and other heavy items as shown or required.
   2. Position valve operators as shown. When the position is not shown, CONTRACTOR shall notify ENGINEER prior to installation for position approval by ENGINEER. The valve shall be installed so that it can be conveniently operated and as approved by ENGINEER. Avoid placing operators at angles to the floors or walls. If valve operator is installed without notification to ENGINEER, CONTRACTOR shall move valve, as required, without additional expense.
   3. Position flow measuring devices in pipe lines so that they have the amount of straight upstream and downstream runs recommended by the manufacturer, unless specific location dimensions are shown.

F. Unions:
   1. Install dielectric unions wherever dissimilar metals are connected, except for bronze or brass valves, in ferrous piping.
   2. Provide a union downstream of each valve with screwed connections.
   3. Provide screwed or flanged unions at each piece of equipment, where shown, and where necessary to install or dismantle piping.

G. Eccentric Reducers: Use eccentric reducers where shown and where air or water pockets would otherwise occur in mains because of a reduction in pipe size.

H. Transitions from One Type of Pipe to Another:
   1. Do not take pipelines out of service unless specifically named below, or approved by ENGINEER.
   2. Provide all necessary adapters, specials and connection pieces required when connecting different types and sizes of pipe or connecting pipe made by different manufacturers.

3.2 THRUST RESTRAINT

A. Provide thrust restraint on all pressure piping systems and where otherwise shown or specified.

B. Restrained Pipe Joints:
   1. Pipe joints shall be restrained by flanges for all exposed ductile iron as specified herein.

3.3 PAINTING

A. All pipe field painting shall conform to the requirements of Section 09900, Painting.

3.4 TESTING OF PIPING

A. General:
   1. Test all piping as specified below, unless otherwise authorized by ENGINEER.
   2. Notify ENGINEER 48 hours in advance of testing.
   3. Provide all testing apparatus including pumps, hoses, gages, and fittings.
   4. Pipelines shall hold the specified test pressure for two hours.
   5. Repair and retest pipelines which fail to hold specified test pressures or which exceed the allowable leakage rate.
   6. Test pressures required are at the lowest elevation of the pipeline section being tested, unless otherwise specified.
   7. Follow special test procedures below for gaseous chemical and liquid chlorine lines.
   8. Conduct all tests in the presence of the ENGINEER. Repeat tests in the presence of local authorities having jurisdiction, if required.

B. Pressure Test Procedure:
   1. Insure that all supports and restraint protection are securely in place.
   2. Fill section to be tested slowly with water and expel all air. Install cocks, if necessary, to ensure removal of air.
   3. Test only one section of pipe at a time.
   4. Apply specified test pressure required for two hours and observe pressure gage. Check carefully for leaks while test pressure is being maintained.

C. Leakage Testing:
   1. Conduct leakage test after satisfactory completion of pressure test.
   2. Allowable Leakage Rates (gallons per hour per 1,000 feet per inch diameter):
      a. Copper, Steel, Ductile Iron, Thermo Plastic, and all Other Piping: 0.0 gallons/hour (none).
   2. Leakage Test Procedure:

a. Examine exposed pipe, joints, fittings, and valves. Repair visible leakage or replace the defective pipe, fitting, or valve.
b. Refill the line under test to reach the required test pressure.
c. Provide a test container filled with a known quantity of water at the start of the test. Attach the test pump suction to the test container.
d. Pump water from the test container into the line with the test pump to hold the specified test pressure for the test period. Water remaining in the container shall be measured and the amount used during the test shall be recorded on the test report.
e. Perform all repairs, replacement, and retesting required because of failure to meet testing requirements.
f. Leakage shall be less than rate specified above.

3.5 CLEANING AND DISINFECTION

A. Cleaning:
1. Thoroughly clean all piping and flush prior to placing in service in a manner approved by ENGINEER.
2. Piping 24-inches in diameter and larger shall be inspected from inside and all debris, dirt and foreign matter removed.
3. If piping which requires disinfection has not been kept clean during storage or installation, CONTRACTOR shall swab each section individually with a 5% hypochlorite solution, to ensure clean piping.

B. Disinfection:
1. Disinfect all potable water piping. Disinfection shall conform to MAG Section 611 and City of Goodyear Infrastructure Development Guidelines.

3.6 IDENTIFICATION OF PIPING

A. Piping markers shall conform to the requirements of Section 15050, Piping Systems.

END OF SECTION

SECTION 15064

COPPER PIPE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install copper pipe and fittings.
   2. The extent of copper pipe is shown and specified in the schedules included in Sections 15051, Buried Piping Installation, and 15052, Exposed Piping Installation.
   3. All jointing materials, end caps, and other appurtenances and accessories shall be provided.
   4. It is the intent of the Contract Documents to provide complete and workable piping systems. Any supplementary fittings and appurtenances required for proper completion of the Work shall be considered as having been included under this Section.

B. Related Sections:
   1. Section 02200, Earthwork.
   2. Section 15051, Buried Piping Installation.
   3. Section 15052, Exposed Piping Installation.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have a minimum of five years of experience in the production of copper pipe and fittings, and shall show evidence of satisfactory service in at least five installations.
   2. Each type of pipe and fitting shall be obtained from no more than one manufacturer.

B. Requirements of Regulatory Agencies: Comply with the applicable provisions of the following regulatory agencies, where applicable:
   1. Underwriters' Laboratories, Inc.
   2. National Fire Protection Association.
   3. ASME, Boiler and Pressure Vessel Code.
   4. State and Local Building Codes and Ordinances.
   5. Uniform Plumbing Code.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ANSI B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
   2. ANSI B16.26, Cast Copper Alloy Fittings for Flared Copper Tubes.
   3. ASTM B32, Specification for Solder Metal.
   4. ASTM B42, Specification for Standard Size Seamless Copper Pipe.
   5. ASTM B68, Specification for Bright Annealed Seamless Copper Tube.
   6. ASTM B75, Specification for Seamless Copper Tube.
   7. ASTM B88, Specification for Seamless Copper Water Tube.
   8. ASTM B280, Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
   9. ASTM B302, Specification for Threadless Copper Pipe.
   10. ASTM B306, Specification for Copper Drainage Tube (DWV).

D. Inspection: The quality of all materials provided and adequacy of installation shall be subject to the review and approval of the ENGINEER.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Detailed drawings and data on pipe fittings and appurtenances. Submit these with Shop Drawings required under Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation.

B. Certificates: Where specified or otherwise required by the ENGINEER, submit test certificates. Submit Certificates of Compliance with referenced standards.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Potable Piping: Potable piping shall conform to the requirements of ASTM B88. Underground, buried piping, unless otherwise specified, shall be Type K. All fittings shall be soldered, except at valves which may be flared, compression types or threaded type supplied with solder socket by threaded adaptors. Exposed piping shall be Type L, unless otherwise specified.

B. Couplings and Fittings for Copper Tubing:

1. Unless otherwise specified, couplings for copper tubing 1/2-inch and smaller nominal diameter shall be compression type, bronze or brass, capable of holding the full bursting strength of the tubing and shall meet the requirements of ANSI B16.26.
2. Product and Manufacturer: Provide fittings and couplings for copper tubing by one of the following:
    a. Swagelok.
    b. Gyrolok.
    c. Or approved equal.

2.2 JOINTING

A. Potable water piping shall be assembled with soldered type joints. Fittings shall conform to ANSI B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
    1. Soldered joints shall be 95-5 tin-antimony solder, conforming to ASTM B32.

B. All joints shall conform to manufacturer's recommendations and shall be made by skilled workmen.

C. Joints shall develop full strength and shall be greater than the pipe joined.

2.3 MARKING

A. All items shall be marked or labeled with the following information:
    1. Metal or alloy designation.
    2. Temper.
    3. Size and schedule.
    4. ASTM specification number.
    5. Name and location of supplier.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Section 15051, Buried Piping Installation, for installation, testing, and cleaning.

B. Refer to Section 15052, Exposed Piping Installation, for installation, testing, and cleaning.

C. Dielectric Protection: Copper tubing or fittings shall not be permitted to come in contact with steel piping, reinforcing steel, or other steel at any location. Electrical checks shall be made to ensure no contact is made between copper tubing and steel elements. Wherever electrical contact is demonstrated by such test, CONTRACTOR

shall provide dielectric protection as specified in Section 15212, Piping Specialties and Accessories.

END OF SECTION

SECTION 15065

THERMOPLASTIC PIPE AND ACCESSORIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish, install, and place in satisfactory service for chlorinated polyvinyl chloride (CPVC) piping, fittings, and specials.
   2. The extent of piping is shown on the Drawings and in the schedules included in Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate with the Work that is related to this Section.

C. Related Sections:
   1. Section 02200, Earthwork.
   2. Section 09900, Painting.
   3. Section 11295, Hydraulic Valves.
   4. Section 15050, Piping Systems.
   5. Section 15051, Buried Piping Installation.
   6. Section 15052, Exposed Piping Installation.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have a minimum of five years of experience in the production of thermoplastic pipe and fittings, and shall show evidence of satisfactory service in at least five installations.
   2. Thermoplastic pipe and fittings shall be the product of one manufacturer.

B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ASTM D1598, Test for Time-to-Failure of Plastic Pipe under Constant Internal Pressure.
   2. ASTM D1599, Test for Short-Time Rupture Strength of Plastic Pipe, Tubing, and Fittings.
   3. ASTM D2122, Determining Dimensions of Thermoplastic Pipe and Fittings.

4. ASTM D1784, Rigid Poly (Vinyl Chloride) PVC Compounds and Chlorinated Poly (Vinyl Chloride) CPVC Compounds.
5. ASTM D1785, Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
6. ASTM D2467, Socket-Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings.
7. ASTM D2774, Underground Installation of Thermoplastic Pressure Piping.
8. ASTM D3034, Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
9. ASTM F477, Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
10. ASTM D2241, Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
11. ASTM D2837, Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials.
12. ASTM D3139, Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
13. ASTM F412, Standard Terminology Relating to Plastic Piping Systems.
14. Standard No. 14, National Sanitation Foundation.
15. American National Standards Institute.

C. Shop Tests:
1. Piping manufacturer shall maintain a continuous quality control program. All CPVC plastic molding materials used to manufacture pipe and fittings under this Section shall be tested for conformance to the requirements of ASTM D1784 and ASTM F441.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. Detailed procedures to be used in jointing and installing piping system including manufacturer's recommendations.
2. Interfacing of piping system to equipment and appurtenances.
3. Detail requirements for burial, supports, anchors, guides, expansion loops, expansion joints, and all accessories required for a satisfactory piping system.
4. Bill of materials, indicating material composition of pipe and solvent, pressure rating, nominal size and its location on the piping installation drawings.
5. Certifications letter from pipe manufacturer confirming that the materials to be used are suitable for the intended service.

B. Certificates: Submit Certificates of Compliance with referenced standards.

1.4 PRODUCT DELIVERY, HANDLING, AND STORAGE

A. Delivery: All necessary precautions shall be taken to prevent damage to pipe fittings and other materials during shipment and delivery. All materials shall be securely

fastened to truck or rail car to prevent movement or damage during shipment. An inspector shall examine all materials before unloading.

B. Handling: All pipe materials shall be handled to prevent damage. Pipe and fittings shall not be dropped, rolled, or pushed off from any height on delivery, storage, or installation.

C. Storage: All pipe materials shall be stored off the ground. Pipe ends shall be secured by caps or plugs. Do not store pipe or fittings in sunlight. Pipe shall be stored to prevent sagging or bending. Store off the ground, under cover, and in a dry location.

PART 2 - PRODUCTS

2.1 MATERIALS

A. CPVC Pressure Pipe:
   1. CPVC pressure pipe shall be Schedule 80, Class 24554B, conforming to ASTM D1784 and ASTM F441.
   2. Fittings and specials shall be Schedule 80, solvent welded, socket type, conforming to ASTM F439. Solvent cement shall conform to requirements of ASTM F493. Provide flanged fittings at all valves and equipment with Teflon gaskets as specified. Where threaded connections are needed, the CONTRACTOR shall use Teflon tape to provide a watertight seal. Liquid Teflon type products are prohibited. If connections are used with liquid Teflon type products, then the CONTRACTOR shall remove and clean the threads before applying the Teflon tape. CONTRACTOR shall chamfer and de-burr pipes at joints to prevent leakage through cemented sockets.
   3. For expansion joints, CONTRACTOR shall provide Redflex SL-50 Single Arch Model or approved equal, as shown on the Drawings.

B. CONTRACTOR shall supply type, grade, and strength of pipe required to meet the specified service conditions. Submit to ENGINEER for approval.

C. Painting shall conform to requirements of Section 09900, Painting.

2.2 DETAILED REQUIREMENTS

A. Workmanship: The pipe shall be homogeneous throughout and free from visible cracks, holes, foreign inclusions, or other defects. The pipe shall be uniform in color, opacity, density, and other physical properties.

B. Dimensions and Tolerances: Dimensions and tolerances shall be measured in accordance with ASTM D2122. The eccentricity of the inside and outside circumferences of the pipe walls shall not exceed 12%.

C. Sustained Pressure: The pipe shall not fail, balloon, burst, or weep as defined in ASTM D1598.

D. Burst Pressure: The minimum burst pressure shall be determined in accordance with ASTM D1599.

E. Marking: Marking on the pipe shall include the following, spaced at intervals of not more than 5 feet:
   1. Pipe nominal size.
   2. Pipe schedule.
   3. Specification of plastic material.
   4. Type and grade of plastic.
   5. Date and place of manufacture.

F. Piping and fittings shall be manufactured with a minimum of 2% of titanium oxide for ultraviolet protection.

2.3 ADAPTERS

A. Where required to join piping of different materials CONTRACTOR shall provide the necessary adapters, as recommended by the thermoplastic pipe manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
   1. Refer to Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation, for piping installation, testing, cleaning, and acceptance.
   2. Request instructions from ENGINEER before proceeding if there is a conflict between Contract Documents and manufacturer's recommendations.
   3. Pipe, fittings, and accessories that are cracked, damaged, not identified, or in poor condition will be rejected.

END OF SECTION

SECTION 15130

PRESSURE GAUGES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pressure gauges.
   2. Accessories.

1.2 REFERENCES

A. ASME B40.1, Gauges, Pressure Indicating Dial Type, Elastic Element.

1.3 SUBMITTALS

A. Submit under provisions of Section 01300, Submittals, for all products specified in this Section.

B. Product Data: Provide product data for all products specified in this Section. Provide catalog illustrations of all products indicating manufacturer, product description, sizes, materials, model number, pressure operating ranges, and dimensions.

C. CONTRACTOR shall supply list of all pressure gauges to be used to ENGINEER for approval prior to ordering. ENGINEER shall then supply pressure range acceptable for each pressure gauge.

D. Submit manufacturer's installation instructions.

1.4 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 01300, Submittals.

B. Maintenance Data: Include installation instructions, assembly views, spare parts lists, and replacement parts list.

1.5 QUALITY ASSURANCE

A. Manufacturer's name and model number marked on each item furnished.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum five years documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products under provisions of Section 01640, Materials and Equipment.

B. Accept products on site in original factory packaging. Inspect for damage.

1.8 EXTRA MATERIALS

A. Provide one pressure gauge for each pressure range.

PART 2 - PRODUCTS

2.1 TYPE A PRESSURE GAUGES

A. Construction: ASME B40.1, UL 404; stainless steel case, phosphor bronze bourdon-tube, rotary stainless steel movement, brass socket, 1/2-inch NPT, black scale and pointer on white background.
   1. Size: 4-1/2-inch diameter.
   2. Lens: Clear Lexan.
   3. Operating Environment: Liquid filled.
   4. Mid-Scale Accuracy: 1%.
   5. Scale: psi.
   6. Accessories: Gauge cock.

B. Systems: Compressed air, potable water, and vacuum.

C. Model 1009 manufactured by Ashcroft, or approved equal.

2.2 PRESSURE GAUGE ACCESSORIES

A. Gauge Cock: Brass body, tee or lever handle.

B. Valve: Stainless steel body, bar stock construction.

C. Diaphragm Seals: AISI 316 stainless steel body and corrugated diaphragm, 1-inch female NPT process connection, flush and fill connection, silicone fill. Model 101 manufactured by Ashcroft, or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Enlarge pipes smaller than 2-1/2-inches for installation of thermometer sockets. Ensure sockets allow clearance from insulation.

C. Pressure ranges shall be 0 to 100 psi.

D. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

E. Adjust gauges to final angle, clean windows and lenses, and calibrate to zero.

F. On thermally insulated equipment or piping, stand-off mounting brackets, bases, adapters, or extended tubes shall be provided. These items shall provide clearance not less than the thickness of the insulation.

G. Where use of diaphragm seal is indicated, delete pressure snubber.

3.2 SCHEDULES

A. Pressure Gauge Locations:
   1. Pumps (suction and discharge).
   2. All other locations indicated on Drawings.

END OF SECTION

SECTION 15140

SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Pipe and equipment supports.

B. Equipment bases and supports.

1.2 SUBMITTALS

A. Submit under provisions of Division 1, General Requirements.

B. Shop Drawings: Indicate system layout with location and detail of pipe supports.

C. Product Data: Provide manufacturer's catalog data for pipe supports including load capacity.

D. Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.

1.3 REGULATORY REQUIREMENTS

A. Conform to specified code for support of plumbing piping.

PART 2 - PRODUCTS

2.1 PIPE SUPPORTS

A. Plumbing Piping - Potable Water/Non-Potable Water:
   1. Conform to Uniform Plumbing Code.
   2. Wall Support for Pipe Sizes to 2-inches: Type 12 split extension or cast iron hook.
   3. Wall Support for Pipe Sizes 3-inches and Over: Type 33 welded steel bracket and oversized U-bolt.
   4. Wall Support for Hot Pipe Sizes 6-inches and Over: Type 33 welded steel bracket and Type 44 cast iron roll.
   5. Vertical Support: Type 8 steel riser clamp.
   6. Floor Support for Pipe Sizes to 3-inches and all DWV Pipe Sizes: Type 37 cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support, or Type 46 adjustable cast iron roll and stand, steel bolts, and concrete pier or steel support.

7. Floor Support for Pipe Sizes 4-inches and Over: Type 46 adjustable cast iron roll and stand, steel bolts, and concrete pier or steel support.
8. Protection Saddles for Piping 2-1/2-inches and Larger: Hard block non-conducting saddles in 90 degree segments, 12-inch minimum length, block thickness same as insulation thickness.
9. Copper Pipe Support: Copper-plated or vinyl-coated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

END OF SECTION

SECTION 15212

PIPING SPECIALTIES AND ACCESSORIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install all piping specialties and accessories. Included, but not limited to, are flexible couplings, mechanical couplings, flanged and harnessed adapters, and expansion joints.

B. Related Sections:
   1. Section 09900, Painting.
   2. Section 11295, Hydraulic Valves.
   3. Division 15, Mechanical.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have a minimum of five years of experience in the production of substantially similar types of piping specialties specified and shall show evidence of satisfactory service in at least five installations.
   2. Each type of piping specialty and accessory shall be the product of one manufacturer.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Detailed drawings and data on each type of coupling, adaptor, expansion joint, and sight glass to be furnished. Submit and coordinate these with Shop Drawings required for piping systems.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Couplings: Unless otherwise specified, piping 2-inches in diameter and larger passing from concrete to earth shall be provided with two pipe couplings or flexible joints as specified within 2 feet or one pipe diameter of the structure, whichever is greater.

1. Sleeve Type, Flexible Couplings:
   a. Pressure and Service: Same as connected piping.
   b. Material: Carbon steel for carbon steel and exposed ductile iron piping systems, or stainless steel for stainless steel and buried or submerged ductile iron piping systems.
   c. Gasket: Suitable for high pressure water service.
   d. Bolts and Nuts: Alloy steel, corrosion-resistant, prime coated. Buried couplings shall have Type 316 stainless steel bolts and nuts.
   e. Harnessing:
      1) Harness couplings to restrain pressure piping. Test pressures for pressure pipe lines are included in the piping schedules in Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation.
      2) Adjacent flanges shall be tied with bolts of corrosion resistant alloy steel. Provide flange-mounted stretcher bolt plates as shown and to be designed by manufacturer, unless otherwise approved.
      3) Conform to dimensions, size, spacing and materials for lugs, bolts, washers, and nuts as recommended by manufacturer and approved by ENGINEER for the pipe size, wall thickness, and test pressure required. However, the following minimum bolting shall be provided, unless otherwise approved by the ENGINEER.

Pipe Diameter (inches)	Number of Bolts	Bolt Diameter (inches)	At (degrees)
4	2	5/8	180
6-8	2	3/4	180
10-12	2	7/8	180 or 250
14-20	4	1	190
24-48	4	1	90

   f. Remove pipe stop, unless otherwise shown or specified.
   g. Product and Manufacturer: Provide one of the following:
      1) Style 38, as manufactured by Dresser Industries.
      2) Type 411, as manufactured by Rockwell International.
      3) Or approved equal.

2. Dismantling Joint:

a. Manufacturer: Viking Johnson, as distributed by Henry Pratt Company, or approved equal.
b. Design and Performance:
    1) The dismantling joint shall comply with AWWA C.219 where applicable, and the manufacturer shall operate an accredited quality management System to ISO 9001.
    2) The manufacturer must have manufactured the dismantling joint for a minimum of five years.
    3) The gasket seal and compression stud and nut arrangement shall be independent of the tie rod restraint system.
    4) Tie rod diameter shall be compatible with the corresponding bolt diameter of the mating flange.
    5) The dismantling joint will allow for up to a minimum 1-inch of longitudinal adjustment.
    6) The pressure rating will be determined by the flange configuration, and all commonly used flanges shall be available.
    7) The dismantling joint shall be furnished as a complete assembly consisting of spigot piece, flange adapter, tie bars, and gasket.
    8) The dismantling joint shall be designed so that no part of the restraint system extends outside the flange diameter.
    9) The internal bore shall match that of the pipe system.
c. Pressure and Service:
    1) Design pressure rating shall be equal to or greater than the mating flanges.
    2) The tie rod restraint system shall be capable of withstanding the full pressure thrust that the pipe system can develop at no more than 50% of the strength of tie rod material.
d. Materials of Construction:
    1) Spigot piece shall be of steel to ASTM A283, Grade C.
    2) The flange adapter shall be either steel to ASTM A283, Grade C, or ductile iron to ASTM A536, Grade 65-45-12.
    3) Tie bars shall be ASTM A193, Grade B7, threaded rod with rolled threads.
    4) The gasket shall be EPDM, Grade E.
    5) The dismantling joint shall be supplied with an in-house applied fusion bonded epoxy or Rilsan Nylon 11 coating applied by fluidized bed method. The coating shall comply with the requirements of NSF 61 and AWWA C550 as applicable.

B. Rubber Type Expansion Joints:
1. General:
    a. Use rubber type expansion joints at all expansion joint locations, as noted on the Drawings.
2. Construction:
    a. Tube and Cover: Synthetic or natural rubber.
    b. Body:

1) Fabric Reinforcement: High quality cotton or synthetic fabric impregnated with rubber or other synthetic compounds to permit flexibility.
2) Metal Reinforcement: Wire or solid steel rings embedded in and bonded to the body rubber.

c. Retaining Rings:
1) Steel with hot-dipped galvanized coating in accordance with ASTM A123.
2) Drilled to match flanged drilling.

d. Flanges: Flat faced, ANSI Class 125 drilling.

e. Temperature:
1) Expansion couplings for ambient service shall be suitable for service temperature up to 300° F at 25 psi pressure.

3. Restraints:

a. General:
1) Provide control units on all expansion joints to permit movement and prevent excessive compression or elongation.
2) Furnish and install control units complete with all tie bolts, drilled plates, spacers, rubber and steel washers, stretcher bolt plates, retaining rings, stretcher bolts, sleeves and appurtenances, as required.
3) Design and install all control units to limit expansion and compression to within the manufacturer's standard limits.
4) Design the stretcher bolts and sleeves to withstand the maximum thrusts developed within the piping system.
5) Anchor, guide, and install all expansion joints according to the manufacturer's recommendations.
6) Harness all rubber expansion joints by tying between adjacent flanges.

b. Materials:
1) Stretcher Bolts and Nuts:
a) Material: Type 304 stainless steel.
b) Number:
i) Twice the number of stretcher bolts as recommended by manufacturer.
ii) Minimum four required for each rubber expansion joint.
iii) Washers: Rubber or neoprene.

4. Product and Manufacturer: Provide one of the following:
a. Standard spool-type, single arch by Red Valve Co.
b. Standard spool-type, single arch by Proco Products, Inc.
c. Or approved equal.

C. Special Restrainers for PVC Pipe:
1. All transitions from PVC pipe to DIP pipe shall be provided with a restraining device. The device must not impart point loads or distort PVC pipe. Device shall be a two-piece, uni-flange design with machined

serrations on the inside diameter of the flange. Device must be rated for all rated pressures of PVC pipe class and range in sizes of 2-inch diameter to 36-inch diameter for PVC pipe. Restrained device shall be Uni-Flange Block Buster 1,300 as manufactured by Ford Meter Box.

D. Dielectric Connections:
   1. Where a copper pipe is connected to steel or cast iron pipe, an insulating section of rubber or plastic pipe shall be provided. The insulating section shall have a minimum length of 12 pipe diameters. Dielectric unions may be used instead of the specified insulating sections.
   2. Product and Manufacturer: Provide one of the following:
      a. EPCO.
      b. Capitol Manufacturing.
      c. Or approved equal.

2.2 PAINTING

A. Clean and prime coat ferrous metal surfaces of equipment in the shop in accordance with the requirements of Section 09900, Painting.

B. Coat machined, polished and non-ferrous surfaces and similar unpainted surfaces with corrosion prevention compound which shall be maintained during storage and until equipment begins operation.

C. Field painting shall conform to the requirements of Section 09900, Painting.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install piping specialties and accessories in accordance with manufacturer's instructions.

B. Make adjustments to expansion joints as required to ensure that they will be fully extended when the ambient temperature is at minimum operating temperature and fully compressed at maximum operating temperature for the system in which they are installed.

END OF SECTION

SECTION 16000

GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Work and materials necessary for erecting a complete electrical and instrumentation system, tested and ready for continuous use.

B. Related Sections:
   1. Division 0, Bid Requirements, Contract Forms, and Contract Conditions.
   2. Division 1, General Requirements.
   3. Division 2, Site Construction.
   4. Division 3, Concrete.
   5. Division 9, Finishes.
   6. Division 11, Equipment.
   7. Division 13 Special Construction.
   8. Division 15 Mechanical.
   9. Division 17 Instrumentation and Controls.

1.2 DEFINITIONS

A. The term "Provide" means "Furnish and Install".

1.3 SYSTEM DESCRIPTION

A. Design Requirements:
   1. If any contradictions, contrasts, or inconsistency appears, the most strict criteria noted and the collective requirements in any and all of the Project documents shall apply.

1.4 SUBMITTALS

A. Intent:
   1. Organize Work so that a complete electrical, instrumentation, and control system for the facility will be provided and will be supported by accurate Shop Drawings, Record Drawings, and O&M Manuals.
   2. Submit detailed Shop Drawings and data prepared and organized by the suppliers. Provide quantity of submittal sets in accordance with the requirements of Division 1, General Requirements.

3. Submittals shall be neatly grouped and organized by Specification Section number, and sub-section. Related information shall be highlighted and the specific product shall be marked. All Submittals shall be complete and presented in one package. Incomplete Submittals will be returned without review. If a portion of the Project requires a fast track schedule, that portion only may be submitted earlier under a separate cover letter.
4. Work performed or equipment provided without ENGINEER approved Submittals is done at CONTRACTOR'S risk. Cost to re-work or re-supply will be born solely by the CONTRACTOR.

.Product Data:

5. A complete list of the equipment and materials, including the manufacturer's name, product Specification, descriptive data, technical literature, performance charts, catalog cuts, installation instructions, and spare part recommendations for each different item of the equipment specified. The above shall clearly show all the specified requirements as described in the Specifications including but not limited to specific UL and NEMA rating, technical capabilities, test result verifications, and acceptance letters.
6. Submittals not in compliance with the Specifications must include the following information:
    a. Reason for non-compliance or variance.
    b. Calculations and Drawings for redesign of related components, including detail drawings showing internal and assembly details, with installation instructions.
    c. Proposed layout showing any modifications or exceptions to related Work made necessary by this Work, with calculations and drawings showing such modifications or exceptions.

B. Shop Drawings:
    1. Drawings containing complete wiring and schematic diagrams, control diagrams, and any other details required to demonstrate that the system has been coordinated and will operate as intended. Drawings shall show proposed layout, anchoring, support, and appurtenances of equipment, and equipment relationship to other parts of the Work, including clearances for maintenance and operations.

C. Utility Coordination:
    1. Submit copies of service entrance Shop Drawings to the utility, per utility submittal requirements, prior to submittal to the ENGINEER. Obtain written approval from the power utility company that the service entrance equipment is acceptable prior to release the order to the supplier for fabrication. Provide a copy of the approval letter from the utility with the Submittal.

D. Closeout Submittals:

1. Provide "Record Drawings" of the electrical, control, and instrumentation work to include:
    a. Step-by-step procedure manuals for the installation, operation start-up, and maintenance of the equipment.
    b. Installation, operating, troubleshooting, and maintenance and overhaul instructions in complete detail.
    c. Possible breakdowns and repairs, and troubleshooting guides, as well as simplified wiring and control diagrams of the system installed. This shall provide the OWNER with comprehensive information on all systems and components to enable operation, service, maintenance and repair.
    d. Exploded or other detailed views of all equipment, devices, assemblies, and accessory components shall be included, together with complete parts lists and ordering instructions.
2. Provide an "As Built" set of Plans to OWNER. Maintain at all times a marked up set of Plans showing the following information:
    a. Actual installed circuit numbers, conduit sizes, cable tray routing, number of conductors, conductor sizes (larger than #12 AWG), and all other deviations from the Design Plans.
    b. Underground conduit, duct banks, and concealed items dimensioned on the Plans from permanent, visible, building features.
    c. Actual motor size, starter size, and overload heater size, along with all other protective equipment for all 480 V and 4160 V motor circuits.
    d. Conductor identification and panel schedules.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements:
1. Electrical work, including connection to electrical equipment integral with mechanical equipment, shall be performed in accordance with the latest published regulations, codes, and standards, of the following:
    a. National Electrical Code (NEC).
    b. State and local codes.
    c. Institute of Electrical and Electronic Engineers (IEEE).
    d. American National Standards Institute (ANSI).
    e. American Society for Testing and Materials (ASTM).
    f. Insulated Cable Engineers Association (ICEA).
    g. National Electrical Manufacturers Association (NEMA) Standards.
    h. Federal Occupational Safety and Health Act (OSHA).
    i. National Fire Protection Association (NFPA).
    j. National Electrical Testing Association (NETA).

1.6 DELIVERY, STORAGE, AND HANDLING

A. Electrical panels, switchgear, motor control centers, and other electrical equipment, shall be shipped in sealed dust and moisture proof plastic sheet enclosures, and the seal maintained until units are installed. Said units shall be new and free of any dirt, dust, water, grease, rust, damaged parts, or components.

1.7 PROJECT/SITE CONDITIONS

A. Verify site conditions before bidding or performing Work.

1.8 SCHEDULING

A. Maintain a Work schedule showing Work to be performed, sequence of Work, major milestones, and manpower loading. Coordinate schedule requirements with other trades. Provide adequate staff to perform the Work in the time required by the schedule.

1.9 SYSTEM START-UP

A. After installation and testing of all electrical and instrumentation equipment and systems, energize all equipment and leave ready for continuous operation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers and model numbers shown on Plans or listed in the Specifications are intended to establish a minimum standard of quality and acceptability.

2.2 MATERIALS

A. Materials, equipment, and parts comprising any unit, or part thereof, specified or indicated on the Plans, shall be new and unused, of current manufacture, and of highest grade consistent with the state of the art. Damaged materials, equipment, and parts are not considered to be new and unused and will not be accepted.

2.3 MANUFACTURED UNITS

A. The fabricator of major components and manufactured units, such as distribution panel boards, switchgear, and motor control centers, shall also be the manufacturer of the major devices therein.

B. Electrical equipment provided with mechanical equipment assemblies shall be in compliance with this Specification.

2.4 EQUIPMENT

A. Minimum sizes of equipment and electrical devices are indicated, but it is not intended to show every offset and fitting, nor every structural or mechanical difficulty that will be encountered during the installation of the Work.

B. Electrical equipment shall be capable of operating successfully at full-rated load, without failure, at an ambient air temperature of 60º C, and specifically rated for the altitude indicated on the Plans. Provide air conditioning to meet the manufacturers' operating temperature for electrical equipment not rated for operation at that temperature.

C. When applicable, the material used in the performance of the electrical work shall be listed by the Underwriters' Laboratories, Inc. (UL), for the class of service for which they are intended.

D. Provide nameplates where indicated elsewhere in these Specifications or on the Plans. Nameplates shall be black laminate with white letters and fastened to the various devices with round head stainless steel screws. Provide nameplates for each disconnecting means for service, feeder, branch, or equipment conductors indicating its purpose.

2.5 FABRICATION

A. Shop Assembly:
   1. Equipment assemblies, such as Service Entrance Sections, Switchgear, Switchboards, Control and Distribution Panels, and other custom fabricated electrical enclosures, shall bear a UL label as a complete assembly. The UL label on the individual components making up the assembly will not be considered sufficient to meet the present requirement. Whenever a generic UL label does not apply for the assembly, a serialized UL label shall be affixed to the assembly, and the serial number shall be submitted with the assembly record Shop Drawings.
   2. Custom fabricated electrical control panels, and enclosures, shall bear a UL label affixed by a local UL inspector.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Site Verification of Conditions:

1. Verify site conditions before bidding or performing Work.

3.2 INSTALLATION

A. Coordinate Work with other trades and with certified vendor shop drawing submittals.

B. Provide equipment in accordance with the manufacturers' requirements.

C. Identify each conductor as required by the Contract Documents.

D. Equipment Access:
   1. Install equipment so it is readily accessible for operation and maintenance.
   2. Equipment shall not be blocked or concealed.
   3. Do not install electrical equipment such that it interferes with normal maintenance requirements of other equipment.

E. Equipment shall be installed plumb, square and true with the building construction, and shall be securely fastened.

F. Outdoor wall-mounted equipment and indoor equipment mounted on earth or water bearing walls, shall be provided with corrosion-resistant spacers to maintain 1/4-inch separation between the equipment and the wall.

G. Arrange for the building in of equipment during structure construction. Where equipment cannot be built-in during construction, arrange for sleeves, box-outs, and other openings, as required to allow installation of equipment after structure construction is complete.

H. Verify that equipment will fit support layouts indicated.

I. Screen or seal all openings into outdoor equipment to prevent the entrance of rodents and insects.

J. Equipment fabricated from aluminum shall not be imbedded in earth or concrete.

K. Provide all necessary anchoring devices and supports.
   1. Use supports as detailed on the Plans and as specified.
   2. Supports and anchoring devices shall be rated and sized based on dimensions and weights verified from approved equipment Submittals.
   3. Hardware shall be stainless steel.
   4. Do not cut, or weld to, building structural members.
   5. Do not mount safety switches and external equipment to other equipment enclosures, unless enclosure mounting surface is properly braced to accept mounting of external equipment.

L. Verify exact rough-in location and dimensions for connection to electrical items furnished by others.
   1. Obtain Shop Drawings from those furnishing the equipment.
   2. Proceeding without proper information may require the CONTRACTOR to remove and replace Work that does not meet the conditions imposed by the equipment supplied.
   3. Provide sleeves wherever openings are required through new concrete or masonry members. Place sleeves accurately and coordinate locations with the ENGINEER.
   4. Do not endanger the stability of any structural member by cutting, digging, chasing, or drilling and shall not, at any time, cut or alter the Work without the ENGINEER'S written consent.
      a. Provide additional reinforcing if required.
      b. Use proper tools and methods to cut, core drill, or make other penetrations.
      c. Restore walls, ceilings, or floors to their original condition.

M. Provide concrete foundations or pads required for electrical equipment as indicated or specified.
   1. Provide a 4-inch concrete housekeeping pad for floor mounted electrical equipment. Pour on top of the finished floor or slab. Drill existing slab and epoxy rebar to anchor housekeeping pad in place.

N. Do not use equipment that exceeds the indicated dimensions except as approved in writing by the ENGINEER.

O. Do not use equipment or arrangements of equipment that reduce required clearances or exceed the space allocation.

P. Work indicated on the Plans is approximately to scale, but actual dimensions and detailed Plans should be followed as closely as field conditions permit. Field verification of scale dimensions on Plans is governed by field conditions. Installation of systems and equipment is subject to clarification as indicated in reviewed Shop Drawings and field coordination.

Q. Discrepancies indicated on different Plans, between Plans and actual field conditions, or between Plans and Contract Documents shall be promptly brought to the attention of the ENGINEER for clarification, prior to purchasing and installing equipment.

R. Adjust the alignment of equipment and conduit to accommodate architectural changes or to avoid work of other trades.

S. Provide parts and pieces necessary to the installation of equipment, in accordance with the best practice of the trade, and in conformance with the requirements of these Contract Documents.

T. Items not specifically mentioned in these Contract Documents, or noted on the Plans, or indicated on reviewed Shop Drawings, but which are obviously necessary to make a complete working installation, shall be deemed to be included herein.

U. Layout and install electrical work prior to placing floors and walls. Provide sleeves and openings through floors and walls, required for installation of conduits. Sleeves shall be rigidly supported and suitably packed, or sealed, to prevent ingress of wet concrete. Spacers shall be installed in order to prevent conduit movement. Dimensions indicated for electrical equipment and their installation are restrictive dimensions.

V. Provide inserts and hangers required to support conduits and other electrical equipment. Coordinate inserts and hangers with other trades. Replace inserts, hangers, sleeves, or other mounting hardware which are improperly placed.

W. Perform necessary saw cutting, core drilling, excavating, removal, shoring, backfilling, and other work required for the proper installation of conduits, whether inside, or outside of the buildings and structures. Use core drills to make circular holes.

X. Electrical Utility:
   1. Coordinate the electrical utility work with the electrical utility company. Note the additional submittal requirements under Paragraph 1.4.D of this Specification. Provide equipment and material required to bring electrical service to the service location in conformance with the electrical utility requirements. Provide the following for the electrical utility company's primary (from utility power line to the utility transformer) and secondary (from utility transformer to the service) electrical lines in accordance with the electrical utility company's specifications and requirements:
      a. Conduits (verify quantity and sizes).
      b. Trenching, backfill, and compacting (verify trench size(s), backfill material, and compaction percentage requirements).
      c. Concrete pad(s) (for pad mounted transformer(s)).
      d. Cable protection along the vertical drop at the utility company's pole (if pole mounted transformer(s)).
      e. Other items required by the power utility company's specifications.

Y. Telephone Service:
   1. Coordinate with the telephone company to provide telephone service as shown on the Plans. Provide trenching, conduit, and backfill for the telephone company's communication lines from the telephone company's

main distribution panel to the telephone company's connection box at this Project site, as required by the telephone company.

Z. Temporary Power:
   1. Provide and maintain temporary power and lighting systems needed for construction. Work shall include:
      a. Weatherproof panel(s) for the CONTRACTOR'S main breakers and distribution system.
      b. Conduit and cable.
   2. Use ground fault interrupting equipment.
   3. Connections shall be watertight, with wiring done with Type SO portable cable.
   4. Route and support cables to avoid mechanical damage.
   5. Remove temporary power equipment and devices upon completion of construction.

AA. Corrosion Protection:
   1. Wherever dissimilar metals, except conduit and conduit fittings, come in contact, the CONTRACTOR shall isolate these metals, as required, with neoprene washers, 9 mil polyethylene tape, or gaskets. Where fastening conduit, electro plated, or equivalent fasteners and stainless steel bolts shall be used.

3.3 REPAIR/RESTORATION

A. Repair damage caused by construction or demolition work to restore damaged areas to original condition.

B. Factory finishes damaged during shipping, or construction, shall be restored to original new condition. Rust shall be removed, and bare metal surfaces shall be primed and painted to match the original surrounding finish.

3.4 FIELD QUALITY CONTROL

A. Site Tests:
   1. The electrical work shall be free from improper grounds and from short circuits. Visually compare the conductor connections with connection diagrams. Perform individual circuit continuity checks using electrical circuit testers. Demonstrate proper operation of the energized electrical and mechanical devices. Correct any wiring deficiencies.

3.5 ADJUSTING

A. Calibrate and set all adjustable electrical equipment, including circuit breakers, motor circuit protectors, overload relays. Align photo cells and lights to achieve desired effects.

3.6 CLEANING

A. Relays, starters, circuit breakers, switches, contacts, insulators, mechanisms, and buses shall be free of dust, dirt, oil, moisture, metal shavings, and other debris before testing and energizing equipment. Vacuum and wipe down inside and outside of electrical enclosures and control panels.

3.7 PROTECTION

A. Once equipment is installed, it shall be protected at all times with plastic sheet covers until the area is free of dirt, dust, paint spray, water, and other trades. Provide heat to eliminate condensation.

END OF SECTION

SECTION 16010

ELECTRICAL: BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes basic requirements for electrical work.

B. Install and wire all equipment, including pre-purchased equipment, and perform all tests necessary to assure conformance to the Drawings and Specifications and ensure that equipment is ready and safe before energizing.

C. Related Sections include but are not necessarily limited to:
   1. Division 0, Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 1, General Requirements.

D. Drawings Use and Interpretation:
   1. Drawings indicate the location and arrangement of electrical equipment and the approximate location of other equipment requiring electrical work.
      a. For exact locations of building elements, refer to dimensioned architectural/structural drawings.
      b. Field measurements take precedence over dimensioned drawings.

E. Installation of all systems and equipment is subject to clarification as indicated in reviewed Shop Drawings and field coordination drawings.

1.2 AREA CLASSIFICATIONS

A. Outdoor locations may contain corrosive and hazardous areas:
   1. Corrosive and hazardous areas are identified on the Drawings.
      a. Areas not identified as such shall be considered wet.

B. Indoor locations may contain damp, wet corrosive, and hazardous areas:
   1. Damp, wet, corrosive and hazardous areas are identified on the Drawings.
      a. Areas not identified as such shall be considered unclassified.

1.3 DEFINITIONS

A. Outdoor Areas:
   1. Those locations on the Project site where the equipment is normally exposed to wind, dust, rain, snow, etc.

B. Indoor Areas:
   1. Those locations on the Project site where the equipment is normally protected from wind, dust, rain, snow, etc.

C. Shop Fabricated:
   1. Manufactured or assembled equipment for which a UL test procedure has not been established.

1.4 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Iron and Steel Institute (AISI):
      a. Steel Products Manual - Stainless and Heat Resisting Steel.
   2. American National Standards Institute (ANSI):
      a. C2, National Electrical Safety Code.
   3. American Society for Testing and Materials (ASTM):
      a. A36, Specification for Structural Steel.
      b. A153, Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   4. Factory Mutual System (FM):
      a. A Guide to Equipment, Materials and Services.
   5. Institute of Electrical and Electronics Engineers (IEEE):
      a. 141, Recommended Practice for Electrical Power Distribution for Industrial Plants.
      b. 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
   6. National Electrical Manufacturers Association (NEMA):
      a. ICS 6, Enclosures for Industrial Controls and Systems.
   7. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   8. Underwriters Laboratories, Inc (UL):
      a. 508, Safety Industrial Control Equipment.
      b. 698, Industrial Control Equipment for Use in Hazardous Locations.

B. When a specific code or standard has not been cited, the applicable codes and standards of the following code-making authorities and standards organizations shall apply:
   1. American Association of State Highway and Transportation Officials (AASHTO).
   2. American Iron and Steel Institute (AISI).
   3. American National Standard Institute (ANSI).
   4. American Society for Testing and Materials (ASTM).
   5. ETL Testing Laboratories, Inc (ETL).
   6. Insulated Cable Engineers Association (ICEA).
   7. Institute of Electrical and Electronic Engineers (IEEE).

8. Illuminating Engineering Society of North America (IES).
9. Instrument Society of America (ISA).
10. Lightning Protection Institute (LPI).
11. National Electrical Manufacturers Association (NEMA).
12. National Fire Protection Association (NFPA).
13. Occupational, Health and Safety Administration (OSHA).
14. Underwriters Laboratories Inc (UL).

C. In case of conflict or disagreement between codes, standards, laws, ordinances, rules, regulations, Drawings, and Specifications, or within either document itself, the more stringent condition shall govern.

1.5 SYSTEM DESCRIPTION

A. Provide functional systems in compliance with manufacturer's instructions, performance requirements specified or shown on the Drawings, and modifications resulting from reviewed Shop Drawings and field coordinated drawings.

1.6 SUBMITTALS

A. Shop Drawings:
1. See Contract Documents for other requirements.
2. Submit shop drawings prior to purchase or fabrication of equipment. See individual Division 16, Electrical, Sections for specific requirements.
3. Prior to submittals of Shop Drawings, coordinate electrical equipment, particularly motor control equipment, control panels, and instrumentation, with all applicable equipment and systems interfacing with that equipment.
4. For each product, clearly identify manufacturer by name.
5. Provide manufacturer's technical information on products to be used, including:
    a. Product descriptive bulletin.
    b. Electrical data pertinent to the Project and necessary to assure compliance with Specifications and Drawings.
    c. Equipment dimensions, where applicable.
    d. Evidence that the products submitted meet the requirements of the standards referenced.
6. When general data sheets are provided as part of the submittal, specifically identify the products to be used on this Project.
7. Ensure that all submittals clearly indicate the equipment is UL or ETL listed or is constructed utilizing UL or ETL listed or UL recognized components. Where an UL standard has not been established, clearly identify that no UL standard exists for that equipment.
8. For all equipment, provide manufacturer's installation instructions.

B. Operation and Maintenance Manuals:

1. See Contract Documents for requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

A. See Section 01600.

B. Ensure that equipment is not used as steps, ladders, scaffolds, platforms, or for storage, either inside or on top of enclosures.

C. Protect nameplates on electrical equipment to prevent defacing.

D. Repair, restore, or replace damaged, corroded, and rejected items at no additional cost to the OWNER.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Refer to related Division 16, Electrical, Sections.
   1. All equipment of a similar type shall be by one manufacturer, unless otherwise noted in the Specifications.

2.2 MATERIALS

A. Trade names and catalog numbers may be used in the Drawings or Specifications to establish quality standards and basics of design.
   1. Other listed manufacturers in the applicable Specification Sections with equal equipment may be acceptable.
   2. If no other manufacturer is listed, then manufacturers of equal equipment may be acceptable.

B. Listed:
   1. Where UL test procedures have been established for the product type, electrical equipment shall be approved by UL or ETL and shall be provided with the UL or ETL label.

C. Structural Steel Supports:
   1. Galvanized Steel: ASTM A36.
      a. PVC coated in Class I and in corrosive areas.
   2. Stainless Steel: AISI Type 316.

2.3 FABRICATION

A. When equipment is shop fabricated for the Project, the electrical devices and enclosures utilized shall be UL or ETL listed and labeled or shall be UL recognized.

B. Shop or Factory Finishes:
   1. Interiors of other painted equipment shall be either white or light gray.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Equipment shall be installed in accordance with the requirements of the NEC.

B. Enclosures for Use with Electrical Equipment:
   1. NEMA 12: Use in unclassified indoor locations.
   2. NEMA 3R: Use with HVAC equipment in wet outdoor locations.
   3. NEMA 4:
      a. Use in wet indoor locations.
      b. Use in wet outdoor locations except with HVAC equipment.
   4. NEMA 4X: Use in all corrosive locations.
   5. Exceptions:
      a. As modified in other Division 16, Electrical, Sections.
      b. As otherwise indicated on the Drawings.
   6. Standards:
      a. NEMA ICS-6, Enclosures for Industrial Controls and Systems.
      b. UL 508, Safety Industrial Control Equipment.
      c. UL 698, Industrial Control Equipment for Use in Hazardous Locations.

C. Coordinate the installation of electrical equipment with other trades.
   1. Arrange for the building in of equipment during structure construction.
   2. Where equipment cannot be built-in during construction, arrange for sleeves, box-outs, openings, etc., as required to allow installation of equipment after structure construction is complete.

D. Verify that equipment will fit support layouts indicated.

E. Equipment Dimensions and Clearances:
   1. Do not use equipment that exceeds the indicated dimensions.
      a. Except as approved in writing by the ENGINEER.
   2. Do not use equipment or arrangements of equipment that reduce required clearances or exceed the space allocation.

F. Install equipment in accordance with the manufacturer's instructions.

G. Equipment Access:
   1. Install equipment so it is readily accessible for operation and maintenance.
   2. Equipment shall not be blocked or concealed.
   3. Do not install electrical equipment such that it interferes with normal maintenance requirements of other equipment.

H. Equipment shall be installed plumbed, square, and true with the building construction and shall be securely fastened.

I. Outdoor wall-mounted equipment and indoor equipment mounted on earth or water bearing walls shall be provided with corrosion-resistant spacers to maintain 1/4-inch separation between the equipment and the wall.

J. Screen or seal all openings into outdoor equipment to prevent the entrance of rodents and insects.

K. Equipment fabricated from aluminum shall not be placed in direct contact with earth or concrete.

L. Provide all necessary anchoring devices and supports.
   1. Use supports as detailed on the Drawings and as specified.
      a. Where not detailed on the Drawings or specified, use supports and anchoring devices rated for the equipment load and as recommended by the manufacturer.
   2. Supports and anchoring devices shall be rated and sized based on dimensions and weights verified from approved equipment submittals.
   3. Hardware shall be malleable type, corrosion resistant, and shall be supported by heavily plated machine screws or brass, bronze or stainless steel bolts.
   4. Do not cut, or weld to, building structural members.
   5. Do not mount safety switches and external equipment to other equipment enclosures, unless enclosure mounting surface is properly braced to accept mounting of external equipment.

M. Provide concrete foundations or pads required for electrical equipment as indicated or specified.
   1. Floor-mounted equipment shall be mounted on a 4-inch high concrete housekeeping pad. Pad shall be poured on top of the finished floor or slab.

N. Material that may cause rusting or streaking on a building surface shall not be used.

O. To avoid interference with structural members and equipment of other trades, it may be necessary to adjust the intended location of electrical equipment. Unless specifically dimensioned or detailed, the CONTRACTOR may, at his discretion,

make minor adjustments in equipment location without obtaining the ENGINEER'S approval.

P. Provide tagging of electrical equipment, conduits, and conductors in accordance with the Contract Documents.
   1. Each equipment item shall be provided with a nameplate identifying the equipment by the tag number shown on the Drawings.
   2. Each branch circuit and feeder shall be provided with a nameplate identifying, by name and tag number as shown on the Drawings, the load served.
      a. Do not abbreviate.
   3. Each control device shall be provided with an escutcheon defining the device function and a nameplate identifying the controlled equipment.

Q. Provide electrical danger, caution, warning or safety instruction signs in accordance with applicable safety standards.

R. Conduit and wire between temperature control thermostats and the associated HVAC equipment shall be furnished and installed with the equipment (see Division 15, Mechanical, of the Specifications).
   1. Conduit and wire between alarm or shutdown thermostats and air flow switches and the associated alarm devices or panels shall be furnished and installed as part of Division 16, Electrical.
   2. Thermostats included as part of a heat trace system shall be installed as part of Division 16, Electrical.

3.2 FIELD QUALITY CONTROL

A. Do not remove or damage fireproofing materials.
   1. Install hangers, inserts, supports, and anchors prior to installation of fireproofing.
   2. Repair or replace fireproofing removed or damaged.

B. Make all penetrations through roofs prior to installation of roofing.
   1. For penetrations required after installation of roofing:
      a. In built-up roofing (BUR), provide all curbs, cants and base flashings.
      b. In elastic sheet roofing (ESR), arrange and pay for base flashing work by authorized roofer.

C. Make all penetrations of electrical work through walls and roofs water and weather-tight.

D. Equipment furnished under this Contract for use on future work and all concealed equipment, including conduits, shall be dimensioned, on the Record Drawings, from visible and permanent building features.

E. After installation, test all electrical equipment and systems as recommended by the manufacturer and in accordance with Specification 16920, Electrical Acceptance Testing.

F. Test Equipment Interface:
   1. Verify systems coordination and operation.

3.3 CLEANING

A. Clean dirt and debris from all surfaces.

B. Apply touch-up paint as required to repair scratches, etc.

C. Replace nameplates damaged during installation.

D. Thoroughly vacuum the interior of all enclosures to remove dirt and debris.

3.4 DEMONSTRATION

A. Demonstrate equipment in accordance with the Contract Documents.

END OF SECTION

SECTION 16050

BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section consists of general electrical materials and methods. Electrical materials that are a part of equipment specified under other Sections shall meet the requirements of this Section, unless part of larger factory-assembled equipment.

1.2 SUBMITTALS

A. Submit manufacturer's literature for raceways and fittings, boxes, wires and cables, wiring devices, nameplates, legend plates, labels, panelboards, and safety switches, service entrance equipment, control panels, and any other electrical component utilized in this Project.

1.3 QUALITY ASSURANCE

A. Refer to Section 16000, General Electrical Requirements.

1.4 SPARE PARTS

A. Provide spare components as indicated on Drawings and elsewhere herein.

PART 2 - PRODUCTS

2.1 BASIC MATERIALS

A. Electrical safety switches, distribution and control equipment shall be rated for heavy-duty service.

B. Wiring devices shall be Specifications Grade.

2.2 MISCELLANEOUS METAL AND MOUNTING CHANNELS

A. Metal Framing:
   1. Unless otherwise shown, mounting channels shall be cold rolled from mild strip steel, 12 gage, 1-5/8-inches by 1-5/8-inches, with 316 stainless steel by Unistrut, Unistrut P-1000, as manufactured by Unistrut, or equal.

2. Screws, bolts, washers, and nuts shall be 316 stainless steel. Parts and brackets for assembly of channels shall be 316 stainless steel.

B. Miscellaneous Metal: 316 stainless steel, unless otherwise shown.

2.3 NAMEPLATES, LEGEND PLATES, AND LABELS

A. Nameplates: Laminated sheet plastic, approximately 1/16-inch-thick, with engraved white letters on a black background, with adhesive backing and mounting screw holes. Stainless steel or brass screws; minimum height of letters shall be 5/16-inch. Card holders are not acceptable.

B. Legend Plates: Type KN-3 standard legend plates; Square D, or equal.

C. Control Wire Markers: Heat-shrink sleeve types, manufactured by W.H. Brady Company or equal.

PART 3 - EXECUTION

3.1 BASIC MATERIALS

A. The completed installation shall conform to all applicable Federal, State, and local codes, ordinances, and regulations. CONTRACTOR shall obtain necessary permits and inspections required by the governing authorities. Work shall be done in a neat, workmanlike, finished and safe manner, according to the latest published NECA Standards of installation, under competent supervision. Install grounding as required by the National Electrical Code.

3.2 MISCELLANEOUS METAL AND MOUNTING CHANNELS

A. Install where electrical equipment is to be surface-mounted to walls and where indicated on Drawings. Where two or more devices are to be installed side by side, support on metal framing, bolt together, and brace as required to form a rigid structure.

B. Clean cuts and welds. Coat unpainted surfaces with cold application zinc galvanizing. Coat cuts and welds on painted surfaces with zinc chromate primer and finish to match existing paint.

3.3 NAMEPLATES, LEGEND PLATES, AND LABELS

A. Nameplates: Identify panels, switchgear, regulators, load-break junction boxes, disconnect switches, and component enclosures. Fasten nameplates with stainless steel self-tapping screws or rivets.

1. Panels: Identify panel number, voltage, and amperage of panel bus.
2. Switchgear: Identify equipment, voltage, amperage, and phase and number of wires.
3. Safety Switches and Relays: Identify equipment controlled and circuits from which they are fed.

B. Legend Plates: Install on selector switches, pushbuttons, pilot lights, starters, and other components.

C. Control Wire Markers: Install at both ends of each control wire interconnecting between such items as control panels, sensors, and control devices at each end of control wires within control panels, and other such enclosures. Wiring markers shall correspond to control wire numbers on approved wiring diagrams.

END OF SECTION

SECTION 16111

CONDUITS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish and install conduits as required and as shown on the Drawings. Materials employed shall be as shown on the Drawings.

1.2 SUBMITTALS

A. Submit product literature including manufacturer part number, model number, material, size, and specifications. Material shall not be installed until the ENGINEER has reviewed the submittal data.

B. Shop Drawings shall be submitted for review and acceptance showing routing, conduit size, and number and size of wires in each conduit before installation of conduit and any related work.

C. Proposed routing of conduits buried under floor slabs-on-grade.

D. Identify conduit by tag number of equipment served or by circuit schedule number.

E. Proposed routing and details of construction including conduit and rebar embedded in floor slabs, columns, etc. Identify conduit by tag number of equipment served or by circuit schedule number.

F. Proposed location and details of construction for openings in slabs and walls for raceway runs.

G. Refer to Section 16000, General Electrical Requirements, for further submittal requirements.

1.3 REFERENCES

A. American National Standards Institute (ANSI): C80.1, Rigid Steel Conduit - Zinc-Coated.

B. National Electric Manufacturers Association (NEMA), RN-1, Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit.

C. Underwriters Laboratories Inc. (UL):

1. 1, Flexible Metal Conduit.
2. 6, Rigid Metal Conduit.
3. 360, Liquid-Tight Flexible Steel Conduit.
4. 467, Grounding and Bonding Equipment.
5. 514, Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers.
6. 651, Schedule 40 and 80 Rigid PVC Conduit.
7. 870, Wireways, Auxiliary Gutters, and Associated Fittings.
8. 884, Underfloor Raceways and Fittings.
9. 886, Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations.

PART 2 - PRODUCTS

2.1 RACEWAYS

A. Exposed conduit in an unclassified or hazardous area shall be galvanized rigid steel (GRS) unless specifically indicated otherwise on the Drawings. Conduits in wet and corrosive areas shall be PVC coated GRS, unless otherwise indicated. Underground and/or concrete encased conduits shall be PVC, unless otherwise indicated. All wiring, except as otherwise noted, shall be in conduit. Conduit size shall not be less than the National Electrical Code (NEC) size required for the conductors therein and shall not be smaller than 3/4-inch. No underground conduit shall be less than 1-inch.

B. Condulet type fittings shall be Crouse-Hinds, Appleton, or equal with wedge nut covers. All condulets located outdoors or in wet locations shall be weathertight.

C. In unclassified areas, flexible conduit shall be grounding type, weatherproof, corrosion resistant, and watertight.

D. Couplings, connectors, and fittings shall be standard types specifically designed and manufactured for the purpose. They shall be installed to provide a firm mechanical assembly and electrical conductivity throughout.

E. Expansion fittings shall be OZ type AX with jumper for exposed locations and Type DX at structural expansion joints, Spring City, or equal. Conduits shall have expansion fittings in accordance with NEC.

F. The conduits and fittings shall be supported per NEC requirements as a minimum.

2.2 GALVANIZED RIGID STEEL (GRS)

A. Conduit and couplings shall be hot-dipped galvanized with zinc coated threads and outer coating of zinc bichromate, in accordance with ANSI C80.1 Standards, as manufactured by Jones & Laughlin Steel Corporation, Allied Tube & Conduit Corporation, Triangle PWC, or equal.

B. Steel conduit shall not be buried in earth without concrete encasement and additional corrosion protection. A half lapped rapping of 20 mil PVC based corrosion protection tape shall be used.

2.3 PVC COATED GALVANIZED RIGID STEEL (PVC-GRS)

A. PVC coated GRS conduit shall be installed where shown on the Drawings or elsewhere specified and shall conform to NEMA RN-1 and ANSI C80.1 Standards.

B. The zinc surface of the conduit shall remain intact and undisturbed on both the inside and the outside of the conduit throughout the preparation and application processing. A Polyvinyl Chloride (PVC) coating shall be bonded to the galvanized outer surface of the conduit. The bond between the PVC coating and the conduit surface shall be greater than the tensile strength of the plastic. The thickness of the PVC coating shall be a minimum of 0.040-inch (40 mil).

C. A loose coupling shall be furnished with each length of conduit. A PVC coating shall be bonded to the outer surface of the coupling and a PVC sleeve equal to the outside diameter of the uncoated conduit shall extend beyond both ends of the coupling approximately one pipe diameter or 1-1/2-inches, whichever is smaller. The wall thickness of the coating on the coupling and the sleeve shall be a minimum of 0.040-inch (40 mil).

D. A PVC coating shall be bonded to the inner and outer surface of all conduit bodies and fittings and a PVC sleeve shall extend from all hubs. The wall thickness of the coating on conduit bodies and fittings and the sleeve walls shall be identical to those on couplings in length and thickness. The covers on all conduit bodies shall be coated on both sides and shall be designed to be completely interchangeable. The inside of conduit bodies shall remain undisturbed in the processing.

E. Type 304 stainless steel screws shall be furnished and used to attach the cover to the conduit body. All coated material shall be installed and patched according to the manufacturer's recommended installation and patching instructions.

F. Conduit straps shall be PVC coated or stainless steel.

G. PVC coated conduit and fittings shall be as manufactured by Rob-Roy, or equal.

H. PVC coated flexible conduits shall be liquid and vaportight and manufactured in accordance with UL 360 Standards.

2.4 RIGID NONMETALLIC – PVC

A. Where specifically indicated on the Drawings, or elsewhere specified, conduit may be high density Schedule 40, 90° C, heavy-duty PVC. The conduit shall be manufactured from virgin polyvinyl chloride compound which meets ASTM D1784, NEMA TC-2, ANSI C33.91, and UL 651 Standards. Smoke emissions shall be limited to less than 6 grams per 100 grams of material tested.

B. Where conduit concrete encasement is indicated on the Drawings, conduit supports shall be installed at 5 foot intervals. PVC conduit shall be manufactured by Carlon, Triangle Conduit & Cable, or equal.

2.5 INTERMEDIATE METAL CONDUIT

A. Conduit and couplings shall be galvanized intermediate metal conduit manufactured in accordance with UL 1242 and as manufactured by Allied Tube & Conduit Corporation, Jones & Laughlin Steel Corporation, or equal.

B. Intermediate metal conduit shall not be buried without concrete encasement. Threadless couplings and connectors shall not be used.

2.6 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

A. Liquidtight flexible metal conduit shall be liquid and vaportight, oil and ultraviolet ray resistant, and manufactured in accordance with UL 360 Standards. Liquidtight flexible metal conduit shall be formed of a continuous, spiral wound, galvanized steel core with an extruded PVC jacket. The PVC jacket shall be rated for high ambient heat applications, 90° Celsius.

B. For corrosive locations, liquidtight flexible metal conduit shall be formed of a continuous, spiral wound, aluminum core with an extruded PVC jacket. The PVC jacket shall be impervious to corrosive liquids and vapors.

C. An external bonding conductor shall be required for flexible conduit connections containing circuits rated at 60 amps or greater and for sizes 1-1/2-inches or larger. Flexible conduit and connectors for 1-1/4-inches and smaller shall be listed for grounding.

D. Connectors for liquidtight flexible conduit shall be PVC Coated, furnished with a sealing ring and locknut, and suitable for corrosive or wet locations.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Conduit runs are schematic only, and shall be modified as required to suit field conditions, subject to review and acceptance by the ENGINEER.

B. Conduit shall run continuously between outlets and shall be provided with junction boxes where connections are made. Couplings, connectors, and fittings shall be acceptable types designed and manufactured for the purpose, and shall provide a firm mechanical assembly, and electrical conductivity throughout.

C. Conduit runs shall be straight and true. Elbows, offsets, and bends shall be uniform and symmetrical. Changes in direction shall be made with long radius bends, or with fittings of the condulet type.

D. Conduit runs in buildings and structures shall be exposed except as specifically noted or accepted by the ENGINEER.

E. Conduit runs shall not interfere with the proper and safe operation of equipment, and shall not block or interfere with ingress or egress, including equipment removal hatches.

F. Exposed conduits shall be securely fastened with clamps, or straps, intended for conduit use. All exposed conduit shall be run on the walls and ceiling only and shall be parallel to the planes of the walls or ceiling. No diagonal runs will be permitted. Flexible conduit shall be used only for short lengths required to facilitate connections between rigid conduit to motors from junction boxes, or control equipment.

G. Conduit runs on water-bearing walls shall be supported 1-inch away from the wall on an accepted channel. When channel galvanizing, or other coating, is cut or otherwise damaged, it shall be field coated to original condition. No conduit shall be run in water-bearing walls, unless specifically designated otherwise.

H. Conduit shall be thoroughly reamed to remove burrs. IMC or GRS shall be reamed during the threading process, and rigid nonmetallic PVC shall be reamed before applying fittings. A zinc rich cold galvanizing shall be used to restore corrosion protection on field cut threads. Bushings and lock nuts or hubs shall be used at conduit termination's. The total number of bends in any run between pull points shall not exceed 360 degrees. Junction boxes and pull boxes shall be installed at points acceptable to the ENGINEER. Conduit ends shall be plugged to prevent the entrance of moisture or debris during construction. All spare conduits shall be adequately capped and shall contain a suitable pull string.

I. Joints shall be set up tight. Hangers and fastenings shall be secure, and of a type appropriate in design, and dimensions, for the particular application.

J. Conduit runs shall be cleaned and internally sized (obstruction tested) so that no foreign objects, or obstructions remain in the conduit prior to pulling in conductors.

K. After installation of complete conduit runs 2-inches and larger, conduits shall be snaked with a conduit cleaner equipped with a cylindrical mandrel of a diameter not less than 85% of the nominal diameter of the conduit. Conduits through which the mandrel will not pass shall not be used.

L. Expansion fittings shall be installed across all expansion joints and at other locations where necessary to compensate for thermal expansion and contraction.

M. Provide trenching, backfill, and compaction for conduits installed underground.

N. Unless approved in advance by the ENGINEER, all conduits which transition from underground to aboveground will utilize galvanized rigid steel conduit for the bend from horizontal to vertical and for the extension above the ground. Factory 90 degree GRS bends shall be used. GRS bends and conduits shall be half lapped with 20 mil PVC tape in non-corrosive areas and shall be PVC coated rigid steel in corrosive areas. Tape wrapping shall extend a minimum 6-inches above top of slab or above finished grade.

O. Liquid tight flexible metallic conduit 1-1/2-inch and larger shall be provided with grounding style bushings and shall have an external ground wire sized and installed in accordance with the NEC.

END OF SECTION

SECTION 16123

600 VOLT CLASS CABLE

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This Section covers the furnishing and installation of 600 volt class cables and conductors, terminations and splicing, and pulling lubricants.

1.2 SUBMITTALS

A. Products shall be submitted in accordance with Section 16000, General Electrical Requirements, and elsewhere in the Contract Documents, prior to installation.

1.3 REFERENCES

A. Insulated Cable Engineers Association/National Electrical Manufacturers Association (ICEA/NEMA):
   1. S-68-516/WC 8, ethylene-propylene rubber-insulated wire and cable for the transmission and distribution of electrical energy.
   2. S-61-402/WC 5, thermoplastic-insulated wire and cable for the transmission and distribution of electrical energy.
   3. S-66-524/WC 7, cross-linked thermosetting-polyethylene-insulated wire and cable for transmission and distribution of electrical energy.

B. Underwriters Laboratory, Inc.
   1. 44, rubber insulated wires and cables.
   2. 83, thermoplastic-insulated wires and cables.
   3. 486A, wire connectors and soldering lugs for use with copper conductors.
   4. 486B, wire connectors for use with aluminum conductors.
   5. 510, insulating tape.

C. National Electric Code.

D. Insulated Cable Engineers Association.

PART 2 - PRODUCTS

2.1 ACCEPTED MANUFACTURERS

A. Conductors and Multi Conductor Cables (MCC), subject to compliance with Contract Documents, the following manufacturers are acceptable: American Insulated Wire Corporation, Cablec Corporation, Okonite Company, Southwire Company, or equal.

2.2 CONDUCTORS

A. Wire sizes shall be American Wire Gauge (AWG) sizes with Class B stranded construction. No. 2 AWG and smaller shall be factory color coded with a separate color for each phase and neutral, which shall be used consistently throughout the system. Larger cables shall be coded by the use of colored tape. Conductors sized No. 1 and larger shall be Type 2, rated for 90° C. All circuit conductors, #6 or smaller shall be "THWN" stranded copper. All other conductors shall be "XHHW" stranded copper.

B. Individual or multiple conductor cables for power, control, and alarm circuits of 480 volts or less shall be insulated for not less than 600 volts and shall have insulation type as indicated on the Drawings. "THHW" shall conform to ICEA S-61-402/NEMA WC 5 and UL 83 and "XHHW" shall conform to ICEA S-66-524/NEMA WC 7 and UL 44. Where wire size is not indicated, they shall be of the size required by the NEC, except that no wire external to panels and motor control centers shall be less than No. 12 AWG, unless specifically noted on the Drawings. Panel control wiring shall not be less than No. 14 AWG.

C. All wiring shall be as indicated on the Drawings. Wires shall be new and shall be soft drawn copper with not less than 97% conductivity. The wire and cable shall have size, grade of insulation, voltage, and manufacturer's name permanently marked on the outer covering at not more than 2 foot intervals. All wires shall conform to the latest Standards of the ASTM, and ICEA, and shall be tested for their full length by these Standards. Insulation thickness shall be not less than that specified by the National Electrical Code.

2.3 TERMINATIONS AND SPLICES

A. Cable shall be rated 600 volts. Other parts of cable systems such as splices and terminations shall be rated at not less than 600 volts. Splicing shall join conductors mechanically and electrically to provide a complete circuit prior to installation of insulation.

B. Splices in wires No. 10 AWG and smaller shall be made with an insulated, solderless, pressure type connector, Type I, Class 1, Grade B, Style G, or Type II, Class 1 of FS W-S-610 and conforming to the applicable requirements of UL 486A.

C. Splices in wires No. 8 AWG and larger shall be made with noninsulated, solderless, pressure type connector, Type II, Class 2 of FS W-S-610, conforming to the applicable requirements of UL 486A and UL 486B. They shall then be covered with an insulation and jacket material equivalent to the conductor insulation and jacket.

D. Insulated conductor splices below grade or in wet locations shall be sealed type conforming to ANSI C119.1 or shall be waterproofed by a sealant-filled, thick wall, heat shrinkable, thermosetting tubing or by pouring a thermosetting resin into a mold that surrounds the joined conductors.

E. Bare conductor splices in wet locations or below grade shall be of the exothermic type.

2.4 PULLING LUBRICANT

A. All cables shall be properly coated with pulling compound such as ClearGluide, Aqua Gel, Polywater, or equal before being pulled into conduits so as to prevent mechanical damage to the cables during installation. "Yellow 77" is not acceptable.

B. Other lubricants to be substituted must be accompanied by a statement from the cable manufacturer as to its acceptable use with the cable being installed.

2.5 IDENTIFICATION

A. All conductors shall be numbered with "tube sleeve" type tags with heat impressed letters and numbers.

B. Color code all wiring as follows:
   1. Lighting and Power Wiring:

Conductor	**120/208 VAC**	**480VAC**	**24V DC**	**120 VAC Control/ Power**
Phase 1	Black	Brown	Blue	Red
Phase 2	Red	Orange	(-) Blue w/ white stripe	
Phase 3	Blue	Yellow		
Neutrals	White	White		White

   2. Color code ends of feeder phase conductors only.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The pulling tension and side-wall pressures, as recommended by the cable manufacturer, shall not be exceeded.

B. As far as practical, all circuits shall be continuous from origin to termination without splices in intermediate pull boxes. Sufficient slack shall be left at the termination to make proper connections. In no case shall a splice be pulled into the conduit. Conductor splicing shall not be permitted without the ENGINEER'S approval.

C. Install all cables in conduit.

D. Each feeder and branch circuit shall be installed in its own individual conduit, unless combining feeder and branch circuits is permitted as defined in the following:
   1. As specifically indicated on the Drawings.
   2. For lighting, multiple branch circuits may be installed in a conduit as allowed by the NEC and with the wire ampacity derated in accordance with the requirements of the NEC. Conduit fill shall not exceed the limits established by the NEC.
   3. When field conditions dictate and written permission is obtained from the ENGINEER.

E. Feeder and branch circuits shall be isolated from each other and from all instrumentation and control circuits.

F. Control circuits shall be isolated from all other feeder, branch and instrumentation circuits, except as noted below:
   1. 12 VDC, 24 VDC and 48 VDC control circuits may be combined in common conduit.
   2. 125 VDC control circuits shall be isolated from all other DC and AC control circuits.
   3. 120 VAC control circuits shall be isolated from all DC control circuits.

G. Make splices only at pull or junction boxes.
   1. Crimp or indented-type connectors are not allowed, except for control circuits landed on terminal strips.

3.2 TESTING

A. In accordance with Specification 16920Electrical Acceptance Testing.

END OF SECTION

SECTION 16124

INSTRUMENTATION CLASS CABLE

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This Section covers cable use for process signal and controls.

1.2 SUBMITTALS

A. Products shall be submitted in accordance with Section 16000, General Electrical Requirements, and elsewhere in the Contract Documents, prior to installation.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with Contract Documents, the instrumentation cable shall be as manufactured by Belden, Okonite, or equal.

2.2 INSTRUMENTATION CABLE

A. Instrument cable shall be Type TC, and have the number of individually shielded twisted pairs indicated on the Drawings and shall be insulated for not less than 600 volts. Unless otherwise indicated, conductor size shall be No. 16 AWG minimum. Shielded, grounded instrumentation cable shall be used for all analog signals.

B. The jacket shall be flame retardant with 90° C temperature rating. The cable shield shall be a minimum of 2.3 mil aluminum or copper tape overlapped to provide 100% coverage and a tinned copper drain wire.

C. The conductors shall be bare soft annealed copper, Class B, 7 strand minimum concentric lay with 15 mils nominal thickness, nylon jacket, 4 mil nominal thickness, 90° C temperature rating. One conductor within each pair shall be numerically identified.

D. Pairs shall be assembled with a nominal 2-inch lay and shall then be group shielded with a minimum of 1.3 mil aluminum or copper tape overlapped to provide 100% coverage. All group shields shall be completely isolated from each other.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Feeder and branch circuits shall be isolated from each other and from instrumentation and control circuits. Instrumentation cables shall be installed in separate raceways from other cables and wiring. This includes portions running through manholes. Instrumentation cable shall be continuous between instruments or between field devices and instrument enclosures. There shall be no intermediate splices or terminal boards, unless otherwise shown on the Drawings.

B. Maintain electrical continuity of the shield when splicing twisted shielded pair conductors. Drain wires shall be terminated inside enclosures at grounded terminal blocks. Only one end of each instrument loop cable drain wire shall be grounded. Ground drain wire of shielded conductors at one end only.

C. Terminate instrumentation and control wiring, including spare wires, at control panels and motor control centers on terminal boards mounted inside the equipment.
   1. Contractor shall supply terminal boards as required.
   2. Do not field wire directly to devices.

END OF SECTION

SECTION 16160

ENCLOSURES

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This Specification includes enclosures to house electrical controls, instruments, terminal blocks, and serve a junction boxes where shown on the Drawings.

1.2 SUBMITTALS

A. Products shall be submitted in accordance with Section 16000, General Electrical Requirements, and elsewhere in the Contract Documents, prior to installation.

1.3 MANUFACTURERS

A. Enclosures shall be manufactured by Hammond, Hoffman, Rittal, or equal.

PART 2 - PRODUCTS

2.1 STEEL

A. Enclosures shall be fabricated from 14 gauge steel with seams that are continuously welded. Doors shall have full length piano hinges with the door removable by pulling the hinge pin.

B. A rolled lip shall be provided around three sides of the door and around all sides of the enclosure opening. The gasket shall be attached with oil-resistant adhesive and held in place with steel retaining strips. Exterior hardware, such as clamps, screws, and hinge pins, shall be of stainless steel for outdoor installations. A hasp and staple shall be provided for padlocking. Each enclosure shall have a print pocket. All wires entering or leaving the enclosure shall terminate on terminal strips. All wires and terminals shall be clearly identified as specified elsewhere in these Specifications.

C. Finish shall be white enamel interior, light gray enamel, ANSI 61 exterior, over phosphatized surfaces. Special finishes and colors shall be furnished for wet locations. Drawings should be checked for special conditions.

2.2 NEMA RATING

A. Unless otherwise indicated on the Drawings, enclosures shall be NEMA 12 for indoors and NEMA 4X for corrosive areas and outdoor installations. NEMA 4X enclosures shall be stainless steel, unless noted otherwise. NEMA 4X enclosures shall also be used in wet or wash down areas.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Enclosures shall be installed as indicated on the Drawings and according to manufacturer's instructions.

B. Enclosures shall be properly grounded and shall include ground straps connected to hinged doors and accessories.

END OF SECTION

SECTION 16161

CONTROL PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Control panels.
   2. Products shall be submitted for review in accordance with Section 16000, General Electrical Requirements, and elsewhere in the Contract Documents, prior to installation.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society for Testing and Materials (ASTM):
      a. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
   2. Joint Industrial Council (JIC):
      a. EMP-1, Mass Production Equipment.
   3. National Electrical Manufacturers Association (NEMA):
      a. ICS 4, Terminal Blocks for Industrial Use.
      b. ICS 6, Enclosures for Industrial Controls and Systems.
      c. 250, Enclosures for Electrical Equipment (1000 V Maximum).
   4. National Fire Protection Association (NFPA):
      a. National Electric Code (NEC).

B. Miscellaneous:
   1. Prior to placement of conduit feeds, assure approved control panel layouts available.
   2. Assure completely matching color tones for any individual color specified.
   3. Provide panel with the required NEMA rating per NEMA Publication No. 250 to meet classifications shown on Drawings or Specifications.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Scaled panel face and subpanel face instrument and nameplate layout drawings.
   2. Panel and subpanel materials of construction.
   3. Panel and subpanel dimensions and weights.
   4. Panel access openings.

5. Conduit and wiring access locations.
6. Internal wiring and terminal block drawings.
7. Nameplate text.
8. Scaled layouts of any graphic panels.
9. Heat load calculations and Air Conditioners (if Required), ensuring temperature sensitive devices are protected.

B. Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Enclosures:
      a. Hoffman.
      b. Rittal.
      c. Hammond.
      d. Or equal.

B. Submit requests for substitution in accordance with the Contract Documents.

2.2 MATERIALS

A. Front Panel, Subpanel or Front Door: Steel.

B. Frame and Bottom Angles: Steel.

C. Top, Sides, Back, Sides, and Back Door: Steel.

D. Hinges: Stainless steel.

E. Nameplates: Phenolic.

F. Filler Panels: Steel.

2.3 ACCESSORIES

A. Control Panels:
   1. Single Function Pilot Lights:
      a. Flush, non-protruding.
      b. Heavy-duty lights with glass lenses.
      c. Colors:

1) Red: "ON" or "RUNNING".
2) Blue: "REQUIRED" or "STAND-BY".
3) Amber: "Alarm".
4) Green: "OFF" or "STOPPED".

d. Lens-type with LED illumination.

B. Panel Nameplates and Identification:
1. Identify each item on the control panel with rectangular nameplates.
2. Provide nameplates with black letters on white background.
3. Minimum letter height is 1/2-inch for instrument description and 1/4-inch height for instrument tag number.
4. For all panels which have a panel identification number, provide 2-inch high white nameplate with black, 1-inch high lettering with panel identification number.
5. Provide labeling inside enclosure identifying the following as a minimum:
a. Panel manufacturer.
b. Panel manufacturers' contact information.
c. Short Circuit Current Rating (SCCR).

2.4 FABRICATION

A. General:
1. Fabricate panels with instrument arrangements as shown on the Drawings.
2. Prime control panels with rust inhibitive shop applied primer and paint with two coats of UV resistant white water-based paint.
3. Finish interior of panel with epoxy glass white.
4. Provide control panel which meets the following requirements:
5. Panel depth per JIC EMP-1-1967, E7.1.4.
6. Door opening per JIC EMP-1-1967, E7.1.5.
7. Data pocket per JIC EMP-1-1967, E7.1.6.
8. Rigidity per JIC EMP-1-1967, E7.1.7.
9. Door alignment and reinforcement per JIC EMP-1-1967, E7.1.8.
10. Panel holes and openings per JIC EMP-1-1967, E7.3.2, E7.3.3, and E7.3.4.
11. Doors per JIC EMP-1-1967, E7.5.
12. Clear panel mounting space per JIC EMP-1-1967, E8.2.9.
13. Panel mounted control device location per JIC EMP-1-1967, E8.3.4.
14. Clearances in enclosures per JIC EMP-1-1967, E8.4.

B. Free-Standing Panels:
1. Minimum construction thicknesses:
a. Front panel, subpanel, or front door with cutouts: 0.123-inch.
b. Top, sides, back, filler plates and side or doors with no cutouts: Minimum thickness per, NEMA ICS 6, Tables 3-8, 9.
2. Welded construction.
3. Completely enclosed, self-supporting, and gasketed dusttight.

4. Edges turned back minimum of 2-inch.
5. Seams and corners welded and ground smooth to touch and smooth in visual appearance.
6. Arrange control panel faces continuous and flush with face of adjacent electrical motor control centers.
7. Provide filler panels where necessary to close gaps between panels or back of panel and wall. Provide full length flush pan doors.
8. Provide full length piano hinges rated for 1.5 times door plus instrument weight.
9. Furnish doors with keyed alike locking handles and three point catch.
10. Provide appropriate conduit, wiring, and instrument openings in accordance with best panel design.
11. After cutouts have been made, finish opening edges to smooth and true surface condition.
12. Provide each panel with lifting eyebolts. Furnish hot-dipped galvanized steel base channels.
13. Slotted bolt holes in base, 1-1/2 long for field adjustment.

C. Wall Mounted Panels:
   1. Minimum construction thicknesses:
      a. Front panel, subpanel or door with cutouts:
         1) Width or height not exceeding 42-inches: 0.093-inch.
         2) Width or height exceeding 42-inches: 0.123-inch.
      b. Side, top, back and doors without cutouts: minimum thickness per NEMA ICS 6, Tables 3-8,9.
   2. Seams continuously welded and ground smooth.
   3. Body stiffeners for extra rigidity if either height or width exceeds 28 IN.
   4. Rolled lip around all sides of enclosure door opening.
   5. Gasketed dust tight.
   6. Three-point latching mechanism operated by oil tight key-locking handle.
   7. Key doors alike.
   8. Continuous heavy gauge hinge pin on doors.
   9. Hinges rated for 1.5 times door, plus instrument weight.
   10. After cutouts have been made, finish opening edges to smooth and true surface condition.
   11. Front full opening door.
   12. Brackets for wall mounting.

D. Panel Front Construction:
   1. Minimum Construction Thicknesses: Per NEMA ICS 6, Tables 3-8, 9.
   2. Welded construction.
   3. Edges turned and ground smooth to touch and visual appearance.
   4. At joints where panel face meets side walls, provide dustproof sponge rubber gasket entire height and face.

5. Use full length piano hinges rated for 1.5 times door weight for panel access door.
6. Equip doors with locking devices and handle and three point catches.
7. Finish all instrument cutouts smooth and true.

E. Panel Wiring and Piping:
1. Factory pipe and wire panels to identified terminal blocks equipped with screw type lugs.
2. Install all wiring without splicing in factory in raceways:
   a. Size raceways per the requirements of NEC Article 312.
   b. Raceways shall have removable covers.
3. Wire bending space shall be in accordance with Tables 307B, C in NEMA ICS 6.
4. Keep AC power lines separate from low-level DC lines, I/O power supply cables, and all I/O rack interconnect cables.
5. Keep AC signal wires separate from DC signal wires.
6. When I/O wiring must cross AC power wiring, it shall only do so at right angles.
7. Arrange circuits on terminal blocks plus any spare conductors on adjacent terminals.
8. Provide necessary power supplies for control equipment.
9. Equip each panel with a main thermal magnetic circuit breaker. Limit load to maximum of 80% of circuit breaker rating.
10. Provide all necessary stabilizing voltage transformers, balancing potentiometers and rectifiers as necessary for specific instrument requirements.
11. Assure each panel mounted device is bonded or otherwise grounded to panel or panel grounding system by means of locknuts or pressure mounting methods.
    a. Equip panel with grounding terminals.
12. Arrange wiring with sufficient clearance for all leads.
13. Wiring to subpanels or rotary switches shall be individually bundled and installed with a "flexible loop" of sufficient length to permit the component to be removed from panel for maintenance without disconnecting wiring.
14. Identify all wires with plastic sleeve type wire markers at each end. Markers shall:
    a. Identify circuit numbers.
    b. Identify function and polarity.
15. Provide all wiring according to color code as follows:

Color of Insulation	120 V, 60 Hz Service	Low Voltage DC Service
Black	Phase Conductor	
Red	Signal Wire	
White	Neutral	

Brown		DC Common
Orange		24 VDC/12 VDC Power
Blue		Signal Wires
Green	Ground	Ground

a. For intrinsically safe instruments, provide uniform and compatible additional color scheme.

16. Termination Requirements:
    a. Terminal block markings, mechanical characteristics and electrical characteristics shall be in accordance with NEMA ICS 4.
    b. Terminals shall facilitate wire sizes as follows:
        1) 120 VAC applications: Wire size 12 AWG and smaller.
        2) Other: Wire size 14 AWG and smaller.
    c. Provide terminal blocks with continuous marking strip.
    d. Tag each I/O terminal to indicate tag number of the connected device.
    e. Provide terminals for individual termination of each signal shield.
    f. Provide 20% excess terminals for future expansion.
17. Pneumatic tubes and appurtenances:
    a. Provide 1/4-inch OD pneumatic control tubing.
    b. Main headers within panels shall be minimum 1-inch.
    c. Compression-type pressure fittings.
    d. Equip panel instrument leads with globe type isolation valve.
    e. Connection to devices not in the panel shall be terminated on tubing terminal plate.
    f. Install tubing neatly and mount securely.
    g. Do not route tubing in front of or in wiring raceways.
    h. Code terminal plates.
    i. Supply and install dual function filter regulator to serve pneumatic devices.

F. Panel Lighting and Power:
1. Receptacles:
    a. Panels less than 4 feet long:
        1) One electrical outlet.
        2) One incandescent light fixture with switch(es) and separate circuit breakers.
    b. Panels or panel faces greater than 4 feet long:
        1) One electrical outlet per 6 feet of length.
        2) Continuous fluorescent lighting strip with switches and separate circuit breakers.

G. Environmental Controls:
1. Furnish circulation fans near hot spots where required to prevent temperature from exceeding instrument rating.

2. Over-temperature switches shall be utilized to provide special cooling if required to maintain operating temperatures within the manufacturer's specified range.
3. Air conditioning applications shall include means of preventing moisture condensation.
4. For panels or control cabinets located outside, or in area classification requiring a NEMA 4 or 4X rating:
    a. Provide printed circuit boards with "Humiseal" conformal coating, covering entire components on both side of board except not covering adjustable components.
    b. Furnish gold plated edge connectors on circuit board and socket contacts.
    c. Install thermostatically controlled condensation protection heaters or 10 cubic inch desiccant packs in enclosures housing electronic equipment.
        1) Provide one pack for each 10 cubic feet of panel capacity.

2.5 MAINTENANCE MATERIALS

A. Extra Materials:
    1. Replacement Bulbs. Provide minimum 25% or 25 bulbs, whichever is greater, for replacement indicating light bulbs for each type of indicator furnished in this Project.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install free-standing panels on concrete pads as detailed on the Drawings.

B. Anchor panel fronts rigidly into wall system with approved anchorage devices.

END OF SECTION

SECTION 16170

GROUNDING AND BONDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 SUBMITTALS

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

B. Product Data: For the following:
   1. Ground rods.
   2. Grounding conductors and cables.
   3. Connector products.

C. Submit Shop Drawings identifying each ground rod location, distance between Ground Rods and ground rod assemblies and other grounding electrodes. Identify each by letter in alphabetical order, add a key legend including GPS coordinates.

D. Qualification Data: For firms and persons specified in Paragaph 1.4 of this Specification.

E. Field Test Reports: Submit written test reports to include the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.4 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.
   1. Comply with UL 467.

B. Comply with NFPA 70; for overhead-line construction and medium-voltage underground construction, comply with IEEE C2.

C. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Grounding Conductors, Cables, Connectors, and Rods:
      a. Apache Grounding/Erico, Inc.
      b. Chance/Hubbell.
      c. Copperweld Corp.
      d. Dossert Corp.
      e. Erico, Inc.; Electrical Products Group.
      f. Framatome Connectors/Burndy Electrical.
      g. Galvan Industries, Inc.
      h. Kearney/Cooper Power Systems.
      i. Korns: C. C. Korns Co.; Division of Robroy Industries.
      j. O-Z/Gedney Co.; a business of the EGS Electrical Group.
      k. Raco, Inc.; Division of Hubbell.
      l. Superior Grounding Systems, Inc.
      m. Thomas & Betts, Electrical.

2.2 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Sections 16123 and 16124, Conductors and Cables.

B. Material: Copper.

C. Equipment Grounding Conductors: Insulated with green-colored insulation.

D. Isolated Ground Conductors: Insulated with green-colored insulation with yellow stripe. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.

E. Grounding Electrode Conductors: Stranded cable.

F. Underground Conductors: Bare, tinned copper, stranded, unless otherwise indicated.

G. Bare Copper Conductors: Comply with the following:
   1. Solid Conductors: ASTM B3.
   2. Assembly of Stranded Conductors: ASTM B8.
   3. Tinned Conductors: ASTM B33.

H. Copper Bonding Conductors: As follows:
   1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4-inch in diameter.
   2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
   3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8-inches wide and 1/16-inch thick.
   4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8-inches wide and 1/16-inch thick.

I. Grounding Bus: Bare, annealed copper bars of rectangular cross-section, with insulators.

2.3 CONNECTOR PRODUCTS

A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

B. Bolted Connectors: Bolted pressure-type connectors, or compression type.

C. Welded Connectors: Exothermic welded type, in kit form, and selected per manufacturer's written instructions.

2.4 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel.
   1. Size: 3/4-inch in diameter by 120-inches long.

B. Ground Rods: Sectional type; copper-clad steel.
   1. Size: 3/4-inch in diameter by 120-inches long.

PART 3 - EXECUTION

3.1 APPLICATION

A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

B. In raceways, use insulated equipment grounding conductors.

C. Exothermic Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells.

D. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.

E. Ground Rod Clamps at Test Wells: Use bolted pressure clamps with at least two bolts.

F. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
   1. Use insulated spacer, space 1-inch from wall and support from wall 6-inches above finished floor, unless otherwise indicated.
   2. At doors, route the bus up to the top of the door frame, across the top of the doorway, and down to the specified height above the floor.

G. Underground Grounding Conductors: Use copper conductor, No. 4/0 AWG minimum. Bury at least 24-inches below grade or bury 12-inches above duct bank when installed as part of the duct bank.

3.2 EQUIPMENT GROUNDING CONDUCTORS

A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

B. Install equipment grounding conductors in all feeders and circuits.
   1. Install insulated equipment grounding conductor with circuit conductors for the following items, in addition to those required by NEC:
   2. Feeders and branch circuits.
   3. Lighting circuits.
   4. Receptacle circuits.
   5. Single-phase motor and appliance branch circuits.
   6. 3-phase motor and appliance branch circuits.
   7. Flexible raceway runs.
   8. Armored and metal-clad cable runs.

C. Busway Supply Circuits: Install insulated equipment grounding conductor from the grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.

D. Computer Outlet Circuits: Install insulated equipment grounding conductor in branch-circuit runs from computer-area power panels or power distribution units.

E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate grounding conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

F. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply raceway with a non-metallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate equipment grounding conductor. Isolate equipment grounding conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

G. Non-metallic Raceways: Install an equipment grounding conductor in non-metallic raceways unless they are designated for telephone or data cables.

H. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
   1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-inch by 2-inch by 12-inch grounding bus.
   2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

I. Metal Poles Supporting Outdoor Lighting Fixtures: Provide a grounding electrode in addition to installing a separate equipment grounding conductor with supply branch circuit conductors.

3.3 COUNTERPOISE

A. Ground the steel framework of the building with a driven ground rod at the base of every corner column and at intermediate exterior columns at distances not more than 60 feet apart. Provide a grounding conductor (counterpoise), electrically connected to each ground rod and to each steel column, extending around the perimeter of the building. Use tinned-copper conductor not less than No. 4/0 AWG for counterpoise and for tap to building steel. Bury counterpoise not less than 18-inches below grade and 24-inches from building foundation.

3.4 INSTALLATION

A. Ground Rods: Install at least three rods spaced at least one rod length from each other, and located at least the same distance from other grounding electrodes.
   1. Drive ground rods until tops are 2-inches below finished floor or final grade, unless otherwise indicated.
   2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.

B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

C. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

D. Metal Water Service Pipe: Provide insulated copper grounding conductors, in conduit, from building's main service equipment or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

E. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.

F. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.

G. Bond each aboveground portion of gas piping system upstream from equipment shut-off valve.

H. Install test wells as indicated on the Contract Documents.

3.5 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
   1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.

2. Make connections with clean bare metal at points of contact.
3. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically non-continuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

E. Connections at Test Wells: Use compression-type connectors on conductors and make bolted- and clamped-type connections between conductors and ground rods.

F. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

G. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

H. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.6 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

A. Duct Banks: Install a grounding conductor with at least 50% ampacity of the largest phase conductor in the ductbank.

B. Manholes and Handholes: Install a driven ground rod close to wall and set rod depth to 4-inches above handhole or manhole floor. If necessary, install ground rod before manhole is placed and provide a No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole

wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive tape or heat-shrunk insulating sleeve from 2-inches above to 6-inches below concrete. Seal floor opening with waterproof, non-shrink grout.

C. Connections to Manhole Components: Connect exposed-metal parts, such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

D. Pad-Mounted Transformers and Switches: Install two ground rods and counterpoise circling pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Use tinned-copper conductor not less than No. 4/0 AWG for counterpoise and for taps to equipment ground pad. Bury counterpoise not less than 18-inches below grade and 6-inches from the foundation.

3.7 FIELD QUALITY CONTROL

A. See Specification 16920, 3.1, Qualifications, for Independent Third Party Testing organization requirements.

B. Testing: Perform the following field quality control testing:
   1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
   2. Test completed grounding system at each location where a maximum ground resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by the fall-of-potential method according to IEEE 81.
   3. Provide Drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
      a. Equipment Rated 500 kVA and Less: 10 ohms.
      b. Equipment Rated 500 to 1,000 kVA: 5 ohms.
      c. Equipment Rated More Than 1,000 kVA: 3 ohms.
      d. Substations and Pad-Mounted Switching Equipment: 5 ohms.

e. Manhole Grounds: 10 ohms.

4. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION

SECTION 16190

SUPPORTING DEVICES

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Supports, anchors, sleeves, and seals are indicated on the Drawings, schedules, and specified in other Sections of these Specifications.

B. Types of supports, anchors, sleeves and seals specified in this Section include the following:
   1. One-hole conduit straps.
   2. One-hole conduit straps with clamp backs.
   3. Two-hole conduit straps.
   4. Conduit hangers.
   5. I-beam clamps.
   6. Channel clamps.
   7. Round steel rods.
   8. Drop-in anchors.
   9. Wedge type anchor bolts.
   10. Lead expansion anchors.
   11. Toggle bolts.
   12. Wall and floor seals.
   13. Cable supports.
   14. U-Channel strut system.
   15. Sleeves.

1.2 SUBMITTALS

A. Products shall be submitted in accordance with Section 16000, General Electrical Requirements, and elsewhere in the Contract Documents, prior to installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following: Abbeon Cal Inc., Ackerman Johnson Fastening Systems Inc., Elcen Metal Products Co., Ideal Industries, Inc., Josyln Mfg and Supply Co., McGraw Edison Co., Rawlplug Co. Inc., Star Expansion

Co., U.S. Expansion Bolt Co., Allied Tube and Conduit Corp., B-Line Systems, Inc., Greenfield Mfg Co., Inc., Midland-Ross Corp., O-Z/Gedney Div; General Signal Corp., Power-Strut Div.; Van Huffel Tube Corp., and Unistrut Div; GTE Products Corp., and Robroy Industries.

2.2 GENERAL

A. Provide supporting devices that comply with manufacturers standard materials, design, and construction, in accordance with published product information, and as required for complete installations, and as specified herein.

2.3 SUPPORTS

A. Provide supporting devices of types, sizes, and materials indicated, and having the following construction features:
   1. One-Hole Conduit Straps: For supporting electrical metallic tubing, and liquidtight flexible conduit; zinc plated steel, stainless steel or galvanized steel; snap-on, heavy duty.
   2. One-Hole Conduit Straps with Clamp Backs: For supporting rigid metal conduit, and intermediate metal conduit; cast galvanized steel.
   3. Two-Hole Conduit Straps: For supporting electrical metallic tubing, rigid metal conduit, and intermediate metal conduit; zinc plated steel, stainless steel or galvanized steel.
   4. Conduit Hangers: For supporting electrical metallic tubing, rigid metal conduit, and intermediate metal conduit; zinc plated steel, stainless steel or galvanized steel.
   5. I-Beam Clamps: Electroplated zinc or hot-dipped galvanized malleable iron.
   6. Channel Clamps: Electroplated zinc or hot-dipped galvanized steel.
   7. Round Steel Rod: National coarse thread, electroplated.

2.4 ANCHORS

A. Provide anchors of types, sizes, and materials indicated, with the following construction features:
   1. Lead Expansion Anchors: For CMU walls, 1/4-inch-20 threads, set tool required.
   2. Toggle Bolts: Electroplated steel, size as required.
   3. Drop-in Anchors: Stainless steel, size as required.
   4. Anchor Bolts: Stainless steel, size as required.
   5. Half-round head, non-removable anchor bolts shall not be used.

2.5 SEALS

A. Provide seals of types, sizes, and materials indicated, with the following construction features:

1. Wall and Floor Seals: Provide factory-assembled watertight wall and floor seals, of types and sized indicated; suitable for sealing around conduit, pipe, or tubing passing through concrete floors and walls. Construct seals with steel sleeves, malleable iron body, neoprene sealing grommets and rings, metal pressure rings, pressure clamps, and cap screws.
2. Conduit sealing bushings shall be manufactured by O-Z/Gedney, Model CSMI, or equal.
3. The conductor sealing bushings shall be manufactured by O-Z/Gedney, Model CSBG, or equal.

2.6 CONDUIT CABLE SUPPORTS

A. Provide cable supports with insulating wedging plug for non-armored type electrical cables in risers; construct 2-inch rigid metal conduit; 3-wires, type wire as indicated; construct body of malleable-iron casting with hot-dip galvanized finish.

2.7 U-CHANNEL STRUT SYSTEM

A. Provide U-channel strut system for supporting electrical equipment, 12 gauge hot-dip galvanized steel, of types and sizes indicated; construct with 9/16-inch diameter holes, 8-inch o.c. on top surface, with the following fittings that mate and match with U-channel:
   1. Fixture hangers.
   2. Channel hangers.
   3. End caps.
   4. Beam clamps.
   5. Wiring stud.
   6. Thinwall conduit clamps.
   7. Rigid conduit clamps.
   8. Post bases.
   9. U-bolts.

2.8 PIPE SLEEVES

A. Provide pipe sleeves from the following:
   1. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.

2.9 PVC COATED U-CHANNEL STRUT SYSTEM

A. Provide PVC Coated U-channel strut system for supporting electrical equipment, 20 mil PVC coated steel, of types and sizes indicated; construct with 9/16-inch diameter holes, 8-inch o.c. on top surface, with all stainless steel hardware, and the following fittings that mate and match with PVC coated U-channel:
   1. PVC coated strut nut.

2. PVC coated pipe straps.
3. Touch up compound (gray).

2.10 STAINLESS STEEL U-CHANNEL STRUT SYSTEM

A. Provide stainless steel U-channel strut system for supporting electrical equipment, of types and sizes indicated; construct with 9/16-inch diameter holes, 8-inch o.c. on top surface, with all stainless steel hardware, and the following stainless steel fittings that mate and match with stainless steel U-Channel:
   1. Fixture hangers.
   2. Channel hangers.
   3. End caps.
   4. Beam clamps.
   5. Wiring stud.
   6. Post bases.
   7. Rigid conduit clamps.
   8. U-bolts.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install hangers, anchors, sleeves, and seals as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to insure supporting devices comply with requirements. Comply with requirements of NECA and NEC for installation of supporting devices.

B. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.

C. Install hangers, supports, clamps and attachments to support piping properly from building structure. Arrange for grouping of two or more parallel runs of conduits to be supported together on channel type hangers where possible. Install supports with spacing indicated and in compliance with NEC requirements.

D. Torque sleeve seal nuts, complying with manufacturer's recommended values. Ensure that sealing grommets expand to form watertight seal.

E. Comply with manufacturer’s recommendations for touch up of field cut ends or damaged PVC coated U-channel and fittings.

F. Remove burrs and apply a cold zinc galvanizing paint to field cut galvanized U-channel strut.

END OF SECTION

SECTION 16195

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Electrical identification work specified in this Section covers the following:
   1. Buried cable warnings.
   2. Electrical power, control and communication conductors.
   3. Operational instructions and warnings.
   4. Danger signs.
   5. Equipment/system identification signs.

1.2 SUBMITTALS

A. Submittals to the ENGINEER shall include the following:
   1. Manufacturers data on electrical identification materials and products.
   2. Samples of each color, lettering style, and other graphic representation required for each identification material or system.

1.3 MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering electrical identification products maybe incorporated in the Work include, but not limited to, the following:
   1. Brady, W.H. Co.
   2. Ideal Industries, Inc.
   3. Panduit Corp.
   4. Or equal.

1.4 QUALITY COMPLIANCE

A. Comply with applicable requirements of UL Std. 969, "Marking and Labeling Systems", pertaining to electrical identification systems.

B. Comply with applicable requirements of NEMA Std. No's WC-1 and WC-2 pertaining to identification of power and control conductors.

PART 2 - PRODUCTS

2.1 GENERAL

A. Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an application, selection is installer's option, but provide single selection for each application.

2.2 COLOR-CODED CONDUIT MARKERS

A. Provide manufacturer's standard pre-printed, flexible or semi-rigid, permanent, plastic-sheet conduit markers, extending 360 degrees around conduits; designed for attachment to conduit by adhesive, adhesive lap joint of marker, matching adhesive plastic tape at each end of marker, or pretensioned snap-on. Except as otherwise indicated, provide lettering that indicates voltage of conductor(s) in conduit. Provide 8-inches minimum length for 2-inch and smaller conduit, 12-inches length for larger conduit.

B. Unless otherwise indicated or required by governing regulations, provide white markers with black letters.

2.3 CABLE AND CONDUCTOR WIRE MARKERS

A. Cable and conductor wire markers shall be self laminating vinyl on white background, printed using a Seton printer, a Brady TLS2200 printer or equal. Handwritten wire markers are not acceptable.

2.4 SELF-ADHESIVE PLASTIC SIGNS

A. Provide manufacturer's standard, self-adhesive or pressure-sensitive, pre-printed, flexible vinyl signs for operational instructions or warnings; of sizes suitable for application areas and adequate for visibility, with proper wording for each application, e.g., 208 V, EXHAUST FAN, RECTIFIER.

B. Unless otherwise indicated or required by governing regulations, provide white signs with black lettering.

2.5 LETTERING AND GRAPHICS

A. Coordinate names, abbreviations and other designations used in electrical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper

identification and operation/maintenance of electrical systems and equipment. Comply with ANSI A13.1 pertaining to minimum sizes for letters and numbers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install electrical identification products as indicated, in accordance with manufacturer's written instructions and requirements of NEC.

B. Where identification is to be applied to surfaces that require finish, install identification after completion of painting.

C. Comply with governing regulations and requests of governing authorities for identification of electrical work.

3.2 CONDUIT IDENTIFICATION

A. Where electrical conduit is exposed in spaces with exposed mechanical piping that is identified by a color-coded method, apply color-coded identification on electrical conduit in manner similar to piping identification. Except as otherwise indicated, use white as coded color for conduit.

3.3 CABLE/CONDUCTOR IDENTIFICATION

A. Apply cable/conductor identification, including voltage, phase and feeder number, on each cable/conductor in each box/enclosure/cabinet where wires of more than one circuit or communication/signal system are present, except where another form of identification (such as color-coded conductors) is provided. Match identification with marking system used in panelboards, shop drawings, contract documents, and similar previously established identification for Project's electrical work.

3.4 EQUIPMENT/SYSTEM IDENTIFICATION

A. Install engraved plastic-laminate sign on each major unit of electrical equipment in building; including central or master unit of each electrical system including communication-control-signal systems, unless unit is specified with its own self-explanatory identification or signal system. Except as otherwise indicated, provide single line of text, 1/2-inch high lettering on 1-1/2-inch high sign (2-inch high where two lines are required), white lettering in black field. Provide text matching terminology and numbering of the contract documents and shop drawings. Provide signs for each unit of the following categories of electrical work:

1. Panelboards, electrical cabinets and enclosures.
2. Access panel/doors to electrical facilities.
3. Major electrical switchgear.

B. Install signs at locations indicated or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of equipment. Secure to substrate with brass or stainless steel screws, except use adhesive where screws should not or cannot penetrate the substrate.

3.5 CIRCUIT IDENTIFICATION

A. The 3-phase wires shall be identified at the switchgear, panelboards and motor control centers as Phases A, B, and C. At 277/480 V, Phase A shall be brown, Phase B shall be orange, and Phase C shall be yellow. The neutral shall be gray.

B. In addition to color coding all conductors, each conductor shall be identified in each pull box, manhole, panelboard, cable tray, or termination with circuit identification markers. This identification is applicable to all power, control, alarm, and instrumentation conductors and these markings shall be recorded on the Record Documents. Markers shall be slip-on PVC sleeve type as manufactured by Brady, Seton, or equal.

C. Markers for other cabling shall be B-292 vinyl as manufactured by Brady, Seton, or equal.

D. Exposed medium voltage conduits shall be labeled at 50 foot intervals with 1-inch letters stating the voltage - example – "12,470 volts". Labels shall be vinyl plastic as manufactured by Brady, Seton, or equal.

3.6 AUTOMATIC EQUIPMENT WARNING SIGNS

A. Permanent warning signs shall be mounted at all mechanical equipment that may be started automatically or from remote locations. Signs shall be in accordance with OSHA Regulations and shall be suitable for exterior use. The warning signs shall be fastened with round head brass screws or bolts, located and mounted in a manner acceptable to the ENGINEER.

B. Warning signs shall be 7-inches high by 10-inches wide, colored yellow and black, on not less than 18 gauge vitreous enameling stock. Sign shall read:

CAUTION
THIS EQUIPMENT STARTS
AUTOMATICALLY
BY REMOTE CONTROL

3.7 HIGH VOLTAGE WARNING SIGNS

A. Permanent and conspicuous warning signs shall be mounted on all equipment, doorways to equipment rooms, pull boxes, manholes, where the voltage exceeds 600 volts.

B. Signs shall be in accordance with OSHA regulation, and shall be suitable for exterior use. The warning signs shall be fastened with round head brass screws or bolts, located and mounted in a manner acceptable to the ENGINEER.

C. Signs shall be 7-inches high by 10-inches wide, colored red and white, on not less than 18 gauge vitreous enameling stock. Sign shall read:

WARNING
HIGH VOLTAGE
KEEP OUT

3.8 CONDUCTOR FASTENERS

A. Glue-on type conductor fasteners shall not be used in any panels, panelboards, switchboards, switchgear, motor control centers, or other enclosures containing electrical devices and/or conductors.

END OF SECTION

SECTION 16440

DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This Section covers electrical disconnecting switches.

1.2 SUBMITTALS

A. Products shall be submitted in accordance with Section 16000, General Electrical Requirements, and elsewhere in the Contract Documents, prior to installation.

PART 2 - PRODUCTS

2.1 DISCONNECT SWITCHES

A. Disconnect switches shall be heavy-duty safety switches with a quick-make, quick-break operating mechanism, with full cover interlock, and indicator handle. The disconnect switches shall be furnished with fuses of the size indicated on the Drawings. One set of spare fuses shall be furnished for each fused disconnect switch. Disconnect switches shall be NEMA Type HD heavy duty construction, UL 98 listed.

B. Enclosures shall be rated NEMA 12 for indoor use and NEMA 3R for outdoor use, unless otherwise indicated on the Drawings.

C. Disconnect switch handle shall be padlockable.

D. Disconnect switches in the corrosive areas, as indicated on the Drawings, shall be NEMA 4X, 304 stainless steel.

E. Disconnect switches shall be as manufactured by Square D, Cutler Hammer, Allen-Bradley, General Electric, or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Disconnect switches shall be installed as indicated on the Drawings.

B. Provide grounding per NEC and Section 16170, Grounding and Bonding.

3.2 TESTING

A. Test in accordance with Specification 16920, Electrical Acceptance Testing.

END OF SECTION

SECTION 16902

ELECTRICAL CONTROLS, RELAYS, AND ALARMS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This Section includes the following:
   1. Pushbutton and selector switches.
   2. Relays.
   3. Alarms.
   4. Intrinsic safety barriers.
   5. Wireways.
   6. Watt-hour transducers.
   7. Elapsed time meters and time clocks.
   8. Temperature Switches.

1.2 RELATED SECTIONS

A. Section 16000, General Electrical Requirements.

B. Section 16160, Enclosures.

1.3 REFERENCES

A. NEMA ICS 1, General Standards for Industrial Control Systems.

B. NEMA ICS 2, Standards for Industrial Control Devices, Controllers and Assemblies.

C. NEMA ICS 6, Enclosures for Industrial Controls and Systems.

D. NEMA ST 1, Standard for Specialty Transformers (Except General Purpose Type).

1.4 SUBMITTALS

A. Data: A complete list of equipment and material including manufacturer's descriptive data and technical literature, performance charts, catalog cuts and installation instructions, spare parts data for each different item of equipment specified. The data shall include a complete Bill of Materials.

B. Drawings: Containing complete wiring and schematic diagrams, control diagrams, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout, anchorage, support and appurtenances of equipment and equipment relationship to other parts of the work including clearances for maintenance and operations.

C. Submit Shop Drawings in accordance with the Contract Documents and NEMA ICS 1 Specifications indicating control panel layouts, wiring connections and diagrams, dimensions, support points.

1.5 PROJECT RECORD DOCUMENTS

A. Submit record documents in accordance with the Contract Documents.

B. Accurately record actual locations of control equipment. Revise diagrams included in Drawings to reflect actual control device connections.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit operation data in accordance with the Contract Documents.

B. Include instructions for adjusting and resetting time delay relays, timers, and counters.

C. Submit maintenance data in accordance with the Contract Documents.

D. Include recommended preventative maintenance procedures and materials.

PART 2 - PRODUCTS

2.1 PUSHBUTTONS AND SELECTOR SWITCHES

A. Pushbuttons, pilot lights, and selector switches shall be of the full size, heavy-duty industrial, oil tight, 120 volt, with interchangeable pilot lights, plug-in construction, double break silver contacts, chrome plated lock rings, with modular contacts, and NEMA rating equal to that of the enclosure on which devices are installed. All components shall be flush mounted on front of panel, unless otherwise noted.

B. Provide individual legend plates for indication of switch, pushbutton, and light function (e.g., Open, Closed, Hand-Off-Auto). A list shall be submitted for review and approval.

C. Pilot lights shall be high intensity LED type. Pilot lights shall have clear lenses and LED lamps colored as shown on the Drawings. Common, remote push-to-test circuitry shall be provided for each control panel to simultaneously test all indicating lights on the panel using a single pushbutton when there are 10 or more lights on the panel. Control panels with less than 10 lights shall utilize individual push-to-test lights and control circuitry.

D. Pushbuttons shall be maintained or momentary as required and as shown on the Drawings. Provide extended head pushbutton for all stop functions, mushroom head for emergency stop functions, and flush head pushbuttons for all other functions. Where indicated on the Drawings pushbuttons shall be illuminated type. Provide locking mechanism for all lock out functions. Selector switches shall have black knob operator, be maintained contact type unless noted otherwise, number and arrangement as required to perform intended functions specified but not less than one double pole, double throw, double break contact per switch. Contact rating shall be compatible with AC or DC throughput current of devices simultaneously operated by the switch contact but not less than 10 amperes resistive at 120 volts AC or DC continuous.

E. Potentiometers shall be provided with operators and resistive elements of the type and quantity indicated on the Drawings and as required with legend plates indicating percent of span.

F. The above devices shall be manufactured by Cutler Hammer or approved equal.

2.2 RELAYS

A. Timing relays shall be heavy duty, have 250 V/5A rated contacts, solid state design, poles as required per application, -10□□C to +60□□C, have timing repeatability of ±2.0% of setting, and be UL listed. The range shall be determined from the control descriptions and or schematic drawings. Provide mounting accessories, as required. The timing relays shall be manufactured by Allen Bradley, Square D, Cutler Hammer, or equal.

B. Control relays shall be of the plug-in socket base type with dust-proof plastic enclosures, with silver-cadmium oxide contacts rated 250 volt, 10 amperes, with contact arrangement and operating coils of the proper voltage as required by the control circuit sequence. Relays shall have indicating lamp to show energized state. Each relay shall have a minimum of two double pole, double throw contacts, or as required. Control relays shall be Allen Bradley, Square D, Cutler Hammer, or equal.

C. Alternating relays shall be UL listed, 120 VAC, with contacts rated for 10 amperes at 250 VAC, life expectancy of 100,000 operations, load indicating LEDs, and switch for load locking and load selecting options. Alternating relays

shall be manufactured by Time Mark Models 261, 271, and 471, Diversified Electronics Model ARA, A.T.C. model "AR", or equal.

2.3 ALARMS

A. Audible alarms shall be UL listed, 120 VAC, with solid state circuitry, vibrating horn, non-metallic corrosion resistant housing, with required mounting hardware, suitable for outdoor use capable of producing 100 dB at 10 feet. The audible alarm shall be manufactured by Federal Signal model 350, Edwards Model 870-EX, or equal.

B. Rotating beacons for interior and/or exterior locations shall be UL listed, 120 VAC, with motor and cooling fan, rotating lights at 60 times per minute minimum, capable of producing 36,000 candlepower with required mounting hardware. Lens color shall be verified at the time of construction. The rotating beacons shall be manufactured by Federal Signal Model 371L or equal.

C. Rotating beacons for corrosive and/or hazardous locations shall be UL listed, 120 VAC, with solid state circuitry, rotating lights at 60 times per minute minimum, suitable for outdoor use capable of producing 36,000 candlepower with required mounting hardware. Lens color shall be verified at the time of construction. The rotating beacons shall be manufactured by Edwards Model 52EX, or equal.

D. Strobe beacons shall be UL listed, NEMA 4X, 120 VAC, flashing at 80 times per minute minimum, producing peak candlepower of 520,000, effective candlepower of 165, with required mounting hardware. Lens color shall be verified at the time of construction. The rotating beacons shall be manufactured by Federal Signal model 151XST, Edwards Model 92EX, or equal.

2.4 INTRINSIC SAFETY BARRIERS

A. Intrinsic safety barriers shall permit connection of devices located in a hazardous area to other devices located in a safe area. Intrinsic safety barriers shall be EMC compliant, 10 to 35 VDC, 35 mA output current, hazardous area terminals identified by blue labels, terminals accommodating conductors up to 12 AWG, ambient temperature rating of -20° C to +60° C. The intrinsic safety barriers shall be manufactured by MTL Inc., Ronan Engineering Co., R. Stahl Inc., A.T.C., or equal.

2.5 WIREWAYS

A. Wireways shall be PVC, snap-in slot design, with non-slip cover. Safe area wireways shall be light gray and marked "Safe Area Wiring". Hazardous area wireways shall be intrinsic blue and marked "Hazardous Area Wiring". The wireways shall be manufactured by Panduit Corporation or equal.

2.6 WATTHOUR TRANSDUCERS

A. Watt-hour Transducers for active or reactive power shall be DIN rail and surface mount, single-phase or three-phase with balanced or unbalanced load, electrically isolated input and output signals, 4 to 20 mA output signal, 0 to10 mA to 0 to10 A input current, 0 to 10 V to 0 to 600 VAC input voltage, 16 to 500 Hz selectable frequency. The watthour transducers shall be manufactured by Sineax Model PQ502, or equal.

2.7 ELAPSED TIME METERS AND TIME CLOCKS

A. Elapsed time meters shall be self powered, non-reset, solid state counter which provides silent, accurate and noise immune operation. Elapsed time meters shall require no external power, five year minimum battery life, 120 VAC power, accessories for panel mounting, nameplate below LCD display reading "HOURS", liquid crystal display with 6 digits approximately 2-inches high with 50,000 hour minimum display life and indication of sufficient battery power. The elapsed time meters shall be manufactured by Durant, Automatic Timing and Controls, a Division of Sycon Corp., or equal.

B. Time clocks shall be microprocessor based, have 24 hour time control, up to 24 operations per day, programmable from panel face keys, skip-a-day feature allowing schedule to be skipped for one to seven days, SPDT switch contact rated at 15 amps at 120 VAC, with battery carryover to maintain time and program during power outage for 275 hours. The time clocks shall be manufactured by Tork, Paragon Electric Company, or equal.

2.8 TEMPERATURE SWITCHES

A. Temperature switches shall be self powered, accurate and noise immune operation. Temperature switches range shall be 30 degrees – 140 degrees. Temperature switches shall require no external power, accessories for panel mounting. Alarm contact shall be rated 120VAC, 15 amperes. The temperature switches shall be manufactured by Hoffman, or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Fasteners shall be Type 304 stainless steel.
B. Install devices in strict accordance with NEC requirements and per manufacturer's recommendation.

C. Coordinate with other trades as necessary during installation of these devices.

3.2 ACCEPTANCE

A. All installations are subject to evaluation in accordance with NEC requirements and manufacturers recommendations. CONTRACTOR shall remove the unacceptable work and correct work at no charge to OWNER.

END OF SECTION

SECTION 16920

ELECTRICAL ACCEPTANCE TESTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Requirements for electrical acceptance testing of electrical equipment and materials.
   2. It is the intent of the tests described herein to assure that all electrical equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications.
   3. Acceptance testing performed by equipment vendors at the point of manufacturer must conform to all requirements of this specification. Testing performed at the point of manufacture which conforms to generally accepted industry practices is also acceptable so long as adequate test result documentation is provided.

B. Scope:
   1. All of the Acceptance Tests are required to be performed whether they are described in this Section or other applicable Sections. At a minimum, the following electrical systems are to be tested:
      a. Service entrance section.
      b. Main distribution panel.
      c. Motor control centers.
      d. Switchgear, low and medium voltage.
      e. Panelboards, power and lighting/receptacle.
      f. Transformers, dry type and oil filled.
      g. Feeders.
      h. Cables rated 600 volts and higher.
      i. Transfer switches, manual and automatic.
      j. Transient voltage surge suppression systems.
      k. Grounding and bonding system.
      l. Lighting fixtures and associated controls.
      m. Other systems as listed under Part 3 of this Specification.

C. Related Documents:
   1. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and other Division 1, General Requirements, Specification Sections, apply to the Work of this section.

2. All work performed under this Section of the Work is subject to all requirements contained under Section 16000, General Electrical Requirements".
3. All Division 16, Electrical, Specifications for electrical equipment provided for this Project that requires electrical acceptance testing.

1.2 References

A. NETA ATS, Acceptance Testing Specifications, 2013 edition.

B. NFPA 70, National Electrical Code, 2011 edition.

C. Incorporated by reference all Codes, Standards, and Specifications referred to in the "Applicable References" section of NETA ATS-2013.

1.3 DEFINITIONS

A. NETA, InterNational Electrical Testing Association Inc.

B. NEC, National Electrical Code.

1.4 SYSTEM DESCRIPTION

A. Conditions:
1. Provide all items, articles, materials, operations, or methods listed, mentioned, or scheduled on Drawings and/or herein including all labor, materials, equipment, and incidentals necessary and required for Electrical Acceptance Testing.
2. Following established procedures, equipment shall be energized after certification by the testing organization that the installation is satisfactory.
3. Correct or replace any current-carrying circuit, electrical equipment, or system which is defective or grounded and correct all other troubles encountered by these tests. All defects, whether through faulty workmanship or materials furnished, shall be corrected under this Section at the CONTRACTOR'S expense.

1.5 SUBMITTALS

A. Test Report Forms:
1. All test reports shall be submitted using NETA or approved similar format and, where appropriate, test forms. Reports shall be legible using permanent ink. Pencil is not acceptable.
2. Provide for ENGINEER'S review and approval a copy of each test form to be used on the Project. No testing shall be started prior to approval of all test forms.

3. All test reports shall include the following information:
    a. Summary/description of the Project.
    b. Description of equipment tested.
    c. Description of the tests.
    d. Test data and analysis of the data indicating whether the equipment passed or failed the test.
4. All test data records shall include the following minimum requirements:
    a. Equipment identification, including tag numbers.
    b. Humidity, temperature, and other conditions that may affect the results of the tests and/or calibrations.
    c. Date of inspections, tests, maintenance, and/or calibrations.
    d. Identification of the testing technician and their employer.
    e. Indication of inspections, tests, maintenance, and/or calibrations to be performed and recorded.
    f. Indication of expected results when calibrations are to be performed.
    g. Indication of "as-found" and "as-left" results, as applicable.
    h. Sufficient spaces to allow all results and comments to be indicated.

B. Closeout Submittals:
1. Provide one copy each to ENGINEER and OWNER of all testing reports organized as follows:
    a. Bind report in 3-ring binder(s).
    b. Identify Project name, description, testing organizations name, and submittal date on front face and back cover of binder.
    c. Provide all test reports, organized by equipment tag number.
    d. Separate different equipment numbers with colored or numbered tabs.
    e. Provide an index/table of contents.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Any materials provided as part of the testing shall be new, unused, and in manufacturer's original packing.

2.2 TEST INSTRUMENT CALIBRATION

A. Contractor performing the testing shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy for each test instrument calibrated.
B. Contractor performing the testing shall maintain up-to-date instrument calibration instructions and procedures for each test instrument calibrated.

C. It is preferred that instrument calibration accuracy be directly traceable to the national Institute of Standards and Technology (NIST).

D. Instruments shall be calibrated in accordance with the following frequency schedule:
   1. Field Instruments: Analog, six months maximum. Digital, 12 months maximum
   2. Laboratory Instruments: 12 months maximum
   3. Leased Specialty Equipment: 12 months maximum.

E. Dated calibration labels shall be visible on all test equipment.

F. Records, which show date and results of instruments calibrated or tested, must be kept up to date.

G. Calibrating standard shall be better accuracy than that of the instrument tested.

PART 3 - EXECUTION

3.1 QUALIFICATIONS

A. The testing organization shall be an independent, third party entity which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems being evaluated. When such testing organization is used, it must meet the following requirements:
   1. The testing organization shall be regularly engaged in the testing of electrical equipment, devices, installations, and systems.
   2. The testing organization shall use technicians who are regularly employed for testing purposes.
   3. The testing organization shall be a member of NETA or be able to prove qualifications equal to or better than required for membership in NETA.
   4. Submit appropriate documentation demonstrating that the testing organization meets the requirements listed above.
   5. Technicians performing these electrical tests and inspections shall be trained and experienced concerning the apparatus and systems being evaluated. These individuals shall be capable of conducting the tests in a safe manner and with complete knowledge of the hazards involved. They must evaluate the test data and make a judgment on the serviceability of the specific equipment.
   6. Technicians shall be certified in accordance with ANSI/NETA ETT-2000, “Standard for Certification of Electrical Testing Personnel”. Each on-site crew leader shall hold a current certification, Level III or higher, in electrical testing.

B. CONTRACTOR may perform the electrical acceptance testing under the following conditions:
   1. CONTRACTOR'S personnel performing the testing and their testing equipment meets all other requirements of this Specification.
   2. Written approval is received from ENGINEER after review of testing personnel qualifications. At a minimum, CONTRACTOR'S testing personnel must have specific instruction on the testing instruments, accessories, and tests being performed and must be able to evaluate the test results.

3.2 NOTIFICATION

A. Notify ENGINEER and Construction Manager at least two days prior to testing so that they may be present during testing.

3.3 SAFETY AND PRECAUTIONS

A. Safety practices shall include, but are not limited to, the following requirements:
   1. Occupational Safety and Health Act OSHA.
   2. Accident Prevention Manual for Industrial Operations, National Safety Council, Chapter 4.
   3. Applicable State and local safety operating procedures.
   4. NETA Safety/Accident Prevention Program.
   5. National Fire Protection Association - NFPA 70E.
   6. ANSI Z244.1 American National Standards for Personnel Protection.

B. All tests shall be performed with apparatus de-energized, except where otherwise specifically specified.

C. The testing firm shall have a designated safety representative on the Project to supervise operations with respect to safety.

3.4 EQUIPMENT TESTING REQUIREMENTS

A. The intent of this Specification is not to duplicate testing performed at the point of manufacture or to impose additional burden on the CONTRACTOR which does not benefit the Project. The intent is to verify that electrical equipment has been securely fastened down, supported, and installed in accordance with the manufacturer's requirements. The intent is also to verify that all electrical connections are correctly torqued, properly aligned, properly insulated, and properly supported and that equipment is clean and ready for operation.

B. Except as noted below or as approved by engineer, test the following equipment and assemblies in full accordance with NETA-ATS 2003.

C. Switchgear and switchboard assemblies.

D. Transformers, dry type, air-cooled, low-voltage, small.

E. Transformers, dry type, air-cooled, large.

F. Transformers, liquid-filled.

G. Cables, low-voltage, 600 volt maximum.
   1. Perform tests only on cables Size #4 AWG and larger.

H. Cables, medium-voltage and high-voltage.

I. Metal-enclosed busways.

J. Switches, air, low-voltage:
   1. Perform tests only on switches rated 100 amps or higher.

K. Switches, air, medium-voltage, metal-enclosed.

L. Switches, oil, medium-voltage.

M. Switches, vacuum, medium-voltage.

N. Switches, Cutouts:
   1. Perform tests only on equipment rated 100 amps or higher.

O. Circuit Breakers, Air, Insulated-Case, Molded-Case:
   1. Perform visual and mechanical inspections in accordance with NETA for all circuit breakers.
   2. Perform electrical tests only on circuit breakers rated 100 amps or higher provided in power distribution and lighting/receptacle panelboards.
   3. No testing is required for circuit breakers provided as part of any of the following:
      a. A UL listed control panel.
      b. UL listed factory supplied motor control centers.
      c. Stand-alone combination motor starters.

P. Circuit breakers, air, medium voltage.

Q. Circuit breakers, oil, medium voltage and high voltage.

R. Circuit breakers, vacuum, medium voltage.

S. Circuit switchers.

T. Network protectors, 600 volt class.
U. Protective relays.

V. Metering devices.

W. Regulating apparatus, voltage, step and induction voltage regulators.

X. Regulating apparatus, load tap-changers.

Y. Grounding systems.

Z. Ground-fault protection systems, low-voltage.

AA. Rotating Machinery, AC Motors, and Generators:
1. Motors provided as part of valve actuators do not require testing.
2. Perform visual and mechanical inspections on all motors.
3. Perform rotation tests on all motors.
4. Perform electrical tests only on motors 50 horsepower and larger.

BB. Motor control, motor starters, low-voltage.

CC. Motor control, motor starters, medium-voltage.

DD. Adjustable speed drive systems.

EE. Direct-current systems, batteries, flooded and valve-regulated lead-acid.

FF. Direct-current systems, chargers.

GG. Surge arresters, low-voltage surge protection devices.

HH. Surge arresters, medium and high-voltage surge protection devices.

II. Capacitors and reactors - all types.

JJ. Outdoor bus structure.
KK. Emergency and standby power systems, engine generator.

LL. Emergency and standby power systems, UPS.

MM. Emergency and standby power systems, automatic transfer switches.

NN. Fiber-optic cables.

3.5 CONSTRUCTION

A. Interface with Other Work:
   1. Coordinate all testing activities with other disciplines. Retest any equipment disturbed or damaged in any manner after initial testing.

3.6 CLOSEOUT REPORT

A. Provide comprehensive bound test report in accordance with Part 1 of this Specification.

END OF SECTION

SECTION 17000

INSTRUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Provide complete instrumentation and control systems as indicated on the Drawings, in the Specifications, and as required by other Contract Documents. These documents include descriptions of functional operation and performance, as well as standards, but do not necessarily enumerate detailed specifications for all components and devices which are necessary. However, all components and devices shall be furnished and installed as required to provide complete and operable systems for accomplishing the functions and meeting the performance requirements.
   2. Scope of Work includes:
      a. Provide all instruments.
      b. Provide all control panels, programmable logic controllers (PLC) panels, SCADA consoles.
      c. Provide all communication equipment required to make the control system fully operational including, but not limited to, radios, antennas, switches, routers, hubs, protocol converters, communication cables, and communication racks and power supplies.
      d. Provide all conduit, conductors, enclosures, materials, and labor to fully interconnect and make operational all control system components.
      e. Provide power at proper voltage and amperage to all system components.
      f. Provide programming for the PLC and SCADA components.
      g. Provide start-up and commissioning assistance.
      h. Train OWNER'S personnel on proper use and maintenance of the control systems.
      i. Other equipment, materials, and work as necessary to achieve a fully tested and operational control system.

B. Products Supplied But Not Installed Under This Section:
   1. None.

C. Products Installed But Not Supplied Under This Section:
   1. Instruments and controls provided loose for field installation by packaged equipment or skid-mounted equipment vendors.

D. Related Sections:
   1. All Division 16 Specifications provided for this Project.

2. All Division 17 Specifications provided for this Project.
3. Other division Specifications provided for this project as they relate to Submittals, concrete, structural, piping/plumbing, mechanical, and HVAC systems.

E. Allowances:
1. Not applicable this Section.

F. Unit Prices:
1. Not applicable this Section.

G. Measurement Procedures:
1. Not applicable this Section.

H. Special Payment Procedures:
1. Not applicable this Section.

I. Alternates/Alternatives:
1. All alternates, alternatives, or proposed substitutions of materials or equipment must be approved by ENGINEER.

1.2 REFERENCES

1.3 DEFINITIONS

A. The word "provide" means "furnish and install".

B. PLC means Programmable Logic Controller.

C. SCADA means Supervisory Control and Data Acquisition System.

1.4 SYSTEM DESCRIPTION

A. Design Requirements:
1. Using sound engineering principals and current best design practices, provide engineering Drawings, and design documents specifying system components and detailing their interconnection and installation.

B. Performance Requirements:
1. The instrumentation and control systems shall be furnished and installed complete and ready to operate, including all necessary interconnections and connections to sources of electrical power, air, water, drains and vents, with all required valves, switches and accessories as specified or as recommended for best operation by the manufacturer of the equipment furnished.

1.5 SUBMITTALS

A. General:
   1. Submittals for the equipment shall be provide in accordance with Section 16000, General Electrical Requirements, and as required elsewhere in the Contract Documents.

B. Product Data:
   1. Detailed catalog information for all system components in sufficient detail so that ENGINEER has sufficient information to determine if the equipment is acceptable for the intended purpose. Minimum information shall be:
      a. Instrument or equipment tag number.
      b. Manufacturer.
      c. Model number.
      d. Materials of construction.
      e. Materials in contact with process fluids.
      f. Dimensional information.
      g. Weight.
      h. Power consumption with required voltage and ampacity.
      i. Heat dissipation if greater than 200 watts.
      j. Process connection information detailing connection size, and type (threaded, flanged, socket weld, etc.).
      k. Recommended mounting details.
      l. Recommended spare parts for one year of operation.
   2. Instrument Data Sheets in ISA S20 format for all instruments.

C. Shop Drawings:
   1. For complex control systems consisting of mechanical, electrical, and control components, provide the following:
      a. A piping and instrument diagram in ISA format.
      b. Electrical load calculations with conduit and conductor sizing.
   2. For integrated control panels or control assemblies, provide the following:
      a. Dimensioned layout of the control enclosure and mounted equipment and instruments.
      b. Full bill of material for all components with detailed catalog information on all components.
      c. 11-inch by 17-inch fully developed schematic diagram(s) showing power and control wiring, terminal block assignments, and identifying field and enclosure wiring. Provide a drawing index and symbols and legend sheet with all schematics. Show all Input/Output (I/O) card details including rack, slot, channel numbers, field termination points, and control power wiring. Label all conductors and identify conductor size and color. Identify all field devices by tag number and by description. Provide over current protection in accordance with NEC requirements.
      d. 11-inch by 17-inch instrument loop drawings in ISA format for all

analog control loops. Alternatively, multiple loops may be combined on a single analog input or analog output I/O card schematic diagram.

e. Nameplate legend.

f. Paint color and type for painted assemblies.

3. Any special installation details.

D. Samples:

1. Not applicable for this Section.

E. Quality Assurance/Control Submittals:

1. Design Data, Test Reports:

a. Submit calibration sheets for all field instruments containing the following information:

1) Instrument tag number.

2) Instrument manufacturer and model number.

3) Person who performed the calibration.

4) Manufacturer, model, and serial number of the calibrating device.

5) Date that calibrating device was last calibrated.

6) For analog instruments, process range and associated analog signal in at least five increments (For example: 4 mA DC/0 psig, 8 mA DC/25 psig, 12 mA DC/50 psig, 16 mA DC/75 psig, 20 mA DC/100 psig).

7) For switches, process values at which the switch changes state and at which the switch resets.

8) For instruments calibrated by manufacturer, manufacturer's calibration report is acceptable as proof of calibration.

b. Factory acceptance test reports on all fabricated control panels or assemblies shall containing the following information:

1) Date of test.

2) Test participants.

3) Visual inspection of components.

4) Successful application of power.

5) Validation of all internal wiring.

6) Validation of correct control operation.

7) Validation of screen graphics or alarm operation (if applicable)

8) Validation of program installation into PLC's and that I/O is functioning properly (if applicable).

2. Certificates, Manufacturer's:

a. UL 508 certification for all assembled control panels and assemblies.

3. Instructions, Manufacturer's Field:

a. Furnish a complete Operations and Maintenance Manual for all assembled control panels and assemblies.

4. Reports:

a. Not applicable to this Section.

F. Closeout Submittals:

1. Furnish Operations and Maintenance Manuals in 3-ring binders complete with the following:
    a. On front and spine of binders provide the project name, OWNER'S name and Project number.
    b. Within the binder, identify the CONTRACTOR and provide contact information.
    c. Inside binders, provide a volume index and table of contents for each binder. Each instrument or control component tag number must be cross-referenced to a specific binder tab.
    d. Furnish manufacturers complete operations and maintenance manuals for all discrete instruments and controls.
    e. Furnish custom operations and maintenance Section for each custom control system, control panel, or fabricated assembly.
    f. Furnish "As-Built" loop and wiring diagrams.
    g. Furnish the written warranty.
2. Turn over all spare parts to OWNER with documentation showing which instrument or control system the spare parts are for.

G. Schedule:
1. Submit a detailed Work schedule showing start/finish dates, task duration, task sequencing, critical path, and available float. Identify task predecessors and identify coordination activities with other trades.

H. Start-up and Commissioning Plan:
1. Submit a detailed start-up and commissioning plan for review by OWNER and ENGINEER. Plan should include the following information:
    a. The order in which the various plant systems will be started up
    b. What work must be performed prior to the start-up
    c. What documentation will be maintained by the CONTRACTOR and provided to the OWNER validating that the start-up was performed in a safe and efficient manner.

1.6 QUALITY ASSURANCE

A. Qualifications:
1. CONTRACTOR performing the Work shall have a minimum five years experience performing similar work in similar industries. All CONTRACTOR'S personnel shall be trained and experienced in best current construction practices.

B. Regulatory Requirements:
1. Perform all Work in accordance with all applicable national and local codes.

C. Certifications:
1. Not applicable this Section.

D. Field Samples:
   1. Not applicable this Section.

E. Mock-Ups:
   1. Not applicable this Section:

F. Pre-Installation Meetings:
   1. Not applicable this Section.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Packing, Shipping, Handling, and Unloading:
   1. Perform these activities in a manner which assures instruments and equipment will arrive undamaged and in proper working order. Replace any instrument or equipment damaged upon arrival at no additional cost to OWNER.

B. Acceptance at Site:
   1. Maintain a comprehensive log by instrument or equipment tag number of all received instruments or equipment.

C. Storage and Protection:
   1. Store all instruments and equipment as recommended by manufacturer. Protect from physical damage, moisture, dirt/dust, or extremes of temperature.

1.8 PROJECT/SITE COORDINATIONS

A. Environmental Requirements
   1. Follow any and all environmental requirements pertaining to the site.
   Maintain a safe and clean job site.
   Dispose of all trash and construction debris in an approved manner.

B. Existing Conditions:
   1. CONTRACTOR is to examine the site and be thoroughly familiar with any site requirements which may affect the Work or storage of instruments or equipment.

1.9 SEQUENCING

A. Coordinate all Work with other trades.

1.10 SCHEDULING

A. Provide and maintain a detailed schedule for performance of the Work identifying start/finish dates, durations, required preceding activities, and coordination with

other trades. Organize procurement, deliveries, and staff labor to meet the overall construction schedule and to assure that other trades are not delayed.

1.11 WARRANTY

A. Instrumentation:
   1. One year from system acceptance by OWNER for all discrete instrumentation, control devices, or equipment. During this period, replace any defective or malfunctioning device with 15 working days after notification by OWNER.
   2. One year from system acceptance by OWNER for the performance of the overall control system. Correct the defect within 15 working days after notification by OWNER. Warranty repair work includes but is not limited to the following:
      a. Improper sequencing or interlocking of equipment control systems.
      b. Wiring errors or omissions.
      c. Improper calibration of field instruments.
      d. Improper operation of programmable logic controllers or operator interface terminals.
      e. Improper operation of communications systems installed as part of the overall control system.
      f. Unsafe operations or maintenance conditions.
      g. Other system malfunctions which prevent or impair the plant from operating at design capacity, requires excessive operator intervention, or results in unsafe operating conditions.

1.12 SYSTEM START-UP/COMMISSIONING

A. General:
   1. Provide labor, tools, and equipment to start up the facility in a safe and efficient manner.
   2. Plant shall be started up by system. A system is defined as a collection of mechanical, electrical, and controls equipment configured to perform a specific function or purpose. Examples may be a UV disinfection system, a dissolved oxygen blower system, a grit removal system, etc. The order in which the systems will be started shall be submitted by CONTRACTOR in the start-up Plan and approved by OWNER and ENGINEER. Any variance in this schedule must be approved by OWNER and ENGINEER.
   3. Unless approved otherwise by OWNER and ENGINEER, CONTRACTOR is to follow the start-up sequence detailed below. The following Work must be complete prior to beginning the start-up:
      a. All mechanical equipment installed and tested in accordance with manufacturer's recommendations.
      b. All motors must have been rotation checked.
      c. Electrical power is available and wired to all mechanical equipment.
      d. All instruments must have been calibrated and installed in accordance

with the manufacturer's recommendations.

e. Control system communication systems are installed and fully operational. This includes DH+ networks, Modbus+ networks, Ethernet networks, radio telemetry systems, telephone systems, etc.
f. All power and control wiring must be installed, rung out, and validated to be in accordance with approved Construction Drawings.
g. Programmable logic controllers, SCADA computers, and Operator Interface Terminals all are installed, have their programs installed, and these devices are fully operational and functioning in their design configuration.

B. System Start-up Sequence:
1. By manipulation of the instrument or direct signal injection at the instrument, verify that the control signal (discrete or analog) is received at the programmable logic controller or by the hard wired control circuit.
2. For motorized equipment, disconnect the power leads at the starter, VFD, or solid state motor controller.
3. Completely exercise the control circuit in Manual, Remote, and Automatic modes and verify that all interlocks and permissives are functioning correctly.
4. Verify that the programmable logic controller can start and stop the motor in Auto or Remote. Motors may be "bumped" by forcing PLC outputs but these program forces must be removed immediately afterward.
5. Verify that run status, signal levels, and alarms display properly on the OIT and the SCADA screens.
6. Reconnect the motor power leads.
7. Verify PID loop operating correctly (either direct or reverse) and adjust gain constants to achieve critically damped operation.
8. Configure the mechanical system for normal operation and leave system ready for normal operation.
9. Utilize colored tagging scheme to identify start-up condition. Red is not ready for start-up, yellow is mechanically and electrically ready but not yet tested or started up, and green is fully tested and ready for normal operation. Place these tags on all mechanical, electrical, instrumentation, and control components of each system.
10. As plant systems are started up, coordinate and remedy any coordination or interface issues between systems.

C. Remedies for Damages:
1. CONTRACTOR is liable for any and all damage done to mechanical or electrical equipment due to improper start-up procedures and shall repair or replace any damaged equipment at OWNER'S discretion without additional cost to OWNER.
2. CONTRACTOR is forbidden to jumper around any process or safety interlock either with wiring or within a PLC program without the express written permission of both the OWNER and ENGINEER. All jumpers,

hardwired and programmed, must be maintained in a log book. Entries shall include:

a. Name of person placing the jumper.
b. Date of installation.
c. Reason for installation.
d. Approval of OWNER and ENGINEER.
e. Date of removal.
f. Name of person removing the jumper.

1.13 OWNER'S INSTRUCTIONS

A. Not applicable this Section.

1.14 MAINTENANCE

A. Extra Materials:
   1. Not required this Section.

B. Maintenance Service:
   1. Not required this Section.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Approved manufacturers are listed in the other electrical and instrument Specification Sections.

2.2 EXISTING PRODUCTS

A. Not applicable this Section.

2.3 MATERIALS

A. All materials are to be new and the manufacturer's most current model.

2.4 MANUFACTURED UNITS

A. Manufactured units are to be fully assembled and tested at the point of manufacture and delivered to the job site ready for installation and start-up.

B. Regulated DC power supplies for instrument loops shall be designed and arranged so that loss of one supply does not affect more than one instrument loop or system. Power supplies shall be suitable for an input voltage variation of ±10%, and the supply output shall be fused or short circuit protected. Output voltage

regulation shall be as required by the instrumentation equipment being supplied. Multi-loop, or multi-system power supplies, will be acceptable if backup power supply units are provided which will automatically supply the load upon failure of the primary supply. The backup supply systems shall be designed so that either the primary or backup supply can be removed, repaired, and returned to service without disrupting the instrument system operation.

C. The power distribution from multi-loop supplies shall be selectively fused such that a fault in one instrument loop will be isolated from the other loops being fed from the same supply. Fuses shall be clearly labeled and located for easy access. Multi-loop supply systems shall be oversized for an additional 10% future load. Failure of a multi-loop supply shall be indicated on the respective instrument panel or enclosure.

2.5 EQUIPMENT

A. All equipment is to be new and the manufacturers most current model. All instruments and control devices and assemblies shall be standard devices constructed of corrosion-resistant materials enclosed in a water and dust proof case and mounted as specified in the individual application. Enclosures shall be manufacturer's standard color unless specified otherwise.

2.6 COMPONENTS

A. Not applicable this Section.

2.7 ACCESSORIES

A. Not applicable this Section.

2.8 MIXES

A. Not applicable this Section.

2.9 FABRICATION

A. Shop Assembly:
   1. Fabricate assemblies in accordance with approved Drawings. Notify ENGINEER and OWNER at least five working days prior to start of testing so that they may witness the testing if they choose to do so.

2.10 FINISHES

A. General:
   1. Finishes for all components, equipment, and fabricated assemblies must take into account the environment in which they will be installed. NEMA ratings

must be appropriate for the environment. Ratings for corrosive areas must be NEMA 4X, for outdoor areas NEMA 4 or 3R, indoor dusty areas may be NEMA 12.

B. Shop Finishing:
   1. Where called for in other sections, sandblast, prime, and paint assemblies.

2.11 SOURCE QUALITY CONTROL

A. Fabrication/Tolerances:
   1. In accordance with generally accepted manufacturing standards.

B. Tests, Inspections:
   1. In accordance with generally accepted manufacturing standards.

C. Verification of Performance:
   1. Not applicable this Section.

PART 3 - EXECUTION

3.1 ACCEPTABLE INSTALLERS

A. CONTRACTORS having a minimum five years experience in the design, procurement, and construction of industrial water/wastewater instrumentation and control systems.

3.2 EXAMINATION

A. Site Verification of Conditions:
   1. Visit job site and ascertain any environmental or physical conditions which may affect the performance of the Work or the equipment requirements.

3.3 PREPARATION

A. Protection:
   1. Not applicable this Section.

B. Surface Preparation:
   1. Not applicable this Section.

3.4 ERECTION

A. Provide 4-inch tall reinforced concrete housekeeping pads for all control panels and floor-mounted fabricated control assemblies and consoles. Dowel into concrete base and extend a minimum of 2-inches past edges of equipment.

B. Provide Unistrut or fabricated structural supports for heavy equipment or assemblies. Prime and paint supports so that they are unaffected by the environment in which they are installed.

C. Securely fasten all panels and assemblies to their housekeeping pads or structural supports.

D. All interconnecting wiring shall be run in conduit in accordance with the Division 16 Electrical, Sections requirements.

3.5 INSTALLATION

A. Install all instruments and controls in accordance with manufacturer's recommendations and all applicable electrical codes and standards. Connect all required utilities including electrical power, air, hydraulics, etc.

B. Provide stainless steel tags for each instrument engraved with instrument tag number. Attach to instrument with stainless steel wire.

C. Provide engraved nameplates for all panel-mounted instruments. Attach to panel with stainless steel screws.

3.6 APPLICATION

A. Not applicable this Section.

3.7 CONSTRUCTION

A. Special Techniques:
In accordance with manufacturers recommended installation procedure.

B. Interface with Other Work:
Coordinate with all other trades.

C. Sequences of Operation:
Not applicable this Section.

D. Site Tolerances:
Not applicable this Section.

3.9 REPAIR/RESTORATION

A. Repair any damages caused by the installation or erection to original condition.

3.10 INSTALLATION

A. Not applicable this Section.

3.11 FIELD QUALITY CONTROL

B. Site Tests:
   1. Test and calibrate instrumentation in accordance with other parts of this Section.

C. Inspection
   1. Not required this Section.

D. Manufacturer's Field Services:
   1. If recommended by manufacturer, have equipment/control systems inspected, tested, and started up by manufacturer's representative.

3.12 ADJUSTING

A. Not required this Section.

3.13 CLEANING

A. Remove and dispose of construction debris daily. Wipe down and vacuum out all enclosures.

3.14 DEMONSTRATION/TRAINING

A. In accordance with the Start-up part of this Section.

B. Provide training of personnel in the operation and maintenance of the furnished control systems.

C. Training shall be provided as required elsewhere in the Contract Documents, but shall consist of at least eight hours, in a single, or multiple sessions, to accommodate the personnel schedules.

D. Coordinate with the ENGINEER, and the OWNER, to schedule the training sessions at least five workings days in advance.

3.15 PROTECTION

A. Protect instrumentation and control equipment from environmental damage and from damage by other trades.

3.16 SCHEDULES

A. Not applicable this Section.

END OF SECTION