JORDAN VALLEY WATER CONSERVANCY DISTRICT

VOLUME I - SPECIFICATIONS
for

ZONE D - CHEMICAL FEED FACILITY

JUNE 2022

BIDDING DOCUMENTS

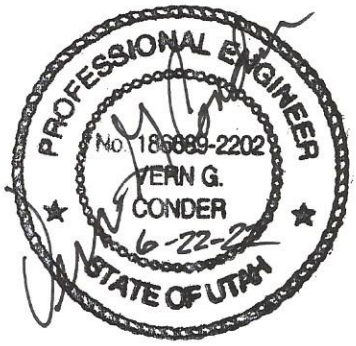

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TABLE OF CONTENTS

ZONE D – CHEMICAL FEED FACILITY

DIVISION 16 ELECTRICAL

PART 5 - DRAWINGS

SECTION 01010

SUMMARY OF WORK

1.01 GENERAL

A. The work to be performed under this project shall consist of furnishing all labor, materials, and equipment necessary or required to complete the work in all respects as shown on the plans and as herein specified. All work, materials, and services not expressly shown or called for in the Contract Documents which may be necessary to complete the construction of the work in good faith shall be performed, furnished, and installed by CONTRACTOR as though originally so specified or shown, at no increase in cost to OWNER.

1.02 WORK COVERED BY CONTRACT DOCUMENTS

A. The construction of a 20-inch HDPE pipeline, modifications and connection to an existing meter vault; new piping and pumps in the existing flow control vault; new chemical feed building at 7886 West and New Bingham Highway; new fluoride and chlorination systems with related items; and site work, as set forth in the Bidding Documents. Work for the chemical feed facility shall include all earthwork; footings; foundations; buildings; mechanical piping; valving; HVAC; electrical and bringing electrical power to the site; instrumentation and controls; chemical storage and feed systems; communications; security systems; utilities; grading; backfill; site and transmission piping; general appurtenances; and to construct, install and test all mechanical, electrical, HVAC, and other systems and project features on and off the sites as shown and/or specified in these documents. The work also includes testing agency services and construction surveying. The work includes but is not limited to supply, installation, startup, and testing of the complete and functional facilities.

B. Work is located with a fully functional treated municipal water reservoir. Reservoir to remain in service except for limited shutdown as may be necessary for piping tie-in.

C. Contractor shall provide start-up testing, and training of district personnel for all equipment supplied under these contract documents and furnish operation, maintenance and technical manuals pertaining to all equipment that is supplied.

D. Contractor shall be responsible for complete improvements and systems in accordance with the intent of these Contract Documents, coordinating the details of equipment and systems which affect the work covered under the Contract Documents; and furnishing all incidental items not actually shown or specified, but which are required by good practice to provide a complete and properly functioning fluoridation system.

1.03 CONTRACT METHOD

A. The work hereunder will be constructed both under a lump sum contract and unit price.

B. CONTRACTOR shall include the General Conditions and Supplementary Conditions of the Contract as a part of all of its subcontract agreements.

1.04 WORK SEQUENCE

A. The contract time for substantial and final completion is as indicated in the Agreement.

1.05 CONTRACTOR USE OF PROJECT SITE

A. CONTRACTOR's use of the project site shall be limited to its construction operations, including on-site storage of materials, on-site fabrication facilities. Hours of construction shall be limited to from 7:00 a.m. to 10:00 p.m. Contractor shall schedule work with Owner, utilities, and others to minimize mutual interference.

1.06 PROJECT SECURITY

A. CONTRACTOR shall make all necessary provisions to protect the project and CONTRACTOR's facilities from fire, theft, and vandalism, and the public from unnecessary exposure to injury.

1.07 CHANGES IN THE WORK

A. It is mutually understood that it is inherent in the nature of municipal construction that some changes in the plans and specifications may be necessary during the course of construction to adjust them to field conditions, and that it is of the essence of the Contract to recognize a normal and expected margin of change. ENGINEER shall have the right to make such changes, from time to time, in the plans, in the character if the work, and in the scope of the project as may be necessary or desirable to ensure the completion of the work in the most satisfactory manner without invalidating the Contract.

- END OF SECTION -

SECTION 01025

MEASUREMENT AND PAYMENT

1.01 GENERAL

A. All work completed under this contract shall be in accordance with the Plans and Specifications and will be measured by the ENGINEER. The quantities appearing on the Bid Schedule or Schedule of Values are approximate only, and are prepared for the comparison of bids. Payment to CONTRACTOR on bid items with unit prices other than "Lump Sum" will be made for actual quantities of work performed and accepted, or material furnished in accordance with the Contract. The scheduled quantities of work to be done and materials to be furnished may be increased or decreased.

B. The term "Lump Sum" when used as an item of payment will mean complete payment for the work described in the contract. When a complete structure, portion of work, or unit is specified "Lump Sum" as the unit of measurement, the unit will include fittings, accessories, and all work necessary to complete the work as shown on the plans and as specified.

C. “Unit Price Payment” Includes: Full compensation for required labor, Products, tools, equipment, plant and facilities, transportation, services and incidentals; erection, application or installation of an item of the Work; overhead and profit.

D. When the accepted quantities of work vary from the quantities in the bid schedule, CONTRACTOR shall accept as payment in full, so far as contract items are concerned, payment at the original contract unit prices for the work done. OWNER reserves the right to add to or delete from quantities listed in the bid schedule in order to match the total bid with the budgeted money available.

1.02 BID SCHEDULE ZONE D CHEMICAL FEED FACILITY

A. BID ITEM 1 - "ZONE D - CHEMICAL FEED FACILITY COMPLETE”

1. **METHOD OF MEASUREMENT** This Bid Item shall not be measured, but shall be paid for on a lump sum basis for the construction of the chemical feed building, modifications to the existing flow control valve vault and existing meter vault piping, and pipelines, including all of the work shown and specified for the site including design and implementation of a SWPPP.

2. **BASIS OF PAYMENT** Payment shall be made at the contract lump sum bid price. Payment shall be considered complete compensation for all labor, equipment, tools, and materials, mobilization/demobilization, including but not limited to all earthwork; excavation; footings; foundations; curb walls; chemical feed building; mechanical piping; valving; HVAC; electrical; instrumentation and controls; chlorine and fluoride chemical storage and dosing systems; SCADA and instrumentation systems; stockpiling existing landscape rock and reinstalling landscape materials around new building; modifications to the flow control vault and modification to the existing meter vault; site work; security

systems; utilities; grading; concrete curbing, and flatwork; asphalt; backfill and compaction; disposal of excess excavated materials; site piping and 20" diameter HDPE transmission piping (with open cut and boring and HDPE concrete anchors) and connections, coordination and permitting with UDOT for transmission pipeline crossing under New Bingham Highway; general appurtenances; drain system including: floor drains, PVC drain line, piping, and other appurtenances as shown and as specified; installation of site drainage improvements; restoration of surface and underground improvements, including any improvement damaged or affected by the work; permits; testing agency services including foundation investigation and construction surveying; and to construct, install and test all mechanical, electrical, HVAC, drainage, and other systems and project features on and off the sites as shown on the drawings and/or specified in these documents. Payment also includes but is not limited to supply, installation, startup, and testing of the complete and functional facilities and design and development and implementation of the SWPPP.

1.03 ADDITIVE ALTERNATE - FOUNDATION STABILIZATION

A. Contractor shall as part of the Base Bid include a cost for Foundation Investigation (see Schedule of Values Item 13) which will include geotechnical testing beneath the new Chemical Building to a depth of 6 feet as indicated in the Soils Report. If the material is satisfactory, Contractor shall scarify and recompact the upper 1-foot of material to grade and build on the existing material.

B. If material does not meet the soils report requirements, the Foundation Stabilization - Additive Alternate shall apply. Cost for this item shall include removal of material to a depth of 6 feet, stockpiling the material, installing and compacting approved engineered fill material to meet the soils report requirements. Surplus material shall be hauled off at Contractors expense.

1. **METHOD OF MEASUREMENT** If awarded, this Bid Item shall not be measured, but shall be paid for on a lump sum basis for the “Foundation Stabilization” of the Chemical Feed Facility, including all of the work shown and specified for the site.

2. **BASIS OF PAYMENT** Payment shall be made at the contract lump sum Additive Alternate Bid price. Payment shall be considered complete compensation for all labor, equipment, tools, and materials, mobilization/demobilization, including but not limited to all earthwork including but not limited to: excavation, stockpiling, installing and compaction of material, and any removal of surplus material.

- END OF SECTION -

SECTION 01040

COORDINATION

1.01 GENERAL

A. The Owner and/or utility owners may be working within the project area while this contract is in progress. If so, the Contractor shall schedule his work in conjunction with these other entities to minimize mutual interference.

B. All compaction and other testing requirements specified shall be provided and paid for by CONTRACTOR.

C. Contractor shall notify ENGINEER of the schedule for materials testing required by Contractor in Sections 01410 and 01440 a minimum of 24 hours in advance of doing the work. Contractor shall be responsible for obtaining copies of testing reports or data and insuring that the work is in full compliance with the Contract Documents.

D. Contractor shall obtain all required permits.

E. Contractor shall notify Owners of Private right-of-ways 72 hours prior to work being performed across Owners right-of-way.

F. If required to work in City Streets or Utah Department Of Transportation (UDOT) right-of-way, Contractor shall notify right-of-way owner 72 hours prior to work being performed therein. Work within the City Streets or UDOT right-of-way shall be in accordance with required permits and any license agreement with OWNER.

1.02 MEASUREMENT AND PAYMENT

A. Coordination shall not be measured or paid as a separate item, but shall be included as part of the various items to which it relates.

- END OF SECTION -

SECTION 01050

FIELD ENGINEERING

1.01 GENERAL

A. CONTRACTOR shall provide all construction staking as necessary to complete the facilities and appurtenant work according to the contract documents.

B. Construction staking and property surveys shall be performed by a registered land surveyor in the State of Utah.

1.02 SUBMITTALS

A. Contractor shall submit the name and documentation of registration of the registered land surveyor.

1.03 MEASUREMENT AND PAYMENT

A. Measurement and payment shall be as specified in Section 01025 - Measurement and Payment.

- END OF SECTION -

SECTION 01070

ABBREVIATIONS

PART 1 GENERAL

1.01 DESCRIPTION

A. Wherever in these Specifications references are made to the standards, specifications, or other published data of the various national, regional, or local organizations, such organizations may be referred to by their acronym or abbreviation only. As a guide to the user of these specifications, the following acronyms or abbreviations which may appear in these specifications shall have the meanings indicated herein.

1.02 ABBREVIATIONS AND ACRONYMS

AAR	Association of American Railroads
AASHTO	American Association of the State Highway and Transportation Officials
ACI	American Concrete Institute
AGA	American Gas Association
AGC	American General Contractors
AI	The Asphalt Institute
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
ANSI	American Nation Standards Institute, Inc.
APWA	American Public Works Association
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASOC	American Society of Quality Control
ASSE	American Society of Sanitary Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
BBC	Basic Building Code, Building Officials and Code Administrators International
CEMA	Conveyors Equipment Manufacturer's Association
CGA	Compressed Gas Association
CLFMI	Chain Link Fence Manufacturer's Institute
CMA	Concrete Masonry Association
CRSI	Concrete Reinforcing Steel Institute
DWQ	Department of Water Quality
DWR	Drinking Water Regulations
EIA	Electronic Industries Association
ETC	Electrical Test Laboratories

IBC	International Building Code
ICC	International Code Council
ICBO	International Conference of Building Officials
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society
IFC	International Fire Code
IMC	International Mechanical Code
IME	Institute of Makers of Explosives
IPC	International Plumbing Code
ISAS	Instrument Systems and Automation Society
ISO	International Organization of Standardization
ITE	Institute of Traffic Engineers
MBMA	Metal Building Manufacturer's Association
NACE	National Association of Corrosion Engineers
NBS	National Bureau of Standards
NEC	National Electrical Code
NEMA	National Electrical Manufacturer's Association
NFPA	National Fire Protection Association
NFPA	National Forest Products Association
OSHA	Occupational Safety and Health Administration
PCA	Portland Cement Association
RWMA	Resistance Welder Manufacturer's Association
SAE	Society of Automotive Engineers
SSPWC	Standard Specification for Public Works Construction
UDOT	Utah Department of Transportation
UBC	Uniform Building Code
UL	Underwriters Laboratories, Inc.
UPRR	Union Pacific Railroad
WCRSI	Western Concrete Reinforcing Steel Institute
WRI	Wire Reinforcements Institute, Inc.
WWPA	Western Wood Products Association

- END OF SECTION -

SECTION 01090

REFERENCE STANDARDS

1.01 GENERAL

A. TITLES OF SECTIONS AND PARAGRAPHS. Captions accompanying Specifications sections and paragraphs are for convenience of reference only, and do not form a part of the Specification.

B. APPLICABLE PUBLICATIONS. Whenever in these specifications references are made to published specifications, codes, standards, or other requirements, it shall be understood that wherever no date is specified, only the latest specifications, standards or requirements of the respective issuing agencies which have been published as of the date that the work is advertised for bids, shall apply; except to the extent that said standards or requirements may be in conflict with applicable laws, ordinances, or governing codes. No requirements set forth herein or shown on the drawings shall be waived because of any provision of, or omission from, said standards or requirements.

C. SPECIALISTS, ASSIGNMENTS. In certain instances, specifications test requires (or implies) that specific work is to be assigned to specialists or expert entities, who must be engaged for the performance of that work. Such assignments shall be recognized as special requirements and shall not be interpreted so as to conflict with the enforcement of building codes and similar regulations governing the work; also they are not intended to interfere with local union jurisdiction settlements and similar conventions. Such assignments are intended to establish which party or entity involved in a specific unit of work is recognized as "expert" for the indicated construction processes or operations. Nevertheless, the final responsibility for fulfillment of the entire set of contract requirements remains with CONTRACTOR.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of other requirements of the specifications, all work specified herein shall conform to or exceed the requirements of all applicable codes and the applicable requirements of the following documents to the extent that the provisions of such documents are not in conflict with the requirements of these Specifications nor the applicable codes.

B. Reference herein to "Building Code" or Uniform Building Code” shall mean the International Building Code of the International Code Council. The latest edition of the code as approved and used by the local agency as of the date of award, as adopted by the agency having jurisdiction, shall apply to the work herein, including all addenda, modifications, amendments, or other lawful changes thereto.

C. In case of conflict between codes, reference standards, drawings and the other Contract

Document, the most stringent requirements shall govern. All conflicts shall be brought to the attention of the ENGINEER for clarification and directions prior to ordering or providing any materials or labor. CONTRACTOR shall bid the most stringent requirements.

D. APPLICABLE STANDARD SPECIFICATIONS. CONTRACTOR shall construct the work specified herein in accordance with the requirements of the Contract Documents and the referenced portions of those referenced codes, standards, and specifications listed herein; except, that wherever references to "Standard Specifications" are made, the provisions therein for measurement and payment shall not apply.

E. References in the Contract Documents to "Standard Specifications" shall mean the Contract Documents including all current supplements, addenda, and revisions thereof.

F. References herein to "OSHA Regulations for Construction" shall mean Title 29, Part 1926, Construction Safety and Health Regulations, Code of Federal Regulations (OSHA), including all changes and amendments thereto.

G. References herein to "OSHA Standards" shall mean Title 29, Part 1910, Occupational Safety and Health Standards, Code of Federal Regulations (OSHA), including changes and amendments thereto.

H. UTAH DEPARTMENT OF ENVIRONMENTAL QUALITY. Wells, tanks, pumping stations and culinary water pipelines shall conform to the requirements of Utah Administrative Code Rule R 309. Water and sewer pipeline installation shall conform to the requirements of Utah Administrative Code Rule R317-3-2.9 “Protection of Water Supplies” for horizontal and vertical separation.

I. UTAH DEPARTMENT OF TRANSPORTATION (UDOT) REQUIREMENTS. CONTRACTOR's work shall conform to UDOT specifications for excavation on State highways. (See Section 01570)

J. U.S. ARMY CORPS OF ENGINEERS REQUIREMENTS. CONTRACTOR's work shall conform to C.O.E. Specifications in accordance with Section 404 of the Clean Water Act for excavation in wetlands.

K. Reference herein to APWA shall mean the latest edition of the “Manual of Standard Specifications” and “Manual of Standard Plans” as prepared by the American Public Works Association and the Associated General Contractors of America.

- END OF SECTION -

SECTION 01100

SECURITY

PART 1 - GENERAL

1.01 PROJECT SECURITY

A. The Contractor shall make adequate provisions, subject to the approval of the Engineer, to protect the project and Contractor's facilities from fire, theft, and vandalism, and the public from unnecessary exposure to injury.

B. CONTRACTOR shall be responsible for protection of the Site, and all Work, materials, equipment, and existing facilities thereon, against vandals and other unauthorized persons.

C. No Claim shall be made against OWNER by reason of any act of an employee or trespasser, and CONTRACTOR shall make good all damage to OWNER's property resulting from CONTRACTOR's failure to provide security measures as specified. Security measures shall be at least equal to those usually provided by OWNER to protect OWNER's existing facilities during normal operation, but shall also include such additional security as fencing, barricades, lighting, and other measures as required to protect the Site.

D. Site Personnel List. CONTRACTOR shall provide OWNER with a listing of subcontractors that will be working on the project. OWNER shall be notified in writing of any updates or changes to the listing as they occur. CONTRACTOR and their subcontractors shall provide the OWNER with a listing of employee names and their employer. The listing will be used by the OWNER to issue security badges. Only employees that are listed will be able to obtain a badge. If additional employees need to be added at a later date, the CONTRACTOR must supply the OWNER with those names.

E. Security Badges. The CONTRACTOR and their subcontractors are required to obtain a security badge. To obtain a security badge, deliver a copy of the employee's driver's license or other government-issued picture identification to the OWNER. Badges shall be presented to the OWNER's security staff in order to gain access to secured areas. Once in a secured area or when working at a remote site, badges shall be on the person and visible at all times. Badges may be obtained between 8:00 am and 4:00 pm, Monday through Thursday.

F. CONTRACTOR shall notify the OWNER when a subcontractor no longer has reason to be on-site. CONTRACTOR is responsible for collecting badges from their subcontractors when the subcontractor no longer has need for them. The CONTRACTOR shall return all badges to the OWNER. Final payment will be withheld until all badges have been returned to the OWNER. The CONTRACTOR shall promptly report any lost or stolen badges to the OWNER and pay the costs associated with replacement of any lost or stolen badges.

G. Criminal Background Checks. The OWNER may, at its expense, perform criminal background checks in accordance with Utah State and Federal laws on all contractor and subcontractor employees that access secure or sensitive facilities.

H Shipments. Materials shipped to the jobsite that require a signature must be signed for by the CONTRACTOR or their subcontractors. OWNER employees are not authorized to sign for job site deliveries. The OWNER's receptionist will call the CONTRACTOR or their subcontractors and notify them that a delivery has arrived. If no listed contact is available to sign for the shipment, the delivery will be refused.

I. Deliveries. All deliveries to the jobsites shall be escorted by the CONTRACTOR. The CONTRACTOR, or their direct subcontractors, shall escort the delivery person at all times while on OWNER premises. Delivery persons need not be badged when accompanied by badged contractors at all times.

END OF SECTION

SECTION 01210

PROJECT MEETINGS

1.01 PRECONSTRUCTION CONFERENCE

A. Prior to the commencement of work at the site, a preconstruction conference will be held at a mutually agreed time and place which shall be attended by CONTRACTOR, its superintendent, and its subcontractors as appropriate. Other attendees will be:

1. ENGINEER and the Resident Project Representative (RPR).

2. Representatives of OWNER.

3. Governmental representatives as appropriate.

4. Others as requested by CONTRACTOR, OWNER, or ENGINEER.

B. Unless previously submitted to ENGINEER, CONTRACTOR shall bring to the conference one copy of each of the following:

1. Progress schedule.

2. Procurement schedule of major equipment and materials and items requiring long lead time.

3. Shop Drawings/Sample/Substitute or "Or Equal" submittal schedule.

C. The purpose of the conference is to designate responsible personnel and establish a working relationship. Matters requiring coordination will be discussed and procedures for handling such matters established. The complete agenda will be furnished to CONTRACTOR prior to the meeting date, which may include the following:

1. CONTRACTOR's tentative schedules.

2. Transmittal, review, and distribution of CONTRACTOR's submittals.

3. Processing applications for payment.

4. Maintaining record documents.

5. Critical work sequencing.

6. Field decisions and Change Orders.

7. Use of project site, office and storage areas, security, housekeeping, and OWNER's

needs.

8. Major equipment deliveries and priorities.

9. CONTRACTOR's assignments for safety and first aid.

D. ENGINEER will preside at the preconstruction conference and will arrange for keeping the minutes and distributing the minutes to all persons in attendance.

1.02 PROGRESS MEETINGS

A. CONTRACTOR shall schedule and hold regular on-site (or if requested by OWNER at OWNER’s office) progress meetings at least monthly and at other times as required by ENGINEER or as required by progress of the work. CONTRACTOR, ENGINEER, and all subcontractors active on the site shall be represented at each meeting. CONTRACTOR may at its discretion request attendance by representatives of its suppliers, manufacturers's, and other subcontractors.

B. ENGINEER shall preside at the meetings and provide for keeping and distribution of the minutes. The purpose of the meetings will be to review the progress of the work, maintain coordination of efforts, discuss changes in scheduling, and resolve other problems which may develop.

C. At each construction progress meeting a progress report shall be presented by the CONTRACTOR containing an updated Progress Schedule. Where the delayed completion data of a project phase is noted, the Contractor shall describe the anticipated delays or problems and outline the action plan being taken to counter their effect.

1.03 MEASUREMENT AND PAYMENT

1. Project Meetings shall not be measured or paid as a separate item, but shall be included as part of the various items to which it relates.

- END OF SECTION -

SECTION 01300

CONTRACTOR SUBMITTALS

1.01 SHOP DRAWING SUBMITTAL

A. CONTRACTOR shall furnish to ENGINEER for review, one (1) electronic copy of each shop drawing submittal. The term "Shop Drawings" as used herein shall be understood to include detail design calculations, shop drawings, fabrication and installation drawings, erection drawings, list, graphs, operating instructions, catalog sheets, data sheets, and similar items. Shop drawings and submittal requirements shall include interpretations of proposed or required configurations not shown on the drawings, so as a document record of such can be approved.

B. Drawings shall be submitted sufficiently in advance to allow ENGINEER not less than ten regular working days for examining the drawings. These drawings shall be accurate, distinct, and complete and shall contain all required information, including satisfactory identification of items and unit assemblies in relation to the contract drawings and/or specifications.

C. When the shop drawings are approved by ENGINEER, one electronic file will be returned to CONTRACTOR marked "Approved", "Approved, Except as Noted", or similar notification. If changes or corrections are necessary, an electronic file will be returned to CONTRACTOR with such changes or corrections, indicated by a brief statement, and CONTRACTOR shall correct and resubmit the drawings when requested by ENGINEER.

D. Approval of shop drawings, will not be required of reinforcing steel that is detailed by CONTRACTOR in accordance with the plans and specifications. Any change from the plans and specifications that is made by CONTRACTOR in reinforcing steel as well as any other change shall be approved by ENGINEER in a written change order prior to any work being altered from that already approved for construction.

E. Fabrication of an item may be commenced only after ENGINEER has reviewed the pertinent submittals and returned copies to CONTRACTOR marked either "Approved", or "Approved - Except as Noted". Corrections indicated on submittals shall be considered as changes necessary to meet the requirements of the Contract Documents and shall not be taken as the basis of claims for extra work.

F. All CONTRACTOR shop drawing submittals shall be carefully reviewed by an authorized representative of CONTRACTOR, prior to submission to ENGINEER.

G. ENGINEER's review of CONTRACTOR shop drawing submittals shall not relieve CONTRACTOR of the entire responsibility for the corrections of details and dimensions. CONTRACTOR shall assume all responsibility and risk for any misfits due to any errors in CONTRACTOR submittals. CONTRACTOR shall be responsible for dimensions and the design of adequate connections and details.

1.02 SAMPLES SUBMITTAL

A. Whenever requested of ENGINEER, CONTRACTOR shall submit at least one sample of each item or material to ENGINEER for acceptance at no additional cost to OWNER.

B. Samples, as required herein, shall be submitted for acceptance prior to ordering such material for delivery to the jobsite, and shall be submitted in an orderly sequence so that dependent materials or equipment can be assembled and reviewed without causing delay in the Work.

C. Unless otherwise specified, all colors and textures of specified items will be selected by ENGINEER from the manufacturer's standard colors and standard materials, products, or equipment lines.

1.03 OPERATIONS AND MAINTENANCE MANUAL SUBMITTAL

A. CONTRACTOR shall furnish to ENGINEER 3 (three) identical sets of Operations and Maintenance Manuals. Each set shall consist of one or more volumes, each of which shall be bound in a standard size, 3-ring, loose-leaf, vinyl, hard-cover binder suitable for bookshelf storage. Binder ring size shall not exceed 2.5 inches. A Table of Contents shall be provided which indicates all equipment and suppliers in the Operations and Maintenance Manuals.

B. CONTRACTOR shall also furnish ENGINEER one copy of the Operations and Maintenance Manuals in PDF electronic format.

C. CONTRACTOR shall include in the Operations and Maintenance manuals full details for care and maintenance for all visible surfaces as well as the following for each item of mechanical, electrical, and instrumentation equipment (except for equipment furnished by the Owner):

1. Complete operating instructions, including location of controls, special tools or other equipment required, related instrumentation, and other equipment needed for operation.

2. Preventative maintenance procedures and schedules.

3. A description of proper maintenance activities.

4. Complete parts lists, by generic title, identification number, and catalog number, complete with exploded views of each assembly.

5. Disassembly and reassembly instruction.

6. Name and location of nearest supplier and spare parts warehouse.

7. Name and location of manufacturer.

8. Recommended troubleshooting and start-up procedures.

9. Prints of the record drawings, including diagrams and schematics, as required under the electrical and instrumentation portions of these specifications.

D. All Operations and Maintenance manuals shall be submitted in draft form to ENGINEER not later than the 75 percent of construction completion date. All discrepancies found by ENGINEER in the Operations and Maintenance manuals shall be corrected by CONTRACTOR prior to final acceptance of the project.

1.04 PROGRESS SCHEDULE SUBMITTAL

A. Prepare as progress schedule using the Critical Path Method.

B. Minimum Sheet Size: 11 x 17 inches.

C. Show complete sequence of construction by activity, with dates for beginning and completion of each element of construction.

D. Provide separate schedule of submittal dates for shop drawings, product data, and samples.

E. Submit revised Progress Schedule with each Application for Payment.

1.05 MEASUREMENT AND PAYMENT

1. CONTRACTOR submittals shall not be measured or paid as a separate item, but shall be included as part of the various items to which it relates.

- END OF SECTION -

SECTION 01410

TESTING AGENCY SERVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. CONTRACTOR shall be responsible for providing Construction Quality Control Testing of all soils, concrete, etc. as required by the various sections of these specifications. This section includes the following:

1. Use of independent testing agency.
2. Control testing report submittal requirements.
3. Responsibilities of testing agency.

1.02 REFERENCES

A. ASTM D 3740: Standard Recommended Practice for Evaluation of Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.

B. ASTM D 4561: Standard Practice for Quality Control Systems for and Inspection and Testing Agency for Bituminous Paving Materials.

C. ASTM E 329: Standard Recommended Practice for Inspection and Testing Agencies for Concrete, Steel, and Bituminous Materials as Used in Construction.

1.03 DEFINITIONS

A. Independent Testing Agency: A testing agency NOT owned by CONTRACTOR, and an agency that does not have any preferential affiliation or association with CONTRACTOR, or any of CONTRACTOR's Subcontractors and Suppliers other than entering into a contract with CONTRACTOR to perform the duties defined in these specifications.

B. Professional Engineer: An engineer who complies with Utah licensing law and is acceptable to the authority having jurisdiction.

1.04 QUALITY ASSURANCE

A. CONTRACTOR shall employ and pay for services of an independent testing agency which complies with ASTM D 3740, ASTM D 4561, and ASTM E 329 to test materials for contract compliance including any required "Special Inspections".

B. Concrete Technician: Approved by ENGINEER or ACI certified.

1.05 CONTRACTOR SUBMITTALS

A. Prior to start of Work, submit testing agency's name, address, telephone number and the following:

1. Person charged with engineering managerial responsibility.
2. Professional engineer on staff to review services.
3. Level of certification of technicians.

1.06 TESTING AGENCY SUBMITTALS

A. Field Test Report: Submit report no later than the end of the current day.

B. Laboratory Test Report: Submit original report within 48 hours after test results are determined.

C. Final Summary Report: Submit prior to final payment.

D. On all reports include:

1. Project title, number and date of the report.
2. Date, time and location of test
3. Name and address of material Supplier.
4. Identification of product being tested and type of test performed.
5. Identify whether test is initial test or retest.
6. Results of testing and interpretation of results.
7. Name of technician who performed the testing.

1.07 RESPONSIBILITIES OF TESTING AGENCY

A. Calibrate testing equipment at least annually with devices of an accuracy traceable to either National Bureau of Standards or acceptable values of natural physical constraints.

B. Provide sufficient personnel at site and cooperate with CONTRACTOR, ENGINEER and OWNER's Representative in performance of testing service.

C. Secure samples using procedures specified in the applicable testing code.

D. Perform testing of products in accordance with applicable sections of the Contract Documents.

E. Immediately report any compliance or noncompliance of materials and mixes to CONTRACTOR, ENGINEER and OWNER's Representative.

F. When an out-of-tolerance condition exists, perform additional inspections and testing until the specified tolerance is attained, and identify retesting on test reports.

1.08 LIMITS ON TESTING AGENCY AUTHORITY

A. Agency may not release, revoke, alter, or enlarge on requirements of Contract Documents.

B. Agency may not suspend Work.

C. Agency has no authority to accept Work for OWNER.

- END OF SECTION -

SECTION 01440

QUALITY CONTROL AND MATERIALS TESTING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Responsibilities for controlling quality of materials, products and workmanship.

B. Responsibilities for manufacturer’s instructions, certificates and field service.

1.02 MATERIALS

A. All materials incorporated in the project shall be new and shall fully comply with the specifications. Unless otherwise clearly provided in the specifications, all workmanship, equipment, materials, and articles incorporated in the work covered by the contract are to be of the best available grade of their respective kinds. Whenever, in the specifications, any material, article, device, product, fixture, form, type of construction, or process indicated or specified by patent or proprietary name, by name of manufacturer, or by catalog number, such specifications shall be deemed to be used for the purpose of establishing a standard of quality and facilitating the description of the material or process desired and shall be deemed to be followed by the words "or approved equal" and CONTRACTOR may in such case, upon receiving the ENGINEER's approval, purchase and use any item, type, or process which shall be substantially equal in every respect to that indicated or specified.

B. Materials and equipment may be used in the Work based upon receipt of a Supplier’s certificate of compliance. Certificate must be in possession of CONTRACTOR and reviewed by ENGINEER prior to use.

C. Quality Assurance Testing by the OWNER and/or ENGINEER shall not relieve CONTRACTOR of responsibility to furnish materials and work in full compliance with Contract Documents.

1.03 MANUFACTURER’S INSTRUCTIONS

A. Should instructions conflict with Contract Documents, request clarification before proceeding.

B. When required in individual sections, submit manufacturer’s instructions in the quantity required for product data, delivery, handling, storage, assembly, installation, start-up, adjusting, balancing, and finishing, as appropriate.

1.04 MANUFACTURER'S CERTIFICATES

A. When required in individual sections, submit manufacturer's certificate in duplicate executed by responsible officer certifying that product meets or exceeds specified requirements.

1.05 MANUFACTURER'S FIELD SERVICES

A. When required in individual sections, have manufacturer or Supplier provide qualified representative to observe field conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust, and balance of equipment as applicable and to make written report of observations and recommendations to ENGINEER.

1.06 WORKMANSHIP

A. Maintain performance control and supervision over Subcontractors, Suppliers, manufacturer's, products, services, workmanship, and site conditions, to produce work in accordance with Contract Documents.

B. Comply with industry standards except when more restrictive tolerances or specified requirements indicate more rigid standards or more precise workmanship.

C. Provide suitable qualified personnel to produce specified quality.

D. Ensure finishes match approved samples.

1.07 INSPECTION AND TESTING OF MATERIALS

A. Testing agency and testing for quality control and material testing shall be furnished by CONTRACTOR as part of the project. Results of testing shall be reported to CONTRACTOR and ENGINEER on site. Reports of the testing shall be transmitted directly to the ENGINEER or inspector immediately , but in no case later than the end of current day.

B. Materials to be supplied under this contract will be tested and/or inspected either at their place of origin or at the site of the work by the testing agency. CONTRACTOR shall give the ENGINEER written notification well in advance of actual readiness of materials to be tested and/or inspected at point of origin so ENGINEER may witness testing by the testing agency. Satisfactory tests and inspections at the point of origin shall not be construed as a final acceptance of the material nor shall it preclude retesting or reinspection at the site of the work.

C. CONTRACTOR shall furnish such samples of materials as are requested by the ENGINEER, without charge. No material shall be used until reports from the testing agency have been reviewed and accepted by the ENGINEER. See Section 01300, CONTRACTORs Submittal.

1.08 UNSATISFACTORY CONDITIONS

A. Examine areas and conditions under which materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to installer.

1.09 QUALITY CONTROL TESTING

A. ENGINEER's failure to detect any defective Work or materials does not prevent later rejection when such defect is discovered nor does it obligate ENGINEER for acceptance.

B. CONTRACTOR shall provide 24-hours minimum notice to ENGINEER for all testing required by these specifications.

1.10 TESTING ACCEPTANCE AND FREQUENCY

A. Minimum Quality Control Testing Frequency: As defined in Table 01440-1, the CONTRACTOR shall be responsible to ensure that all testing is performed at the frequencies shown. CONTRACTOR shall uncover any work at no cost to OWNER to allow the testing agency to perform required testing at the frequency shown.

B. Acceptance of Defective Work: As defined in Article 13.06 of the General Conditions.

1.11 MEASUREMENT AND PAYMENT

A. Quality Control and Materials Testing shall be measured and paid as provided in Section 01025 - Measurement and Payment.

B. Quality Control and Materials Testing required in Table 01440-1, shall be paid for by CONTRACTOR. Any additional independent Quality Assurance testing shall be paid for by OWNER.

TABLE 01440-1: QUALITY CONTROL TESTING FREQUENCY

SYSTEM or MATERIAL	TESTS	MINIMUM REQUIRED FREQUENCY
SUBGRADE AND BACKFILL MATERIALS		
Section 02221 Excavation and Backfill for Buried Pipelines	Field Density	1 test per 300 linear feet per 1.5 feet of backfill thickness placed.
	Laboratory	1 test for each material type which includes proctor, classification and gradation.
Section 02222 Excavation and Backfill for Structures	Field Density	1 test per 300 linear feet per 1.5 feet of backfill thickness placed.
	Laboratory	1 test for each material type which includes proctor, classification and gradation.
Section 02278 Road Base - Untreated Base Course	Field Density	Base course subgrade: 1 test per 8,000 square feet of area. Base course: 1 test per 8,000 square feet of area or 200 cu. yds., which ever is greater.
	Laboratory	Base course: 1 test for each material type which includes proctor, classification and gradation.
ASPHALT		
Section 02500 Removal and Replacement of Surface Improvements	Mix Design	Marshall Test Method: 1 test initially per each type of material and each change in target, and for each day of production thereafter. Specific Gravity: 1 per each Marshall Test Extraction: 1 test per each Marshall Test
	Field Density	Bituminous surfaces: 1 test per 8,000 square feet placed or part thereof.
	Asphalt Thickness and Core Density	Bituminous surfaces: 1 test sample every 300 linear feet of completed roadway.

SYSTEM or MATERIAL	TESTS	MINIMUM REQUIRED FREQUENCY
PORTLAND CEMENT CONCRETE		
Section 03300 Cast-in-Place Concrete	Slump	1 test every day of placement or 1 test for every 100 cubic yards and more frequently if batching appears inconsistent. Conduct with strength tests.
	Entrained air	1 test with slump test.
	Ambient and concrete tem-peratures	1 test with slump test.
	Water cement ratio.	to be verified and provided with batch tickets.
	Compressive strength	1 set of 4 cylinders every 100 c.y. or part thereof per day.

NOTES:

1 Additional tests shall be conducted when variations occur due to the contractor's operations, weather conditions, site conditions, etc.

2 Classification, moisture content, Atterberg limits and specific gravity tests shall be conducted for each compaction test if applicable.

3 Tests can substitute for same tests required under "Aggregates" (from bins or source), although gradations will be required when blending aggregates.

4 Aggregate moisture tests are to be conducted in conjunction with concrete strength tests for water/cement calculations.

- END OF SECTION -

SECTION 01500

TEMPORARY CONSTRUCTION UTILITIES AND ENVIRONMENTAL CONTROLS

PART 1 GENERAL

1.01 DESCRIPTION

A. This section covers temporary utilities, including electricity, lighting, telephone service, water, and sanitary facilities; temporary controls, including barriers, protection of work, and water control; and construction facilities, including parking, progress cleaning, and temporary buildings.

1.02 REFERENCES

A. UOSH Construction Standards Chapter D: Occupational Health and Environmental Controls.

1.03 TEMPORARY UTILITIES

A. Temporary Electricity: CONTRACTOR shall provide, maintain, and pay for all power required by CONTRACTOR, including electrical service to CONTRACTORS field office (Power is available on site - coordinate usage with JVWCD).

B. Temporary Lighting: CONTRACTOR shall provide all temporary lighting required for prosecution of his work and for employee and public safety. As a minimum, lighting levels during working hours shall meet the requirements of U.O.S.H.A. Subsection 1926.56 illumination.

C. Telephone Service: CONTRACTOR shall provide, maintain and pay for mobile telephone service to project superintendent.

D. Temporary Water Service

1. CONTRACTOR shall provide for all his workers on the project, adequate and reasonably convenient uncontaminated drinking water supply. All facilities shall comply with the regulations of the local and State Departments of Health.

2. CONTRACTOR shall be responsible to arrange for water, both potable and non-potable water.

3. When water is taken from a city water system or any other potable water supply source for construction purposes, suitable precautions shall be taken to prevent cross connections and contamination of water supply.

E. Temporary Sanitary Facilities: CONTRACTOR shall provide and maintain sanitary

facilities at each site for his employees and his subcontractors' employees that will comply with the regulations of the local and State Departments of Health.

1.04 TEMPORARY CONTROLS

A. Barriers: Provide barriers as necessary to prevent unauthorized entry to construction areas and to protect existing facilities and adjacent properties from damage from construction operations.

B. Dust Control: Execute Work by methods to minimize raising dust from construction operations. Provide positive means to prevent air-borne dust from dispersing into the atmosphere. Give all unpaved streets, roads, detours, or haul roads used in the construction area an approved dust-preventive treatment or periodically water to prevent dust. Applicable environmental regulations for dust prevention shall be strictly enforced. Contractor shall develop a fugitive dust control plan and submit it to the Executive Secretary at the Division of Air Quality for approval prior to beginning construction activities.

C. Protection of Work: CONTRACTOR shall protect installed work and provide special protection where specified in individual specifications sections. CONTRACTOR shall provide temporary and removable protection for installed products, and shall control activity in immediate work area to minimize damage.

D. Open Burning: No open burning of waste materials will be allowed.

E. Explosives and Blasting: The use of explosives on the work will not be permitted.

F. Noise Abatement: In inhabited areas, particularly residential, operations shall be performed in a manner to minimize unnecessary noise generation. Contractor shall comply with UOSH Construction Standards Chapter D rules and regulations and local Laws and Regulations.

G. Storm & Ground Water

1. CONTRACTOR shall provide and maintain at all times during construction, ample means and devices with which to promptly remove and properly dispose of all water entering the excavation or other parts of the work, whether the water be surface or underground water.

2. In excavation, fill, and grading operations, care shall be taken to disturb the pre-existing drainage pattern as little as possible. Particular care shall be taken not to direct drainage water into private property or into streets or drainageways inadequate for the increased flow.

3. CONTRACTOR shall maintain effective means to minimize the quantity of sediments leaving the work area either by storm water or CONTRACTOR's own dewatering operations. CONTRACTOR shall be responsible for obtaining required

permits and complying with all City, State, and Federal storm water management regulations and requirements, including preparing and implementing a Storm Water Pollution Prevention Plan for Construction Activities. CONTRACTOR shall submit a copy of the Notice of Intent and the Storm Water Pollution Prevention Plan (SWPPP) to the respective City's or public entity in which the facilities are located for review and approval. CONTRACTOR shall implement SWPPP and shal modify best management practices as required to meet all UPDES requirements.

H. Traffic Control: shall be the responsibility of the CONTRACTOR along any road where potential exists for traffic disruption. CONTRACTOR shall assume responsibility for materials (including barricades, flagging, signage, personnel safety equipment, etc., including storage and handling of materials), labor, equipment and incidentals required to control traffic flow for the duration of the project in accordance with all applicable local, state and federal regulations. See Section 01570 - Traffic Control.

1.05 CONSTRUCTION FACILITIES

A. Parking: CONTRACTOR shall provide temporary parking areas to accommodate use of construction personnel. Parking shall be located in an area approved by the ENGINEER.

B. Progress Cleaning

1. CONTRACTOR shall maintain areas free of waste materials, debris, and rubbish. Maintain the site in a clean and orderly condition. Upon completion of work, repair all damage caused by equipment and leave the project free of rubbish or excess materials of any kind.

2. Thoroughly clean all spilled dirt, gravel, or other foreign materials caused by the construction operations from all streets and roads at the conclusion of each day's operation.

3. It shall be the responsibility of CONTRACTOR to promptly clean up and remove any oil and or fuel spills caused by CONTRACTOR or his Sub-contractors during the course of the project. Contaminated soil shall be properly disposed of by CONTRACTOR in accordance with all applicable laws. CONTRACTOR shall be responsible for any damages to OWNER resulting from CONTRACTOR's negligence in promptly cleaning up said spills.

1.06 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

A. Prior to Final Application for Payment, CONTRACTOR shall remove temporary above grade or buried utilities, equipment, facilities, and materials; clean and repair damage caused by installation or use of temporary work; and restore existing facilities used during construction to original condition.

1.07 CHEMICALS

A. All chemicals used during construction or furnished for project operation whether defoliant, soil sterilant, herbicide, pesticide, disinfectant, polymer, reactant or of other classification, shall show approval of the U.S. Department of Agriculture. Use of all such chemicals and disposal of residues shall be in strict accordance with the printed instruction of the manufacturer.

1.08 CULTURAL RESOURCES

A. CONTRACTOR's attention is directed to the National Historic Prevention Act of 1966 (16 U.S.C. 470) and 36 CFR 800 which provides for the preservation of potential historical architectural, archeological, or cultural resources (hereinafter called "cultural resources").

B. CONTRACTOR shall conform to the applicable requirements of the National Historic Preservation Act of 1966 as it relates to the preservation of cultural resources.

C. If a suspected or unsuspected historical, archaeological, or paleontological item, feature, or site or other cultural resource is encountered during subsurface excavations at the site of construction, the following procedures shall be instituted:

1. Construction operations shall be immediately stopped in the vicinity of the discovery and ENGINEER and OWNER shall be notified of the nature and exact location of the finding. CONTRACTOR shall not damage the discovered objects and shall provide written confirmation of the discover to ENGINEER within two (2) calendar days.

2. OWNER and ENGINEER will then immediately notify the State Historical Preservation Office (SHPO) and the Utah Geological Survey (UGS).

3. SHPO and UGS will investigate the finding and determine if the resource requires protection and the disposition of the said resource.

D. If SHPO and UGS determine that the potential find is a bona fide cultural resource, CONTRACTOR shall suspend work at the location of the find under the provisions for changes contained in the General Conditions.

1.09 MEASUREMENT AND PAYMENT

A. Temporary Utilities and Facilities shall not be measured or paid as a separate item, but shall be included as part of the various items to which it relates.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

- END OF SECTION -

SECTION 01505

MOBILIZATION

1.01 GENERAL

A. This Section is provided to cover CONTRACTOR's cost of general and miscellaneous responsibilities and operations not normally attributed to, or included in, any other single bid item. This shall include, but not necessarily be limited to, work described or enumerated in this section under the following subsections.

1.02 MOVING TO AND FROM THE JOB SITE

A. This shall include CONTRACTOR's preliminary arrangement for starting and stopping construction operations, work schedules, and transportation of equipment and personnel to and from the project.

1.03 CLEAN-UP

A. The cost of all clean-up work as specified and not covered under other items shall be included in the Bid. Values shall be included in the Schedule of Values, lump-sum price, for "Mobilization".

1.04 TEMPORARY UTILITIES

A. The cost of water, power, etc. required by CONTRACTOR in performing the work specified in the contract shall be included in the Bid. Values shall be included in the Schedule of Values or Bid Schedule, lump-sum price, for "Mobilization".

1.05 PERFORMANCE BOND, PAYMENT BOND, AND INSURANCE

A. The cost of the performance bond, payment bond, and any required insurance and/or other miscellaneous cost associated with this project shall be included with the Bid. Values shall be included in the Schedule of Values or Bid Schedule, lump-sum price, for "Mobilization.

1.06 PERMITS

A. CONTRACTOR shall provide all necessary permits for completion of the work.

1.07 MEASUREMENT AND PAYMENT

A. Measurement and payment for Mobilization shall be as provided in Section 01025 - Measurement and Payment.

- END OF SECTION -

SECTION 01530

PROTECTION OF EXISTING FACILITIES

1.01 GENERAL

A. Any existing facilities, disturbed which are located in or adjacent to the line of work such as curbs, gutters, drive approaches, sidewalks, driveways, fences, underground pipes, conduits, or utilities, shall be cleaned up and restored in kind by Contractor and in accordance with the specifications contained herein governing the various types of services involved.

1.02 RESTORATION OF FENCES

A. Where it is necessary to remove any fence to facilitate Contractor's operation, Contractor shall obtain prior agreement with Owner for removal of the fence, and shall be responsible for any damage due to negligence of Contractor. As soon as practical, the fence shall be restored substantially to the same or improved condition as it was prior to the commencement of the work. Where livestock is present Contractor shall provide temporary fencing to keep livestock away from the construction area.

1.03 INTERFERING STRUCTURES AND UTILITIES

A. Contractor shall exercise all possible caution to prevent damage to existing structures, reservoirs, and utilities, whether above ground or underground. It shall be the responsibility of Contractor to locate and expose all existing underground and overhead structures and utilities in such a manner as to prevent damage to same. Contractor shall notify all utility offices concerned at least 48 hours in advance of construction operations in which a utility agency's facilities may be involved. This shall include, but not be limited to, irrigation water, culinary water, telephone, gas, and electric. Contractor shall be responsible for any and all changes to, reconnections to public utility facilities encountered or interrupted during prosecution of the work, and all costs relating hereto shall be at Contractor's expense. Contractor shall contract with and pay Public Utility Agencies for work required in connection with all utility interferences and handle all necessary notifications, scheduling, coordination, and details. The cost of public utility interferences shall be included in Contractor's lump sum or unit price bid covering the major contract facility to which interference or changes are attributable.

B. Any damages to private property, either inside or outside the limits of the easements provided by the Owner, shall be the responsibility of the Contractor. Any roads, structures, or utilities damaged by the work shall be repaired or replaced in a condition equal to or better than the condition prior to the damage. Such repair or replacement shall be accomplished at the Contractor's expense without additional compensation from Owner.

C. Contractor shall remove and replace small miscellaneous structures such as fences and culverts which are damaged by the construction activity at his own expense without

additional compensation from the Owner. The Contractor shall replace these structures in a condition as good as or better than their original condition.

D. Contractor shall saw cut the edge of existing drive approaches, where necessary, to prevent their damage during removal and replacement of the adjacent asphalt surface. Drive approaches which are damaged by the construction activity shall be repaired by the Contractor at his own expense without additional compensation from Owner. Contractor shall replace these structures in a condition as good as or better than their original condition.

E. At points where Contractor's operations are adjacent to or across properties of railway, telegraph, telephone, irrigation canal, power, gas, water, or adjacent to other property (damage to which might result in considerable expense, loss, and inconvenience), no work shall be started until all arrangements necessary for the protection thereof have been made.

F. The locations of the major existing culinary water lines, gas pipes, underground electric, cable television, and telephone lines that are shown on the plans, were taken from city maps, and maps supplied by the utility owner. Preliminary investigations have indicated they are generally reliable. However, it should be expected that some location discrepancies will occur. Neither the Owner nor its officers or agents shall be responsible for damages to the Contractor as a result of the locations of the utilities being other than those shown on the plans or for the existence of utilities not shown on the plans.

G. Contractor shall be solely and directly responsible to Owners and operators of such properties for any damage, injury, expense, loss or inconvenience, delay, suits, actions, or claims of any character brought because of an injury or damage which may result from the carrying out of the work to be done under the contract.

H. In the event of interruption to either domestic or irrigation water, or to other utility services as a result of accidental breakage, or as a result of being exposed or unsupported, Contractor shall promptly notify the proper authority. Contractor shall cooperate with the authority in restoration of service as soon as possible, and shall not allow interruption of any water or utility service outside working hours unless prior approval is received.

1.04 RIGHTS-OF-WAY

A. Contractor shall be required to confine construction operations within the dedicated rights-of-way for public through fares, or within areas for which construction easements have been obtained, unless they have made special arrangements with the affected property owners in advance. Contractor shall be required to protect stored materials, cultivated trees and crops, and other items adjacent to the proposed construction site.

B. Contractor shall submit for approval by the Engineer the type and size of equipment used, and the methods for work performed on the rights-of-way across private properties, to avoid or minimize injury to trees, shrubs, gardens, lawns, fences, driveways, retaining walls, or other improvements within the rights-of-way.

C. Property owners affected by the construction shall be notified by Contractor at least 48 hours in advance of the time the construction begins. During all construction operations, Contractor shall construct and maintain such facilities as may be required to provide access by all property owners to their property. No person shall be cut off from access to his property for a period exceeding 8 hours unless Contractor has made special arrangements with the affected persons. Contractor shall, daily or more frequently if necessary, grade all disturbed areas to be smooth for motor vehicle traffic.

1.05 MEASUREMENT AND PAYMENT

A. Protection of existing facilities shall not be measured or paid as a separate item, but shall be included as part of the various items to which it relates.

- END OF SECTION -

SECTION 01550

JOB CONDITIONS

1.01 SITE INVESTIGATION

A. CONTRACTOR acknowledges that he has satisfied himself as to the nature and location of the work; the general and local conditions, particularly those bearing upon availability of transportation, access to the site, disposal, handling and storage of materials, availability of labor, water, electric power, roads, and uncertainties of weather, river stages, or similar physical conditions at the site; the conformation and conditions of the ground; the character of equipment and facilities needed preliminary to and during the prosecution of the work; and all other matters which can in any way affect the work or the cost thereof under this Contract.

1. CONTRACTOR further acknowledges that he has satisfied himself as to the character, quality, and quantity of surface and subsurface materials to be encountered from his inspection of the site and from reviewing any available records of exploratory work furnished by OWNER or included in these Documents. Failure by CONTRACTOR to acquaint himself with the physical conditions of the site and all the available information will not relieve him from responsibility for properly estimating the difficulty or cost of successfully performing the work.

2. CONTRACTOR warrants that as a result of his examination and investigation of all the aforesaid data that he can perform the work in a good and workmanlike manner and to the satisfaction of OWNER. OWNER assumes no responsibility for any representations made by any of its officers or agents during or prior to the execution of this Contract, unless (1) such representations are expressly stated in the Contract, and (2) the Contract expressly provides that the responsibility therefor is assumed by OWNER.

B. STREET USE. Nothing herein shall be construed to entitle CONTRACTOR to the exclusive use of any public street, alleyway, or parking area during the performance of the work hereunder, and CONTRACTOR shall so conduct operations as not to interfere unnecessarily with the authorized work of utility companies or other agencies in such streets, alleyways, or parking areas. No street shall be closed to the public without first obtaining permission of the ENGINEER and proper governmental authority. CONTRACTOR shall keep street clean and free from debris.

1.02 CONTRACTOR'S WORK AND STORAGE AREA

A. CONTRACTOR shall make arrangements for any necessary offsite storage or shop areas necessary for the proper execution of the work.

1.03 MEASUREMENT AND PAYMENT

A. Job conditions shall not be measured or paid as a separate item, but shall be included as part of the various items to which it relates.

- END OF SECTION -

SECTION 01570

TRAFFIC CONTROL

1.01 GENERAL

A. Contractor shall comply with all rules and regulations of the City, County, and State authorities regarding the closing of public streets or highways. If conditions justify, Engineer may authorize Contractor to conduct his work in specific areas and to specific tasks to avoid sporadic and unorganized work efforts.

B. All work performed on or within the right-of-way of state roads shall have traffic control devices in place before work begins that meet the requirements of Utah Department of Transportation's "Specifications for Excavation on State Highways". When construction operations encroach upon traffic lanes, provide UDOT certified and suitably equipped flaggers.

C. No road shall be closed by Contractor to the public except by express permission of Engineer and after obtaining the required permits. Where it is necessary to close a county or city road to thru traffic, the road shall be closed to thru traffic only - not local traffic. The road shall be closed for one block only, not over 700 feet. The road shall be barricaded at each point of public access with barricades meeting the Utah Department of Transportation's specifications.

D. Traffic must be kept open on those roads and streets where no detour is possible. Contractor shall, at all times, conduct his work so as to insure the least possible obstruction to traffic and normal commercial pursuits. All obstructions within traveled roadways shall be protected by approved signs, barricades, and lights where necessary for the safety of the traveling public. The convenience of the general public and residents, and the protection of persons and property is of prime importance and shall be provided for by Contractor in an adequate and satisfactory manner.

E. Excavations on project sites from which the public is excluded shall be marked or guarded in a manner appropriate for the hazard.

1.02 TRAFFIC CONTROL

A. For the protection of traffic in public or private streets and ways, Contractor shall provide, place, and maintain all necessary barricades, traffic cones, warning signs, lights, and other safety devices in accordance with the requirements of the "Manual of Uniform Traffic Control Devices, Part VI - Traffic Controls for Street and Highway Construction and Maintenance Operations," published by U.S. Department of Transportation, Federal Highway Administration (ANSI D6.1) and the UOSH Construction Standards Chapter G: Signs, Signals and Barricades. The Contractor shall take all necessary precautions for the protection of the work and the safety of the public. All barricades and obstructions shall be illuminated at night, and all lights shall be kept burning from sunset until sunrise. Contractor

shall station such guards or flaggers and shall conform to such special safety regulations relating to traffic control as may be required by the public authorities within their respective jurisdictions. All signs, signals, and barricades shall conform to the requirements of Subpart G, Part 1926, of the OSHA Safety and Health Standards for Construction.

B. If at any time the conditions indicate that Contractor's protective facilities and service are inadequate to assure the safety of the public or Contractor's workers, Contractor shall provide additional facilities of services as may be necessary to assure protection at no additional cost to Owner.

C. CONTRACTOR shall obtain a traffic control permit from the governing agency prior to beginning work, and shall comply with all requirements of the permit.

1.03 MEASUREMENT AND PAYMENT

A. Traffic Control shall not be measured or paid as a separate item, but shall be included as part of the various items to which it relates.

- END OF SECTION -

SECTION 01660

TESTING AND STARTUP

PART 1 GENERAL

1.01 DESCRIPTION

A. Requirements of this Section apply to, and are a component part of, each section of the specifications.

1.02 SUBMITTALS

A. Submit the following in accordance with Section 01300 Contractor Submittals:

1. Test reports shall be submitted in accordance with paragraphs entitled, “Factory Tests”, “Functional Test”, and “Final Acceptance Test,” of this section.

2. Test procedures and the recording forms shall be submitted according to paragraph entitled, “Test Procedures.”

B. Tests Required

1. Tests shall be performed to verify proper functioning of chemical storage tanks and feed equipment, HVAC, compressed air, electrical switchgear, protective relaying, fluid and gas systems, pump/motor combinations, hydraulic and pneumatic control, condition/performance monitoring systems, energy control and monitoring systems, and other assemblies and components that need to be tested as an integrated whole.

C. Factory Tests

1. Tests shall be performed at the factory to verify proper build. These test results will be used in the "Final Acceptance Test" section to verify no shipping damage and proper installation.

D. Functional Test

1. Contractor shall perform an "in-house" tests to verify that the systems and components have been properly installed and are functioning properly. Tests shall be performed in the presence of the Project Representative. Test shall be completed and found acceptable when system has performed per other sections and referenced industry standards.

E. Final Acceptance Test

1. Contractor shall perform a formal test at each site with full documentation using the approved recording form. Project Representative will witness this test and issue a written final acceptance. Final test data shall be provided to the Project Representative. Data shall have a cover letter/sheet clearly marked with the system name, date, and the words "Final Test Data - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

F. Test Procedures

1. Test procedure and recording forms that document the test steps shall be submitted for approval to the Project Representative 21 calender days prior to the proposed test date. Procedure shall consist of step by step instruction to verify system parameters, components, and functions.

1.03 COMMISSIONING

A. After completion of all testing, Contractor shall make written application to Project Representative for permission to demonstrate compliance of the equipment, structures, and systems furnished and installed under this contract with all requirements of the Project Manual. Such application shall be furnished to Project Representative not less than 21 days prior to startup of completed portions of the facility. Upon receipt of written permission from Project Representative, and on the agreed upon date, Contractor shall do all things necessary to permit adequate operation of the facilities.

B. Contractor shall allow for a commissioning period as set forth in Part 3 to satisfy Project Representative that the contract requirements have been fulfilled. The commissioning period may be broken into several segments comprising complete systems at the discretion of the Project Representative.

C. During the commissioning period, Owner will provide a full-time (24 hours daily on call) staff for operation and maintenance of the facility. Contractor shall provide full time (8 hours per day for 5 days per week) and on-call (remaining time of 24 hours, 7 days per week) coordinator to coordinate other Contractor personnel including equipment manufacturer service representatives for troubleshooting, training of Owner personnel, or repair and maintenance of equipment within the terms of the contract. Contractor provided personnel for troubleshooting, repair or maintenance of equipment shall be provided as soon as possible and in no case longer than 8 hours after notification from Contractor’s coordinator. Such coordinators shall be familiar with the facility equipment and operations and shall be acceptable to the Project Representative. “Coordinator service” shall mean attendance at the site for whatever period is required at whatever time necessary in response to a request from the Project Representative. In addition, Contractor shall provide the services of one laborer per 8-hour shift, 5 days per week during the commissioning period to assist Owner personnel in general cleanup and maintenance.

D. Owner will pay for all electrical power, water, chemicals, and fuel necessary for operation of the facility during commissioning.

1.04 MEASUREMENT AND PAYMENT

A. Testing and Startup shall not be measured or paid as a separate item, but shall be included as part of the various items to which it relates.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.01 FINAL ACCEPTANCE

A. The duration of the Final Acceptance Test shall be 3 days. Each day the complete facility shall be operated for 8 continuous hours. During that period, Contractor shall demonstrate the operation of all equipment and all systems installed under this contract. Commissioning period shall be 10 days and shall commence from the date of substantial completion of each facility.

- END OF SECTION -

SECTION 01700

PROJECT CLOSEOUT

1.01 FINAL CLEANUP

A. CONTRACTOR shall promptly remove from the vicinity of the completed work, all rubbish, unused materials, concrete forms, construction equipment, and temporary structures and facilities used during construction. Final acceptance of the work by OWNER will be withheld until CONTRACTOR has satisfactorily complied with the foregoing requirements for final cleanup of the project site.

1.02 TOUCH-UP AND REPAIR

A. CONTRACTOR shall touch up or repair all finished surfaces on structures, equipment, fixtures, or whatever, that have been damaged prior to final acceptance. Surface on which such touch-up or repair cannot be successfully accomplished shall be completely refinished or in the case of hardware and similar small items, the item shall be replaced.

1.03 CLOSEOUT TIMETABLE

A. CONTRACTOR shall establish dates for equipment testing, acceptance periods and on-site instructional periods (as required under the Contract). Such dates shall be established not less than one week prior to beginning any of the foregoing items, to allow OWNER, the ENGINEER, and their authorized representatives sufficient time to schedule attendance at such activities.

1.04 OPERATION AND MAINTENANCE MANUAL SUBMITTALS

A. CONTRACTOR's attention is directed to the condition that any monies due CONTRACTOR as progress payments shall be retained if at the 75 percent construction completion point, the approved technical manuals have not been submitted in accordance with Section 01300 entitled "Contractor Submittals" of the Technical Specification. The aforementioned amount will be retained by OWNER until the technical manuals have been submitted. Any such retention of money for failure to submit the approved technical manuals on or before the 75 percent construction completion point shall be in addition to the retention of any payments due to CONTRACTOR as specified in Article 14 of the General Conditions.

1.05 MAINTENANCE AND GUARANTEE

A. CONTRACTOR shall comply with the maintenance and guarantee requirements contained in Article 13 of the General Conditions.

B. Replacement of earth fill or backfill, where it has settled below the required finish elevations, shall be considered as part of such required repair work, and any repair or resurfacing which becomes necessary by reason of such required repair work shall be completed by CONTRACTOR at no cost to OWNER.

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

D. The CONTRACTOR shall obtain a signed release from the property owner approving restoration of work in the construction easements across or bordering private property.

1.06 FINAL ACCEPTANCE

A. Final acceptance and final payment shall not be made until all provisions of the General Conditions have been satisfied.

1.07 CONTRACT CLOSEOUT

A. As a condition precedent to final acceptance of the project, the Contractor shall complete the required forms as indicated in the General Conditions and submit the original and two copies of each form to the Project Representative.

1.08 RECORD DRAWINGS

A. The CONTRACTOR shall provide the Project Representative one neatly and legibly marked set of full-size contract drawings showing the final location of piping, equipment, electrical conduits, outlet boxes and cables. Marking of the drawings shall be kept current and shall be done at the time the material and equipment are installed. These drawings shall be available to the Project Representative at all times.

B. The record drawing set shall be submitted to the Project Representative.

1.09 MEASUREMENT AND PAYMENT

A. Project closeout shall not be measured or paid as a separate item, but shall be included as part of the various items to which it relates.

- END OF SECTION -

SECTION 02051

GENERAL LANDSCAPE SITE WORK REQUIREMENTS

PART 1 GENERAL

1.01SUMMARY

A. Includes But Not Limited To
   1. General procedures and requirements for Site Work.

B. Contractor shall remove, salvage and replace existing decorative rock over all disturbed, non-paved areas.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION

3.01 EXAMINATION

A. Site Verification of Conditions
   1. 48 hours minimum prior to performing any work on site, contact Blue Stakes, to arrange for utility location services.
   2. Pothole to verify location of existing various underground facilities at sufficient locations to assure that no conflict with the proposed work exists and sufficient clearance is available to avoid damage to existing facilities.
   3. Perform potholing at least 10 working days in advance of performing any excavation or underground work.
   4. Upon discovery of conflicts or problems with existing facilities, notify Engineer by phone or fax within 24 hours. Follow telephone or fax notification with letter and diagrams indicating conflict or problem and sufficient measurements and details to evaluate problem.

3.02 PREPARATION

A. Protection
   1. Spillage -
      a. Avoid spillage by covering and securing loads when hauling on or adjacent to public streets or highways.
      b. Remove spillage and sweep, wash, or otherwise clean project, streets, and highways.
   2. Dust Control -
      a. Take precautions necessary to prevent dust nuisance, both on-site and adjacent to public and private properties.
      b. Correct or repair damage caused by dust.
   3. Erosion Control -
      a. Take precautions necessary to prevent erosion and transportation of soil downstream, to adjacent properties, and into on-site or off-site drainage systems.
      b. Develop, install, and maintain an erosion control plan if required by law.

c. Repair and correct damage caused by erosion.

4. Existing Plants & Features - Do not damage tops, trunks, and roots of existing trees and shrubs on site which are intended to remain. Do not use heavy equipment within branch spread. Interfering branches may be removed only with permission of Architect. Do not damage other plants and features which are to remain.

B. If specified precautions are not taken or corrections and repairs made promptly, Owner may take such steps as may be deemed necessary and deduct costs of such from monies due to Contractor. Such action or lack of action on Owner's part does not relieve Contractor from responsibility for proper protection of the Work.

3.03 REPAIR/RESTORATION

A. Adjust existing covers, boxes, and vaults to grade.

B. Replace broken or damaged covers, boxes, and vaults.

C. Independently confirm size, location, and number of covers, boxes, and vaults which require adjustment.

D. Replace salvaged decorative rock in non-paved areas with proper soil compaction, and weed barrier (filter fabric) to match the existing depth before construction commenced.

3.04 FIELD QUALITY CONTROL

A. If work has been interrupted by weather, scheduling, or other reason, notify Architect/Engineer 24 hours minimum prior to intended resumption of grading or compacting.

B. Owner reserves right to require additional testing to re-affirm suitability of completed work including compacted soils which have been exposed to adverse weather conditions.

- END OF SECTION -

SECTION 02110

CLEARING, GRUBBING, AND STRIPPING

PART 1 GENERAL

1.01 SUMMARY

A. This work shall consist of removing and disposing of all trees; shrubs; brush; stumps; windfalls; roots; and other vegetation, including dead and decayed matter; and debris that exist within the designated construction limits, borrow areas, and soil stockpile areas and which are not specifically designated to remain.

1.02 DEFINITIONS

A. Clearing: Clearing operations shall consist of cutting, removing and disposing of trees, shrubs, bushes, windfalls and other vegetation within the construction limits, borrow areas and soil stockpile areas. All brush shall be cut off within six inches of the ground surface.

B. Grubbing: Grubbing operations shall consist of removing and disposing of stumps, roots, debris deleterious materials, and other remains (such as organic and metallic materials) which if left in place would interfere with proper performance or completion of the contemplated work, would impair its subsequent use or form obstructions therein. Organic material from clearing or grubbing operations shall not be incorporated in fill or backfill.

C. Stripping: Stripping operations shall consist of removing all soil material containing sod, grass, or other vegetation and topsoil to a minimum depth of six (6) inches from all areas that will receive fill or over all trenches in field or yard areas.

1.03 MEASUREMENT AND PAYMENT

A. Measurement and payment for clearing, grubbing and stripping shall not be paid as an unit item, but considered as included in the contract unit or lump sum prices for the various items of the contract to which it relates.

PART 2 PRODUCTS (not applicable)

PART 3 EXECUTION

3.01 CLEARING

A. All trees, stumps, shrubs, bushes, windfalls and other vegetation (except such trees and vegetation as may be indicated or directed by ENGINEER to be left standing) shall be cut off to within six inches of the ground surface and shall be removed from the construction limits. Trees and vegetation to be left standing shall be protected from damage incident to clearing, grubbing, and construction operations by such means as the circumstances

require.

3.02 GRUBBING

A. All stumps, roots, debris, deleterious and other organic or metallic materials not suitable for foundations shall be removed completely from the construction limits, borrow areas and soil stockpile areas. Unless otherwise permitted by ENGINEER, stumps shall be removed completely. If any stumps are permitted to remain, they shall be cut off not more than six inches above the ground.

3.03 STRIPPING

A. Soil material containing sod, grass, or other vegetation and topsoil shall be removed to a minimum depth of six (6) inches from all areas to receive fill from the area within lines 5 feet outside all foundation walls, over all trenches, and from beneath pavement and curb and gutter areas. The stripped material shall be deposited in such locations as are acceptable to ENGINEER. Topsoil shall be placed over designated areas to be landscaped, and over all trench areas (outside of paved areas).

B. All areas to be sodded shall have a minimum thickness of 3 inches (or thicker if required elsewhere in these documents or on the drawings) of topsoil.

3.04 DISPOSAL

A. No open burning of combustible materials will be allowed.

B. All trees, timber, stumps, roots, debris, shrubs, bushes, and other vegetation removed during the clearing and grubbing operations shall be removed from the project site and disposed of by CONTRACTOR subject to specific regulations imposed by laws and ordinances and in a manner that will not create a public nuisance nor result in unsightly conditions. CONTRACTOR shall assume full responsibility for acceptable disposition of the material as well as for any damages resulting from his disposal operations.

- END OF SECTION -

SECTION 02210

SITE GRADING

PART 1 GENERAL

1.01 DESCRIPTION

A. This section covers site grading.

1.02 RELATED WORK

A. Related work specified in other sections:

Section 01440 - Quality Control and Materials Testing
Section 01500 - Temporary Construction Utilities & Environmental Controls
Section 02221 - Excavation and Backfill for Buried Pipelines
Section 02222 - Excavation and Backfill for Structures
Section 02278 - Untreated Base Course

1.03 REFERENCES

A. The latest edition of the following publications form a part of this specifications to the extent referred. The publication are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 422- Particle-Size Analysis of Soils
ASTM D 698- Test Method of Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5 lb. (2.5-kg) Rammer and 12-in. (305-mm) Drop
ASTM D 1556- Density of Soil in Place by the Sand-Cone method
ASTM D 1557- Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-in. (457-mm) Drop
ASTM D 2487- Classification of Soils for Engineering Purposes
ASTM D 2922- Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017- Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

1.04 MEASUREMENT AND PAYMENT

A. Measurement and payment for general site grading shall not be paid as an unit item, but considered as included in the contract unit or lump sum prices for the various items of the contract to which it relates.

PART 2 PRODUCTS

2.01 EMBANKMENT MATERIAL

A. Embankment materials shall be structural fill complying with AASHTO A-1-a Classification and a maximum size not greater than 4 inches.

B. Embankment material shall be free from frozen lumps, rocks larger than 4 inches in the larger dimension, roots, trash, lumber or organic material.

C. Required fill under footings shall consist of Untreated Base Course as specified in Section 02278.

PART 3 EXECUTION

3.01 GENERAL

A. Grading shall produce uniform grades or slopes between spot elevations or contours shown.

B. Areas of construction activity shall be left in condition of uniform grade, blending into pre-existing contours and concealing, as much as possible, evidence of construction activity by back dragging or raking to conceal tire marks. Landscaping shall not be performed until the subgrade is acceptable to OWNER.

C. All excess excavated materials shall be removed from the project site and disposed of by CONTRACTOR subject to specific regulations imposed by laws and ordinances and in a manner that will not create a public nuisance nor result in unsightly conditions. CONTRACTOR shall assume full responsibility for acceptable disposition of the material as well as for any damages resulting from his disposal operations.

3.02 LANDSCAPING

A. Contractor shall remove any existing landscape rock and fabric that will be disturbed during construction and stockpile it for reuse. After construction is completed fabric shall be replace and rock reinstalled. **Sprinklers shall be relocated as required.**

3.03 SITE PREPARATION

A. As identified in the geotechnical investigation of the site performed by Applied Geotechnical Engineering Consultants (AGEC), dated May 13, 2015, approximately 6 feet of fill was encountered in the area of the proposed building. Based on the penetration resistance measured in Boring B-1, the fill may be relatively well compacted. Contractor shall conduct compaction testing on the existing fill material and provide the results to Engineer for evaluation to determine if fill is suitable to support the proposed building footings and floor

slab. Unsuitable fill shall be removed from below the building footings and floor slab areas and replaced with compacted embankment materials defined in 2.01.A of this section.

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B. Care shall be taken not to disturb the natural soil which is to remain below the proposed building or pavement areas.

C. Prior to placing grading fill or concrete; any loose or disturbed soil, topsoil or organic material shall be removed. The subgrade shall be proof-rolled to identify soft areas. Soft areas shall be removed and replaced with compacted granular fill containing less than 15 percent passing the No. 200 sieve.

D. Embankment shall include the placement of materials to raise the grade to the established elevations indicated and the construction of driving surfaces, taking into consideration the required thicknesses for base course material and asphalt paving, concrete, or topsoil.

E. Embankment material shall be placed in no more than 6-inch loose lifts.

F. All embankment fill material shall be placed and compacted to at least 90% of maximum dry density in open areas and 95% of maximum dry density beneath all asphalt or concrete areas on the sites as determined by ASTM D-1557 at a moisture content within plus two percent to minus two percent of optimum.

G. Where the moisture content is not suitable and/or sufficient compaction has not been obtained, the fill shall be reconditioned to an approved moisture content and recompacted to the minimum required compaction.

H. Unless otherwise specified, CONTRACTOR shall be responsible for arranging for the placing and compacting of approved fill material in accordance with these Specifications. If the Soils Testing Agency should determine that CONTRACTOR is failing to meet the minimum requirements, CONTRACTOR shall stop operations and make adjustments as necessary to produce a satisfactorily compacted fill at no additional cost to OWNER.

3.04 GRADING

A. The final grade of all completed areas shall be between zero and minus one-tenth (- 0.1) of a foot from the grade designated on the drawings.

3.05 COMPACTION TESTS

A. Compaction Quality Control Testing shall be the provided and paid for in accordance with Section 01440.

B. It shall be the responsibility of the CONTRACTOR to accomplish the specified compaction for fill and other earthwork. It shall be the responsibility of the CONTRACTOR to control his operations by performing any additional tests necessary to verify and confirm that CONTRACTOR has complied, and is complying at all times, with the requirements of these Specifications concerning compaction, control, and testing.

1. Testing of Fill Materials

    a. Characteristics of fill materials shall be determined in accordance with the requirements of Section 01440.

    b. The CONTRACTOR shall demonstrate the adequacy of compaction equipment and procedures before exceeding the first lift for embankment fill materials.

    c. Until the specified degree of compaction on the previously specified amounts of earthwork is achieved, no additional earthwork of the same kind shall be performed.

    d. Periodic Quality Assurance tests may be made by the ENGINEER to verify that compaction is meeting the requirements previously specified at no cost to the CONTRACTOR. However, CONTRACTOR shall perform all Quality Control Testing in accordance with Section 01440.

    e. If compaction fails to meet the specified requirements, the CONTRACTOR shall remove and replace the embankment fill at proper density or shall bring the density up to specified level by other means acceptable to the ENGINEER. Subsequent tests required to confirm and verify that the reconstructed embankment fill has been brought up to specified density shall be paid in accordance with Section 01440. The confirmation tests shall be performed in a manner acceptable to the ENGINEER. Frequency of confirmation tests for remedial work shall be double that amount specified for initial confirmation tests.

2. Field Density Tests

    a. Tests shall be performed in sufficient numbers to meet the requirements of Section 01440 and to ensure that the specified density is being obtained.

C. Field density tests shall be made in accordance with ASTM D-1557.

- END OF SECTION -

SECTION 02221

EXCAVATION AND BACKFILL FOR BURIED PIPELINES

PART 1 GENERAL

1.01 SUMMARY

A. This item shall consist of excavating all pipeline trenches to the lines and grades indicated on the drawings or as directed by ENGINEER in the field, and the backfilling of all pipeline trenches. Excavation shall include the removal of all materials of whatever nature encountered to the depths shown on the Drawings, or as modified in the Field by ENGINEER.

1.02 RELATED SECTIONS

A. Related work specified in other sections:

Section 01440 - Quality Control & Materials Testing
Section 01500 - Temporary Construction Utilities and Environmental Controls
Section 02222 - Excavation and Backfill for Structures
Section 15016 - Acrylonitrile-Butadiene-Styrene (ABS) Pipe
Section 15061 - Steel Pipe
Section 15064 - High Density Polyethylene Pipe
Section 15065 - Polyvinylchloride Pipe

1.03 MEASUREMENT AND PAYMENT

A. There shall be no separate measurement and payment for excavation and backfill for buried pipelines. Full compensation for all excavation and backfill for buried pipelines shall be considered as included in the contract unit or lump sum prices for the various items of the contract to which excavation and backfill for buried pipelines relates.

1.04 REFERENCES

A. The latest edition of the following publications form a part of this specifications to the extent referred. The publication are referred to in the text by basic designation only.

B. AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

1. T 88 Particle Size Analysis of Soils
2. T 180 Moisture-Density Relations of Soils Using a 10-lb. (4.54 kg) Rammer and an 18-in (457 mm) Drop
3. T 191 Density of Soil In-Place by the Sand-Cone Method
4. T 205 Density of Soil In-Place by the Rubber-Balloon Method
5. T 238 Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

6. T 239 Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. D 422 Particle-Size Analysis of Soils
2. D 698 Test Method of Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5 lb. (2.5-kg) Rammer and 12-in. (305-mm) Drop
3. D 1556 Density of Soil in Place by the Sand-Cone method
4. D 1557 Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-in. (457-mm) Drop
5. D 2487 Classification of Soils for Engineering Purposes
6. D 2922 Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
7. D 3017 Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

1.05 DEFINITIONS

A. Degree of Compaction: Degree of compaction shall be expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557.

B. Bedding: That surface of the Excavation or portion of the Pipe Zone below the pipe.

C. Pipe Zone: That zone in an Excavation which supports, surrounds, and extends to 12 inches above the top of the pipe barrel. Specifically, 6 inches from the bottom and 12 inches from the top of the pipe and 1 foot from the sides of the pipe.

D. Trench Backfill: That zone in an Excavation which begins 12 inches above the top of the pipe barrel and extends to the natural surface level or the finished grade indicated on the Plans.

E. Unyielding Material: Unyielding material shall consist of rock and gravelly soils with stones greater than 12 inches in any dimension or as defined by the pipe manufacturer, whichever is smaller.

F. Unstable Material: Unstable material shall consist of materials too wet to allow backfill compaction or to properly support the utility pipe, conduit, or appurtenant structures.

1.06 SUBMITTALS

A. The following shall be submitted in accordance with Section 01300 Contractor Submittals:

1. Copies of Field Density Test reports shall be submitted to ENGINEER or RPR at the beginning of each work day for the previous day’s testing of subgrades, embankments and backfill Materials.

2. Copies of all Laboratory Test Reports shall be submitted to ENGINEER or RPR within 24 hours of the completion of the test.

3. Submit gradations and proctors for Pipe Zone Material and Trench Backfill.

1.07 SITE CONDITIONS

A. Unsuitable Weather Limitations: CONTRACTOR shall not place, spread, or roll any fill material during unsuitable weather conditions. CONTRACTOR shall not resume operations until moisture content of material is satisfactory.

B. Weather Softened Subgrade: CONTRACTOR shall remove and replace at no additional cost to OWNER soft subgrade materials resulting from adverse weather conditions.

C. Protection of Graded Areas: CONTRACTOR shall protect all graded areas from traffic and erosion and shall keep these areas free of trash and debris. Work required to repair and reestablish grades in settled, eroded, and rutted areas shall be completed to specified tolerances at CONTRACTOR's expense.

D. Reconditioning Compacted Areas: All areas compacted to required specifications that become disturbed by subsequent construction operations or weather conditions shall be scarified, moisture conditioned and recompacted to the required density prior to further construction.

E. Grading: the final compacted surface of base course shall not vary more than 1/4 inch above or below design grade.

PART 2 PRODUCTS

2.01 MATERIALS

A. Select Granular Material: Select granular material shall consist of hard, durable particles of stone or gravel, screened or crushed to the required size and gradation. The material shall be free from vegetation matter, lumps or balls of clay, or other deleterious matter and shall conform to the following gradation when tested in accordance with AASHTO T-27 or ASTM C 136.

1. Coarse material shall be crushed or wasted and fine material shall be wasted to meet the grading requirements set forth below.

2. Coarse aggregate, retained on the No. 4 sieve, shall have a percentage of wear not greater than 40 percent when tested by the Los Angeles Test, AASHTO T-96 or ASTM C 131.

Sieve Size (Square Opening)	Percent By Weight Passing Screen
2-inch	100
1-1/2 inch	10 - 50
3/4-inch	0 - 25
No. 4	0 - 10
No. 200	0 - 3

B. Pipe Zone Material: All material in the pipe zone shall be clean sand mixture free from alkali, salt, petroleum products, vegetative matter or other deleterious matter, slag, cinders, ashes and rubbish or other material that in the opinion of the ENGINEER may be objectionable or deleterious. "Squeegee" or any other flowable material shall not be permitted. Pipe zone material shall conform to the following gradation:

U.S. Standard Sieve Size (Square Opening)	Percent By Weight Passing Screen
3/4 - inch	100
No. 4	80 - 100
No. 10	30 - 50
No. 40	10 - 30
No. 200	0 - 15

C. Trench Backfill: Trench Backfill shall consist of native material meeting soils classifications A-1, A-2 or A-3 of AASHTO M 145 or import fill material meeting the same soils classifications, with a maximum particle size no greater than 4 inches in any dimension and shall be capable of meeting the compaction requirements. Trench backfill shall be free from clods of earth debris, alkali, salt, petroleum products, vegetative matter or other deleterious or decomposable matter, frozen material, slag, cinders, ashes and rubbish or other material that in the opinion of ENGINEER may be objectionable or deleterious. "Squeegee" or any other flowable material shall not be permitted.

PART 3 EXECUTION

3.01 EXCAVATION

A. Excavation shall be performed to the lines and grades indicated. Excavated material not required or not satisfactory for backfill shall be removed from the site. If topsoil is on site, remove and store for later use on site.

3.02 SAFETY

A. Excavations shall be sloped or otherwise supported in a safe manner in accordance with applicable State safety requirements and the latest requirements of OSHA Safety and Health

Standards for Construction (29 CFR 1926). CONTRACTOR is responsible for assessing safety needs to meet such requirements, arranging for proper equipment and/or construction methods, and maintaining such equipment, methods and construction practices so as to fully comply with all safety requirements.

3.03 TRENCH WIDTH

A. The bottom of the trench shall have a minimum width equal to the outside diameter of the pipe plus 24-inches or as detailed on the drawings.

B. The width of the trench shall be ample to permit the pipe to be laid and jointed properly, and the backfill to be placed as specified. Trenches shall be of such extra width, when required, as will permit the convenient placing of timber supports, sheeting, and bracing, and the handling of special units as necessary.

3.04 TRENCH PREPARATION

A. Each trench shall be excavated so that the pipe can be laid to the alignment and grade as required. The trench wall shall be so braced that the workmen may work safely and efficiently. All trenches shall be drained so the pipe laying may take place in dewatered conditions.

B. Bottom Preparation

1. The bottom of the trench shall be over excavated 6 inches or 1/12 the outside diameter of the pipe, whichever is greater, below the required grade and replaced with suitable materials as provided in paragraph PIPELINE TRENCH BACKFILLING AND COMPACTION.

2. The bottoms of trenches shall be accurately graded to provide uniform bearing and support for the bottom quadrant of each section of the pipe. Bell holes shall be excavated to the necessary size at each joint or coupling to eliminate point bearing. Stones of 2 inches or greater in any dimension, or as recommended by the pipe manufacturer, whichever is smaller, shall be removed to avoid point bearing.

C. Removal of Unstable Material

1. Where unstable material is encountered in the bottom of the trench, such material shall be removed to the depth directed and replaced to the proper grade with select granular material as provided in paragraph PIPELINE TRENCH BACKFILLING AND COMPACTION. When removal of unstable material is required due to the fault or neglect of the CONTRACTOR in his performance of the work, the resulting material shall be excavated and replaced by the CONTRACTOR without additional cost to the OWNER.

D. Each trench shall be excavated so that the pipe can be laid to the alignment and grade as required. The trench wall shall be so braced that the workmen may work safely and

efficiently. All trenches shall be drained so the pipe laying may take place in dewatered conditions.

E. The trench bottom shall be given a final trim using a string line, laser, or another method approved by ENGINEER for establishing grade, such that each pipe section when first laid will be continually in contact with the ground along the extreme bottom of the pipe. Bell holes shall be provided at each joint to permit the jointing to be made properly. The trench grade shall permit the pipe spigot to be accurately centered in the preceding-laid pipe joint, without lifting the pipe above the grade, and without exceeding the permissible joint deflection.

3.05 REMOVAL OF WATER

A. CONTRACTOR shall provide and maintain at all times ample means and devices with which to remove promptly and to properly dispose of all water entering the trench excavation.

B. Water shall be disposed of in a suitable manner without damage to adjacent property or without being a menace to public health and convenience. No water shall be drained into work built or under construction without prior consent of ENGINEER.

C. Dewatering shall be accomplished by well points, sumping, or any other acceptable method which will insure a dewatered trench.

3.06 LAYING AND JOINING PIPE

A. Laying pipe: Provide proper facilities for lowering pipe sections into place. Dropping pipe will not be permitted. Place each section true to line and gradient in close and true contact with adjacent sections.

B. Pipe shall be installed in accordance with these specifications and the manufacturers written specifications for the type of pipe installed.

3.07 PIPELINE TRENCH BACKFILLING AND COMPACTION

A. Pipe Zone:

1. Pipe zone material shall be as required in Section 2.01, above, and be of the type and thickness shown for the type of pipe used.

2. Backfill material for pipe zone areas shall be as defined above and free from rocks of such size as recommended by the pipe manufacturer, whichever is smaller. Backfill shall be placed in layers not exceeding 6 inches loose thickness for compaction by hand operated machine compactors, and 8 inches loose thickness for other than hand operated machines, unless otherwise approved or specified. The backfill shall be brought up evenly on both sides of the pipe for the full length of the pipe. Care shall be taken to ensure thorough compaction of the fill under the haunches of the pipe. Each

layer shall be compacted to at least 95 percent of the maximum Modified Proctor density (ASTM D-1557), unless otherwise specified.

3. Replacement of Unyielding Material

    a. Unyielding material removed from the bottom of the trench shall be replaced with pipe zone material.

4. Replacement of Unstable Material

    a. Unstable material removed from the bottom of the trench or excavation shall be replaced with select granular material placed in layers not exceeding 6 inches loose thickness.

5. Where the pipe grade exceeds 30%, Cohesive material shall be used in lieu of pipe bedding. The Cohesive material shall be moistened to within 2% of optimum moisture and compacted as noted.

6. The relative density of the compacted cohesionless material shall not be less than 60% as determined by the Bureau of Reclamation Relative Density of Cohesionless Soil Test (Designation E-12) of the "Earth Manual."

B. Trench Backfill: Trenches shall be backfilled to the grade shown with Trench Backfill material as specified in 2.01 above.

1. Trench backfill for trench cuts in areas outside the traveled right-of-way and in open country (Unimproved Areas) shall consist of backfilling the trench from above the pipe zone to finished grade with Trench Backfill material compacted to at least 95 percent of maximum density (ASTM D-1557). Backfill shall be placed in layers not exceeding 6 inches loose thickness for compaction by hand operated machine compactors, and 8 inches loose thickness for other than hand operated machines, unless otherwise approved or specified. Backfill from the specified thickness for topsoil below finished grade to finished grade shall consist of topsoil replacement.

2. Trench backfill in road areas, and parking areas (Improved Areas) shall consist of backfilling the trench from above the pipe zone up to underneath the noted recommended depth for gravel or asphalt of finished grade with Trench Backfill material compacted to 96 percent of maximum density (ASTM D-1557). Backfill shall be placed in layers not exceeding 6 inches loose thickness for compaction by hand operated machine compactors, and 8 inches loose thickness for other than hand operated machines, unless otherwise approved or specified.

3. It shall be the responsibility of CONTRACTOR to be assured that the native material, if used, complies with the requirements of these specifications. It shall be CONTRACTOR's responsibility to remove and dispose of all excess excavated material.

C. Final Backfill: In unimproved areas, the most upper portion of the trench shall be backfilled with topsoil at the designated topsoil thickness. In improved areas the upper portion of the

trench shall be backfilled with the designated untreated base course and asphalt. Topsoil may be native material stripped prior to excavation of the trench. Backfill material shall be placed and compacted as follows:

1. Turfed Areas and Miscellaneous Areas: Backfill shall be deposited in layers of a maximum of 6-inch loose thickness, and compacted to 85 percent maximum density (ASTM D-1557). Compaction by water flooding or jetting will not be permitted. This requirement shall also apply to all other areas not specifically designated above.

2. Roadways shall be completed with the type and thickness of materials as indicated or shown on the drawings.

3.08 SPECIAL REQUIREMENTS

A. Special requirements for both excavation and backfill relating to the specific utilities from above the pipe zone to the natural surface level or the finished grade indicated on the Plans shall be placed and compacted as follows:

1. Where existing underground pipes or conduits larger than 3 inches in diameter cross the trench above the new work, the backfill from the bottom of the trench to 1 foot above the top of the intersecting pipe or conduit shall be pipe zone material compacted to 95 percent of maximum density (ASTM D-1557). The pipe zone material shall extend 2 feet on either side of the intersecting pipe or conduit to insure that the material will remain in place while other backfill is placed.

B. The maximum trench length open at any given time shall not exceed 700 lineal feet in open areas, and 200 lineal feet in barricaded areas except in traveled roadways only 80 lineal feet unless approved by the Engineer, and must be backfilled in a timely manner. Trenches must be closed during nighttime conditions.

3.09 MAINTENANCE OF BACKFILL

A. All backfill shall be maintained in satisfactory condition, and all places showing signs of settlement shall be filled and maintained during the life of the contract and for a period of one year following the day of final acceptance of all work performed under the contract. When CONTRACTOR is notified by ENGINEER or OWNER that any backfill is hazardous, CONTRACTOR shall correct such hazardous condition at once. Any utility, road and/or parking surfacing damage by such settlement shall be repaired by CONTRACTOR to the satisfaction of OWNER and ENGINEER. In addition, CONTRACTOR shall be responsible for the cost to OWNER of all claims for damage filed with the Court, actions brought against the said OWNER for, and on account of, such damage.

3.10 FINISH GRADING AND CLEANUP

A. CONTRACTOR shall grade the trench line to a smooth grade to effect a neat and workmanlike appearance of the trench line.

B. All tools, equipment and temporary structures shall be removed. All excess excavated material and rubbish shall be removed from the site by CONTRACTOR.

C. CONTRACTOR shall restore the site to at least as good as original condition, including but not limited to final trench grade and restoration of affected public and private facilities whether in the public right of way or on private property. Any exception to this requirement must be in writing from ENGINEER for the job specific conditions.

3.11 COMPACTION TESTS

A. It shall be the responsibility of CONTRACTOR to accomplish the specified compaction for backfill, fill, and other earthwork. It shall be the responsibility of CONTRACTOR to control his operations by performing any additional tests necessary to verify and confirm that CONTRACTOR has complied, and is complying at all times, with the requirements of these Specifications concerning compaction, control, and testing.

1. Testing of Backfill Materials

a. Characteristics of backfill materials shall be determined in accordance with the requirements of Section 01440.

b. The CONTRACTOR shall demonstrate the adequacy of compaction equipment and procedures before exceeding any of the following amounts of earthwork quantities:

(1) 50 linear feet of trench backfill.

c. Until the specified degree of compaction on the previously specified amounts of earthwork is achieved, no additional earthwork of the same kind shall be performed.

d. After satisfactory conclusion of the initial compaction demonstration and at any time during construction, earthwork which does not comply with the specified degree of compaction shall not exceed the previously specified quantities.

e. Additional Quality Assurance tests may be made by ENGINEER to verify that compaction is meeting the requirements previously specified at no cost to CONTRACTOR. ENGINEER may require retesting of backfill that has settled from water penetration in the trench. CONTRACTOR shall remove the overburden above the level at which ENGINEER wishes to test and shall backfill and recompact the excavation after the test is complete at no additional cost.

f. If compaction fails to meet the specified requirements, CONTRACTOR shall remove and replace the backfill at proper density or shall bring the density up to specified level by other means acceptable to ENGINEER. Subsequent tests required to confirm and verify that the reconstructed backfill has been brought up to specified density shall be paid by CONTRACTOR. CONTRACTOR's confirmation tests shall be performed in a manner acceptable to ENGINEER.

2. Field Density Tests

   a. Field density tests shall be made in accordance with ASTM D-1557.

- END OF SECTION -

SECTION 02222

EXCAVATION AND BACKFILL FOR STRUCTURES

PART 1 GENERAL

1.01 DESCRIPTION

A. This section covers excavating, backfilling and compacting for structures as directed by ENGINEER.

1.02 RELATED WORK

A. Related work specified in other sections:

Section 01440 - Quality Control and Materials Testing
Section 01500 - Temporary Construction Utilities and Environmental Controls
Section 02210 - Site Grading
Section 02221 - Excavation and Backfill for Buried Pipelines
Section 02278 - Untreated Base Course
Section 02720 - Drainage System
Section 03300 - Cast-in-Place Concrete

1.03 REFERENCES

A. The latest edition of the following publications form a part of this specifications to the extent referred. The publication are referred to in the text by basic designation only.

AASHTO T 88-	Particle Size Analysis of Soils
AASHTO T 180-	Moisture-Density Relations of Soils Using a 10-lb. (4.54 kg) Rammer and an 18-in (457 mm) Drop
AASHTO T 191-	Density of Soil In-Place by the Sand-Cone Method
AASHTO T 205-	Density of Soil In-Place by the Rubber-Balloon Method
AASHTO T 238-	Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
AASHTO T 239-	Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 422-	Particle-Size Analysis of Soils
ASTM D 698-	Test Method of Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5 lb. (2.5-kg) Rammer and 12-in. (305-mm) Drop
ASTM D 1556-	Density of Soil in Place by the Sand-Cone method
ASTM D 1557-	Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-in. (457-mm) Drop

ASTM D 2487- Classification of Soils for Engineering Purposes
ASTM D 2922- Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017- Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

B. The latest Edition of the State of Utah Standard Specification for Road and Bridge Construction.

C. The latest Edition of the American Public Works Association (APWA) and Associated General Contractors of America Standard Plans and Standard Specifications.

1.04 SUBMITTALS

A. The following shall be submitted in accordance with Section 01300 Contractor Submittals:

1. Laboratory test results showing that Untreated Base Course conforms to the Specification requirements.

2. Copies of Field Density Test reports shall be submitted to ENGINEER or OWNER's RPR at the beginning of each work day for the previous day's testing of subgrades, gravel and structural fill.

1.05 MEASUREMENT AND PAYMENT

A. Excavation and Backfill for Structures shall not be measured or paid as a separate item, but shall be included as part of the various items to which it relates.

PART 2 PRODUCTS

2.01 WALL BACKFILL

A. Wall backfill material shall be free from frozen lumps, rocks larger than 4 inches in the largest dimension, roots, trash, lumber and organic material, and shall meet the requirements of 2.01.A of Section 02210 Site Grading. The natural soils may be used as structural fill where it meets the above stated criteria.

2.02 STRUCTURAL FILL

A. Structural fill material placed below foundations shall be Untreated Base Course complying with the requirements of Section 02278.

B. Fill to support the floor slab (below the upper 4 inches) shall embankment structural fill meeting the be requirements 2.01.A of Section 02210 Site Grading. The natural soils may be used as embankment structural fill where it meets the stated criteria in 2.01.A. of Section 02210.

2.03 FLOOR SLAB FILL (Upper 4 inches)

A. The upper 4 inches of fill under the floor slab shall be 3/4" Washed Rock which shall consist of hard, durable particles of stone or gravel, screened or crushed, to the required size and gradation. The material shall be free from vegetation matter, lumps or balls of clay, or other deleterious matter and shall conform to the following gradation when tested in accordance with AASHTO T 27 or ASTM C 136.

Sieve Size (Square Opening)	Percent By Weight Passing Screen
3/4 inch	100
3/8 inch	78-92
No. 4	0-50
No. 8	0-5
No. 200	0-3

PART 3 EXECUTION

3.01 EXCAVATION

A. Excavation shall be performed to the lines and grades indicated. Excavated material not required or not satisfactory for backfill shall be removed from the site

B. The geotechnical site investigation for the Bingham Canyon Fluoride site indicates that approximately 6 feet of fill was encountered in the boring for the building. The fill may be relatively well compacted. Compaction tests shall be conducted by Contractor to determine if it is suitable for the proposed footing and slab. If not stable, excavation shall be performed such that all of the existing fill beneath the proposed construction at this site shall be removed down to undisturbed natural soil and then filled and with compacted structural fill meeting the requirements of 2.02 above.

C. A flat cutting edge shall be used on excavation equipment when excavating for foundations to reduce the disturbance of the natural bearing soils.

D. The base of all footing excavations shall be cleared of loose or deleterious material prior to structural fill or concrete placement.

3.02 BACKFILL

A. Backfill and structural fill material shall not be placed against concrete structure that have not been properly cured.

B. Backfill and structural fill material shall be placed in no more than 6-inch loose lifts.

C. Structural fill placed beneath footings and beneath the floor slab shall be placed and compacted to at least 95 percent of maximum dry density at a moisture content within 2 percent of optimum moisture content in accordance with ASTM D-1557.

D. Where required excavation of existing fill materials extends below the depth of the base of the proposed footings for the buildings, such that the footings cannot be placed on undisturbed natural soils, structural fill shall be placed beneath the footings. If structural fill is placed below footings, the structural fill shall extend down to the undisturbed natural soil and out away from the edge of the footings a distance at least equal to the depth of the fill beneath the footings.

E. All other backfill material shall be placed and compacted to at least 95 percent of maximum dry density at a moisture content within 2 percent of optimum moisture content in accordance with ASTM D-1557.

F. Where the moisture content is not suitable and/or sufficient compaction has not been obtained, the fill shall be reconditioned to an approved moisture content and compacted to the minimum required compaction prior to placing any additional fill material.

G. Unless otherwise specified, CONTRACTOR shall be responsible for arranging for the placing and compacting of approved fill material in accordance with these Specifications. If the Testing Agency determines that CONTRACTOR is failing to meet the minimum requirements, the Testing Agency shall notify ENGINEER immediately. Adjustments to CONTRACTOR'S operation that are necessary to produce a satisfactorily compacted fill shall be made at no additional cost to OWNER.

H. Sufficient personnel, equipment, sumps or other means should be provided to maintain the site in an acceptable dry condition for the duration of this contract.

I. Excavations shall be so braced and supported as needed to prevent the ground, adjacent to the excavation, from sliding or settling. Localized slides or settlements shall be promptly removed and corrected by CONTRACTOR.

3.03 REMOVAL OF WATER

A. The CONTRACTOR shall provide and maintain at all times ample means and devices with which to remove promptly and to properly dispose of all water entering the excavation.

B. Water shall be disposed of in a suitable manner without damage to adjacent property or without being a menace to public health and convenience. No water shall be drained into work built or under construction without prior consent of ENGINEER.

C. Dewatering shall be accomplished in accordance with Section 02319 - Dewatering.

D. CONTRACTOR shall obtain all necessary permits required for discharge of water.

3.04 FINISHED GRADE

A. The finished subgrade and grade of the structural fill shall not vary more than 0.05 feet from the established grades and cross-sections shown on the Drawings.

3.05 COMPACTION TESTS

A. Compaction Quality Control Testing shall be the provided and paid for in accordance with Section 01440.

B. It shall be the responsibility of CONTRACTOR to accomplish the specified compaction for backfill, structural fill, Untreated Base Course and other earthwork. It shall be the responsibility of CONTRACTOR to control his operations by performing any additional tests necessary to verify and confirm that CONTRACTOR has complied, and is complying at all times, with the requirements of these Specifications concerning compaction, control, and testing.

1. Testing of Backfill Materials

a. Characteristics of backfill materials shall be determined in accordance with the requirements of Section 01440.

b. CONTRACTOR shall demonstrate the adequacy of compaction equipment and procedures before exceeding any of the following amounts of earthwork quantities:

(1) One (1) test per 1.5 feet of backfill thickness placed per structure.

c. Until the specified degree of compaction on the previously specified amounts of earthwork is achieved, no additional earthwork of the same kind shall be performed.

d. After satisfactory conclusion of the initial compaction demonstration and at any time during construction, earthwork which does not comply with the specified degree of compaction shall not exceed the previously specified quantities.

e. Periodic additional Quality Assurance tests may be made by ENGINEER to verify that compaction is meeting the requirements previously specified at no cost to CONTRACTOR. ENGINEER may require retesting of backfill (by CONTRACTOR's Testing Agency). CONTRACTOR shall remove the overburden above the level at which ENGINEER wishes to test and shall backfill and recompact the excavation after the test is complete at no additional cost.

f. If compaction fails to meet the specified requirements, CONTRACTOR shall remove and replace the backfill at proper density or shall bring the density up to specified level by other means acceptable to ENGINEER. Subsequent tests required to confirm and verify that the reconstructed backfill has been brought up to specified density shall be paid in accordance with Section 01440. The confirmation tests shall be performed in a manner acceptable to ENGINEER. Frequency of

confirmation tests for remedial work shall be double that amount specified for initial confirmation tests.

2. Field Density Tests

    a. Tests shall be performed in sufficient numbers to meet the requirements of Section 01440 and to ensure that the specified density is being obtained.

C. Field density tests shall be made in accordance with ASTM D-1557.

D. The cost of field density testing shall be paid as specified in Section 01440.

- END OF SECTION -

SECTION 02278

ROAD BASE - UNTREATED BASE COURSE

PART 1 GENERAL

1.01 DESCRIPTION

A. This work consists of the placement of Untreated Base Course material at designated road ways and all driving surfaces as indicated on the Drawings.

1.02 RELATED SECTION

A. Related work specified in other Sections:

Section 01440 - Quality Control & Materials Testing
Section 02222 - Excavation and Backfill for Buried Structures

1.03 REFERENCES

A. The latest edition of the following publication forms a part of this specification to the extent referenced. The publication is referred to in the text by basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 88-	Particle Size Analysis of Soils
AASHTO T 180-	Moisture-Density Relations of Soils Using a 10-lb. (4.54 kg) Rammer and an 18-in (457 mm) Drop
AASHTO T 191-	Density of Soil In-Place by the Sand-Cone Method
AASHTO T 205-	Density of Soil In-Place by the Rubber-Balloon Method
AASHTO T 238-	Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
AASHTO T 239-	Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 422-	Particle-Size Analysis of Soils
ASTM D 698-	Test Method of Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5 lb. (2.5-kg) Rammer and 12-in. (305-mm) Drop
ASTM D 1556-	Density of Soil in Place by the Sand-Cone method
ASTM D 1557-	Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-in. (457-mm) Drop
ASTM D 2487-	Classification of Soils for Engineering Purposes

ASTM D 2922- Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

ASTM D 3017- Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

B. The Utah Department of Transportation Standard Specification for Road and Bridge Construction (UDOT).

1.04 SUBMITTALS

A. Untreated Base Course (State approved 3/4" or 1 ½ Gradation) and modified gradation for Untreated Base Course materials placed to a depth of 6 inches beneath concrete floor slabs and to a depth of 6 inches beneath all other concrete slabs on grade.

1.05 MEASUREMENT AND PAYMENT

A. Road Base shall not be measured or paid as a separate item, but shall be included as part of the various items to which it relates.

PART 2 PRODUCTS

2.01 MATERIALS

A. **Untreated Base Course:** Untreated Base Course Materials shall meet the current UDOT Specifications for Road Base as shown in Table 1.

TABLE 1

SIEVE SIZE	GRADE 1 1/2 GRADATION (PERCENT PASSING)	GRADE 3/4 GRADATION (PERCENT PASSING)
1 1/2 inch	100	-
1 inch	90 -100	-
3/4 inch	70 - 85	100
1/2 inch	65 - 80	-
3/8 inch	55 - 75	78 -92
No. 4	40 - 65	55 - 67
No. 16	25 - 40	28 - 38
No. 200	7 - 11	*7 - 11

Percent passing based on total aggregate (dry weight), and fine and coarse aggregate having approximately the same bulk specific gravities.

* The gradation criteria passing the No. 200 sieve for the 3/4" Untreated Base Course gradation shall be changed to less than 5% passing the No. 200 sieve for Untreated Base Course materials placed to a thickness of 6 inches below concrete floors or other slabs.

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION

A. Prior to placement of untreated base course materials, the foundation area to receive untreated base course materials shall be scarified to a minimum depth of 8-inches and recompacted to 95% minimum laboratory density as determined by ASTM D-1557.

3.02 UNTREATED BASE COURSE MATERIAL PLACEMENT

A. No Untreated Base Course material shall be placed on sub-grade materials until the sub-grade has been checked and accepted by ENGINEER.

B. Road base material placed on driving surfaces shall be compacted to a minimum density of 96% in accordance with ASTM D-1557 to provide a uniform graded smooth surface.

C. UBC material shall be placed to a minimum thickness of eight (8) inches on driving surfaces or as shown on the DRAWINGS.

3.03 GRADING

A. The final grade of the Untreated Road Base material shall provide a minimum thickness of eight (8) inches or as shown on the DRAWINGS.

3.04 FIELD QUALITY CONTROL

A. CONTRACTOR shall be responsible for directing proper placement of all road base materials. CONTRACTOR shall be responsible for the stability of the road base materials during placement and shall replace any portions which have become displaced due to careless or negligent work on the part of CONTRACTOR, or to damage resulting from natural causes, such as storms.

B. Whenever the work areas to receive Untreated Base Course material are covered with snow, the snow must be removed prior to placing the road base and/or Untreated Base Course, and deposited outside the immediate construction areas at CONTRACTOR's expense.

- END OF SECTION -

SECTION 02319

DEWATERING

PART 1 GENERAL

1.1 DESCRIPTION

A. This Section provides specifications for dewatering systems and appurtenances to be used during construction as required to remove water and continuously maintain groundwater at a level at least 1-foot below the bottom of the excavation.

B. CONTRACTOR shall obtain all necessary permits for disposal of water removed from the excavation.

1.2 RELATED WORK

A. Related Work specified in other Sections includes, but is not limited to:

1. Section 01300 Contractor Submittals

1.3 SUBMITTALS

A. Provide submittals in accordance with Section 01300 – Contractor Submittals.

B. Before dewatering is commenced, CONTRACTOR shall provide information to ENGINEER outlining the method, installation and details of the proposed dewatering system. CONTRACTOR shall provide ENGINEER with plans setting forth details of the proposed dewatering systems. The dewatering system plans shall be of sufficient detail to indicate sizes of pumps, piping, appurtenances, the ultimate disposal point for water, and to indicate the overall completeness and effectiveness of the proposed system.

C. CONTRACTOR shall certify to OWNER that the design and implementation of the proposed dewatering system is sufficient to complete the Work.

D. Submit a plan to monitoring settlement of adjacent structures.

1.4 QUALITY CONTROL

A. CONTRACTOR shall be responsible to control the rate and effect of dewatering to avoid all settlement and subsidence.

B. Where critical structures exist immediately adjacent to areas of proposed dewatering, reference points shall be established and observed at frequent intervals to detect any settlement which may develop. CONTRACTOR is responsible for protecting adjacent structures from settlement. The cost of repairing any damage to adjacent structures and restoration of facilities shall be the responsibility of CONTRACTOR.

PART 2 PRODUCTS

2.1 MATERIALS

A. CONTRACTOR shall be responsible for selection of dewatering means, methods and materials.

B. Standby pumping equipment shall be maintained on the Site.

PART 3 EXECUTION

3.1 DESIGN AND IMPLEMENTATION

A. CONTRACTOR shall be responsible for complete design and implementation of the dewatering system.

B. CONTRACTOR shall be responsible for the design and implementation of any modifications that may be required to the initial design of the dewatering system (at no additional cost to OWNER) to provide a dewatering system that operates adequately to complete the Work.

C. CONTRACTOR shall furnish, install, operate and maintain all machinery, appliances, and equipment to maintain all excavations free from water during construction.

D. CONTRACTOR shall dispose of water so as to not cause damage to public or private property, or to cause a nuisance or menace to the public or violate the law.

E. CONTRACTOR shall be responsible to obtain groundwater discharge permits, if required.

F. CONTRACTOR shall install and operate the dewatering system so as to not cause damage or endanger adjacent structures or property.

G. The control of groundwater shall be such that softening of the bottom of excavations, or formation of "quick" conditions or "boils," does not occur. Dewatering systems shall be designed and operated so as to prevent removal and migration of the natural soils.

H. CONTRACTOR shall have sufficient stand-by equipment at the project site at all times to continuously maintain the dewatering program until Work necessitating dewatering is complete.

I. CONTRACTOR shall have on hand equipment and machinery in good working condition for emergencies and shall have personnel available for operation of such equipment and machinery.

J. CONTRACTOR shall control surface water to prevent entry into excavations.

- END OF SECTION -

SECTION 02500

REMOVAL AND REPLACEMENT OF SURFACE IMPROVEMENTS

PART 1 GENERAL

1.01 SUMMARY

A. This section provides for the restoration, removal and replacement of surface improvements as established in this specification, as shown in the Drawings and as directed by ENGINEER.

B. Contractor shall remove, stockpile, salvage and replace decorative rock in non-paved areas. Work shall include proper soil compaction and weed barrier (filter fabric) to match the existing depth before construction commenced.

1.02 RELATED SECTIONS

A. Related work specified in other sections includes but is not limited to:

Section 01440 - Quality Control and Materials Testing
Section 02221 - Excavation and Backfill for Buried Pipelines
Section 02278 - Road Base - Untreated Base Course
Section 02745 - Hot Mix Asphalt Concrete
Section 02748 - Prime Coat, Tack Coat (UDOT)
Section 02749 - Asphalt Driveway (UDOT)
Section 02771 - Curbs, Gutters, Driveways (UDOT)
Section 02922 - Seed, Turf Seed, and Turf Sod (UDOT)
Section 03310 - Structural Concrete (UDOT)

1.03 REFERENCES

A. The Utah Department of Transportation Standard Specifications for Road and Bridge Construction (UDOT), latest edition.

B. The following are also references applicable to this section.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 1557-	Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-in. (457-mm) Drop
ASTM D 2487-	Classification of Soils for Engineering Purposes
ASTM D 2922-	Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017-	Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

1.04 DEFINITIONS

A. Class A Road Repair: This term shall consist of construction of a bituminous surface course, aggregate base and bituminous prime and tack coats as defined in Section 02745 - Hot-Mix Concrete Asphalt Paving.

B. Class B Road Repair: This term shall consist of construction of a gravel road surface as defined in Section 02278, Road Base - Untreated Base Course.

C. Site Drainage: This section pertains to the restoration of storm water naturally draining across or falling on the project site and irrigation water.

1.05 SUBMITTALS

A. Prior to placement of asphalt concrete, CONTRACTOR shall submit to ENGINEER for review and acceptance, full details, including design and calculations for the asphalt concrete mix he proposes to use.

B. Laboratory mix design for proposed seal coat application.

C. Quality assurance tests for asphalt and aggregate material sources.

D. Copies of weight and delivery tickets shall be submitted during progress of the work.

E. Untreated Base Course - 3/4" or 1 ½" gradation as noted.

1.06 MEASUREMENT AND PAYMENT

A. Removal and Replacement of Surface Improvements shall not be measured or paid as a separate item, but shall be included as part of the various items to which it relates.

PART 2 PRODUCTS

2.01 BITUMINOUS MATERIAL

A. The bituminous material shall be as specified in Section 02745, Hot-Mix Asphalt Concrete Paving.

B. Sampling and testing shall be the responsibility of CONTRACTOR, and shall be performed as required in Section 01440 - Quality Control and Materials Testing.

2.02 TACK COAT

A. Tack coat material shall conform to all requirements of UDOT Section 02748.

2.03 UNTREATED BASE COURSE

A. Untreated Base Course (UBC) beneath asphalt surfaces shall be 3/4" Gradation (see Section 02278 - Road Base-Untreated Base Course).

2.04 CONCRETE

A. Concrete shall meet UDOT specification Section 03310 - Structural Concrete.

PART 3 EXECUTION

3.01 CLASS A ROAD REPAIR

A. Class A Roads shall be constructed in accordance with Section 02745. Asphalt pavement replacement shall be 4-inches minimum, unless noted otherwise on the DRAWINGS..

B. CONTRACTOR shall install temporary asphalt pavement or the first course of permanent pavement replacement immediately following backfilling and compaction of trenches that have been cut through existing pavement. Except as otherwise provided, this preliminary pavement shall be maintained in a safe and reasonably smooth condition until required permanent pavement is installed. Temporary paving removed shall be hauled from the jobsite and disposed of at CONTRACTOR's expense.

C. Where a longitudinal trench is partly in pavement, the pavement shall be replaced to the original pavement edge, on a straight line, parallel to the center line of the roadway.

D. Where no part of a longitudinal trench is in the pavement, surfacing replacement will only be required where existing surfacing materials have been removed.

E. Existing asphalt pavements to be removed for trenches or other underground construction or repair shall be cut (a minimum of one foot outside the edge of the proposed excavation line) by a wheel cutter, clay spade, asphalt grinder, or other device capable of making a neat, reasonably straight and smooth cut without damaging adjacent pavement that is not to be removed. The cutting device operation shall be subject to the approval of ENGINEER.

F. The existing pavement shall be cut and trimmed after placement of required UBC and just prior to placement of asphalt concrete for pavement replacement, and the trimmed edges shall be painted with a light coating of asphalt cement or emulsified asphalt immediately prior to constructing the new abutting asphalt pavements. No extra payment will be provided for these items, and all costs incurred in performing this work shall be incidental to pipe laying or pavement replacement.

G. Any existing base, surfacing, or pavement shall be thoroughly cleaned immediately prior to receiving the plant-mixed surfacing. Where existing pavement is being widened or extended, it shall be cut to a straight vertical face prior to the paving operations and treated with asphalt paint binder.

H. ENGINEER shall be notified of the source of the asphalt to be used. ENGINEER will specify the temperature limits for the asphalt cement, aggregate mix and lay-down.

3.02 ASPHALT WORK BETWEEN OCTOBER 15 AND APRIL 15

A. Asphalt cuts repaired prior to April 15 shall be repaired using a temporary patch, unless temperatures are 50 degrees F and rising or written approval is provided from OWNER or ENGINEER as specified above. Temporary patches may consist of either asphalt cold patch or concrete. Temporary patches shall be completely removed after April 15 and repaired in accordance with these specifications at no additional expense to OWNER.

3.03 CLASS B ROAD REPAIR

A. Class B Roads shall be constructed in accordance with Section 02278, Road Base - Untreated Base Course.

B. No aggregate base course material shall be place on the subgrade until it has been checked and accepted by ENGINEER.

C. Prior to excavation on graveled roads, the graveled surface shall be graded off the road and away to the downhill side of the trench, far enough from the trench that the subsurface materials will not pollute the salvaged gravel material. After completion of the pipeline work and backfill operations, the road shall be graded smooth and the salvaged gravel shall be mixed with additional untreated base course material to allow for a uniform 8 inch layer over the entire trench surface, graded smooth, and compacted to 96% minimum modified proctor density (ASTM D-1557).

3.04 CONCRETE WORK

A. Concrete shall meet UDOT specifications Section 03310 - Structural Concrete and Section 02771 - Curb, Gutters, Driveways, and Disabled Pedestrian Ramps.

B. All flat work in streets tying into existing flatwork shall be doweled into the existing concrete. Dowels to be spaced at 12" O.C. and be No. 5 x 14" for slabs up to 8 inches in thickness and No. 8 x 18" for slabs over 8 inches.

3.05 LAWNS

A. Lawns that are damaged or destroyed during performance of the work shall be repaired or replaced with turf sod according to UDOT Section 02922 - Seed, Turf Seed, and Turf Sod.

3.06 FENCES

A. Fences that are damaged or destroyed during performance of the work shall be repaired or replaced back to the original condition or better.

3.07 LANDSCAPING

A. All landscaping on private property that is damaged or destroyed during performance of the work shall be repaired or replaced back to original condition or better.

B. Contractor shall remove, stockpile and replace decorative rock in non-paving areas. Work shall include proper soil compaction, and weed barrier (filter fabric) to match the existing depth before construction commenced.

3.08 OTHER SURFACE IMPROVEMENTS

A. Sprinklers:
   1. Contractor shall provide an approved modified sprinkler system for the building sites. The existing piping system or a proposed engineered system shall be modified or installed to accommodate the requirements of the existing landscaping and new structures to the satisfaction of ENGINEER.

B. All other surface improvements not explicitly mentioned herein that are damaged or destroyed during performance of the work shall be repaired or replaced back to original condition or better.

- END OF SECTION -

SECTION 02745

HOT-MIX ASPHALT CONCRETE PAVING

PART 1 GENERAL

1.01 SUMMARY

A. This section addresses the requirements for installing hot-mix, lot-laid asphalt concrete, as outlined in the "Utah Department of Transportation Standard Specifications for Road and Bridge Construction (UDOT)", and as modified herein. The more stringent requirement shall be used.

1.02 RELATED SECTIONS

A. Related work specified in other sections includes but is not limited to:

Section 01570 - Traffic Control
Section 02278 - Road Base - Untreated Base Course
Section 02500 - Removal and Replacement of Surface Improvements
Section 02741 - Hot-Mix Asphalt (UDOT)
Section 02745 - Asphalt Material (UDOT)
Section 02748 - Prime Coat/Tack Coat (UDOT)
Section 02770 - Curbs, Gutters, Driveways, and Disabled Pedestrian Ramps (UDOT)
Section 03310 - Structural Concrete (UDOT)

1.03 REFERENCES

A. The Utah Department of Transportation Standard Specifications for Road and Bridge Construction (UDOT), latest edition.

B. The following are also references applicable to this section.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 1559: Standard Test Method for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus.
ASTM D 2041: Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures.
ASTM D 2950: Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Method.
ASTM D 3665: Standard Practice for Random Sampling of Construction Materials.

1.04 SUBMITTALS

A. Laboratory mix design for proposed hot-mix asphalt concrete paving.

B. Means and methods for removal, reprocessing, and placement of existing asphalt surfaces as base course material.

C. Laboratory mix design for proposed prime coat application.

D. Laboratory mix design for proposed tack coat application.

E. Quality assurance tests for asphalt and aggregate material sources.

F. Copies of batch delivery tickets shall be submitted during progress of the work, and shall show the following information:
   1. Name of production facility
   2. Serial number of ticket
   3. Date and truck number
   4. Name of CONTRACTOR
   5. Job name and location
   6. Weight of asphalt concrete
   7. Loading temperature
   8. Signature or initial of plant representative
   9. Type and grade of asphalt cement
   10. Type and grade of aggregate
   11. Applicable mix design method
   12. Separate weights of aggregate and asphalt

G. Submit type and number of rollers required for compacting asphalt concrete

1.05 SITE CONDITIONS

A. Pave only when air and roadbed temperatures in the shade are greater than 50 deg. F. The temperature restrictions may be waived only upon written authorization from ENGINEER.

B. Do not pave during rain or unsuitable weather or when surface is wet.

1.06 ACCEPTANCE

A. Acceptance of hot-mix asphalt concrete paving is based upon minimum density, minimum thickness, smoothness, and surface appearance. Smoothness and surface appearance shall be as defined by Section 02741 - Hot-Mix Asphalt (UDOT).

1.07 MEASUREMENT AND PAYMENT

A. Asphalt shall not be measured or payed as a separate item, but it shall be included as part of the various items to which it relates.

PART 2 PRODUCTS

2.01 BITUMINOUS MATERIAL

A. The bituminous material shall be **PG64-22** cement (or engineer approved). The mix design shall target 3% voids. However, the percent asphalt or fines may need to be adjusted to achieve optimal strength.

B. The hot-mix asphalt cement design shall meet Category 2 as defined by Section 02741 - Hot-Mix Asphalt (UDOT). The gradation for Dry Mass of aggregate shall be for 1/2".

C. Sampling and testing shall be the responsibility of CONTRACTOR, and shall be performed as required in Section 01440 - Quality Control and Materials Testing.

2.02 TACK COAT

A. Tack coat material shall conform to all requirements of Section 02748 - Prime Coat/Tack Coat (UDOT).

PART 3 EXECUTION

3.01 PREPARATION

A. Preparation shall conform to all requirements of Section 02745 - Asphalt Material (UDOT) specifications.

B. CONTRACTOR shall map and mark all existing surface utilities within the line of work, and shall lower fixtures if pavement machine is not capable of passing over structure.

C. All asphalt and concrete surfaces within the line of work are to be removed and disposed of properly by CONTRACTOR. CONTRACTOR may, upon written authorization of OWNER, use processed asphalt materials as base course material. Excess materials shall be removed and disposed by CONTRACTOR.

D. Existing asphalt pavements and drive approach extensions to be removed shall be cut by a wheel cutter, clay spade, or other device capable of making a neat, reasonably straight and smooth cut without damaging adjacent pavement and/or concrete that is not to be removed. The cutting device operation shall be subject to the approval of ENGINEER.

3.02 BASE COURSE

A. Base course material shall be placed in accordance with Section 02278 of these specifications.

B. Base course surfaces shall be maintained in an acceptable condition for both moisture and density, as defined by Section 02278 - Road Base, until the overlying hot-mix asphalt cement materials have been placed, at no additional expense to OWNER.

C. Processed asphalt materials may be used as base course provided that the resulting gradation for the 3/4" and -200 sieves comply with the requirements of Section 02278 - Road Base. Processed asphalt which has been contaminated with clay or silt materials will not be accepted.

3.03 PLACEMENT OF TACK COAT

A. Apply tack coat to all existing asphalt concrete or Portland cement concrete surfaces preparatory to placing asphalt concrete pavement in accordance with Section 02748 - Prime Coat/Tack Coat (UDOT) specifications.

3.04 PLACEMENT OF HOT-MIX ASPHALT CONCRETE

A. Spreading shall be as nearly continuous as possible.

B. Placement shall also allow for line, grade, elevations, and thickness specified herein and as shown on the drawings.

C. When asphalt concrete is laid against vertical surfaces such as gutters, the face of the vertical surface shall be roughened for proper bonding, cleaned, and then painted with a light coating of asphalt cement or emulsified asphalt.

D. At terminations of new surface course, the asphalt concrete shall be feathered into the existing surface over such a distance as may be required to produce a smooth riding transition. Base course and single course construction shall be joined by vertical butt joints finished and rolled to a smooth surface.

E. Asphaltic concrete shall not be placed when frozen materials are present in the base or subbase.

F. Asphaltic concrete shall not be placed during adverse conditions, i.e., rain or when a roadway surface is wet.

G. Asphaltic concrete shall be placed between April 15 and October 15. Asphalt concrete shall not be placed after October 15 and before April 15 of the following year unless roadway surface temperatures are 50° F and rising in the shade. Approval to place the asphalt concrete after October 15 and before April 15 of the following year requires written approval from OWNER.

H. Roadways not completed prior to October 15, and not meeting the requirements of this section, shall be repaired by placing a temporary 2-inch thick asphalt (or other ENGINEER approved surface) course over all exposed, earthen surfaces. These temporary surfaces shall be completely removed and repaired in accordance with these specifications at no additional expense to OWNER.

I. Asphalt rolling shall be in accordance with Section 02741 - Hot-Mix Asphalt (UDOT) specifications. CONTRACTOR shall establish and document a rolling pattern for obtaining densities. The test strip shall be no shorter than 300 feet. Establishment of rolling patterns are for the purpose of establishing minimum rolling patterns, and shall not release CONTRACTOR of meeting all requirements of these specifications and drawings.

J. The target density for asphalt placement shall be 96 percent of laboratory density. If an individual test result falls below 94 percent of maximum density, the material represented by that test will be considered defective, and shall be removed and replaced by CONTRACTOR at no additional cost to OWNER.

K. The minimum acceptable thickness of completed roadways shall be 6 inches, as verified by core samples. Areas found to contain less than 6 inches shall be removed and replaced, or overlain with an additional 1.5-inch minimum thickness asphalt at no additional expense to OWNER.

L. The completed finish shall be as specified in Section 02741 - Hot-Mix Asphalt (UDOT) specifications.

M. CONTRACTOR shall adjust the height of all street fixtures to match final grade. Concrete collars shall be placed around all surface street fixtures (i.e. manholes, valve boxes, monuments, etc.).

N. CONTRACTOR shall complete all concrete collars within 2 weeks of completion of paving each roadway section.

3.05 SITE SAFETY AND TRAFFIC CONTROL

A. Site safety and traffic control shall be the responsibility of CONTRACTOR.

B. CONTRACTOR shall verify full compliance with all applicable local, county, state and/or federal regulations, and shall comply with Section 01570 - Traffic Control.

- END OF SECTION -

SECTION 03100

CONCRETE FORMWORK

PART 1 GENERAL

1.01 SUMMARY

A. This section covers the work necessary to furnish, install and complete, the concrete formwork.

1.02 MEASUREMENT AND PAYMENT

A. Concrete formwork shall not be measured or paid as a separate item, but shall be included as part of the various items to which it relates.

1.03 REFERENCES

A. The latest edition of the following publications form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

1. American Concrete Institute (ACI) -ACI 347R- Concrete Formwork.
2. American Hardboard Association (AHA) -AHA A135.4- Basic Hardboard.
3. Department of Commerce (DOC) -DOC PS 1- Construction and Industrial Plywood.
4. ACI 350R-89 - Environmental Engineering Concrete Structures.

1.04 DESIGN

A. Formwork shall be designed in accordance with methodology of ACI 347R for anticipated loads, lateral pressures, and stresses. Forms shall be capable of producing a surface which meets the requirements of the finish specified in Section 03300 Concrete. Forms shall be capable of withstanding the pressures resulting from placement and vibration of concrete.

1.05 SUBMITTALS

A. The following shall be submitted:

1. Drawings showing details of forming, shoring and bracing for footings, walls, and floors shall be submitted to ENGINEER at least 3 weeks prior to their use. Drawings showing details of formwork shall include, joints, supports, studding and shoring, and sequence of form and shoring removal.

2. If requested by ENGINEER, design analysis and calculations shall be submitted for form design and methodology used in the design. The analysis and calculations shall verify the selection of form ties, horizontal and vertical stiff-backs or braces for wall

panels, forming and form openings, or any other part of forming, shoring or bracing which may be considered critical by ENGINEER.

3. Manufacturer's data including literature describing form materials, accessories, and form releasing agents.

4. Manufacturer's recommendation on method and rate of application of form releasing agent.

B. ENGINEER's review will not relieve CONTRACTOR from any responsibility as to the adequacy of the forming, shoring and bracing design. Any formwork installed by CONTRACTOR shall be solely at CONTRACTOR's risk. ENGINEER's review will not lessen or diminish CONTRACTOR's liability. The turn-around time of ENGINEER's review will be 2 weeks from date of receipt of each written submittal.

PART 2 PRODUCTS

2.01 FORM MATERIALS

A. Form surfaces shall be in "new and undamaged" condition and may be plywood, hard plastic finished plywood, overlaid waterproof particle board, and steel of sufficient strength and surface smoothness to produce the specified finish. CONTRACTOR shall verify that form surfaces and panel sizes satisfy all requirements of these specifications.

B. The wall form design shall be such that wall sections can be poured full height without creating horizontal cold joints and without causing snapping of form ties which shall be of sufficient strength and number to prevent spreading of the forms during the placement of concrete and which shall permit ready removal of the forms without spalling or damaging the concrete.

2.02 FORM TIES

A. Form ties on exposed surfaces shall be located in a uniform pattern. Snap ties shall not be broken until the concrete has reached the design concrete strength. The use of tie wires as form ties will not be permitted. Snap ties, designed so that the ends must be broken off before the forms can be removed, shall not be used.

B. Taper ties with plastic or rubber plugs of an approved and proven design may also be used. The plugs must be driven into the hole with a steel rod, placed in a cylindrical recess made therefore in the plug. At no time shall plugs be driven on the flat area outside the cylindrical recess.

2.03 FORM RELEASING AGENTS

A. Form releasing agents shall be commercial formulations that will not bond with, stain or adversely affect concrete surfaces. Agents shall not impair subsequent treatment of

concrete surfaces depending upon bond or adhesion nor impede the wetting of surfaces to be cured with water or curing compounds.

PART 3 EXECUTION

3.01 INSTALLATION

A. Forms shall be mortar tight, properly aligned and adequately supported to produce concrete surfaces meeting the surface requirements specified in Section 03300 Concrete. Forms shall be used, whenever necessary, to confine the concrete, to shape the concrete to the required lines and grades, and to obtain a thoroughly compacted dense concrete through proper vibrating. The forms shall have sufficient strength and rigidity to hold the concrete and to withstand the necessary pressure, tamping and vibration, without deflection from the prescribed lines. Where forms for continuous surfaces are placed in successive units, care shall be taken to fit the forms over the completed surface so as to obtain accurate alignment of the surface and to prevent leakage of mortar.

B. The surfaces of all forms in contact with the concrete shall be clean, rigid, tight and smooth. All dirt, chips, sawdust, mud, water and other foreign matter shall be removed from within the forms or within the excavated areas, before any concrete is deposited therein.

C. Forms shall not be reused if there is any evidence of surface wear and tear or defects which would impair the quality of the surface. Surfaces of forms to be reused shall be thoroughly cleaned of mortar from previous concreting and of all other dirt and foreign matter before reuse. Form ties that are to be completely withdrawn shall be coated with a non-staining bond breaker.

D. Bulkheads to form vertical wall joints shall be strong enough to withstand concrete pressures during pouring and vibrating, and shall be properly placed between the forms to avoid mortar seepage. Holes shall be provided in the bulkheads to permit passage of horizontal mild steel reinforcing where required by the Drawings. Unless these are specifically called for on the Drawings, no chamfer strips shall be placed in the corners of vertical construction joints.

3.02 COATING

A. Form inside surfaces shall be coated with a form releasing agent before the form or reinforcement is placed in final position. The coating shall be used as recommended in the manufacturer's printed or written instructions. Surplus coating on form surfaces and coating on reinforcing steel and construction joints shall be removed before placing concrete.

3.03 ALIGNMENT AND TOLERANCES

A. Forms shall be properly aligned and adequately supported to produce concrete surfaces conforming to construction tolerance given in Table 3-1, Tolerances for Formed Surfaces.

TABLE 3-1
TOLERANCES FOR FORMED SURFACES

1	Variations from the plumb:	
	a. In the lines and surfaces of columns, piers, walls and in arises	In any 10 feet of length. . . . . 1/4 inch Maximum for entire length.. . . . . 1 inch
	b. For exposed corner columns, control-joint grooves, and other conspicuous lines	In any 20 feet of length. . . . . 1/4 inch Maximum for entire length.. . . . . 1/2 inch
2	Variation from the level or from the grades indicated on the drawings	In any 10 feet of length. . . . . 1/4 inch In any bay or in any 20 feet of length. . . . . 3/8 inch
3	Variation of the linear building lines from established position in plan	In any 20 feet. . . . . 1/2 inch Maximum. . . . . 1 inch
4	Variation of distance between walls, columns, partitions	1/4 inch per 10 feet of distance, but not more than 1/2 inch in any one bay, and not more than 1 inch total variation
5	Variation in the thickness of slabs and walls	Minus. . . . . 1/4 inch Plus.. . . . . 1/2 inch

3.04 FORM REMOVAL

A. Forms shall be removed in a manner that will prevent injury to the concrete and ensure the complete safety of the structure. Forms shall not be removed until approval is given by ENGINEER. Formwork for columns, walls, side of beams and other parts not supporting the weight of concrete may be removed when the concrete has attained sufficient strength to resist damage from the removal operation but not before at least 24 hours has elapsed since concrete placement.

B. CONTRACTOR shall remove all wood splinters on concrete surfaces after stripping of wood forms.

- END OF SECTION -

SECTION 03200

CONCRETE REINFORCEMENT

PART 1 GENERAL

1.01 SUMMARY

A. This section covers the reinforcing steel bars, wire fabric or rod mats for cast-in-place concrete.

1.02 MEASUREMENT AND PAYMENT

A. Concrete reinforcement shall not be measured or paid as a separate item, but shall be included as part of the various items to which it relates.

1.03 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

B. AMERICAN CONCRETE INSTITUTE (ACI)

1. 301 Specifications for Structural Concrete for Buildings.
2. 315 Details and Detailing of Concrete Reinforcement.
3. 318 (1989; 318R-89) Building Code Requirements for Reinforced Concrete
4. 350R Environmental Engineering Concrete Structures

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. A 82 Standard Specifications for Steel Wire, Plain, for Concrete Reinforcement.
2. A 184 Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
3. A 185 Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
4. A 615 Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

D. CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

1. DA4 Manual of Standard Practice

1.04 SUBMITTALS

A. The following shall be submitted in accordance with Section 01300 Contractor Submittals:

1. Drawings of Concrete Reinforcement System with details showing reinforcing steel schedules, sizes, grades, and splicing and bending details. Drawings shall show support details including types, sizes and spacing.

2. Reinforcing Steel with certified copies of mill reports attesting that the reinforcing steel furnished meets the requirements specified, prior to the installation of reinforcing steel.

1.05 DELIVERY AND STORAGE

A. Reinforcement and accessories shall be stored off the ground on platforms, skids, or other supports.

PART 2 PRODUCTS

2.01 DOWELS

A. Dowels shall conform to ASTM A 615, Grade 60.

2.02 FABRICATED BAR MATS

A. Fabricated bar mats shall conform to ASTM A 184.

2.03 REINFORCING STEEL

A. Reinforcing steel shall be deformed bars conforming to ASTM A 615 grades and sizes as indicated. Cold drawn wire used for spiral reinforcement shall conform to ASTM A 82. When no grade is indicated use 60 ksi grade steel. Special coated bars (epoxy and zinc) may be specified for use in a highly corrosive atmosphere where concrete cover is not considered sufficient. In which case reference to ASTM A 767 and A 775 will be included.

2.04 WELDED WIRE FABRIC

A. Welded wire fabric shall conform to ASTM A 185 or ASTM A 497.

2.05 WIRE TIES

A. Wire ties shall be 16-gauge or heavier black annealed steel wire.

2.06 SUPPORTS

A. Bar supports for formed surfaces shall be designed and fabricated in accordance with CRSI DA4 and shall be steel or precast concrete blocks. Precast concrete blocks shall be not less than 4 inches square when supporting reinforcement on ground. Precast concrete block shall have compressive strength equal to that of the surrounding concrete. Where concrete formed surfaces will be exposed to weather or where surfaces are to be painted, steel supports within 1/2 inch of concrete surface shall be plastic protected or of stainless steel. Concrete supports used in concrete exposed to view shall have the same color and texture

as the finish surface. For slabs on grade, supports shall be precast concrete blocks, plastic coated steel fabricated with bearing plates, or specifically designed wire-fabric supports fabricated of plastic.

PART 3 EXECUTION

3.01 REINFORCEMENT

A. Reinforcement shall be fabricated to shapes and dimensions shown and shall conform to the requirements of ACI 318. Reinforcement shall be cold bent unless otherwise authorized. Bending may be accomplished in the field or at the mill. Bars shall not be bent after embedment in concrete.

B. Safety caps shall be placed on all exposed ends of vertical concrete reinforcement bars that pose a danger to life or safety.

C. Placement:

1. Reinforcement shall be free from loose rust and scale, dirt, oil, or other deleterious coating that could reduce bond with the concrete.

2. Reinforcement shall be placed in accordance with ACI 318 at locations shown plus or minus one bar diameter. Reinforcement shall not be continuous through expansion joints and shall be as indicated through construction or contraction joints. Concrete coverage shall be as indicated or as required by ACI 318. If bars are moved more than one bar diameter to avoid interference with other reinforcement, conduits or embedded items, the resulting arrangement of bars, including additional bars required to meet structural requirements, shall be approved before concrete is placed.

D. Splicing:

1. Splices of reinforcement shall conform to ACI 318 and shall be made only as required or indicated. Splicing shall be by lapping or by mechanical connection; except that lap splices shall not be used for bars larger than No. 11 unless otherwise indicated. Lapped bars shall be placed in contact and securely tied or spaced transversely apart to permit the embedment of the entire surface of each bar in concrete. Lapped bars shall not be spaced farther apart than one-fifth the required length of lap or 6-inches. Mechanical butt splices shall be in accordance with the recommendation of the manufacturer of the mechanical splicing device. Butt splices shall develop 125 percent of the specified minimum yield tensile strength of the spliced bars or of the smaller bar in transition splices. Bars shall be flame dried before butt splicing. Adequate jigs and clamps or other devices shall be provided to support, align, and hold the longitudinal centerline of the bars to be butt spliced in a straight line.

3.02 WELDED-WIRE FABRIC

A. Welded-wire fabric shall be placed in slabs as indicated. Fabric placed in slabs on grade shall be continuous between expansion, construction, and contraction joints. Lap splices shall be made in such a way that the overlapped area equals the distance between the outermost cross wires plus 2 inches. Laps shall be staggered to avoid continuous laps in either direction. Fabric shall be wired or clipped together at laps at intervals not to exceed 4 feet. Fabric shall be positioned by the use of supports.

3.03 DOWELS

A. Dowels shall be installed in slabs on grade at locations indicated and at right angles to joint being doweled. Dowels shall be accurately aligned parallel to the finished concrete surface and rigidly supported during concrete placement. One end of dowels shall be coated with a bond breaker.

- END OF SECTION -

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SUMMARY

A. This section covers cast-in-place concrete.

B. Concrete for footings and walls shall be Class 4000 with a slump of 2" to 4" unless otherwise noted.

1.02 RELATED WORK

A. Related work specified in other sections includes but is not limited to:

Section 02222 - Excavation and Backfill for Structures
Section 03100 - Concrete Formwork
Section 03200 - Concrete Reinforcement

1.03 MEASUREMENT AND PAYMENT

A. Cast-in-place concrete shall not be measured or paid as a separate item, but shall be included as part of the various items to which it relates.

1.04 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

B. AMERICAN CONCRETE INSTITUTE (ACI)

1. 117 Standard Tolerances for Concrete Construction and Materials
2. 211 Selecting Proportions for Normal, Heavyweight, and Mass Concrete
3. 301 Structural Concrete for Buildings
4. 305R Hot Weather Concreting
5. 306R Cold Weather Concreting
6. 318 Building Code Requirements for Reinforced Concrete
7. 350R Environmental Engineering Concrete Structures

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. C 31 Making and Curing Concrete Test Specimens in the Field
2. C 33 Concrete Aggregates
3. C 39 Compressive Strength of Cylindrical Concrete Specimens

4. C 42 Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
5. C 78 Flexural Strength of Concrete (Using Simple Beam With Third-Point Loading)
6. C 94 Ready-Mixed Concrete
7. C 109 Compressive Strength of Hydraulic Cement Mortars(Using 2-in. or 50-mm Cube Specimens)
8. C 143 Slump of Hydraulic Cement Concrete
9. C 150 Portland Cement
10. C 171 Sheet Materials for Curing Concrete
11. C 172 Sampling Freshly Mixed Concrete
12. C 173 Air Content of Freshly Mixed Concrete by the Volumetric Method
13. C 192 Making and Curing Concrete Test Specimens in the Laboratory
14. C 231 Air Content of Freshly Mixed Concrete by the Pressure Method
15. C 260 Specification for Air-Entraining Admixtures for Concrete
16. C 309 Liquid Membrane-Forming Compounds for Curing Concrete
17. C 494 Chemical Admixtures for Concrete
18. C 618 Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
19. C 1107 Packaged Dry, Hydraulic-Cement Grout (Nonshrinkable)

1.05 DEFINITIONS

A. Average Strength (f_{cr}): The required average strength for 30 consecutive strength tests which statistically assures not more than the permissible proportions of tests will fall below Specified Strength.

B. Specified Strength (f_c'): The indicated strength.

1.06 SUBMITTALS

A. The following shall be submitted in accordance with Section 01300 - Contractor Submittals.

B. The results of trial mix designs along with a statement giving the maximum nominal coarse aggregate size and the proportions of all ingredients that will be used in the manufacture of each strength of concrete, at least 14 days prior to commencing concrete placing operations. Aggregate weights shall be based on the saturated surface dry condition. The statement shall be accompanied by test results from an independent commercial testing laboratory, attesting that the proportions selected will produce concrete of the qualities indicated. No substitutions shall be made in the materials used in the work without additional tests to show that the quality of the concrete is satisfactory. Indicate whether mixes have been designed for pumping. Include in the report the following information:

1. Water-cement ratio.

2. Proportion of materials in the mix.

3. Source and type of cement.

4. Analysis of water to be used unless potable.

5. Type and name of admixtures applied. Indicate when accelerating or retarding admixtures are to be used and the resulting change in placement times.

6. Slump, air content and temperature of samples.

7. Unit weight of fresh and dry light weight concrete.

C. Pre-approved Mix Design Data: If supplier has on record, an OWNER approved mix design, submit name and address of supplier for each mix design 1 day prior to using concrete mix.

D. Certified copies of laboratory test reports, including all test data, for aggregate, admixtures, and curing compound. These tests shall be made by an approved commercial laboratory or by a laboratory maintained by the manufacturers of the materials.

E. Cementitious Materials showing Manufacturer's certification of compliance, accompanied by mill test reports attesting that the materials meet the requirements of the specification under which it is furnished, for cement and pozzolan.

1.07 QUALITY ASSURANCE

A. Do not change material sources, type of cement, air-entraining agent, water reducing agent, other admixtures, or aggregate without ENGINEER'S approval.

B. In proportioning materials for mixing, use scales certified by the State of Utah. Do not use volume measurement except for water and liquid admixtures.

C. Do not change the quantity of cement per cubic yard for approved mix design without written approval of ENGINEER.

D. Use of admixtures will not relax hot or cold weather placement requirements.

E. Ready-mixed concrete to be in accordance with Alternate No. 3 of ASTM C-94 and requirements in this Section.

F. Tolerances for concrete construction and materials shall be in accordance with ACI117.

1.08 PRODUCT STORAGE AND HANDLING

A. Store bagged and bulk cement in weatherproof enclosures to exclude moisture and contaminants.

B. Stockpile aggregate to avoid segregation and prevent contamination.

C. Avoid contamination, evaporation, or damage to admixtures. Protect liquid admixtures from freezing.

PART 2 PRODUCTS

2.01 CONCRETE STRENGTH

A. All cast-in-place concrete shall be Class 4000 as defined in Table No. 03300-A, unless otherwise noted.

2.02 ADMIXTURES

A. Air Entrainment: ASTM C 260.

B. Later Reducing and Set Retarding Agents: ASTM C494.

1. Type A: Set water reducing.
2. Type B: Set retarding.
3. Type C: Set accelerating.
4. Type D: Water reducing and set retarding.
5. Type E: Water reducing and set accelerating.
6. Type F: High range water reducing (super plasticizer).*
7. Type G: High range water reducing and set retarding*

* The relative durability factor of water reducing admixtures shall not be less than 80 and the chlorides content (as C1-) expressed as a percent of the cement shall not exceed .1 percent by weight.

C. Calcium Chloride: None allowed.

D. Pozzolan: Pozzolan conforming to the requirements of ASTM C 618, Class F, is allowed as a Portland cement replacing agent under the following conditions:

1. The maximum percentage of Portland cement replacement is:
   a. 15 percent, for concrete exposed to weather.
   b. 20 percent, for interior concrete.

2. Pozzolan should not exceed 25% by weight of the cement plus Pozzolans.

3. The minimum cement content shall be used in the design formulas before replacement is made.

4. Loss of ignition of pozzolan is less than 3 percent and the water requirement does not exceed 100 percent.

5. All other requirements of this section still apply.

6. Mix designs including trial batches are required for each aggregate source and for each concrete class.

2.03 CEMENTITIOUS MATERIALS

A. Cementitious materials shall each be of one type and from one source when used in concrete which will have surfaces exposed in the finished structure. Cementitious materials shall conform to one of the following:

1. Cement: Use Portland cement, ASTM C 150, Type II, Type IIA, or Type V, low alkali, unless noted otherwise.

2. Portland - Pozzolan Cement: ASTM C-595, Type IP-A(MS). Do not use Pozzolan cement unless approved by the ENGINEER.

B. Only one brand of cement from one manufacturing plant may be used.

2.04 AGGREGATES

A. Aggregates shall be natural aggregates, free from deleterious coatings, and shall conform to the requirements of ASTM C 33, except as modified herein. Aggregates shall not be potentially reactive as defined in Appendix XI of ASTM C 33. The CONTRACTOR shall import nonreactive aggregates if local aggregates are reactive.

B. Fine Aggregates

1. Fine aggregate shall consist of clean, sharp, natural sand and shall conform to the requirements of ASTM C 33. Fine aggregate shall be graded as follows:

SIEVE SIZE	PERCENT PASSING BY WEIGHT
3/8 inch	100
#4	95-100
#8	80-100
#16	50-85
#30	25-60
#50	10-30
#100	2-10

2. Fine aggregates shall have no more than two percent by weight passing #200 sieve.

C. Coarse Aggregate

1. Coarse aggregate shall be washed gravel or crushed stone, or a combination of these materials, consisting of hard, tough, durable particles free from adherent coatings. It shall contain no more than 15 percent flat or elongated particles. A thin, flat or elongated particle is defined as a particle having a maximum dimension in excess of five times its minimum dimension. Aggregate which has disintegrated or weathered badly under exposure conditions similar to those which will be encountered in the work under consideration shall be not be used. Coarse aggregate shall be graded as follows (ASTM C 33):

SIEVE SIZE	PERCENT PASSING BY WEIGHT
1-1/2 inch	100
1 inch	95-100
1/2 inch	25-60
#4	0-10
#8	0-5

2. Coarse aggregates shall have no more than 1.75 percent by weight passing #200 sieve. Proof of gradation will be provided to ENGINEER by the CONTRACTOR.

2.05 ACI MIX DESIGN

A. The amount by which the average strength (f_{cr}) of a concrete mix exceeds the specified compressive strength (f'_c) shall be based upon no more than 1 in 100 random individual strength tests falling more than 500 psi below the specific strength.

B. Proportion the materials in accordance with ACI 211.1, 211.2 or 211.3 as applicable to produce concrete having the properties or limitations of Table No. 03300-A.

2.06 HAND MIXING

A. Do not hand mix batches exceeding 0.5 cubic yards.

B. Hand mix only on watertight platform. Mix cement and aggregate prior to adding water.

C. Ensure all stones are thoroughly covered with mortar and mixture is of uniform color and consistency.

2.07 HEATING, WATER AND AGGREGATE

A. Do not allow products of fuel combustion to contact the aggregate.

B. Heat mixing water 150 degrees F. maximum. Heat aggregates uniformly.

C. Do not mix cement with water and aggregate at a mix temperature greater than 100 degrees F.

2.08 WATER

A. Water shall be potable, except that non-potable water may be used if it produces mortar cubes having 7- and 28-day strengths at least 90 percent of the strength of similar specimens made with water from a municipal supply. The strength comparison shall be made on mortars, identical except for mixing water, prepared and tested in accordance with ASTM C 109. Water for curing shall not contain any substance injurious to concrete, or which causes staining.

2.09 PROPORTIONS OF MIX

A. Mixture Proportioning, Normal Weight Concrete: All concrete that must be watertight, resistant to freeze-thaw cycles, and resistant naturally-occurring or commonly-used chemicals, shall be air-entrained. All materials should be proportioned to produce a well-graded and highly-dense mixture with maximum workability and with a minimum specified 28-day compressive strength of 4000 psi. Trial batches shall contain materials proposed to be used in the project. Trial mixtures having proportions, consistencies and air content suitable for the work shall be made based on methodology described in ACI 211.1, using at least three different water-cement ratios. Trial mixes shall be proportioned to produce concrete strengths specified. In the case where ground iron blast-furnace slag is used, the weight of the slag will be substituted in the equations for the term P which is used to denote the weight of pozzolan. Trial mixtures shall be designed for maximum permitted slump and air content. The temperature of concrete in each trial batch shall be reported. For each water-cement ratio at least three test cylinders for each test age shall be made and cured in accordance with ASTM C 192. They shall be tested at 7 and 28 days in accordance with ASTM C 39. From these test results a curve shall be plotted showing the relationship between water-cement ratio and strength. Maximum water-cement or water-cement plus Pozzolan Ratio: 0.45.

B. Average Strength: In meeting the strength requirements specified, the selected mixture proportion shall produce an average compressive strength exceeding the specified strength by the amount indicated below. Where a concrete production facility has test records, a standard deviation shall be established. Test records from which a standard deviation is calculated shall represent materials, quality control procedures, and conditions similar to those expected; shall represent concrete produced to meet a specified strength or strengths within 1000 psi of that specified for proposed work; and shall consist of at least 30 consecutive tests. A strength test shall be the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days or at other test age designated for determination of the specified strength.

TABLE NO. 03300-A

CONCRETE MIX PROPERTIES (e)			
CONCRETE PROPERTIES	CONCRETE CLASSIFICATION(S)		
	Class 4000	Class 3500	Class 3000
Specified Compressive Strength $f_{c'}$ at 28 days, min., psi	4000	3500 (d)	3000 (d)
Compressive Strength at 7 days, min., psi (a)	3000	2625	2250
Cement content (94 lb. sacks of cement per cubic yard of concrete), min. (b)	6.0	5.75	5.5
Entrained air content, (% by volume).	6±1	6±1	6±1
Slump Range, in. (c)	1 - 4 (f)	2 - 4	2 - 4

(a) Used for monitoring purposes only.
(b) May include pozzolan replacements if approved by ENGINEER.
(c) Not more than 8 inches after adding high range water reducing admixture (super-plasticizer) at site.
(d) Not allowed if concrete is exposed to freezing and thawing temperatures. Use Class 4000 or higher compressive strength and 6±1.0 percent air entrainment.
(e) All mix designs must be approved by ENGINEER.
(f) 1-3" for footings, substructural walls and 1-4" for slabs, beams, reinforced walls and columns.

PART 3 EXECUTION

3.01 PREPARATION OF SURFACES

A. Surfaces to receive concrete shall be clean and free from frost, ice, mud, and water. Conduit and other similar items shall be in place and clean of any deleterious substance.

B. Foundations: Earthwork shall be as specified. Flowing water shall be diverted without washing over freshly deposited concrete. Rock foundations shall be cleaned by high velocity air-water jets, sandblasting, or other approved methods. Debris and loose, semi-detached or unsound fragments shall be removed. Rock surfaces shall be moist but without free water when concrete is placed. Semiporous subgrades for foundations and footings shall be damp when concrete is placed. Pervious subgrades shall be sealed by blending impervious material with the top 6 inches of the in-place pervious material or by covering with an impervious membrane.

C. Preparation of Previously Placed Concrete: Concrete surfaces to which other concrete is to be bonded shall be roughened in an approved manner that will expose sound aggregate

uniformly without damaging the concrete. Laitance and loose particles shall be removed. Surfaces shall be moist but without free water when concrete is placed.

3.02 INSTALLATION OF EMBEDDED ITEMS

A. Embedded items shall be free from oil, loose scale or rust, and paint. Embedded items shall be installed at the locations indicated and required to serve the intended purpose. Voids in sleeves, slots and inserts shall be filled with readily removable material to prevent the entry of concrete.

3.03 BATCHING, MIXING AND TRANSPORTING CONCRETE

A. Ready-mixed concrete shall be batched, mixed and transported in accordance with ASTM C 94, except as otherwise specified. Truck mixers, agitators, and nonagitating units shall comply with NRMCA TMMB-1. Ready-mix plant equipment and facilities shall be certified in accordance with NRMCA-QC 3.

B. The use of non-agitating equipment for transporting ready-mixed concrete will not be permitted. Combination truck and trailer equipment for transporting ready-mixed concrete will not be permitted. The quantity and quality of materials used in ready-mixed concrete and in batch aggregates shall be subject to continuous inspection at the batching plant by the ENGINEER.

C. Truck mixers and their operation must be such that the concrete throughout the mixed batch as discharged is within acceptable limits of uniformity with respect to consistency, mix, and grading. If slump tests taken at approximately the 1/4 and 3/4 points of the load during discharge give slumps differing by more than 1 inch when the specified slump is 3 inches or less, or more than 2 inches when the specified slump is more than 3 inches, the mixer shall not be used on the work unless the causing condition is corrected and satisfactory performance is verified by additional slump tests. All mechanical details of the mixer, such as water measuring and discharge apparatus, condition of the blades, speed of rotation, general mechanical condition of the unit, and clearance of the drum, shall be checked before a further attempt to used the unit will be permitted.

D. Admixtures: Admixtures shall be batched within an accuracy of 3 percent. Where two or more admixtures are used in the same batch, they shall be batched separately and must be compatible. Retarding admixture shall be added within one minute after addition of water is complete or in the first quarter of the required mixing time, whichever is first. Superplasticizing admixtures shall be added at the project site, and the concrete with the admixture shall be mixed 4 to 5 minutes before placing as recommended by manufacturer. Concrete that shows evidence of total collapse or segregation caused by the use of admixture shall be removed from the site.

E. Control of Mixing Water: No water from the truck system or elsewhere shall be added after the initial introduction of mixing water for the batch. No water shall be added at the jobsite without the approval of the ENGINEER.

3.04 SAMPLING AND TESTING

A. Sampling and Testing of the concrete will be in accordance with Section 01440. If required, the CONTRACTOR shall assist the Testing Agency's representative at the site with concrete testing.

1. Aggregates: Aggregates for normal weight concrete shall be sampled and tested in accordance with ASTM C 33.

2. Sampling of Concrete: Samples of concrete for air, slump, unit weight, and strength tests shall be taken in accordance with ASTM C 172.
   a. Air Content: Test for air content shall be performed in accordance with ASTM C 173 or ASTM C 231. A minimum of 1 test shall be conducted each time a slump test is made.
   b. Slump: At least 1 slump test shall be made on randomly selected batches of each mixture of concrete for every 50 cubic yards of ready-mixed concrete delivered to the job site. Also note the time batched at the plant and the starting time when unloading began at the site. Tests shall be performed in accordance with ASTM C 143.
   c. Temperature: Concrete and air temperatures shall be measured and recorded with each set of cylinders and the air temperature shall also be recorded when the air temperature at the site is 40 degrees F or below and/or 90 degrees F or above.

3. Evaluation and Acceptance of Concrete
   a. Frequency of Testing: Samples for strength tests of each class of concrete placed each day shall be taken not less than once a day, nor less than once for each 50 cubic yards of concrete, nor less than once for each 3000 square feet of surface area for slabs or walls. If this sampling frequency results in less than 5 strength tests for a given class of concrete, tests shall be made from at least 5 randomly selected trucks or from each truck if fewer than 5 truck loads are used. Field cured specimens for determining form removal time or when a structure may be put in service shall be made in numbers directed to check the adequacy of curing and protection of concrete in the structure. The specimens shall be removed from the molds at the age of 24 hours and shall be cured and protected, insofar as practicable, in the same manner as that given to the portion of the structure the samples represent.
   b. Testing Procedures: Cylinders for acceptance tests shall be molded and cured in accordance with ASTM C 31. Cylinders shall be tested in accordance with ASTM C 39. A strength test shall be the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days or at another specified test age.
   c. Evaluation of Results: Concrete specified on the basis of compressive strength will be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed the specified strength and no individual strength test result falls below the required strength by more than 500 pounds per square inch.
   d. Unless noted otherwise, make a minimum of four (4) concrete cylinders each time a test is required. When concrete is being placed in suspended slabs, beams and

retaining walls make two (2) extra cylinders which must be cured on site. The extra cylinders will be used to determine when to remove forms and/or when to backfill.

B. Investigation of Low-Strength Test Results: When any strength test of standard-cured test cylinder falls below the specified strength requirement by more than 500 pounds per square inch, or if tests of field-cured cylinders indicate deficiencies in protection and curing, steps shall be taken to assure that load-carrying capacity of the structure is not jeopardized. Nondestructive testing in accordance with ASTM C 597, ASTM C 803 or ASTM C 805 may be permitted by the ENGINEER to determine the relative strengths at various locations in the structure as an aid in evaluating concrete strength in place or for selecting areas to be cored. Such tests, unless properly calibrated and correlated with other test data, shall not be used as a basis for acceptance or rejection. When strength of concrete in place is considered potentially deficient, cores shall be obtained and tested in accordance with ASTM C 42. At least three representative cores shall be taken from each member or area of concrete in place that is considered potentially deficient. The location of cores shall be determined by the ENGINEER to least impair the strength of the structure. If the concrete in the structure will be dry under service conditions, the cores shall be air dried (temperature 60 to 80 degrees F, relative humidity less than 60 percent) for seven days before testing and shall be tested dry. If the concrete in the structure will be more than superficially wet under service conditions, the cores shall be tested after moisture conditioning in accordance with ASTM C 42. Concrete in the area represented by the core testing will be considered adequate if the average strength of the cores is equal to or at least 85 percent of the specified strength requirement and if no single core is less than 75 percent of the specified strength requirement. If the core tests are inconclusive or impractical to obtain, or if structural analysis does not confirm the safety of the structure, load tests may be directed by the ENGINEER in accordance with the requirements of ACI 318. Concrete work evaluated by structural analysis or by results of a load test and found deficient shall be corrected in a manner satisfactory to the ENGINEER. All investigations, testing, load tests, and correction of deficiencies shall be performed, and approved by the ENGINEER, at the expense of the CONTRACTOR.

3.05 CONVEYING CONCRETE

A. Concrete shall be conveyed from mixer to forms as rapidly as possible and within the time interval specified in paragraph CONCRETE PLACEMENT by methods which will prevent segregation or loss of ingredients.

1. Chutes: When concrete can be placed directly from a truck mixer or other transporting equipment, chutes attached to this equipment may be used. Separate chutes will not be permitted except when specifically approved.

2. Buckets: Bucket design shall be such that concrete of the required slump can be readily discharged. Bucket gates shall be essentially grout tight when closed. The bucket shall provide means for positive regulations of the amount and rate of deposit of concrete in each dumping position.

3. Belt Conveyors: Belt conveyors may be used when approved. Belt conveyors shall be designed for conveying concrete and shall be operated to assure a uniform flow of concrete to the final place of deposit without segregation or loss of mortar. Conveyors shall be provided with positive means for preventing segregation of the concrete at transfer points and point of placement.

4. Pumps: Concrete may be conveyed by positive displacement pumps when approved. Pump shall be the piston or squeeze pressure type. Pipeline shall be steel pipe or heavy duty flexible hose. Inside diameter of the pipe shall be at least three times the maximum size of the coarse aggregate. Distance to be pumped shall not exceed the limits recommended by the pump manufacturer. Concrete shall be supplied to the pump continuously. When pumping is completed, the concrete remaining in the pipeline shall be ejected without contaminating the concrete in place. After each use, the equipment shall be thoroughly cleaned. Flushing water shall be wasted outside the forms.

3.06 CONCRETE PLACEMENT

A. Mixed concrete which is transported in truck mixers or agitators or concrete which is truck mixed, shall be discharged within 1-1/2 hours or before the drum has revolved 300 revolutions, whichever comes first after the introduction of the mixing water to the cement and aggregates or the introduction of the cement to the aggregates. These limitations may be waived by the ENGINEER if the concrete is of such slump after the 1-1/2 hour time or 300 revolution limit has been reached that it can be placed, without the addition of water to the batch. When the concrete temperature exceeds 85 degrees F, the time shall be reduced to 45 minutes. Concrete shall be placed within 15 minutes after it has been discharged from the truck.

1. Placing Operation: Concrete shall be handled from mixer to forms in a continuous manner until the approved unit of operation is completed. Adequate scaffolding, ramps and walkways shall be provided so that personnel and equipment are not supported by in-place reinforcement. Placing will not be permitted when the sun, heat, wind, or limitations of facilities furnished by the CONTRACTOR prevent proper consolidation, finishing and curing. Concrete shall be deposited as close as possible to its final position in the forms, and there shall be no vertical drop greater than 4 feet except where suitable equipment is provided to prevent segregation and where specifically authorized. Concrete should not be allowed to drop through a cage of reinforcing steel. Depositing of the concrete shall be so regulated that it will be effectively consolidated in horizontal layers not more than 12 inches thick, except that all slabs shall be placed in a single layer. Concrete to receive other construction shall be screened to the proper level to avoid excessive shimming or grouting.

2. Consolidation: Immediately after placing, each layer of concrete shall be consolidated by internal vibrators, except for slabs 4 inches or less. The vibrators shall at all times be adequate in effectiveness and number to properly consolidate the concrete; a spare vibrator shall be kept at the jobsite during all concrete placing operations. The vibrators shall have a frequency of not less than 8000 vibrations per minute, and the head diameter and amplitude shall be appropriate for the concrete mixture being placed.

Vibrators shall be inserted vertically at uniform spacing over the area of placement. The distance between insertions shall be approximately 1-1/2 times the radius of action of the vibrator so that the area being vibrated will overlap the adjacent just-vibrated area by a few inches. The vibrator shall penetrate rapidly to the bottom of the layer and at least 6 inches into the preceding layer if there is such. Vibrator shall be held stationary until the concrete is consolidated and then withdrawn slowly. The use of form vibrators must be specifically approved. Vibrators shall not be used to transport concrete within the forms. Slabs 4 inches and less in thickness shall be consolidated by properly designed vibrating screeds or other approved technique.

B. Cold Weather Requirements: Special protection measures, approved by the ENGINEER, shall be used if freezing temperatures are anticipated before the expiration of the specified curing period. Provisions should be made to keep the concrete at a minimum temperature of 50 degrees F for 7 days. The ambient temperature of the air where concrete is to be placed and the temperature of surfaces to receive concrete shall be not less than 40 degrees F. No concrete shall be placed on frozen ground. The temperature of the concrete when placed shall be not less than 55 degrees F nor more than 75 degrees F. Heating of the mixing water or aggregates will be required to regulate the concrete placing temperature. Materials entering the mixer shall be free from ice, snow, or frozen lumps. Salt, chemicals or other materials shall not be incorporated in the concrete to prevent freezing. Calcium chloride shall not be used.

C. Hot Weather Requirements: The temperature of the concrete placed during hot weather shall not exceed 85 degrees F except where an approved retarder is used. The mixing water and/or aggregates shall be cooled, if necessary, to maintain a satisfactory placing temperature. In no case shall the placing temperature exceed 95 degrees F.

3.07 CONSTRUCTION JOINTS

A. Construction joints shall be located as indicated or approved. Where concrete work is interrupted by weather, end of work shift or other similar type of delay, location and type of construction joint shall be subject to approval of the ENGINEER. Unless otherwise indicated and except for slabs on grade, reinforcing steel shall extend through construction joints. Construction joints in slabs on grade shall be keyed or doweled as shown. Concrete columns, walls, or piers shall be in place at least 2 hours, or until the concrete is no longer plastic, before placing concrete for beams, girders, or slabs thereon. In walls having door or window openings, lifts shall terminate at the top and bottom of the opening. Other lifts shall terminate at such levels as to conform to structural requirements or architectural details. Where horizontal construction joints are required, a strip of 1-inch square-edge lumber, beveled and oiled to facilitate removal, shall be tacked to the inside of the forms at the construction joint. Concrete shall be placed to a point 1 inch above the underside of the strip. The strip shall be removed 1 hour after the concrete has been placed, and any irregularities in the joint line shall be leveled off with a wood float, and all laitance shall be removed. Prior to placing additional concrete, horizontal construction joints shall be prepared as specified in paragraph 3.1, PREPARATION OF SURFACES.

3.08 FINISHING CONCRETE

A. Formed Surfaces

1. Repair of Surface Defects: Surface defects shall be repaired within 24 hours after the removal of forms. Honeycombed and other defective areas shall be cut back to solid concrete or to a depth of not less than 1 inch, whichever is greater. Edges shall be cut perpendicular to the surface of the concrete. The prepared areas shall be dampened and brush-coated with neat cement grout. The repair shall be made using mortar consisting of not more than 1 part cement to 2-1/2 parts sand. The mixed mortar shall be allowed to stand to stiffen (approximately 45 minutes), during which time the mortar shall be intermittently remixed without the addition of water. After the mortar has attained the stiffest consistency that will permit placing, the patching mix shall be thoroughly tamped into place by means approved by the ENGINEER and finished slightly higher than the surrounding surface. For Class A and Class B finished surfaces the cement used in the patching mortar shall be a blend of job cement and white cement proportioned to produce a finished repair surface matching, after curing, the color of adjacent surfaces. Holes left after the removal of form ties shall be cleaned and filled with patching mortar. Holes left by the removal of tie rods shall be reamed and filled by dry-packing. Repaired surfaces shall be cured as required for adjacent surfaces. The temperature of concrete, mortar patching material, and ambient air shall be above 50 degrees F while making repairs and during the curing period. Concrete with defects which affect the strength of the member or with excessive honeycombs will be rejected, or the defects shall be corrected as directed.

2. Class A Finish: Where a Class A finish is indicated, fins shall be removed. A mortar mix consisting of one part portland cement and two parts well-graded sand passing a No. 30 sieve, with water added to give the consistency of thick paint, shall be prepared. White cement shall be used to replace part of the job cement. After the surface has been thoroughly wetted and allowed to approach surface dryness, the mortar shall be vigorously applied to the area by clean burlap pads or by cork or wood-floating, to completely fill all surface voids. Excess grout shall be scraped off with a trowel. As soon as it can be accomplished without pulling the mortar from the voids, the area shall be rubbed with burlap pads until all visible grout film is removed. The rubbing pads shall have on their surfaces the same sand-cement mix specified above but without any mixing water. The finish of any area shall be completed in the same day, and the limits of a finished area shall be made at natural breaks in the surface. The surface shall be continuously moist cured for 48 hours. The temperature of the air adjacent to the surface shall be not less than 50 degrees F for 24 hours prior to, and 48 hours after, the application. In hot, dry weather the smooth finish shall be applied in shaded areas.

3. Class B Finish: Where a Class B finish is indicated, fins shall be removed. Concrete surface shall be smooth with a texture at least equal to that obtained through the use of Grade B-B plywood forms.

4. Class C Finish: Where a Class C finish is indicated, fins shall be removed. Concrete surfaces shall be relatively smooth with a texture imparted by the forms used.

5. Class D Finish: Where a Class D finish is indicated, fins exceeding 1/4 inch in height shall be chipped or rubbed off. Concrete surfaces shall be left with the texture imparted by the forms used.

B. Unformed Surfaces: In cold weather, the air temperature in areas where concrete is being finished shall not be less than 50 degrees F. In hot windy weather when the rate of evaporation of surface moisture, as determined by methodology presented in ACI 305R, may reasonably be expected to exceed 0.2 pounds per square foot per hour; coverings, windbreaks, or fog sprays shall be provided as necessary to prevent premature setting and drying of the surface. The dusting of surfaces with dry materials or the addition of water during finishing will not be permitted. Finished surfaces shall be plane, with no deviation greater than 5/16-inch when tested with a 10-foot straightedge. Surfaces shall be pitched to drains.

1. Rough-Slab Finish: Slabs to receive fill or mortar setting beds shall be screened with straightedges immediately after consolidation to bring the surface to the required finish level with no coarse aggregate visible.

2. Float Finish: Slabs to receive a steel trowel finish and slabs where indicated shall be given a float finish. Screeding shall be followed immediately by darbying or bull floating before bleeding water is present, to bring the surface to a true, even plane. After the concrete has stiffened to permit the operation and the water sheen has disappeared, it shall be wood floated. Concrete that portrays stickiness shall be finished with a magnesium float in lieu of a wood float, and left free of ridges and other projections. Float finish is normally specified for surfaces that will receive other treatment such as built-up roofing, nonslip surfacing material. Float Finish shall not be used on wearing surfaces.

3. Trowel Finish: Slabs where indicated, shall be given a trowel finish immediately following floating. Surfaces shall be troweled to produce smooth, dense slabs free from blemishes including trowel marks. In lieu of hand finishing, an approved power finishing machine may be used in accordance with the directions of the machine manufacturer. A final hard steel troweling shall be done by hand. Trowel finish shall be used on wearing surfaces and where a smooth finish is required.

4. Broom Finish: After floating, slabs where indicated, shall be lightly trowelled, and then broomed with a fiber-bristle brush in a direction transverse to that of the main traffic.

3.09 CURING AND PROTECTION

A. General: All concrete shall be cured by an approved method for the period of time given below:

Concrete with Type III cement	3 days

Concrete with Type II or IIA, or V, low alkali cement	7 days
Concrete with Type IP-A(MS) cement blended with pozzolan	10 days

B. Immediately after placement, concrete shall be protected from premature drying extremes in temperatures, rapid temperature change, mechanical injury and injury from rain and flowing water. Air and forms in contact with concrete shall be maintained at a temperature above 50 degrees F for the first 3 days and at a temperature above 32 degrees F for the remainder of the specified curing period. Exhaust fumes from combustion heating units shall be vented to the outside of the enclosure and heaters and ducts shall be placed and directed so as not to cause areas of overheating and drying of concrete surfaces or to create fire hazards. All materials and equipment needed for adequate curing and protection shall be available and at the site prior to placing concrete. No fire or excessive heat shall be permitted near or in direct contact with the concrete at any time. Curing shall be accomplished by any of the following methods, or combination thereof, as approved.

C. Moist Curing: Concrete to be moist-cured shall be maintained continuously wet for the entire curing period. If water or curing materials used stains or discolors concrete surfaces which are to be permanently exposed, the concrete surfaces shall be cleaned. When wooden forms are left in place during curing, they shall be kept wet at all times. If the forms are removed before the end of the curing period, curing shall be carried out as on unformed surfaces, using suitable materials. Horizontal surfaces shall be cured by ponding, by covering with a 2-inch minimum thickness of continuously saturated sand, or by covering with waterproof paper, polyethylene sheet, polyethylene-coated burlap or saturated burlap. Once the moist curing has started the concrete surface must not be allowed to become surface dry for the entire curing period.

D. Membrane Curing: Membrane curing shall not be used on surfaces that are to receive any subsequent treatment depending on adhesion or bonding to the concrete; except a styrene acrylate or chlorinated rubber compound meeting ASTM C 309, Class B requirements may be used for surfaces which are to be painted or are to receive bituminous roofing or waterproofing, or floors that are to receive adhesive applications of resilient flooring. The curing compound selected shall be compatible with any subsequent paint, roofing, waterproofing or flooring specified. Membrane curing compound shall not be used on surfaces that are maintained at curing temperatures with free steam. Curing compound shall be applied to formed surfaces immediately after the forms are removed and prior to any patching or other surface treatment except the cleaning of loose sand, mortar, and debris from the surface. Surfaces shall be thoroughly moistened with water and the curing compound shall be applied to slab surfaces as soon as the bleeding water has disappeared, with the tops of joints being temporarily sealed to prevent entry of the compound and to prevent moisture loss during the curing period. Compound shall be applied in a one-coat continuous operation by mechanical spraying equipment, at a uniform coverage in accordance with the manufacturer's printed instructions. Concrete surfaces which have been subjected to rainfall within 3 hours after curing compound has been applied shall be resprayed by the method and at the coverage specified. On surfaces

permanently exposed to view, the surface shall be shaded from direct rays of the sun for the duration of the curing period. Surfaces coated with curing compound shall be kept free of foot and vehicular traffic, and from other sources of abrasion and contamination during the curing period.

- END OF SECTION -

SECTION 04220

REINFORCED UNIT MASONRY

PART 1 GENERAL

1.01 DESCRIPTION

A. This section covers reinforced unit masonry.

1.02 RELATED WORK

A. Related work in other sections includes but is not limited to:

Section 03200 Concrete reinforcement
Section 03300 Cast-in-place concrete
Section 07210 Insulation

1.03 REFERENCES

A. The latest edition of the following publications form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICA CONCRETE INSTITUTE (ACI)

ACI SP-66 - ACI Detailing Manual

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 82	Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
ASTM A 641	Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM C 90	Standard Specification for Hollow Load-Bearing Concrete Masonry Units
ASTM C 144	Standard Specification for Aggregate for Masonry Mortar
ASTM C 150	Standard Specification for Portland Cement
ASTM C 207	Standard Specification for Hydrated Lime for Masonry Purposes
ASTM C 270	Standard Specification for Mortar for Unit Masonry
ASTM C 404	Standard Specification for Aggregates for Masonry Grout
ASTM C 476	Standard Specification for Grout for Masonry
ASTM C 226	Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D 2000	Standard Classification System for Rubber Products in Automotive Applications
ASTM D 2287	Standard Specification for Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds
ASTM E 447	Standard Test Methods for Compressive Strength of Masonry Prisms
ASTM E 518	Standard Test Methods for Flexural Bond Strength of Masonry

ASTM C 578 Standard Density Korfil Hi "R" Insulation

NATIONAL CONCRETE MASONRY ASSOCIATION (NCMA)

NCMA-TEK 45 Removal of Stains from Concrete Masonry Walls

1.04 SUBMITTALS

A. Product Data: Submit manufacturer's product data for each type of masonry unit, accessory, and other manufactured products, including certifications that each type complies with specified requirements and color samples. Submit certificates showing compliance to the specifications for reinforcing steel, manufacturer's literature for anchor ties and any other accessories used, and manufacturer's literature for mortar and grout admixtures used along with Contractor's proposed usage details.

B. Three sample specimens of the masonry units proposed for incorporation into the project shall be submitted to the Project Representative.

C. Shop Drawings: Submit shop drawings for fabrication, bending, and placement of reinforcement bars, complying with ACI SP-66. Show bar schedules, diagrams of bent bars, stirrup, spacing, lateral ties, and other components required for fabrication and placement of masonry reinforcement.

1.05 DELIVERY, STORAGE, AND HANDLING

A. CONTRACTOR shall be responsible to deliver, handle, and store masonry units by means which will prevent mechanical damage and deterioration due to moisture, temperature changes, and corrosion. CONTRACTOR shall provide protection which will limit moisture absorption of concrete masonry units to the maximum percentage specified for Type I units for the average relative humidity at the project site, as reported by the nearest National Weather Service station.

B. Cementitious materials shall be stored off the ground and protected from moisture.

C. Aggregates shall be stored in a manner which will preserve grading characteristics.

D. Masonry accessories shall be stored to prevent corrosion, dirt accumulation, and other deterioration.

1.06 PROJECT CONDITIONS

A. Cold Weather Protection: Do no lay masonry units when outside air temperature is below 40 degrees F.

1. Grouted construction: On any day when the minimum anticipated nighttime temperature is 32 degrees F or less, in addition to complying with general procedures above, grout materials shall be heated to 90 degrees F to produce an in-place grout

temperature of not less than 70 degrees F at end of work day. Protective blankets or enclosures shall remain in place for not less than 48 hours after placement of masonry units.

2. Water: Water for mortar or grout shall not be heated to more than 160 degrees F.

B. Hot-Weather Protection: Cover or shade masonry units and mortar materials and use cool water for mortar whenever ambient air temperature is 90 degrees F or greater. At air temperatures of 85 degrees F or above, if relative humidity is less than 30 percent or wind is in excess of 15 miles per hour, provide protection by immediately covering newly constructed walls by providing windbreaks, or by using fog spray to reduce rate of evaporation.

1.07 MEASUREMENT AND PAYMENT

A. There shall be no separate measurement and payment for reinforced unit masonry. Full compensation for all reinforced unit masonry shall be considered as included in the contract unit or lump sum bid prices for the various items of the contract to which reinforced unit masonry relates.

PART 2 PRODUCTS

2.01 CONCRETE MASONRY UNITS

A. Concrete Block: Comply with referenced standards for types required, and as follows:

1. Unit, Grade and Type: Masonry units shall conform to the requirements of the following table:

	Unit	ASTM	Grade	Type
a.	Hollow Load Bearing	C90	N	I

2. Size: The size of masonry units shall be as indicated on the drawings. Special shapes and sizes shall be provided as required, whether or not specifically indicated on the drawings as special.

3. Compressive Strength: 1,900 psi minimum.

4. Surfaces: Special surface texture or architectural faces shall be provided where indicated on the drawings.

5. Color: Where the finished surface will be visible, masonry units shall have colors as indicated on the drawings. Where colors are not specified, the Project Representative shall determine colors to be provided.

2.02 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150, Type II or IIA.

1. Type III may be substituted during cold-weather construction.

B. Hydrated Lime: ASTM C 207, Type S.

C. Aggregate for Mortar: Sand conforming to ASTM C 144.

D. Aggregate for Grout: ASTM C 404.

E. Water: Clean and potable.

F. Accelerating Admixture: Nonchloride admixture for use in mortar mixes during cold weather, proportioned and mixed to comply with directions of manufacturer.

1. Products: The following products, provided they comply with requirements of the contract documents, will be among those considered acceptable.

a. "Dur-O-Guard"; Dur-O-Wal, Inc.

2.03 REINFORCEMENT AND ANCHORAGE

A. Reinforcing Bars: shall be in accordance with Section 03200.

B. Joint Reinforcement and Anchorage Materials: shall comply with the following general requirements for materials required in joint reinforcement and anchorage devices.

1. Steel wire: ASTM A 82.

a. Zinc coating: ASTM A 641 Class 1.
b. Application: Use at interior locations.

C. Joint Reinforcement: Provide welded-wire units prefabricated into straight lengths of not less than 10 feet, with deformed continuous side rods and plain cross rods, and as follows:

1. Width: Approximately 1-1/2 inches less than nominal wall width, providing not less than 1/2 inch mortar coverage on each exposure.

2. Wire sizes:

a. Side rod diameter: 0.1483 inch.
b. Cross rod diameter: 0.1483 inch.

3. Configuration:

a. Applications of single unit width: Ladder design, cross rods at not more than 16 inches on center.
b. Corners: Provide prefabricated L- and T-shaped units.

2.04 MISCELLANEOUS MASONRY ACCESSORIES

A. Premolded Control Joints Strips: Joints designed to fit standard sash block and to maintain lateral stability in masonry wall, of size and configuration indicated or as required for conditions, and as follows:

1. Either styrene-butadiene rubber compound complying with ASTM D 2000, 2AA-805; or polyvinyl chloride complying with ASTM D 2287, Type PVC 654-4.

B. Bond Breaker Strips: Asphalt-saturated organic roofing felt complying with ASTM D 226, Type 1 (No. 15 asphalt).

2.05 MORTAR AND GROUT MIXES

A. General: Do not use admixtures unless indicated as acceptable in the contract documents. Do not use calcium chloride in mortar or grout mixture.

B. Mixing: Combine and thoroughly mix ingredients in a mechanical batch mixer; comply with referenced ASTM standards for mixing time an water content.

C. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification, for types of mortar required, unless otherwise indicated.

1. Limit cementitious materials in mortar to Portland cement and lime.
2. Use Type S mortar for reinforced masonry. Compressive strength: 1800 psi @ 28 days.

D. Grout: Comply with ASTM C 476 for grout used in construction of unit masonry elements. Use grout of consistency indicated or as required at time of placement to fill completely all spaces intended to receive grout. Compressive strength: 2000 psi @ 28 days.

1. Use fine grout in spaces less than 2 inches in least horizontal dimension, unless otherwise indicated.

2. Use coarse grout in spaces 2 inches or more in least horizontal dimension, unless otherwise indicated.

2.06 MASONRY SEALERS

A. Shall be as noted in Section 09900 Painting & Finishes.

2.07 INSULATION

A. Shall be as noted in Section 07210 Insulation.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION PROCEDURES

A. Concrete Masonry Units: Do not wet concrete masonry units prior to laying.

B. Reinforcing: Before placing masonry reinforcing, remove loose rust, dirt, and other coatings.

C. Masonry Thickness: Build masonry elements to full thickness shown.

1. Build single-wythe walls to actual thickness of masonry units, using units of size indicated.

D. Chases and Recesses: Build masonry to accommodate the work of other trades, including chases and recesses as shown or required. Provide not less than 8 inches of masonry between jambs of openings and chases and recesses.

E. Leave openings for equipment to be installed in masonry. After installation of equipment, complete masonry work to match work immediately adjacent to opening.

F. Cutting Masonry Units: Use motor-driven saws to provide clean, sharp, unchipped edges. Cut units as required to provide continuous pattern and to fit adjoining work. Use dry cutting saws to cut concrete masonry units.

G. Add insulation to open cells if required on drawings. See Section 07210 - Insulation.

3.02 CONSTRUCTION TOLERANCES

A. Variation from Plumb: Do not exceed the following construction tolerances in vertical elements, including surfaces of walls, columns, and arises:

1. 1/4 inch to 10 feet.

2. 3/8 inch to one story height, or 20 feet, whichever is less, except 1/4 inch for external corners, expansion joints, and other highly conspicuous vertical elements.

3. 1/2 inch for 40 feet or more.

4. Plus or minus 1/4 inch in 10 feet, 1/2 inch maximum, for vertical alignment of head joints.

B. Variation from Level: Do not exceed the following construction tolerances for bed joints and lines of exposed lintels, sills, parapets, horizontal grooves, and other conspicuous horizontal elements:

1. 1/4 inch in one bay or in 20 feet maximum.

2. 1/2 inch in 40 feet or more.

C. Variation from Plan Lines: Do not exceed the following horizontal construction tolerances for related portions of columns, walls, and partitions:

1. 3/8 inch in any bay of 16 feet maximum.

2. 1/2 inch in 32 feet or more.

D. Variation in Cross Section: Do not exceed the following masonry elements:

1. Minus 1/4 inch.

2. Plus 1/2 inch.

E. Variation in Mortar Joint Thickness: Do not exceed the following construction tolerances for thickness of mortar joints:

1. Bed joints: Plus or minus 1/8 inch.

2. Head joints: Plus or minus 1/8 inch.

3.03 MASONRY CONSTRUCTION - GENERAL

A. Layout: Lay out masonry for accurate pattern bond, for uniform joint widths, and for accurate location of specific features before beginning actual construction. Avoid use of masonry units of less than 1/2 size. Do not use units with less than nominal 4 inch horizontal face dimensions at corners and jambs.

B. Pattern Bond: Lay exposed masonry in 1/2 running bond with vertical joints in each course centered on units in course above and below except where other bonds are indicated at special features.

1. Lay concealed masonry with all units in a wythe in running bond.

2. Bond and interlock each course of each wythe at corners.

C. Reinforced Concrete Unit Masonry: Maintain vertical continuity of core or cell cavities. Keep cavities clear of mortar, including bed area of first course, to provide minimum clear dimension indicated, to provide minimum clearance and grout coverage for vertical reinforcement bars, and to provide direct grout contact with supporting surfaces.

D. Stopping and Resuming Work: Lay masonry in proper sequence to avoid toothing. Rack walls back in each course at end of each day. Before resuming, clean exposed surfaces and remove loose masonry units and mortar.

E. Built-in Work: As work progresses, build in items indicated for installation in masonry, filling around built-in items solidly with masonry.

1. Fill spaces between metal frames and masonry elements solidly with mortar, unless otherwise indicated.

F. Install lintels of types indicated at all openings.

1. Bearing: Provide not less than 8 inches of bearing at each jamb unless otherwise indicated.

2. Reinforcement: At masonry openings greater than one foot in width, install horizontal joint reinforcement in 2 horizontal joints approximately 8 inches apart immediately above lintel and immediately below sill. Extend reinforcement which is in addition to required continuous joint reinforcement not less than 24 inches beyond jambs of the opening, except at control joints.

G. Formwork: Provide temporary formwork and shores as required for temporary support of reinforced masonry elements. Construct formwork to shape line, and dimensions shown. Make sufficiently tight to avoid leakage of mortar and grout.

1. Brace, tie, and support as required to maintain position and shape during construction and curing of reinforced masonry.

2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other reasonable temporary loads that may be placed on them during construction.

3.04 MORTAR BEDDING AND JOINTING

A. Lay hollow masonry units with full mortar coverage on horizontal and vertical face shells. Bed webs in mortar in starting course and in all courses of piers, columns, and pilasters, and where adjacent to cells or cavities to be grouted or filled with concrete.

B. Maintain joint widths indicated, except for minor variations required to maintain bond alignment. Except as otherwise indicated, maintain joint widths of 3/8 inch.

C. Cut joints flush for masonry walls which are concealed or covered by other materials, unless otherwise indicated.

D. Tool exposed joints slightly concave, using a jointer larger than joint thickness unless otherwise indicated.

E. Remove masonry units disturbed after laying; clean and reset in fresh mortar. Do not pound corners of jambs to shift adjacent stretcher units which have been set in position. If adjustments are required, remove units, clean off mortar, and reset in fresh mortar.

3.05 HORIZONTAL JOINT REINFORCEMENT OF SINGLE-WYTHE WALLS

A. General: Provide continuous horizontal joint reinforcement for all single-wythe masonry walls, unless otherwise indicated. Lap reinforcing a minimum of 6 inches.

B. Install joint reinforcing in mortar joints at not more than 16 inches on center vertically.

C. Cut or interrupt joint reinforcement at control and expansion joints.

D. Provide continuity at corners and wall intersections by means of prefabricated L- and T-shaped sections. Cut and bend reinforcement units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.06 INSTALLATION OF REINFORCEMENT

A. Preparation: Do not use reinforcement bars with kinks or bends not shown on drawings or final shop drawings. Do not use bars with cross section reduced due to excessive rusting and other causes.

B. Placement: Position reinforcement bars accurately at spacings indicated. Support and secure vertical bars against displacement. Horizontal bars may be placed as the work progresses. Provide not less than the greater of either the bar diameter or 1 inch clear between bars. For columns, piers, and pilasters, provide a clear distance between vertical bars as indicated, but not less than 1-1/2 times the nominal bar diameter or 1-1/2 inches, whichever is greater.

C. Splicing: Provide lapped splices at locations shown; do not splice at other points or by other methods, unless approved by the ENGINEER. Provide not less than minimum lap indicated, or as required by governing code.

3.07 GROUTING

A. Grouting Technique:

1. Provide minimum clear dimension of 2 inches and minimum clear area of 8 square inches in vertical cores to be grouted. Place vertical reinforcement prior to laying concrete masonry units, extending above elevation of maximum pour height as required for splicing. Support in position at vertical intervals not exceeding 192 bar diameters or 10 feet, whichever is less.

2. Grout shall be placed in all open areas of the masonry block as specified herein.

3. Lay masonry units to maximum pour height, not to exceed 4 feet.

4. Pour grout using chute or container with spout. Vibrate grout during placement. Place grout continuously; do not interrupt pouring operation for more than 1 hour. Terminate pour 1-1/2 inches below top of highest course in pour, except at tops of walls.

5. Stop grout in vertical cells 1-1/2 inches below bond beam course. Place horizontal reinforcement in bond beams; lap at corners and intersections as shown. Place grout in bond beam course before filling vertical cores above bond beams.

3.08 REPAIR AND POINTING

A. Repair: Remove and replace masonry units which are loose, chipped, broken, stained, or otherwise damaged, or if units do not match adjoining units as intended. Provide new units to match adjoining units, and install in fresh mortar or grout pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of mortar joints, enlarge any holes or voids except weep holes and completely fill with mortar. Point up all joints, including corners, openings, and adjacent work, to provide a neat and uniform appearance.

3.09 CLEANING AND PROTECTION

A. Clean masonry as follows after mortar is thoroughly set and cured:

1. Remove large mortar particles by hand, using wooden paddles and nonmetallic scrape hoes or chisels.

2. Test cleaning methods on sample wall panel, leaving half of panel uncleaned for comparison.

3. Clean concrete unit masonry to comply with directions of masonry manufacturer and as recommended by NCMA in Tek Bulletin No. 45.

B. Protection: CONTRACTOR shall protect all masonry until such time as the Work is completed and accepted by the ENGINEER.

3.10 FINISH

A. Block shall be finished as per Section 09900 Painting & Finishes.

- END OF SECTION -

SECTION 06100

ROUGH CARPENTRY

PART 1 GENERAL

1.01 DESCRIPTION

A. This section covers the carpentry work, material and accessories.

1.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN PLYWOOD ASSOCIATION (APA)

APA AFG-01	Adhesives for Field-Gluing Plywood to Wood Framing
APA Form E30	Design/Construction Guide, Residential and Commercial

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 307	Carbon Steel Bolts and Studs, 60 000 psi Tensile Strength

AMERICAN WOOD PRESERVERS BUREAU

AWPB LP-2	Softwood Lumber, Timber & Plywood Preserve Treated with Waterborn Preservatives for Above Ground Use

NATIONAL FOREST PRODUCTS ASSOCIATION (NFOPA)

NFOPA-01	National Design Specification for Wood Construction
NFOPA-02	Manual for Wood Frame Construction

TRUSS PLATE INSTITUTE (TPI)

TPI TPI-85	Design Specification for Metal Plate Connected Wood Trusse
TPI QST 88	Quality Standard for Metal Plate Connected Wood Trusses Addendum to TPI-85

WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)

WWPA-01	Western Lumber Grading Rules

1.03 SUBMITTALS

A. Structural and Miscellaneous Wood Members: Design analysis and calculations of fabricated wood trusses shall show design criteria used to accomplish the applicable analysis.

B. Shop Drawings: Drawings of fabricated wood trusses shall indicate materials and shop and field erection details including methods of fastening.

C. Manufacture's Certificates: Manufacturer's certificates attesting that lumber and material not normally grade marked or exempt from being grade marked meets the specified requirements.

1.04 DELIVERY AND STORAGE

A. Materials shall be delivered to the site in undamaged condition, stored off ground in fully covered, well ventilated areas, and protected from extreme changes in temperature and humidity.

1.05 MEASUREMENT AND PAYMENT

A. Rough carpentry shall not be measured or paid as a separate item, but shall be included as part of the various items to which it relates.

PART 2 PRODUCTS

2.01 LUMBER AND SHEATHING

A. Grading and Marking: Materials shall bear the grademark, stamp or other identifying marks indicating grades of material and rules or standards under which produced. Such identifying marks on material shall be in accordance with the rule or standard under which the material is produced, including requirements for qualifications and authority of the inspection organization, usage of authorized identification, and information included in the identification. The inspection agency for lumber shall be certified by the Board of Review, American Lumber Standards Committee, to grade species used. Except for plywood and lumber; bundle marking will be permitted in lieu of marking each individual piece. Surfaces that are to be architecturally exposed to view shall not bear grademarks, stamps, or other types of identifying marks.

B. Sizes: Lumber and material sizes shall conform to requirements of the rules or standards under which produced. Unless otherwise specified, lumber shall be surfaced on four sides. Size references, unless otherwise specified, are nominal sizes, and actual sizes shall be within manufacturing tolerances allowed by the standard under which the product is produced.

C. Trussed Rafters: Rafters shall be a prefabricated design. Connections shall be made with light-metal plate-connectors. Light-metal-plate-connected wood trusses shall be designed

in conformance with TPI TPI-85 and fabricated in conformance with TPI QST-88.

D. Plywood: Plywood shall be APA performance rated, Grade C-D with exterior glue. Sheathing for roof without corner bracing of framing shall have a span rating of 16/0 or greater for supports 16 inches on center and a span rating of 24/0 or greater for supports 24 inches on center.

E. Wood: Provide dressed lumber, S4S, unless otherwise indicated. Provide seasoned lumber with 19 percent maximum moisture. For structural framing use No. 2 grade Douglas-fir or Larch or any species or grade meeting the following requirements:

1. F_b: 900 psi
2. E: 1,600,000 psi

2.02 TRUSSES

A. Marking: Each truss shall be marked or have permanently affixed thereto the following information near the center of the span on the bottom chord: truss manufacturer's name and address, design load, and spacing of the trusses.

B. Connector plates shall be designed by the truss manufacturer in accordance with TPI Standards. Structural plates shall be structural quality steel and hot-dip galvanized according to ASTM A 653. Connector plates shall be provided on both sides of the truss, i.e. 2 plates per joint.

2.03 PRESERVATIVE TREATMENT

A. The treatment of lumber, timber, and plywood shall meet the requirements of AWPB LP 2 for above ground use only. All products shall bear the appropriate AWPB Quality Mark. The wood shall then be dried to the moisture content specified and marked with the word "Dry." Surfaces of lumber that will be exposed shall not be incised. Exposed areas of treated wood that are cut or drilled after treatment shall receive a field treatment in accordance with AWPA M4. Unless otherwise specified the following items will always be treated:

1. All wood members used in built-up roofing systems.

2. All wood members set into concrete regardless of location, including flush-with-deck wood nailers for roofs.

3. All wood members used for rough framing of openings in exterior concrete or masonry walls.

4. Nailing strips or nailers used in conjunction with roof systems.

2.04 ACCESSORIES AND NAILS

A. Anchor Bolts shall conform to ASTM A 307, size as indicated, complete with nuts and washers.

B. Expansion Shields shall be the Type and size best suited for intended use.

C. Joist Hangers and Truss Clips shall be steel or iron, zinc-coated, size to fit members where used, sufficient strength to develop the full strength of supported member, complete with any special nails required.

D. Nails and Staples shall be of the size and type best suited for purpose. For sheathing, length of nails shall be sufficient to extend 1 inch into supports. In general, 8-penny or larger nails shall be used for nailing through 1-inch thick lumber and for toe nailing 2-inch thick lumber; 16-penny or larger nails shall be used for nailing through 2-inch thick lumber. Nails used with treated lumber and sheathing shall be galvanized.

PART 3 EXECUTION

3.01 INSTALLATION OF FRAMING AND MISCELLANEOUS WOOD MEMBERS

A. General: Members shall be closely fitted, accurately set to required lines and levels, and rigidly secured in place. Nailing shall be in accordance with the recommended Nailing Schedule as contained in NFOPA-02. Where detailed nailing requirements are not specified, nail size and nail spacing shall be sufficient to develop an adequate strength for the connection without splitting the members. Installation of timber connections shall conform to applicable requirements of NFOPA-01. Members shall be framed for passage of ducts and pipes shall be cut, notched, or bored in accordance with applicable requirements of NFOPA-02. Rafters, purlins, and joists shall be set with crown edge up. Leveling of joists, beams, and girders on masonry or concrete shall be with slate or steel; on wood or metal leveling shall be without shims.

B. Sill Plates: Sill plates shall be set level and square and anchor bolted at not more than 2 feet 8 inches on centers and not more than 12 inches from end of each piece. A minimum of two anchors shall be used for each piece.

C. Roof Framing or Rafters: Tops of supports or rafters shall form a true plane. Valley, ridge, and hip members shall be of depth equal to cut on rafters where practicable, but in no case less than depth of rafters. Valleys, hips, and ridges shall be straight and true intersections of roof planes. Necessary crickets and watersheds shall be formed. Rafters, except hip and valley rafters, shall be spiked to wall plate and to ceiling joists with no less than three 8-penny nails. Rafters shall be toe-nailed to ridge; valley, or hip members with at least three 8-penny nails. Rafters shall be braced to prevent movement until permanent bracing, decking or sheathing is installed. Hip and valley rafters shall be secured to wall plates by clip angles. Openings in roof shall be framed with headers and trimmers. Unless otherwise indicated, headers carrying more than two rafters and trimmers supporting headers carrying more than one rafter shall be double. Hip rafters longer than the available lumber shall be

butt jointed and scabbed. Valley rafters longer than the available lumber shall be double, with pieces lapped not less than 4 feet and well spiked together. Trussed rafters shall be installed in accordance with TPI TPI-85.

D. Blocking: Blocking shall be provided as necessary to meet the latest codes for lateral bracing and for application of siding, sheathing, subflooring, wallboard, and other materials or building items, and to provide fire stopping. Blocking shall be cut to fit between framing members and rigidly nailed thereto.

E. All nailing, except where noted on the drawings, to be per Table 2304.9.1 of the 2012 IBC.

3.02 INSTALLATION OF SHEATHING

A. Plywood: Sheathing shall be applied with edges 1/8 inch apart at side and end joints, and nailed at supported edges at 6 inches on center and at intermediate supports 12 inches on center. Nailing of edges shall be 3/8 inch from the edges. Wall sheathing shall extend over top and bottom plates, and if applied horizontally the vertical joints shall be made over supports and staggered. Roof sheathing shall be applied with long dimension at right angles to supports, end joints made over supports, and end joints staggered.

3.03 INSTALLATION OF ROOF TRUSSES

A. Contractor shall be responsible for field erection of the trusses, including proper handling, safety precautions, temporary bracing to prevent toppling, and other safeguards which are consistent with good workmanship and building erection practices.

B. Contractor shall comply with all applicable requirements and recommendations of TPI.

C. Contractor shall not field repair, cut or otherwise alter trusses without consulting the truss manufacturer.

- END OF SECTION -

SECTION 07210

INSULATION

PART 1 GENERAL

1.01 SUMMARY

A. This section covers the work required to insulate structures.

1.02 MEASUREMENT AND PAYMENT

A. There shall be no separate measurement and payment for Insulation. Full compensation for all insulation shall be considered as included in the contract unit or lump sum bid prices for the various items of the contract to which it relates.

1.03 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

B. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. C 516 Vermiculite Loose Fill Thermal Insulation

2. C518 Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus

3. C 549 Perlite Loose Fill Insulation

4. C 578 Preformed, Cellular Polystyrene Thermal Insulation

5. C665 Mineral Fiber Blanket Thermal Insulation for Light Frame Construction

6. D2842 Standard Test Method for Water Absorption of Rigid Cellular Plastics

7. E-84 Standard Test Method for Surface Burning Characteristics of Building Materials

C. FEDERAL SPECIFICATIONS (FS)

1. HH-I-558 Insulation Board, Thermal, Unfaced Polyurethane or Polyisocyanurate

1.04 SUBMITTALS

A. Submittals are required for Manufacturer's product installation instructions.

B. Product data is required on all insulation required.

C. Submit manufacturer's certification that the proposed materials comply with this Section.

D. For foam-in-place insulation, submit a copy of the foam insulation contractor's certification and ICC-ES report and manufacturer's documentation confirming material conforms to ASTM C 1029.

1.05 DELIVERY AND STORAGE

A. Materials shall not be allowed to become wet, soiled, or covered with ice and snow. Manufacturer's recommendations for handling storage and protection shall be strictly followed. Material shall not be exposed to sunlight and shall be protected against ignition. Materials shall be concealed as quickly as possible after completion of work.

PART 2 PRODUCTS

2.01 INSULATION

A. Thermal resistance of insulation shall be not less than the R-values shown. R-values shall be determined at 75 degrees F in accordance with ASTM C 518. Insulation shall be the standard product of a manufacturer and factory marked or identified with manufacturer's name or trademark and R-value. Identification shall be on individual pieces or individual packages. Insulation shall conform to the following:

B. Blanket Insulation: Insulation shall be glass or other inorganic fibers and resinous binders formed into flexible blankets complying with FS HH-1-521, Type III, with foiled back vapor barrier laminated to one face, with 1-inch flanges on long edges, and vapor transmission not more than 0.50 perms. R-19 shall be provided unless noted otherwise. Manufacturers shall be Owens-Corning, Johns-Manville, U.S. Rock Wool Co., or equal.

C. Sill Sealer: Mineral wool, 1 inch thick and compressible to 1/32 inch, width of sill, designed to perform as an air, dirt, and insect seal.

D. Rigid Insulation shall be Polystyrene conforming to ASTM C 578 Type II minimum and as recommended by the manufacturer for the location noted.

E. Minimum R-Value in all roof insulation shall be R-30.

2.02 FOAMED-IN-PLACE THERMAL INSULATION

A. Foamed-in-place or sprayed polyurethane foam plastic insulation conforming to the requirements of ASTM C 1029 shall be placed in cavities of masonry walls. Foamed-in-place thermal insulation in walls shall be 2-component spray polyurethane mix for producing rigid, closed-cell insulation by frothing/pouring in place. It shall have the following characteristics:

Property	Requirement	Standard
Core Density	1.5 to 2.5 pcf	ASTM D 1622
Termal Resistance at 140°F/90 day Aged R Value, at 75°F mean Temp, min	R6.0/inch	ASTM C 518
Vapor Transmission, max	3.0 perm-inch	ASTM E 96
Water Absorption, max	3.0 %	ASTM D 2842

B. Foamed-in-place insulation shall be Bayseal CCX by Covsetro, STYROFOAM (MX Series) by Dow Chemical, CertaSpray by CertainTeed, Corbond MCS by Johns-Manville, ICYNENE MD-C-200 by Icynene, Inc., or approved equal.

PART 3 EXECUTION

3.01 PREPARATION

A. Verify substrate and adjacent materials and insulation board are dry and ready to receive adhesive.

B. Verify mechanical and electrical services within walls have been installed and tested.

3.02 INSTALLATION OF INSULATION

A. Insulation shall be installed after construction has advanced to a point that the installed insulation will not be damaged by remaining work. For thermal insulation the actual installed thickness shall provide the R-values shown. For acoustical insulation the installed thickness shall be as shown. Insulation shall be installed on the weather side of such items as electrical boxes and water lines. Unless otherwise specified, installation shall be in accordance with the manufacturer's recommendation.

3.03 INSTALLATION OF FOAMED-IN-PLACE THERMAL INSULATION

A. The polyurethane foam shall be poured in 4-foot lifts. All insulation shall be done in close coordination with the masonry contractor to allow quality control.

B. The polyurethane foam shall be applied by qualified firms with proper dispensing equipment.

3.04 INSTALLATION - RIGID INSULATION

A. Foundation Perimeter:

1. Adhere a 6 inches wide strip of polyethylene sheet over joints with double beads of

adhesive each side of the joint. Tape seal joints between sheets. Extend sheet full height of joint.

2. Install boards on foundation wall perimeter, horizontally. Place boards in a method to maximize contact bedding. Stagger end joints. Butt edges and ends tight to adjacent board and to protrusions.

3. Extend boards over expansion joints, unbonded to foundation 12 inches either side of joint.

B. Exterior Walls:

1. Apply adhesive in 3 continuous beads per board length. Daub adhesive tight to protrusions.

2. Install boards on wall surface perimeter, vertically. Place membrane surface of insulation against adhesive.

3. Place boards in a method to maximize contact bedding. Stagger side joints. Butt edges and ends tight to adjacent board and to protrusions.

4. Place 24" side polyethylene sheet at perimeter of wall openings from adhesive vapor and air retarder bed to window and door frames. Tape seal in place to ensure continuity of vapor and air retarder.

C. Cavity Walls:

1. Secure impale fasteners to substrate at a frequency of 6 per insulated board.

2. Apply adhesive in 3 continuous beads per board length. Daub adhesive tight to protrusions to ensure continuity of vapor and air retarder.

3. Install boards horizontally between wall reinforcement.

D. Under Concrete Slabs:

1. Place insulation under slabs on grade after base for slab has been compacted.

2. Prevent insulation from being displaced or damaged while placing vapor retarder and placing slab.

3.05 INSTALLATION - BATT INSULATION

A. Install batt insulation and vapor retarder in accordance with manufacturer's instructions.

B. Install batt insulation without gaps or voids

C. Trim insulation neatly to fit spaces. Use batts free of damage.

D. Fit insulation tight in spaces airtight to exterior side of mechanical and electrical services within the plane of insulation.

E. Protect all insulation materials during storage and insulation from moisture, tears or other damage. All damaged material shall be replaced at no additional cost to the OWNER.

- END OF SECTION -

SECTION 07312

FIBERGLASS REINFORCED SHINGLES ROOFING SYSTEM

PART 1 GENERAL

1.1 DESCRIPTION

A. Contractor shall furnish and install asphalt roofing shingles, metal flashing, metal fascia and soffit panels, leak barrier and roof deck underlayment, system support framing, rain gutters and downspouts, and appurtenant work, complete and in place.

B. The principal items of sheet metal work included in the asphalt shingle roofing shall include sheet metal flashing, covers, trim, enclosure batts, collars and sleeves at all roof penetrations, metal soffit panels, rain gutters, downspouts, and all other sheet metal items necessary for a complete and watertight asphalt shingle roofing system.

C. The roofing applicator shall coordinate his work with sheet metal gutter work and shall report to CONTRACTOR and ENGINEER if any sheet metal work provided by others affects his work negatively.

1.2 RELATED WORK

A. Related work in other sections includes but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 07 62 00 Sheet Metal Flashing and Trim

1.3 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

B. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM A 653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
2. ASTM D 1079 Standard Terminology Relating to Roofing and Waterproofing
3. ASTM D 3018 Standard Specification for Class A Asphalt Shingles Surfaced with Mineral Granules
4. ASTM D 3161 Standard Test Method for Wind-Resistance of Asphalt Shingles (Fan-Induced Method)
5. ASTM D 3462 Standard Specification for Asphalt Shingles Made From Glass Felt and Surfaced with Mineral Granules
6. ASTM D 4586 Standard Specification for Asphalt Roof Cement, Asbestos-Free
7. ASTM D 7158 Standard Test Method for Wind-Resistance of Sealed Asphalt Shingles (Uplift Force/Uplift Resistance Method)
8. ASTM E 330 Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static AirPressure Difference

C. UNDERWRITERS LABORATORY (UL)

1. UL 580 Test for Uplift Resistance of Prepared Roof Assemblies
2. UL 790 Tests for Fire Resistance of Roof Covering Materials
3. UL 997 Wind Resistance of Prepared Roof Covering Materials

D. AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

1. AAMA 1402 Standard Specifications for Aluminum Siding, Soffit, and Fascia

1.4 DEFINITIONS

A. Roofing Terminology: Refer to ASTM D1079 and the glossary of the National Roofing Contractors Association (NRCA) Roofing and Waterproofing Manual for definitions of roofing terms related to this section.

1.5 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Submit detailed shop drawings showing materials, gages, finishes, layout, corners, trim, flashing, enclosures, edge conditions, jointing, profiles, supports, fasteners, fabrication of special shapes, and method of attachment to adjacent construction to Engineer prior to fabrication. Submit drawings indicating roof size, location and type of penetrations, perimeter and penetration details, roof insulation make-up and sheet layout that have been accepted by an authorized manufacturer's representative.

C. Submit manufacturer's literature indicating materials, finish, construction, and method of installation of prefabricated items and sealant.

D. Provide color samples for color selection by OWNER.

E. Submit the following test reports, certified by an Independent Testing Laboratory or a professional engineer registered in the State of Utah to verify the proposed roofing will meet performance requirements of this Specification:

1. Thermal Cycle Test
2. ASTM E-330 Adapted to Test Formed Metal Panels
3. Clip Fastener Pull-Out Tests and Calculations
4. UL 580 Class 90
5. Concentrated Load Test Data
6. Air Infiltration (E-283) and Water Penetration (E-331) Test Results
7. Coating Performance Testing

F. Submit certification by the manufacturer that the roofing assembly is listed in the UL Building Materials Directory with a Class 1-90 wind uplift rating, including relevant construction number.

1.6 WARRANTIES

A. Roofing manufacturer shall provide written 50-year material and labor warranty beginning at the date of final acceptance.

B. CONTRACTOR shall provide to OWNER written warranty that the roof system is installed in accordance with the manufacturer's recommendations and will be free from defective workmanship and remain watertight and weatherproof with normal usage for two (2) years following Project Substantial Completion date.

1.7 QUALITY ASSURANCE

A. A single installer shall perform the work of this Section and shall have completed projects of similar scope and complexity.

B. Provide all primary roofing products, including shingles, underlayment, leak barrier, and ventilation, by a single manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store all products in manufacturer's unopened, labeled packaging until they are ready for installation.

B. Store products in a covered, ventilated area, at temperature not more than 110 degrees F (43 degrees C); do not store near steam pipes, radiators, or in direct sunlight.

C. Store bundles on a flat surface. Maximum stacking height shall not exceed the manufacturer’s recommendations. Store all rolls on end.

D. Store and dispose of solvent-based materials in accordance with all federal, state and local regulations.

1.9 ENVIRONMENTAL CONDITIONS

A. Do not install ice dam membrane and shingles when surface temperatures are below 45 degrees F (7 degrees C).

1.10 SEQUENCING

A. Install roofing system only after installation of metal fascia. Install underlayment and formed valley metal in valleys after installation of general secondary underlayment, but before installation of general primary underlayment.

1.11 MAINTENANCE

A. Provide one square minimum of bundled shingles for OWNER’s future use.

1.12 MEASUREMENT AND PAYMENT

A. There shall be no separate measurement and payment for asphalt shingles roofing systems. Full compensation for roofing systems shall be considered as included in the contract unit or lump sum bid prices for the various items of the contract to which roof system relates.

PART 2 PRODUCTS

2.1 SHINGLES

A. Self-sealing, granule surfaced, asphalt shingle with a strong fiberglass reinforced core and stain protection, which prevents pronounced discoloration from blue-green algae through formulation/unique blends of granules. Architectural laminate styling provides a wood shake appearance with a 5 5/8 inch exposure. Features high definition color blends and enhanced shadow effect. UL 790 Class A rated with UL 997 Wind Resistance Label; ASTM D 7158, Class H; ASTM D 3161, Type 1; ASTM D 3018, Type 1; ASTM D 3462; AC438; CSA A123.5-98; ICC Report Approval. Asphalt shingles shall be **Timberline HD Lifetime High Definition Shingles by GAF, Heritage by TAMKO**, or approved equal.

B. Color shall be selected by OWNER from the manufacturer's standard colors.

2.2 HIP AND RIDGE SHINGLES

A. High profile self-sealing hip and ridge cap shingle matching the color of selected roof shingle. Hip and ridge shingles shall be **Timbertex Premium Ridge Cap Shingles by GAF, TAMKO Heritage Hip and Ridge Shingles**, or approved equal.

2.3 STARTER STRIP

A. Self-sealing starter shingle designed for all roof shingles. Starter strip shall be **ProStart Starter Strip by GAF, TAMKO Shingle Starter**, or approved equal.

2.4 LEAK BARRIER

A. Leak Barrier shall be a cold applied, self-adhering membrane composed of high strength polyethylene film coated with a layer of rubberized asphalt adhesive and interwound with a disposable release sheet. An embossed lip resistant surface is provided on the polyethylene. Color shall be black. Membrane thickness shall be 40 mil minimum. Underlayment shall be UL 790 listed Class A fire classification under fiber-glass shingles and Class C under organic felt shingles. Leak Barrier shall be **Ice and Water Shield by Grace Construction Products, Moisture Guard Plus by TAMKO**, or approved equal.

2.5 ROOFING UNDERLAYMENT

A. #30 Roofing Underlayment - Water repellent breather type cellulose fiber building paper. Meets or exceeds the requirements of ASTM D-4869 Type II.

2.6 ROOFING CEMENT

A. Asphalt Plastic Roofing Cement meeting the requirements of ASTM D 4586, Type I or II.

2.7 ATTIC VENTILATION

A. Ridge Vents

1. Flexible rigid plastic ridge ventilator designed to allow the passage of hot air from attics, while resisting snow infiltration. Ridge vents shall be for use in conjunction with eave/soffit ventilation products. Provides 12.5 sq inches Net Free Ventilation

Area per lineal foot. Ridge vent shall be **Cobra Ridge Runner by GAF, Coolridge or Xtractor Vent XLP Turbo by TAMKO**, or approved equal.

2.8 METAL FLASHING

A. Metal flashing shall be 24 gauge hot-dip galvanized steel sheet, complying with ASTM A 653, G90/Z275.

2.9 FASCIA AND SOFFIT SYSTEM

A. Fascia, soffit, J-Channel, and trim shall be fabricated from aluminum 3105 or equivalent alloy. Fascia shall have a nominal thickness of 0.024 inch and soffit nominal thickness shall be 0.019 inch. Materials shall meet the requirements of AAMA 1402. Soffit shall 12 inches wide and perforated with a net free area of at least 8 square inches/foot.

B. Finish shall be a baked on enamel. Color shall be as selected by OWNER.

C. Nails and screws shall be stainless steel.

2.10 RAIN GUTTER AND DOWNSPOUTS

A. Rain gutters, downspouts, and accessories shall be fabricated from aluminum 3105 or equivalent alloy. Rain gutters shall have a nominal thickness of 0.032 inch. Hangers shall have a nominal thickness of 0.081 inch. Downspouts and fittings shall have a nominal thickness of 0.024 inch.

B. Finish shall be a baked on enamel. Color shall match the fascia and soffit.

C. Connection screws shall be stainless steel or coated aluminum.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin installation until the roof deck has been properly prepared.

B. Verify proper placement of all roof openings, pipes, curbs, sleeves, ducts, vents and drains.

3.2 SUBSTRATE PREPARATION

A. Comply with manufacturer’s instructions for preparation of substrate to receive roofing. Clean substrate of dust, debris and other substances detrimental to the roofing work. Verify the roof deck is free of any depressions, waves, and projections. Cover with sheet metal all holes over 1-inch in diameter and cracks over 1/2-inch in width. Replace damaged deck with new materials.

3.3 INSTALLATION OF UNDERLAYMENT

A. General: Install underlayment using methods recommended by the manufacturer and in accordance with local building codes. When local codes and application instructions are in conflict, the more stringent shall take precedence.

B. Eaves: Install eaves with metal flashing tight with fascia boards. Lap joints 2 inches and seal with plastic cement or high quality urethane sealant. Nail at the top of the flange. Install leak barrier up slope from eaves edge a full 36 inches or to at least 24 inches beyond the interior “warm wall”. Lap ends of leak barrier at least 6 inches.

C. Valleys: Install leak barrier at least 36 inches wide and centered on the valley. Lap ends at least 6 inches.

D. Hips and Ridges: Install leak barrier along entire lengths. If ridge vents are to be installed, position leak barrier so that the ridge slots will not be covered.

E. Roof Deck: Install on layer of roof underlayment over the entire area not protected by leak barrier. Install sheets horizontally so water sheds and nail in place. On roofs sloped more than 4:12 lap horizontal edges at least 2 inches and at least 2 inches over leak barrier. For roofs sloped between 2:12 and 4:12, lap horizontal edges at least 19 inches and at least 19 inches over leak barrier. Lap ends at least 4 inches and stagger ends laps at least 36 inches. Lap roof underlayment at least 6 inches over leak barrier in valley.

F. Penetrations

1. Vent Pipes: Install a 24 inch square piece of leak barrier lapping over roof underlayment and seal tightly to pipe.

2. Skylights: Install leak barrier membrane extending at least 6 inches up the wall and 12 inches on to the roof surface. Lap the membrane over the roof deck underlayment.

3.4 INSTALLATION OF STARTER SHINGLES

A. General: Install in accordance with the manufacturer’s instructions and local building codes. When local codes and application instructions are in conflict, the more stringent shall take precedence.

B. Placement and Nailing

1. For maximum wind resistance along rakes and eaves, install starter strip containing sealant or cement shingles to underlayment and each other in a 4 inch width of asphalt plastic roof cement.

2. Place starter strip shingles over eave and rake edges to provide drip edge.

3. Nail approximately 1-1/2” to 3” above the butt edge of the shingle.

4. Rake starter course should overlap eave edge starter strip at least 3 inches.

3.5 INSTALLATION OF SHINGLES

A. General: Install in accordance with the manufacturer’s instructions and local building codes. When local codes and application instructions are in conflict, the more stringent shall take precedence.

B. Placement and Nailing

1. Secure with 4, 5, or 6 nails per shingle per manufacturer's instructions or local codes.

2. Placement of nails varies based on the type of shingle specified. Consult the application instructions for the specified shingle for details.

3. Nails must be driven flush with the shingle surface. Do not overdrive or underdrive the nails.

4. Shingle offset varies based on the type of shingle specified. Consult the application instructions for the specified shingle for details.

C. Penetrations: All penetrations are to be flashed according to ARMA and NRCA application instructions and construction details.

3.6 INSTALLATION OF ATTIC VENTILATION

A. General: Ventilation must meet or exceed the current FHA, HUD, or local code requirements.

B. Ridge Ventilation

1. Install ridge vent along the entire length of ridges
2. Cut continuous vent slots through the sheathing, stopping 6 inches from each end of the ridge.
3. Install ridge vent material along the full length of the ridge, including uncut areas.
4. Butt ends of ridge vent material and joint using roofing cement.

3.7 INSTALLATION OF FASCIA, SOFFIT, AND RAIN GUTTERS

A. Install fascia, vented soffit, and rain gutters according to the manufacturer's written instructions.

- END OF SECTION –

SECTION 08300

DOORS

PART 1 GENERAL

1.01 DESCRIPTION

A. This section covers all the work necessary to furnish and install all doors for the Chemical Feed Facility.

B. All doors and their pressed steel frames shall be steel, insulated, exterior, 1 3/4-inch doors of the dimensions in drawings.

1.02 RELATED WORK

A. Related work in other sections includes but is not limit to:

Section 04220 Reinforced Unit Masonry
Section 09900 Painting and finishes

1.03 REFERENCES

A. Work covered by this Specification shall meet or exceed the provisions of the latest editions of the following Codes and Standards in effect at the time of award of the Contract:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A 224.1 Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 229	Steel Wire, Oil-Tempered for Mechanical Springs
ASTM A 366	Cold Rolled Steel
ASTM A 525	Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process
ASTM C 177	Thermal Properties
ASTM D 256	Impact Resistance
ASTM D 635	Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position
ASTM D 790	Flexural Strength
ASTM D 792	Density/Specific Gravity of Laminate
ASTM D 882	Tensile Strength
ASTM D 1622	Density/Specific Gravity
ASTM D 2583	Barcol Hardness

ASTM D E 84	Surface Burning Characteristics
ASTM E 84	Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E 330	Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference

1.04 SUBMITTALS

A. Manufacturer's catalog data and preprinted installation instructions of doors.

B. A schedule showing the location of each door shall be included with the drawings. Submittal drawings shall include elevations of each door type, details and method of anchorage, details of construction, method of assembling sections, location and installation of hardware, shape and thickness of materials, details of joints and connections.

1.05 DELIVERY AND STORAGE

A. Doors shall be delivered to the job site wrapped in a protective covering with the brands and names clearly marked thereon. Doors shall be stored in a dry location that is adequately ventilated and free from dust or water, and in a manner that permits easy access for inspection and handling. Doors shall be handled carefully to prevent damage to the faces, edges, and ends. Damaged items that cannot be restored to like-new condition shall be replaced.

1.06 MEASUREMENT AND PAYMENT

A. There shall be no separate measurement and payment for doors. Full compensation for all doors shall be considered as included in the contract unit or lump sum bid prices for the various items of the contract to which doors relate.

PART 2 PRODUCTS

2.01 ACCESS DOORS

A. Access doors and frames shall be made of prime quality, cold rolled, pickled annealed, stretcher leveled steel free from scale, pitting and surface defects and shall conform to the following:

1. Hollow metal door, 1 3/4 inches thick flush type, constructed of two sheets of not less than 16-gauge steel sheets formed and welded for flush pan assembly, with internal 20-gauge vertical reinforcing channels spaced not over 8 inches on centers the full height of the door. There shall be no visible joints on the face of the doors. Reinforcing channels shall be uniformly spot welded to face plates at top and bottom of all doors. Filler channels shall be provided at the top and bottom of doors to provide a flush closure.

2. All interior void spaces shall be completely filled with not less than 3 pound density rock wool or polyurethane.
3. Concealed sheet or bar steel reinforcement shall be provided for mortise type hardware. Reinforcing shall not be less than the following: 9-gauge for butts, 12-gauge for locksets and 14-gauge for surface applied hardware. Reinforcing shall be drilled and tapped to template requirements. Concealed reinforcing shall be provided for closures. Door bottom weatherstripping shall be included to match thresholds.
4. Door frames shall be pressed steel constructed of not less than 16-gauge steel and shall be of the shape indicated on the plans and as required to fit the various wall constructions. Frames shall be of welded unit construction assembled and welded in the shop. Welding shall be to a hairline joint with all exposed beads ground smooth.
5. Concealed reinforcing of the frames for the mortise hardware shall be not less than the following : 3/16 inch for butts, 12- gauge for lock strike, 14-gauge for surface applied items and 18-gauge for plaster guards over mortised hardware reinforcement. Frames shall be mortised drilled, and tapped to template requirements. Lock reinforcing units shall be supplied by finishing hardware supplier. Frames shall be anchored as shown in the drawings.
6. Hinges shall be heavy duty ball bearing hinges with non-removable pins.
7. Pull plates shall be chrome plated or stainless steel and mounted on interior and exterior sides of all doors.
8. All double doors are to be supplied with a “Z” astragal of 14-gage steel for 1-3/4-inch doors and 16-gage for 1-3/8-inch doors.
9. Hardware including locksets and hinges shall be stainless steel.

B. Door Hardware (or approved equal):

1. Pull Plates: Rockwood No. 110, 316 stainless steel, 4" x 16".
2. Hinges: Hager BB119932DNRP (primed with non-removable hinge pins), number of hinges per door manufacturer’s recommendation (minimum of 3 hinges per door). Where necessary to keep door leaf clear of walls, casings, jambs or reveals in door opening, wide throw hinges of an approved ttype shall be furnished.
3. Cylinder Lock Set: Best Access Systems, Cylinder Core 1C-7E1 626. Pin cylinders to customer Code 2-1. Locks must be compatible with Owners existing keys. Contractor shall verify that lock sets and keys will match Owner’s requirements.
4. Surface Bolt, Upper Rockwood No. 555, cadmium plated finish (inactive leaf only).
5. Surface Bolt, Lower Rockwood No. 555 cadmium plated finish (inactive leaf only).
6. Threshold: #277AS by Pemko Corporation, raised interior, extruded aluminum threshold with neoprene seal, or equal.
7. Drip Cap: Pemko 346C
8. Door Closers: Door closers shall be full rack and pinion, cast iron, with adjustable regulators for closing and latching speed, back check and spring power. Closers shall be mounted for 180 degrees of swing whenever possible.

All closers shall be LCN Model 4041 with extra duty hold and with T-handle stop. Mounting plates shall be supplied as necessary. All door closers attached to mineral core or particle filled doors shall be installed with hex bolts. Closures are not required for the access doors with removable walls in front of them.

9. Lock Strikes: Strikes shall have extended curved lips where required to protect trim from being marred by latch bolt. Strike lips shall not protrude more than 1/8-inch beyond door frame trim. Wrought box strikes shall be furnished on all locks, latches and deadlocks.
10. Door Stop: Rockwood #445 (Inactive leaf only)
11. Astragal: Rockwood 306B-AST (double doors only)
12. Kick Plates: Unless otherwise indicated, kick plates shall be provided and shall be satin stainless 18-8, 18 gage.

2.02 FABRICATION OF ACCESS DOORS AND FRAMES

A. Fabricate doors and frames as shown on the drawings and in accordance with best shop practices. Frames shall be rigid, neat in appearance and free from defects. Field measurements shall be taken as required for coordination with adjoining work.

B. Form exposed surfaces free from warp, wave and buckle, with all corners square, unless otherwise shown. Set each member in proper alignment and relationship to other members with all surfaces straight and in a true plane.

C. Reinforce members and joints with plates, tubes or angles for rigidity and strength.

D. Doors and frames shall be mortised and reinforced for hardware in accordance with the hardware manufacturer's instructions and templates. The reinforcing shall be designed to receive hinges, locks, strikes, closures, etc.

E. Mortar guard boxes shall be provided for hardware cutouts in frames.

F. Furnish at least three (3) metal anchors or polymer spacers in each jamb of frames up to 84" high and one (1) additional anchor for each 24" in height above 84", in shapes, sizes and spacing shown or required for anchorage into adjoining wall construction. Fabricate joint anchor of stainless steel.

G. Terminate bottom of frames at the indicated finished floor level.

H. Provide clearance for doors of 1/8" at jambs and heads; 1/4" clearance above threshold.

I. Where glazing is required, flush integral stops on one side and screw-on stops on the opposite side shall be provided.

2.03 FINISH

A. Surfaces shall be provided with a shop-primed galvanized finish. Prior to receiving primer, all surfaces shall be cleaned thoroughly and phosphate-treated to assure maximum paint adherence. Primer shall be a metallic oxide or synthetic resin primer of the manufacturer's standard type and shall be applied by dipping or spraying in accordance with ANSI A 224.1.

B. Painting of doors and frames shall be in accordance with Section 00900.

PART 3 EXECUTION

3.01 INSTALLATION

A. Doors shall be installed in accordance with approved detail drawings and manufacturer's instructions. Anchors and inserts for guides, brackets, hardware, and other accessories shall be accurately located. Upon completion, doors shall be weather tight and shall be free from warp, twist, or distortion. Doors shall be lubricated, properly adjusted, and demonstrated to operate freely.

B. Access Door Frame Installation

1. Place frames prior to construction of enclosing walls and ceilings. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is completed, remove temporary braces and spreaders leaving surfaces smooth and undamaged. Frame must not be drilled for brace supports as finish may be damaged.

2. Locate three (3) wall anchors per jamb at hinge and strike levels. Frames may be grouted full of mortar at jambs and anchors shall be built into the joints as walls are laid up. A continuous bead of silicone sealant is to be applied between the head and jamb at the miter joint.

- END OF SECTION -

SECTION 09900

PAINTING & FINISHES

PART 1 GENERAL

1.01 DESCRIPTION

A. This section covers furnishing and applying paints and coatings to all specified surfaces of the new CHEMICAL FEED building facility.

1.02 RELATED WORK

A. Related work in other sections includes but is not limit to:

Section 03300 Cast-in-place concrete
Section 04220 Reinforced unit masonry
Section 06100 Rough Carpentry
Section 08300 Doors
Section 15061 Steel Pipe
Section 15100 Miscellaneous Appurtenances
Section 15200 Building Piping

1.03 REFERENCES AND STANDARDS

A. Work covered by this Specification shall meet or exceed the provisions of the latest editions of the following Codes and Standards in effect at the time of award of the Contract:

1. OSHA Occupation Safety and Health Act: State of Utah and Federal
2. AWWA C210-97 Standard for Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines

1.04 SUBMITTALS

A. CONTRACTOR shall supply shop drawings for approval on all paint materials prior to installation. Shall include the following data sheets:

1. For each paint system used herein, furnish a Paint System Data Sheet (PSDS), Technical Data Sheets, and paint colors available (where applicable) for each product used in the paint system, except for products applied by equipment manufacturers.

1.05 QUALITY ASSURANCE

B. All inspection for quality assurance shall ultimately be the responsibility of CONTRACTOR. OWNER retains the right to observe, accept, or reject the work based on the results of CONTRACTOR's inspection or inspection by the RPR, at OWNER's discretion, in

accordance with the specifications.

C. Repair and recoat all runs, overspray, roughness, or any other signs of improper application in accordance with paint manufacturer's instructions and as reviewed by ENGINEER.

D. Inspection by OWNER, or RPR, or the waiver of inspection of any particular portion of the work, shall not be construed to relieve CONTRACTOR of his responsibility to perform the work in accordance with these specifications.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Do not apply paint in extreme heat, temperatures below 40 degrees F, nor in dust, smoke-laden atmosphere, damp or humid weather.

B. Do not perform abrasive blast cleaning whenever relative humidity exceeds 85 percent, nor whenever surface temperature is less than 5 degrees F above dewpoint of ambient air. Strictly adhere to manufacturer's recommendations.

1.06 MEASUREMENT AND PAYMENT

A. There shall be no separate measurement and payment for this section. Full compensation for painting shall be considered as included in the contract unit or lump sum bid prices for the various items of the contract to which painting and finishing relate.

PART 2 PRODUCTS

2.01 PAINT, SEALERS AND SURFACE FINISH MATERIALS

A. All paints shall be Sherwin Williams® or approved equal, except for interior concrete floor surfaces and interior concrete surfaces of the foundation walls which shall be Tnemec Company Inc. If recommended by the paint manufacturer for a particular surface, primer shall be applied according to the paint manufacturer's recommendations. Paint shall be applied according to the following schedule, unless directed otherwise by ENGINEER. See Table below:

B. Exterior Above Grade Concrete: Products for the "Class A" finish are identified or specified in Section 03300 - Cast-In-Place Concrete.

C. Interior Above Grade Concrete: Products for the "Class B" finish are identified or specified in Section 03300 - Cast-In-Place Concrete.

D. External & internal masonry and above grade exterior concrete sealer: Sealer shall consist of a polymeric transparent water repellent coating system, or an integral water-repellent admixture system. Sealer shall be Hydropel 16 by L&M Construction Chemicals or Clear Double 7 by Hydrozo.

Application	Reference	# of Coats	Min. Dry Thickness per Coat	Color
Water Piping, Fittings, and Valves	B54Z Series	2	2.0 mil	SW4086
Gas Piping, Fittings, and Valves	B54Z Series	2	2.0 mil	SW4081
Electrical Conduit	A26 Series	2	1.5 mil	SW101
Interior Electrical Panels	A26 Series	2	1.5 mil	Gray
Masonry Walls (inside)- Laytex Block Filler. Catalyzed Acrylic Epoxy	Primer: PrepRite B25W25 Inter: Catalyzed Epoxy B 70 Finish: Catalyzed Epoxy B60V25		Primer: 6 - 8 Inter: 2.5 - 3 Finish: 2.5 - 3	White
Floors	Primer: Epoxoprime Tnemic Series 201 Inter: Tneme Glaze Tnemic Series 282 Finish: Tneme Glaze Tnemic Series 282		Primer: 6 - 8 Inter: 6 - 8 Finish: 6 - 8	Per Owner
Ceiling	A27W15	2	1.2 mil	SW101
Doors & Frames (both interior and exterior surfaces)	Primer: Macropoxy 646 Series, Final: Tile-Clad HS B62WZ Series	2	3.0	Per Owner

PART 3 EXECUTION

3.01 SURFACE PREPARATION

A. All surfaces which receive paints, or other coatings shall be prepared in accordance with the recommendations of the manufacturer of the material being used.

B. Concrete floors shall be cured a minimum of 28 days and thoroughly etched with muriatic acid as recommended by the paint manufacturer. After etching, the muriatic acid shall be thoroughly removed with clean water. The concrete shall be allowed to dry not less than 48 hours following cleaning before application of the coating.

C. Perform sandblasting for items and equipment where specified and as required to restore damaged surfaces previously shop or field blasted and primed. Materials, equipment, and procedures shall meet requirements of Steel Structures Painting Council.

3.02 PROTECTION OF MATERIALS NOT TO BE PAINTED

A. Remove, mask or otherwise protect hardware, lighting fixtures, switchplates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not intended to be painted.

B. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.

C. Protect working parts or mechanical and electrical equipment from damage.

D. Mask openings to motors to prevent paint and other materials from entering the motors.

3.03 APPLICATION

A. Exposed Metal Piping, Fittings and Valves shall be painted in accordance with the manufacturer's recommendations.

1. Minimum Dry Film Thickness: See Section 2.01.A
2. Each coat shall be free of runs, skips or "holidays". All excess paint and/or drips on floors, walls, and other surfaces which are not designated for paint shall be removed.

B. Exterior Above Grade Concrete: Concrete surfaces exposed to view outside the building and including 6 inches below finish grade on building or structure shall have a “Class A” finish as defined in Section 03300 - Cast-In-Place Concrete.

C. Interior Above Grade Concrete: Surface shall receive a “Class B” finish or better as specified in Section 03300 - Cast-In-Place Concrete.

D. Masonry sealer: Exterior & interior block shall be cleaned and sealed per manufacturer’s recommendation. Sealers shall not discolor the surfaces to which applied.

E. Floor painting shall extend to the top of the foundation wall (a minimum of 8" above finished floor along wall areas).

F. All work shall be done in accordance with the manufacturer's recommendations.

- END OF SECTION -

SECTION 11300

CHEMICAL PROCESS EQUIPMENT

PART 1 GENERAL

1.01 DESCRIPTION

A. This section covers the work necessary to install complete and ready-to-use variable flow rate fluoridation and chlorination chemical process injection systems. CONTRACTOR shall provide all components required for a complete and functional system.

1.02 RELATED WORK

A. Related work in other sections includes but is not limited to:

Section 11500 Process Equipment
Section 15065 Polyvinyl Chloride Pipe
Section 15100 Mechanical Appurtenances

1.03 REFERENCES AND STANDARDS

A. Work covered by this Specification shall meet or exceed the provisions of the latest editions of the following Codes and Standards in effect at the time of award of the Contract:

B. AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

1. B16.3 Malleable Iron Threaded Fittings, Classes 150 and 300

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. A 53 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
2. B 88 Seamless Copper Water Tube
3. B 703 Standard for Fluorosilicic Acid
4. D 1784 Rigid Polyvinyl Chloride (PVC) Compounds and Chlorinated Polyvinyl Chloride (CPVC) Compounds
5. D 1785 Polyvinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120
6. D 1998 Standard Specifications for Upright Storage Tanks
7. D 2466 Polyvinyl Chloride (PVC) Plastic Pipe and Fittings, Schedule 40
8. D 2564 Solvent Cements for Polyvinyl Chloride (PVC) Plastic Pipe and Fittings
9. F 411 Chlorinated Polyvinyl Chloride (CPVC) Plastic Pipe, Schedules 40 and 80

D. AMERICAN WATER WORKS ASSOCIATION (AWWA)

1. C 800 Standard for Underground Service Line Valves and Fittings

2. C 900 Standard for Polyvinyl Chloride (PVC) pressure Pipe and Fabricated Fittings, 4 In. (100mm) Through 12 In. (300 mm), for Waster Distribution.
3. C 901 Standard for Polyethylene (PE) Pressure Pipe and Tubing, ½ In. (13 mm) Through 3 In. (76 mm), for Water Service.
4. M4 Manual of Water Fluoridation Principles and Practices

E. CHLORINE INSTITUTE (CI)
1. The Chlorine Manual
2. CI Pamphlet 6 - Piping Systems for Dry Chlorine

F. INTERNATIONAL ASSOCIATION OF PLUMBING AND MECHANICAL OFFICIALS (IAPMO)

G. INTERNATIONAL MECHANICAL CODE (IMC)

H. INTERNATIONAL PLUMBING CODE (IPC)

1.04 SUBMITTALS

A. Contractor shall supply operation and maintenance manuals for all chlorination and fluoridation equipment.

1.05 WARRANTY

A. Manufacturer shall provide to ENGINEER written guarantee against defects in material or workmanship for a period of one (1) year.

1.06 DELIVERY AND STORAGE

A. All equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variation, dirt and dust, or other contaminants.

1.07 MEASUREMENT AND PAYMENT

A. There shall be no separate measurement and payment for the fluoridation and chlorination chemical systems. Full compensation for these systems shall be considered as included in the contract unit or lump sum bid prices for the various items of the contract to which it relates.

PART 2 PRODUCTS

2.01 CHEMICAL SYSTEMS

A. The fluoride system shall be complete with all piping and fittings as recommended by the manufacturer and as shown on the Drawings. All equipment shall be rated for the use with 23% Hydrofluorosilicic Acid.

B. The chlorination system shall be complete with all piping and fittings as recommended by the manufacturer and as shown on the Drawings. All equipment shall be rated for the use with 12% Sodium Hypochlorite.

2.02 STORAGE TANKS - BULK AND DAY

A. Capacity and containment shall be as noted in the following Table 1.

TABLE 1 - STORAGE TANK CAPACITY/CONTAINMENT

SITE	Bulk Storage (gallons)		Day Tank (gallons)	
	Primary	Secondary	Primary	Secondary
Fluoride (cross-linked polyethylene)				
Tanks	1500	1950	50	Pallet
Chlorination (cross-linked polyethylene) *				
Tanks	1000	1100	50	Pallet

* Tank shall either be cross-linked polyethylene or lined with an approved material.

B. Storage tank systems shall consist of a primary tank and a secondary containment tank. Manways and covers in the tank tops shall be made of crosslinked or linear polyethylene (see Table 1) and shall be fume tight. Tanks shall meet the requirements of ASTM D 1998, Type I and shall be molded from crosslinkable or linear polyethylene as listed in Table 1. Tanks may be either dome or flat top. Tank size shall be such that they fit via the doors.

C. Resin Type:

1. Resin used shall be 100% virgin, UV-stabilized, 35 mesh crosslinkable or linear high density polyethylene.

2. Tanks shall have weatherability equal to that of PAXON grade 7004 natural.

3. Resins shall meet or exceed the following properties listed in Table 2, below.

TABLE 2 - RESIN PROPERTIES

Classification	ASTM Test	Nominal Value
Density	D1505	0.944 g/cm^3
Tensile strength at yield	D638	3,000 psi
Elongation at Break	D638	400%

Classification	ASTM Test	Nominal Value
Tensile modulus of elasticity	D638	80,000 psi
Flexural modulus	D790	100,000 psi
Heat deflection temperature, 66 psi load	D648	138° F
Vicat softening temperature	D1525	248° F
Impact brittleness temperature	D746	<-180° F
Dart Impact (-40°F)	ARM Std.	120 ft. lb
Environmental stress crack Resistence	D1693	>1,000 hrs

D. Tank design standards shall meet the requirements of ASTM D 1998. Molded part lines shall be located above the lower 1/3 of the straight side wall of the tank. The inner tank wall shall yield gel test results of no less than 65%; entire wall thickness must be more than 80% gelled. Rotationally molded polyethylene tanks shall have an uninterrupted bottom knuckle radius for maximum strength per design requirements in ASTM 1998.

E. Fittings shall be provided as shown on referenced drawings. All fittings shall be located away from the bottom knuckle radius. Fittings and gaskets must be chemically compatible with the materials to be handled in the tanks. All fittings shall terminate in socket, threaded or flanged connections. Flanges shall match 150 lb ANSI, all threaded plumbing connections shall be standard American Pipe thread cut. Any fittings used on upper tank sidewall or top of tank may be PVC Bulkhead Fittings and they shall be fume-tight.

F. Tanks shall have a leak detection system between the primary and secondary tank containment. See Drawings for device specifications.

G. Seismic restraint shall be supplied and the design for same certified by a licensed Structural Engineer. Design shall conform to the latest edition of the International Building Code. Detailed instructions for installation shall be provided, along with all necessary hardware including anchor bolts. All components of the restraint system shall be protected against the chemical stored in the tank.

H. Tanks shall have a warranty for five (5) years to be free of defects in material and workmanship. The warranty shall fully cover the tank during the first 3 years of service and be prorated during the remaining two years of warranty period.

I. A ladder shall be provided to access the top of the tank for all tanks over 3,000 gallon capacity.

J. Manufactures shall be one who is regularly engaged in the business of designing and fabricating polyethylene storage tanks. Tanks shall be manufactured bySnyder Industries, LLC., Assmann, Poly Processing, or approved equal.

2.03 DOSING PUMPS

A. Chemical dosing pumps shall be Grundfos SMART Digital S dosing pumps designed for hydrofluosilicic acid (23%) or sodium hypochlorite (12%) as specified complete with pump head, tubing and fittings. Pumps shall be rated for a maximum feed rate as noted on the drawings or specified herein. Pumps shall be capable of manual adjustment and instrument responsive external control for an automatic system. Pumps shall be capable of injection to the existing system pressure or as noted on the Drawings.

B. Pumps shall be rated for 120 VAC. Duty cycle shall be continuos. Pumps shall have 4-20ma analog speed input when put in Analog mode.

C. Pumps shall be warranted for two years and shall be as-noted on the drawings.

D. Fluoride Pump shall be Grundfos DDA 17-7 with the AR control variant, PVDF pump head material, viton gaskets, ceramic check ball, and backpressure valve, No. DDA 17-7 AR-PV/V/C-F-3 1 U7U7 B G w/backpressure.

E. Chlorine Pump shall be Grundfors DDA 30-4 with the FC control variant, PVDF pump head material, viton gaskets, ceramic check ball, and backpressure valve, No. DDA 30-4 FC-PV/V/C-F-3 1 U7U7 B G w/backpressure

2.04 TRANSFER PUMPS - PNEUMATIC TYPE

A. Chemical transfer pumps type shall be suitable for hydrofluosilicic acid (23%) or sodium hypochlorite (12%) for the fluoride and chlorine systems, respectively. Pumps shall be capable of lifts up to 20 feet and flows of 20 gpm minimum. Tube piping length shall be extended to within 1 inch of the bottom of the Bulk Tank. Pumps shall have a fume-tight mounting seal and connector.

B. Pumps shall be activated by compressed air and shall have two diaphragms linked by a shaft. The pumping stroke on one side shall be simultaneously suction stroked on opposing diaphragm. Pumps shall have a self-lubricating, non-stalling air valve. Pumps shall have no close fitting or sliding parts in fluid section such that pumps can run dry indefinitely. Pumps shall be self-priming, and shall be capable of variable flow rates with an included flow adjustment valve. Pumps shall have PTFE-coated fasteners. Wetted internal components shall be PVDF and PTFE.

C. Pumps shall be Marathon II Air Operated Model MO7 3/4" with Kynar body and teflon check valve.

2.05 CIRCULATION PUMPS

A. Contractor shall furnish and install the Circulation pumps as shown on the plans. Pumps shall be equipped with a 480 VAC, three phase, 60 hertz motor. The pump shall be rated for potable water to 150 psi and have a design flow of 20 gallons per minute at 30 feet of head for the fluoride pump and 65 feet of head for the chlorine pump. Pumps shall be stainless steel Aurora, Xylem - Bell & Gossett Model Ecocirc XL or approved equal.

2.06 ELECTRONIC DRUM SCALE

A. Contractor shall furnish and install electronic drum scales of 0-600 lb capacity. Scale shall be of the digital readout/electronic load cell type. Platform height shall be no more than 2" to permit easy loading and unloading of drums. Platform shall be epoxy powder coated steel. The unit shall be designed and fully warranted for continuous operation, and shall use 115 VAC, 60 hertz.

B. Scales for fluoridation and chlorination day tanks shall include a single combined wall mounted backlit digital indicator at each site. Indicator shall output net weight via a 4-20 mA signal for remote monitoring. All indicator operations shall be menu prompted for ease of operation. Operator shall be able to monitor chemical by weight, volume or percent full. An “Auto Load” function shall automatically compensate for tank tare weight during tank change. A data log function shall store the “Daily Usage” for each of the previous 10 days. Full-scale accuracy shall be better than 1/4 of 1% and display to 0.1 lbs. The scales and indicator shall be Models No. 27-DR6DS for 50 gallon day tanks with the Wiizard 4000 as manufactured by Force Flow/Floquip, or approved equal.

2.07 CALIBRATION COLUMN

A. Calibration columns shall be 100ml capacity, with ½" NPT(F) threads bottom connection with dust cover top. They shall be made of PVC with Mylar polyester-film shroud. Columns shall be Accudraw PV#3-100, Cole-Parmer P-74600-01 or approved equal.

2.08 INJECTION QUILL ASSEMBLY

A. The Corp Stop shall be 1-inch with a PVC quill that extends into the pipe by one third the diameter.

B. Injection Quill Assembly shall be a SAF-T-FLO Chemical Injection Assembly or approved equal.

C. The anti-siphon valve shall be a LMI model #35641 with a 0-150 psi rating or approved equal.

D. District will supply for Contractor installation the 1" chlorine injection nozzle with valve.

2.09 EJECTOR TEE ASSEMBLY

A. The Ejectors Tee and Injection Check Valve shall be rated for 150 psi working pressure. The Check Valve assembly shall be manufactured from high impact plastic to fit the 1" injection pipeline. The unit shall be as manufactured by LMI or approved equal.

2.10 RETRACTABLE INJECTION QUILL ASSEMBLY

A. The Injector Quill for the 12" Steel Pipe shall have a 2" main connection, Corp Stop, by 1 ½" Solution Tube that extends into the pipe by one third the diameter. Injection Quill Assembly shall be a SAF-T-FLO Chemical Injection Assembly, Series. EB-150 or approved equal.

B. The back pressure valves to prevent siphoning shall be Griffco G-Series Back Pressure Valve, Hayward PBV Series, or approved equal with a 0-375 psi rating.

2.11 EMERGENCY EYE WASH AND SHOWER

A. Emergency eye wash and showers shall meet ANSI Standards. Showers shall be floor mounted combination eye/face wash station. Inlet piping shall be 1 1/4" and have a 150 psi rating. Showers shall have hand held spray units, provisions for a mechanical or pressure flow indicating switch, and 20 gallon per minute flow control. Showers shall be Speakman Company, SE-697 Emergency Station, with options HS, or approved equal.

B. Provide a minimum of four wall hooks for installation in the shower room area.

C. Supply and install optical safety switch as shown on drawings.

2.12 EMERGENCY SHOWER WATER SUPPLY TEMPERING TANK

A. Contractor shall furnish and install the water supply line as shown on the drawings including all tubing, valves, air release valve, couplings, and any other accessories necessary to have a complete and ready-to-use system.

B. The eye wash and shower shall have a minimum 80-gallon capacity tempering tank mounted as recommended by the manufacturer and shown on the drawings. The tank shall be glass-lined per ASME HLW procedures using NSF-approved glass lining compound. The tank shall have replaceable magnesium anodes, threaded openings on each end, and be rated for 150 psi minimum.

C. Tanks shall be A.O. Smith Water Products or approved equal.

2.13 RADAR LEVEL SENSOR

A. Radar level sensors shall be suitable for measurement of fluoridation or chlorination liquids. The gauge shall be operated on the Frequency Modulated Continuous Wave (FMCW) principle with an output signal directly proportional to process level, distance or volume.

B. The sensor assembly and signal converter shall be an integral, compact unit. Converter shall be capable of operation with wave stick antenna which shall be supported by a wall-mounting bracket above the tanks.

C. The unit shall be powered by the A 4-20mA current loop. The maximum loop resistance shall be 750 Ohms. The output shall provide a continuous analog output of signal directly proportional to volume. The gauge shall be capable of local and remote interrogation and/or configuration.

D. On-site start up assistance and operator training shall be required.

E. The radar level sensor shall be Endruss Hauser FMR50 - no approved equal.

2.14 PIPING AND TUBING

A. Piping and tubing shall be suitable to handle the materials carried as recommended by the manufacturer.

B. PVC piping and fittings shall be schedule 80 unless otherwise noted. Only Teflon tape shall be used for joint gaskets.

C. Dosing pump tubing shall be Teflon PFA with a minimum pressure rating of 230 psi. Fittings for tubing shall be Kynar.

D. Sampling line tubing shall be reinforced clear PVC with polyester reinforcement (Ryan Herco 0512-3/8, pressure rating at 225 psi)

E. Hose fittings shall be polyethylene with double hose clamps.

F. Hose shall be reinforced clear PVC.

2.15 SAFETY EQUIPMENT

A. Contractor shall furnish the Safety Equipment listed below in Table 3 -Safety Equipment for each site.

TABLE 3 - SAFETY EQUIPMENT (NIOSH approved where applicable)

Description	Quantity (per site)	Notes
Cartridge Respirator with Full-Face Shield	2 ea	Northern #152-4340
Chemical Cartridges	5 sets (10 total)	Northern #153-7253

TABLE 3 - SAFETY EQUIPMENT (NIOSH approved where applicable)		
Gauntlet neoprene gloves (12" glove minimum length)	6 pair	Northern #121-9934
Full-Face Shield (8" min.)	2 ea	Northern #107-1286 w/shield
Heavy Duty acid type neoprene aprons	2 ea	Northern #136-1372
12" latex Hazmat Boot Covers	4 pair (Owner to select sizes)	Northern #145-1473
Spill Containment Drum	2 ea	Northern #195-9877
Spill control pillows (foamed-sand type) or Maintenance Sorbents	Capacity: 50 Gal.	Northern #200-17817
Disposable Towels w/ Dispenser	1 dispenser w/ 6 Towels	Northern #109-6628
Hazardous Material Identification Signs w/ Identification Indicators	1 sign per door (10" x 10") and storage tank (4 ½" x 4 ½")	Northern #233-5321R Northern #233-5319P and Indicators

B. Spill containment pallets shall be sized to contain 110% of the volume of the day tank and shall be able to contain the chemical without damage to the pallet.

PART 3 EXECUTION

3.01 INSTALLATION

A. All equipment shall be installed as per manufacturers directions. Weight of valves, hoses and equipment must not be carried by the fittings themselves. Proper support for all equipment shall be provided.

B. Dosing pumps shall not be mounted higher than 4 feet above the highest liquid level of the day tank. Fluoridation injection points shall have anti-siphon valves and diffuser piping as required mounted on a 45 degree angle off of vertical from the floor.

C. Vents shall extend to the outside of structure roofs and be turned down and be equipped with a non-corrodible screen.

3.02 START-UP AND TESTING

A. Contractor and Equipment Supplier (ES) shall verify that structures, equipment, pumps and motors are compatible for an efficient system.

B. Contractor and ES shall make equipment adjustments required to place system in proper operating condition.

C. Contractor and ES shall test the fluoridation and chlorination feed systems for proper operation in the presence of the Owner and Engineer. The Contractor shall start up and test the system with water for a 24-hour period prior to testing with chemicals.

D. ES shall furnish all testing equipment and devices required.

E. If the fluoridation or chlorination feed system fails to meet any of the specified performance requirements, Contractor and/or ES shall modify and/or replace defective equipment until it meets specified requirements. Re-test system to verify satisfactory operation.

F. Demonstrate the accuracy of each dosing pump using job supplied calibration column.

G. Contractor shall, after installation of storage tanks is complete but before piping connections are made, block all outlets and fill each tank with water to again check for leaks. No leakage will be permitted.

H. The ES field services:

1. Retain, for a period of not less than one-half (1/2) day per site for installation of fluoridation and chlorination systems, factory-trained representatives. For installation, the representative shall perform the services listed below:

    a. Inspect the completed installation and prepare an inspection report.

    b. Test, calibrate and adjust all components for optimum performance.

    c. Assist in initial start-up and field testing.

    d. Instruct Owner's personnel in the operation and user maintenance of all components. Conduct a training seminar at the site.

    e. Supervise the correction of any defective or faulty work before and after acceptance by Owner.

I. Contractor shall be responsible to supply all chemicals required for testing.

J. All piping shall be tested hydrostatically for leaks. If any deficiencies are revealed during any tests, such deficiencies shall be corrected and the tests shall be reconducted.

- END OF SECTION -

SECTION 11540

PROCESS EQUIPMENT

PART 1 GENERAL

1.1 DESCRIPTION

A. This section covers the work necessary to install a ready to use and tested process and analysis system. The Contractor shall provide all components required for a complete and functional system.

1.2 SUBMITTALS

A. Submit catalog cuts on all process equipment including: switches, meters, sensors, or other items shown on the Drawings referencing each item by mark number. Information shall indicate manufacture specification compliance and dimensional data.

B. Contractor shall supply operation and maintenance manuals for all process equipment.

1.3 WARRANTY

A. Manufacturer shall provide to the Owner written guarantee against defects in material or workmanship for a period of one (1) year.

1.4 DELIVERY AND STORAGE

A. All equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variation, dirt and dust, or other contaminants.

1.5 MEASUREMENT AND PAYMENT

A. There shall be no separate measurement and payment for any systems. Full compensation for the system shall be considered as included in the contract unit or lump sum bid prices for the various items of the contract to which it relates.

PART 2 PRODUCTS

2.1 FLOW METER

A. Flow meters shall be a magnetic flow meter manufactured by Endruss+Hauser (Promag W400 - 12-inch meter shall be W400, 5W4C3H, DN300 12” (no equal), and shall be NSF-61 approved for potable water. Liners shall be as recommended by the manufacturer for potable water service. Flow meters flanges shall be ANSI Class 150. Meters shall operate on 120 VAC. Standard output shall be MODBUS RTU/RS485 and have remote mounted indicator/transmitter from a liquid crystal display (LCD) reading in million gallons per day. The meter shall have a NEMA 6P watertight rating. The meter shall also have a scalable totalizer (with pulsed output), and non-full pipe detection. CONTRACTOR shall verify length of cable for connection.

1. Meters shall include grounding rings.

2.2 CHLORINE ANALYZER

A. On-line Chlorine Monitors shall be provided to continuously measure free chlorine residual, where indicated on the drawings. Each Chlorine Monitor shall consist of a direct measuring chlorine sensor, a clear constant-head flowcell, 25 feet of sensor interconnect cable (field verify length of cable before purchase) with quick disconnect plug, and an electronic monitor housed in a NEMA 4X enclosure suitable for wall, pipe, or panel mounting.

B. The chlorine sensor shall be a direct measuring polarographic sensor utilizing a special polymeric membrane to isolate the sensing electrodes from the sample and eliminate the potential for electrode contamination. The membrane shall allow chlorine to diffuse into the sensor where it shall react with the sensing electrode, generating a signal that is linearly proportional to chlorine concentration. The sensor assembly shall also contain a precision RTD temperature sensor to continuously measure sample temperature to allow temperature compensation of the measured chlorine value. The chlorine sensor shall be constructed with a quick disconnect receptacle to allow easy sensor servicing or exchange. Chlorine sensors shall be supplied complete with at least 10 spare membranes, electrolyte, and a spare parts kit that includes all o-rings and special hardware.

C. The flowcell assembly supplied with the monitor shall be constructed of clear material allowing the condition of the sensor membrane to be inspected without removal of the sensor. The sensor shall slide easily into the side of the flowcell, with a double o-ring seal to prevent water leakage. Flow to the sensor shall be regulated automatically through a constant-head overflow arrangement. Hose barbs for sample inlet (1/4" I.D. tubing) and drain (1/2" I.D. tubing) shall be supplied as part of the flowcell.

D. The chlorine monitor shall be supplied with a pH sensor. The pH sensor shall allow free chlorine monitors to automatically correct the chlorine value for changes in sample pH to maintain measurement accuracy over wide pH swings from pH 7 to pH 9.5. The pH sensor shall fit into the inlet chamber of the chlorine sensor flowcell. The pH value shall be available for display on the second line of the monitor display, and one analog output shall be assignable as a pH output.

E. Monitors shall be powered by 90-260 VAC single-phase line power. Monitor shall provide two isolated 4-20 mA outputs as standard, with an option for a third 4-20 mA output. Outputs shall be configurable for chlorine, pH, temperature, or PID control. Analog outputs shall be both ground isolated and isolated from each other.

F. For alarm purposes, monitors shall contain three SPDT relays. Relay functions shall be programmable for control, alarm, or fail functions, and may be designed for either normal or failsafe operation. For monitors supplied with only 2 analog outputs, monitors shall have the option of an additional 3 low-power relays to allow for additional external alarm functions.

G. The complete Chlorine Monitor shall be Series Q46H/62-63 as manufactured by Analytical (no equal). Unit shall include back mounting panel.

2.3 FUTURE FLUORIDE ANALYZER (BY OTHERS)

A. The future fluoride analyzer shall be supplied and installed by others. Contractor shall provide a removable end cap to the system piping.

2.4 TOXIC GAS SENSOR/TRANSMITTER

A. Gas Transmitter for the detection of fluoride shall be provided to monitor the ambient gas concentrations in the chemical building. Gas transmitter shall consist of a NEMA 4X transmitter with a remotely mounted gas sensor. The gas sensor/transmitter shall be ATI series F12 (no equal) with integral power supply and relays). In addition, the transmitter shall be supplied with standard RS-485 MODBUS communication capability or a digital output using HART protocol.

B. Series F12 transmitter shall utilize plug-in “smart sensor” modules that allow sensors to be swapped quickly without interruption of instrument function. Sensors plugged into the transmitter shall automatically upload zero offset and calibration information so that no transmitter adjustment is needed when sensors are exchanged. Transmitters shall provide a large graphic display indicating both gas concentration and the status of any alarm settings. In addition, the transmitter shall be capable of storing 1 minute average gas concentrations, with stored data displayed in either graphical or tabular format.

C. Four sealed buttons on the front of the transmitter shall allow the operator to access all program functions. Controls shall allow analog output simulation for convenience in testing remotely connected devices. Switches may also be used for manually resetting alarm relays (if installed) and for activating sensor Auto-Test generator if used.

1. Gas transmitter shall be provided with an integral AC power supply suitable for operation from 85-265 VAC or VDC, 50/60 Hz. The power supply assembly shall also provide three SPST relays for external alarm functions. Each relay shall be assignable as to function using front panel program keys.
2. Gas transmitter shall be supplied with a sensor “Auto-Test” gas generator to provide automatic sensor response verification. The generator shall automatically generate a small amount of gas on command from the transmitter, and a fault alarm shall be generated if the sensor does not respond to the gas test. The system shall provide this automatic response test every 24 hours or as programmed by the user. The results of all sensor tests shall be maintained in on-board memory for review by the user.

2.5 TEMPERATURE SENSOR

A. Temperature sensors shall be DEVAR Inc. Model d-RTTI, Digital Room Temperature Transmitter with Indication.

1. Mount sensors in each room (on wall 60” above finished floor) and route the 4-20 signal back to the RTU cabinet.

PART 3 EXECUTION

3.1 INSTALLATION

A. All equipment shall be mounted and installed as per manufacturer recommendations. Coordinate final location with OWNER and ENGINEER.

3.2 TESTING

A. After installation of the equipment is complete, operating tests shall be carried out to assure that the equipment operates properly. All piping shall be tested hydrostatically and for leaks. If any deficiencies are revealed during any tests, such deficiencies shall be corrected and the tests shall be conducted again.

- END OF SECTION -

SECTION 15016

ACRYLONITRILE-BUTADIENE-STYRENE (ABS) PIPE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. ABS Pipe, fittings and joint materials

1.02 RELATED WORK

A. Related work specified in other sections includes but is not limited to:

Section 01500 - Temporary Construction and Environmental Controls
Section 02221 - Excavation and Backfill for Buried Pipelines
Section 02222 - Excavation and Backfill for Structures

1.03 MEASUREMENT AND PAYMENT

A. ABS Pipe shall not be measured or paid as a separate item, but shall be included as part of the various items to which it relates.

1.04 REFERENCES

A. The latest edition of the following publications form a part of this specification to the extent referenced. The publication is referred to in the text by basic designation only.

B. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. C443 Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
2. D1527 Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe, Schedules 40 and 80.
3. D1788 Standard Specification for Rigid Acrylonitrile-Butadiene-Styrene (ABS) Plastics.
4. D2235 Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
5. D2321 Standard Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe.
6. D2412 Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
7. D2468 Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe Fittings, Schedule 40.
8. D2469 Standard Specification for Acrylonitrile-Butadiene- Styrene (ABS) Plastic Pipe Fittings, Schedule 80.
9. D2680 Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping.

10. D2751 Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
11. D2774 Standard Recommended Practice for Underground Installation of Thermoplastic Pressure Piping.

PART 2 PRODUCTS

2.01 GRAVITY PIPE SYSTEMS

A. Pipe Fittings: ASTM D2751 for 2 inches to 12 inches ABS pipe and ASTM D2680 for 8 inches to 15 inches ABS composite sewer pipe. Fittings per ASTM D 2751.

B. Material: Rigid ABS plastic conforming to ASTM D1788 and based on short term tests

1. Type I, Grade 1; cell (322).
2. Type IV, Grade 1; cell (133).

C. Joints: Bell and spigot with solvent cement which complies with ASTM D2235 or mechanical-seal joint with gasket complying to ASTM C443.

D. Flattening: No evidence of splitting, cracking, or breaking per ASTM D2412.

2.02 PRESSURE PIPE SYSTEMS

A. For Specified Pressure Pipe: ASTM D1527 for 1/8 inch to 12 inch pipe for schedule 40 or 80 sizes and pressure rating as indicated.

B. Material: Rigid ABS pipe materials in Schedule 40 and 80 sizes per ASTM D1788 and based on short-term tests.

1. Type I, Grade 2; cell (522).
2. Type I, Grade 3; cell (355)
3. Type II, Grade 1; cell (445).

C. Joints:

1. Socket type with Iron Pipe Size (IPS) outside diameter per ASTM D2468 for Schedule 40 pipe and ASTM D2469 for Schedule 80 pipe.

2. Bell and spigot with solvent cement per ASTM D2235 or mechanical-seal joint with gasket per ASTM C443.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install pipe per manufacturer's instructions, ASTM D2321 for gravity pipe systems, ASTM D2774 for pressure pipe systems.

- END OF SECTION -

SECTION 15061

STEEL PIPE

PART 1 GENERAL

1.01 DESCRIPTION

A. This section covers furnishing and installation of the epoxy coated and lined steel pipeline as shown on the drawings and specified herein.

1.02 RELATED WORK

A. Related work specified in other sections includes:

Section 01500 - Temporary Construction Utilities and Environmental Controls
Section 02221 - Excavation and Backfill for Buried Pipelines
Section 02222 - Excavation and Backfill for Structures
Section 09900 - Painting and Finishes
Section 15063 - Pipeline Disinfection
Section 15100 - Mechanical Appurtenances

1.03 REFERENCES

A. The latest edition of the following publications form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

1. American Society for Testing Materials (ASTM)

    a. ASTM A 283: Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
    b. ASTM A370: Standard Test Methods and Definitions for Mechanical Testing of Steel Products.
    c. ASTM A 569: Standard Specification for Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip, Commercial Quality.
    d. ASTM A 570: Standard Specification for Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality.

2. American Water Works Association (AWWA)

    a. AWWA C200: Standard for Steel Water Pipe 6 in. and Larger.
    b. AWWA C206: Standard for Field Welding of Steel Water Pipe.
    c. AWWA C207: Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 in. Through 144 in.
    d. AWWA C208: Standard for Dimensions for Fabricated Steel Water Pipe Fittings.
    e. AWWA C210: Standard for Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines

f. AWWA M-11: Steel Pipe - A Guide for Design and Installation.

1.04 SUBMITTALS

A. Shop drawings of special fittings and outlets.

B. Certified copies of test reports demonstrating conformance to applicable pipe specifications, before pipe is installed.

1.05 QUALITY ASSURANCE

A. Perform quality assurance tests required by AWWA C200.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Attach end covers to pipe stored either in the yard or in the field. Protect pipe from scrapes or damage.

1.07 MEASUREMENT AND PAYMENT

A. There shall be no separate measurement and payment for steel pipe, but it shall be included as part of the meter station lump sum price.

PART 2 PRODUCTS

2.01 PIPE

A. Steel pipe shall conform to AWWA C200 conforming to requirements of: ASTM A53 - Grade B Standard Schedule.

B. Pipe shall be designed for a test pressure of 250 psi. Pipe shall be designed to cover laying and backfill conditions as shown on the drawings. Pipe design shall be in accordance with AWWA M11.

C. Unless otherwise shown on the drawings, the specials and fittings shall conform to the dimensions of AWWA Standard C208. Fittings shall be of the same material and minimum thickness as the pipe. The minimum radius of elbows shall be 2.5 times the pipe diameter, and the maximum miter angle on each section of the elbow shall not exceed 11-1/4 degrees. Fittings shall be equal in pressure design strength and shall have the same lining and coating as the abutting pipe. Specials and fittings, unless otherwise shown on the drawings, shall be made of segmentally welded sections from hydrostatically tested pipe, with ends compatible with the type of joint or coupling specified for the pipe.

2.02 JOINTS

A. The standard joint shall be flanged and shall conform to AWWA C207 Standard, or shall be grooved end (victaulic) as shown on the drawings .

2.03 GASKETS AND BOLTS

A. Except as otherwise provided, gaskets for flanged joints shall be 1/8-inch thick rubber fabric. Gaskets shall be Garlock Sealing Technologies Blue-Gard Compressed Gasket Style 3000, no approved equal. Wherever blind flanges are shown, the gaskets shall consist of 1/8-inch thick cloth-inserted rubber sheet which shall cover the entire inside surface of the blind flange and shall be cemented to the surface of the blind flange.

B. All buried fittings using steel bolts shall be coated with no-oxide wax and wrapped with polyethylene or as otherwise approved by the ENGINEER.

2.04 BOLTS AND NUTS

A. Bolts and nuts shall be rated for the system working pressure with a minimum safety factor of three. Bolts and nuts buried, submerged, and inside vaults shall be zinc coated steel. Bolts and nuts above grade, exposed or inside structures, shall be Type 304 stainless steel. Bolts and nuts in exposed to wastewater or in corrosive environments shall be Type 304 stainless steel.

B. All flange bolt lengths shall be selected by CONTRACTOR such that three full threads, as a minimum, protrude from the hex nut and washer after assembly.

C. Flange bolts shall have ASME B1.1, Class 2A threads, and be manufactured of ASTM A 193, Grade B7 steel. Bolts shall conform to ASME B18.2.1.

D. Flange nuts shall have Class 2A fit, and be manufactured of ASTM A 194, Grade 2H steel, having square or hex heavy dimensions in accordance with ASME B18.2.2.

E. Connection T-bolts for mechanical joint (MJ) fittings shall be Cor-Ten high strength, low alloy steel conforming to AWWA C111.

2.05 COATING AND INTERIOR LININGS

A. Pipe shall be coated and lined with epoxy paint meeting AWWA C210 Standards.

2.06 BENDS AND SPECIFIC FITTINGS

A. Fabricate short radius bends or special fittings such as wyes, tees and crosses from previously tested steel cylinders in accordance with AWWA C208. Fabricate bends or special fittings at least equal in strength to the abutting pipe sections. Obtain approval of design prior to fabrication.

2.07 OUTLETS

A. Build outlets into the wall of the pipe, prior to testing, for blow-offs, branches, air valves, access manholes, etc. Provide cast or fabricated steel fittings of suitable design and securely weld to the cylinder before being coated. Reinforce the pipe cylinder, as necessary, for the required opening. Obtain approval of the design of such outlets prior to fabrication.

2.08 PIPE SUPPORTS

A. Pipe supports shall be manufactured by Grinnell, and shall be Grinnell Adjustable Pipe Support Model No. 264 (no equal). Saddle shall be sized for the pipe or mechanical appurtenance it supports. All pipe supports shall have a 1-inch high grouted pad to be used as a leveling base.

2.09 STEEL COUPLINGS

A. Steel couplings shall be Smith-Blair 411 or 413 (as required) steel coupling epoxy coated sleeve, or approved equal.

2.10 FLANGE COUPLING ADAPTER (DISMANTLING JOINT)

A. Provide flanged coupling adapters (dismantling joint) where shown on the Drawings. CONTRACTOR will not be allowed to substitute any other type of flanged coupling adapter unless approved by ENGINEER. The coupling shall be rated as indicated on the Drawings.

B. Flanged coupling adapter bodies shall be fabricated from steel, ASTM A512 or A 513 or Ductile Iron ASTM A536, without pipe stop. The body shall not be less than 1/4-inch thick or at least the same wall thickness as the pipe to which the coupling is connected. If the strength of the body material is less than the strength of the pipe material, the thickness of the middle ring shall be increased to have the same strength as the pipe. The follower ring shall be fabricated from steel, ASTM A576 or A36.

C. For flanged coupling adapters installed in piping systems rated for positive pressure, the coupling shall be restrained with harness bolts or tie rods. Other means of restraining the coupling such as set screws will not be accepted. Harnesses shall be designed in accordance with AWWA Manual 11, or as indicated. Harness sets shall be designed for the maximum test pressure of the pipe in which they are installed.

D. Gaskets shall be composed of a rubber-compound material that will not deteriorate from age or exposure to air under normal storage or use conditions.

E. Flanged coupling adapters (dismantling joints) shall be Model 975 by Smith-Blair, Model 309 by JCM, Model DJ400 by Romac, or approved equal.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install pipe in accordance with the manufacturer's recommendations and Section 02221.

3.02 PRELIMINARY CLEANING AND FLUSHING

A. CONTRACTOR shall flush the pipeline as the work progresses by a means in accordance with good practice to insure that sand, rocks, or other foreign material are not left in any of the pipeline. If possible the flushing shall be made with an open pipe end.

3.03 PRESSURE AND LEAK TEST

A. The Contractor shall test all piping either in sections or as a unit. The test shall be made by placing temporary bulkheads as needed in the pipe and filling the line slowly with water. Care shall be taken to see that all air vents are open during the filling. After the piping or section thereof has been filled, it shall be allowed to stand under a slight pressure for a sufficient length of time to allow the concrete to absorb what water it will and to allow the escape of air from any pockets. During this period, bulkheads, valves, and connections shall be examined for leaks. If any leaks are found, corrective measures satisfactory to the Engineer shall be taken. The test shall consist of holding a minimum pressure of 200 psi on the section being tested for a minimum period of two hours using either pneumatic or hydraulic means to maintain the pressure. Suitable means shall be provided by the Contractor for determining the quantity of water lost by leakage under the test pressure. The maximum allowable leakage shall be defined as follows:

$$L = SD\sqrt{P}/133{,}200$$

L = Leakage allowable in gallons per hour of test
S = Length of pipe in feet
D = Diameter of pipe in inches
P = Test Pressure in pounds per square inch

B. CONTRACTOR shall assume all responsibility to obtain the necessary water supplies for pressure testing of the pipeline.

C. In the case of pipelines that fail to pass the leakage test, CONTRACTOR shall determine the cause of the excessive leakage, shall take corrective measures necessary to repair the leaks, and shall again test the pipelines, all at no additional cost to OWNER. The ENGINEER shall be notified at least 48 hours before the pipeline is to be tested so that he may be present during the test.

3.04 DISINFECTION

A. Disinfection shall be in accordance with Section 15063.

- END OF SECTION -

SECTION 15062

STAINLESS STEEL PROCESS PIPING

PART 1 GENERAL

1.1 DESCRIPTION

A. CONTRACTOR shall furnish and install all stainless steel process piping and appurtenances as shown and specified, and as required for a complete and workable piping system.

1.2 RELATED WORK

A. Related work specified in other sections:

1. Section 01300 Contract Submittals
2. Section 15063 Pipeline Testing and Disinfection
3. Section 15100 Mechanical Appurtenances
4. Section 15200 Building Piping

1.3 REFERENCES

A. Work covered by this Specification shall meet or exceed the provisions of the latest editions of the following Codes and Standards in effect at the time of award of the Contract. The publication is referred to in the text by basic designation only.

B. AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

1. ASME B 16.5 Pipe Flanges and Flanged Fittings
2. ASME B 16.9 Factory-Made Wrought Butt Welded Fittings
3. ASME B 16.11 Forged Fittings, Socket-Welding and Threaded
4. ASME B 31.1 Power Piping

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM A 312 Standard Specification for Seamless, Welded, and Heavy Cold Worked Austenitic Stainless Steel Pipes
2. ASTM A 403 Standard Specification for Wrought Austenitic Stainless Steel Piping and Fittings
3. ASTM A 409 Standard Specification for Welded Large Diameter Austenitic Steel Pipe for Corrosive or High-Temperature Service
4. ASTM A 778 Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products

D. AMERICA WELDING SOCIETY (AWS)

1. AWS D1.1 Structural Welding Code

E. AMERICAN WATER WORKS ASSOCIATION (AWWA)

1. AWWA C 606 Grooved and Shouldered Joints
2. AWWA C 651 Standard for Disinfecting Water Mains

1.4 SUBMITTALS

A. Provide submittals in accordance with Section 01300 – Contractor Submittals.

B. Submit manufacturer's affidavit certifying product was manufactured, tested and supplied in accordance with applicable references in this section together with a report of the test results and the date each test was completed.

C. Submit shop drawings of pipe, fittings, supports and appurtenances showing compliance with this Section including necessary dimensions, details, pipe joints and material lists.

D. Submit gasket material data including manufacturer's catalog indicating that the proposed product is suitable for each fluid of service application.

E. Submit welders' qualifications in accordance with AWS D1.1.

PART 2 PRODUCTS

2.1 STAINLESS STEEL PIPE

A. Stainless steel process pipe shall be in accordance with ASTM A 312, Type 316, seamless, Schedule 40S, with screwed fittings for sizes up to and including 3-inches and welded fittings for sizes 3-inches and larger. Flange fittings may be used for pipe diameters 2-inches and larger. Stainless steel process piping 12-inches and larger shall be in accordance with ASTM A 409 or ASTM A 778, Type 316, Schedule 40S, with welded or flanged joints.

2.2 PIPE JOINTS

A. Stainless steel pipe 3-inches and smaller shall have screwed ends with NPT threads. Screwed joints shall be up with Teflon tape. Stainless steel pipe 4-inches and larger shall have welded joints or flanges. Flanges shall have stainless steel nuts and bolts the same material type as the pipe. Where indicated on the Drawings, provide grooved ends for rigid or flexible mechanical couplings. Pipe grooving is only allowed for Schedule 40S or 80S pipe. For plain end stainless steel pipe use sleeve-type couplings where noted on the Drawings.

B. Flanged joints shall be in accordance with ASME B16.5 for the pressure class required for the project conditions or as indicated on the Drawings. CONTRACTOR is responsible for providing the appropriate flanges required to connect stainless steel process pipe to equipment and other appurtenances. CONTRACTOR shall replace flanges that do not match the mating equipment or appurtenance at no additional cost to the OWNER. Gaskets shall be ANSI 150 lb. full face, 1/8-inch thick Neoprene for water or wastewater service. Gasket material for chemicals shall be suitable for the chemical service.

2.3 FITTINGS

A. Threaded fittings shall be forged stainless steel fittings in accordance with ASME B 16.11.

B. Socket welded fittings shall be forged stainless steel fittings in accordance with ASME B 16.11.

C. Butt-welded fittings shall be wrought stainless steel fittings in accordance with ASTM A 403 and ASME B 16.9.

D. Flanged fittings shall be in accordance with ASME B 16.5.

E. Grooved fittings shall be wrought stainless steel conforming to ASTM A 403 and ASME B 16.9 and to AWWA C 606. Gasket material shall be suitable for the intended service.

F. Fittings shall be in accordance with the pressure class shown on the Drawings or have the same pressure rating as the pipe.

PART 3 EXECUTION

3.1 INSTALLATION

A. Stainless steel process piping shall be installed in a neat and workmanlike manner, properly aligned, and cut from measurements taken at the Site to avoid interferences with structural members, architectural features, openings, and equipment. Exposed pipe shall afford maximum headroom and access to equipment, and where necessary, piping shall be installed with sufficient slopes for venting or drainage of liquids and condensate to low points.

B. Piping shall be firmly supported with fabricated or commercial hangers or supports in accordance with Section 15200 – Building Piping. Where necessary to avoid stress on equipment or structural members, the pipe shall be anchored or harnessed. Expansion joints and guides shall compensate for pipe expansion due to temperature changes.

C. Unless otherwise indicated, connections to fixtures, groups of fixtures, and equipment shall be provided with a shutoff valve and union, unless the valve has flanged ends. Unions shall be provided at threaded valves, equipment, and other devices requiring occasional removal or disconnection. Low points shall be provided with a drain valve.

3.2 PIPE PREPARATION

A. Prior to installation, each pipe length shall be carefully inspected, flushed clean of any debris or dust, and be straightened, if not true. Ends of threaded pipes shall be reamed and filed smooth. Pipe fittings shall be equally cleaned before assembly

3.3 PIPE JOINTS

A. Pipe threads shall be full and cleanly cut with sharp dies or molded. Joints shall be made with Teflon tape.

B. Welded joints shall conform to the requirements of this Section and the recommendations of ASME B 31.1. Welding shall be done by skilled and qualified welders. Welders shall be qualified under the provisions of AWS D1.1. Machines and electrodes similar to those used in the work shall be used in qualification tests. Field welds shall be kept to a minimum by using couplings or shop fabrication as much as possible. Weld residue, oxide, and heat stain shall be removed shall be removed by stainless steel wire brushes followed by cleaning with an agent, followed by complete

removal of the agent. Cleaning agent shall be **BlueOne Pickling Paste 130 by Avesta Finishing Chemicals, STAR Gel by Krystal Surface Solution**, or approved equal. Passivation must following the cleaning process using **FinishOne Passivator 630 by Avesta Finishing Chemicals, STAR Pass 1 by Krystal Surface Solution**, or approved equal. Following the manufacturer's instruction for the cleaning/pickling and passivation process.

C. Grooved couplings shall be installed per the manufacturer's recommendations and shall conform to AWWA C 606.

3.4 INSPECTION AND TESTING OF PIPELINE

A. Completed stainless steel process piping systems shall be inspected for proper supports, anchorage, and damage to pipe, fittings, and coatings. Any damage shall be repaired by CONTRACTOR at no additional cost to OWNER.

B. CONTRACTOR shall provide temporary blow-off valves and fittings as required to flush and disinfect new pipelines. Temporary blow-off valves and fittings shall be removed prior to placing pipeline into service.

C. Source of Water

1. CONTRACTOR shall assume all responsibility to obtain the necessary water supplies for disinfection and/or pressure testing of the pipeline.

D. Testing Procedure

1. Prior to enclosure or burying, piping systems shall be pressure tested as required on the Drawings, for a period of not less than one hour, without exceeding the tolerances listed on the Drawings. Where no pressures are indicated, the pipes shall be subject to 1-1/2 times the maximum working pressure. CONTRACTOR shall furnish test equipment, labor, materials, and devices

2. Leakage shall be determined by loss of pressure, soap solution, or other positive and accurate method. Fixtures, devices, or other accessories that would be damaged if subjected to the test pressure shall be disconnected and ends of the branch lines shall be plugged or capped as appropriate during the testing procedures.

3. Leaks shall be repaired, and the piping shall be re-tested until no leaks are found.

4. ENGINEER shall be notified at least 48 hours before the pipeline is to be tested so that ENGINEER may be present during the test.

3.5 DISINFECTING

A. Disinfection shall be in accordance AWWA C651 and the requirements of Section 15063 - Pipeline Testing and Disinfection.

- END OF SECTION –

SECTION 15063

PIPELINE TESTING AND DISINFECTION

PART 1 GENERAL

1.1 DESCRIPTION

A. This section covers testing and disinfection in order to remove bacteriological contamination of the pipeline. Disinfection is only required if the pipeline is used for potable water.

B. CONTRACTOR shall be responsible for obtaining permits for discharging excess testing water and dechlorination of such water, if required.

1.2 RELATED SECTIONS

A. Including but not limited to the following:

1. Section 01300 Contractor Submittals
2. Section 15061 Steel Pipe
3. Section 15062 Stainless Steel Process Piping
4. Section 15064 High Density Polyethylene Pipe
5. Section 15065 Polyvinylchloride Pipe
6. Section 15100 Mechanical Appurtenances

1.3 REFERENCES

A. The latest edition of the following publications form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

1. AWWA C-651 - Disinfecting Water Mains
2. Utah Public Drinking Water Regulations

1.4 SUBMITTALS

A. Provide submittals in accordance with Section 01300 – Contractor Submittals.

B. Furnish a written testing plan and schedule, including water source and methods for conveyance to the project, sequence, control, and disposal. Include the name of the certified bacteriological testing laboratory.

C. Disinfection Report:

1. Type and form of disinfectant used.
2. Date and time of disinfectant injection start and time of completion.
3. Test locations.
4. Name of person collecting samples.
5. Initial and 24-hour disinfectant residuals in treated water in parts per million (ppm) for each outlet tested.
6. Date and time of flushing start and completion.
7. Disinfectant residual after flushing in ppm for each outlet tested.

PART 2 MATERIALS

2.1 DESCRIPTION

A. All test equipment, temporary valves, bulkheads, and other water control equipment, shall be as determined by CONTRACTOR. No materials shall be used which damage the project pipelines for future conveyance of potable water.

B. Disinfecting materials shall consist of liquid chlorine, sodium hypochlorite solution, or calcium hypochlorite granules or tablets.

C. Dechlorination agents may be sodium bisulfate, sodium sulfite, or sodium thiosulfate.

PART 3 EXECUTION

3.1 GENERAL

A. Source of Water

1. CONTRACTOR shall assume all responsibility to obtain the necessary water for testing and disinfection of the water line system. All testing water used in the pipeline shall be potable water from a State approved drinking water system.
2. All pressure pipelines shall be tested.
3. Disposal of flushing water and water containing chlorine shall be by methods acceptable to the State of Utah, Division of Water Quality.

3.2 HYDROSTATIC TESTING OF PIPELINES PROCEDURE

A. Prior to hydrostatic testing, pipelines 24-inches diameter and larger shall be swept free of debris and visually inspected that all debris has been removed prior to filling.

B. Prior to hydrostatic testing, pipelines shall be flushed or blown out as appropriate. CONTRACTOR may test pipelines in sections. Sections to be tested shall be defined by isolation valves in the pipeline. Where such valves are not present, CONTRACTOR shall install temporary bulkheads or plugs for the purpose of testing. Sections that do not have isolation valves shall be tested in approximate one-mile segments. Sections that have a zero leakage allowance may be tested as a unit. No section of the pipeline shall be tested until field-placed concrete or mortar has attained an age of 14 Days. The test shall be made by closing valves when available or by placing bulkheads and filling the line slowly with water (maximum filling velocity shall not exceed 0.25 foot per second, calculation based on the full area of the pipe). CONTRACTOR shall be responsible for ascertaining that test bulkheads are suitably restrained to resist the thrust of the test pressure without damage to or movement of the adjacent pipe. Unharnessed sleeve-type couplings, expansion joints, or other sliding joints shall be restrained or suitably anchored prior to the test to avoid movement and damage to piping and equipment. Remove or protect any pipeline-mounted devices that may be damaged by the test pressure. CONTRACTOR shall provide sufficient temporary tappings in the pipelines to allow for trapped air to exit or for water to be drained. After completion of the tests, such taps shall be permanently plugged. Care shall be taken that air relief valves are open during filling.

C. The pipeline shall be filled at a rate which will not cause any surges or exceed the rate at which the air can be released through the release valves at a reasonable velocity. The air within the pipeline shall be allowed to escape completely. The differential pressure across the orifices in the air release valves shall not be allowed to exceed 5 psi at any time during filling. After the pipeline or section thereof has been filled, it shall be allowed to stand under a slight pressure for at least 24 hours to allow the concrete or mortar lining, as applicable, to absorb water and to allow the escape of air from air pockets. During this period, bulkheads, valves, and connections shall be examined for leaks. If leaks are found, corrective measures satisfactory to CONSTRUCTION MANAGER shall be taken. Additional water shall be added to the pipeline to replace any water absorbed by the cement mortar lining.

D. The hydrostatic test shall consist of holding 150% of the design operating pressure (150 psi) on the pipeline segment for a period of 2 hours. Visible leaks that appear during testing shall be repaired. Add water to restore the test pressure if the pressure decreases 5 psi below test pressure during the test period.

E. Pipe with welded joints shall have no leakage. In the case of pipelines that fail to pass the leakage test, CONTRACTOR shall determine the cause of the leakage, shall take corrective measures necessary to repair the leaks, and shall again test the pipeline, repeating as necessary until the pipeline passes.

F. Exposed piping and valves shall show no visible leaks and no pressure loss during the test.

G. Blowoff isolation gate valves and plug valves (throttling valves) shall be operated and tested during a simulated blow down operation to demonstrate functionality of the valves to the satisfaction of CONSTRUCTION MANAGER. Isolation valves (gate valves) shall not be used for throttling.

3.3 DISINFECTING OF PIPELINES PROCEDURE

A. Leakage and pressure testing must be completed prior to disinfection procedures.

B. All water and solution piping installed under this Contract shall be disinfected using an approved disinfection method in accordance with the "American Water Works Association Standard for Disinfecting Water Mains" (AWWA C651).

C. The CONTRACTOR may use one of the three chlorination methods – tablet, continuous feed, and slug, as outlined in AWWA C651 that is acceptable to the OWNER. Care must be taken to prevent the strong chlorine solution in the line being disinfected from flowing back into the line supplying the water.

D. The CONTRACTOR shall provide sampling ports along the pipeline as defined in AWWA C651. Taps may be at manways and air valves to help facilitate the spacing requirement.

E. Heavily chlorinated water shall not be discharged onto the ground. Upon completion of disinfection, Sodium Bisulfate (NaHSO4), or other approved dechlorination agent, shall be applied to the heavily chlorinated water to neutralize thoroughly the chlorine residual remaining. Water shall be neutralized to less than 1 ppm free chlorine residual.

F. After approval of disinfection, CONTRACTOR shall flush the new system until the chlorine residual is a maximum of 0.3 ppm.

G. After final flushing and before the new water main is connected to the distribution system, two consecutive sets of acceptable samples, taken at least 24 hours apart, shall be collected from the pipeline being tested. Sampling and testing will be completed by CONTRACTOR. Contractor shall collect at least one set of samples from every 1,200 feet of pipeline, plus one set from the end of the line and at least one set from each branch. All samples shall be tested for bacteriological (chemical and physical) quality in accordance with "Standard Methods for Examination of Water and Wastewater" and shall show the absence of coliform organisms. If the initial disinfection fails to provide satisfactory bacteriological results, or shows the presence of coliform, then the line shall be re-chlorinated, flushed, and retested until satisfactory results are obtained at the expense of the CONTRACTOR.

3.4 CONNECTIONS TO EXISTING SYSTEM

A. Where connections are to be made to an existing potable water system, the interior surfaces of all pipe and fittings used in making the connections shall be swabbed or sprayed with a one percent hypochlorite solution before installation. Thorough flushing shall be started as soon as the connection is completed and shall be continued until discolored water is eliminated.

B. Final Fill: After a successful pressure and disinfection tests, the pipeline(s) shall be filled with fresh potable water and shall remain filled.

- END OF SECTION –

SECTION 15064

HIGH DENSITY POLYETHYLENE (HDPE) PIPE

PART 1 GENERAL

1.01 DESCRIPTION

A. This section covers furnishing and installation of high density polyethylene (HDPE) pipe for the pressurized piping system as shown on the drawings and specified herein.

1.02 RELATED WORK

A. Related work specified in other sections:

Section 01500 - Temporary Construction Utilities and Environmental Controls
Section 02221 - Excavation and Backfill for Buried Pipelines
Section 02222 - Excavation and Backfill for Structures
Section 15063 - Pipeline Testing and Disinfection

1.03 REFERENCES

A. The latest edition of the following publications form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING MATERIALS (ASTM)

ASTM D 1248	Standard Specifications for Polyethylene Plastics, Molding & Extrusion Materials.
ASTM D 2321	Underground Installation of Flexible Thermoplastic Sewer Pipe.
ASTM D 2837	Standard Method for Obtaining Design Basis for Thermoplastic Pipe Materials.
ASTM D 3261	Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D 3350	Standard Specification for Polyethylene Plastic Pipe and Fittings Materials.

AMERICAN WATER WORKS ASSOCIATION

AWWA C 901	Polyethylene (PE) Pressure Pipe and Tubing, 1/2"-inch through 3-inch, for Water Service.
AWWA C 906	Polyethylene (PE) Pressure Pipe and Fittings, 4 In. through 63 In., for Water Distribution

PHILLIPS PETROLEUM DRISCOPIPE

Technical Note No. 35, "Hydrostatic Testing of HDPE Pressure Pipelines."

1.04 SUBMITTALS

A. The following shall be submitted:

1. Certified copies of test reports demonstrating conformance to applicable pipe specifications, before pipe is installed.

1.05 MEASUREMENT AND PAYMENT

A. Measurement and payment for high density polyethylene pipe shall not be paid as an unit item, but considered as included in the contract unit or lump sum prices for the various items of the contract to which it relates.

PART 2 PRODUCTS

2.01 HIGH DENSITY POLYETHYLENE PIPE

A. High density polyethylene pipe shall be as manufactured by ISCO Industries (or approved equal) and shall have a minimum pressure rating as noted on the plans. The HDPE pipe shall have designation of PE 4710 (IPS size), made from resin with a minimum cell classification of PE 445574C or higher in accordance with ASTM F-714.

B. The manufacturer shall comply with NSF Standard 14 by certifying in writing to the design engineer and making the pipe with the NSF logo in the print line. The manufacturer shall comply with AWWA Standard C901 or C906 by certifying to the design engineer and marking the pipe with the appropriate AWWA standard in the print line. Pipe sections shall be clearly marked to:

1. Identify manufacturer's name or trademark.
2. Nominal pipe size and OD base.
3. AWWA material code designation.
4. Dimension ratio.
5. AWWA pressure class.
6. AWWA specification designation.
7. Product record code.

C. Fittings shall be pressure rated to match the system piping to which they are joined. At the point of fusion, the outside diameter and minimum wall thickness of the fitting shall meet the outside diameter and minimum wall thickness specifications of AWWA C901 or AWWA C906 for the same size of pipe.

D. All high density polyethylene pipe shall be provided from a single manufacturer.

E. High density polyethylene pipe shall be fusion welded and shall have no compression splices.

F. Transition fittings for high density polyethylene pipe that come in contact with the fluoride or chlorine solutions shall not be stainless steel or any other material that is corrodible in the presence of the fluoride or chlorine solutions.

G. High density polyethylene pipe shall have a SDR and minimum pressure rating as shown in Table 1 below. HDPE pipe shall be either SDR 11 or SDR 9 and with color striping as noted on the drawings (Red stripe for fluoride and green stripe for chlorine solution lines).

TABLE 1
HDPE PIPE (PE 4710) MINIMUM PRESSURE RATING

SDR	PRESSURE RATING (psi)
7	336
9	252
11	202
13.5	161
17	126
21	101

2.02 SAFETY TAPE AND TRACING WIRE

A. Safety tracer tape shall be a minimum of 3" wide by 5.0 mil overall thickness, with no less than a 50 gauge solid aluminum foil core. It shall be Safety Blue in color and shall be clearly labeled with the word “WATER”. Safety tape shall be as manufactured by Magnatec or approved equal.

B. Tracing wire shall be #12 insulated solid copper wire with underground weather and water proof connectors.

PART 3 EXECUTION

3.01 STORAGE AND HANDLING

A. Pipe shall be stored on clean level ground to prevent undue scratching or gouging. Sections of pipe with deep cuts or gouges shall be removed and ends of pipes rejoined. Handling of the joined pipe shall be in such a manner that the pipe is not damaged by dragging over

sharp or cutting objects.

B. Lifting of joined pipe sections shall preclude concentration of bending stresses at joints and shall be done in a manner which evenly distributes lifting stresses along the full length of the pipe.

C. Pipe shall be stored in a shaded area or covered to avoid temperature extremes which may cause the pipe to bow or warp.

3.02 INSTALLATION

A. High density polyethylene pipe shall be installed according to the requirements of ASTM D-2321, and the manufacturer's requirements.

B. Care shall be exercised by the Contractor in placing the pipe to avoid damaging the pipe.

C. Any damage to the HDPE pipes shall be repaired at the contractor's expense.

D. Sections of pipe shall be joined into continuous lengths by the butt fusion method and shall be performed in strict conformance with the pipe manufacturer's recommendations using approved equipment. Sections of pipe shall be as long as practical to minimize the number of joints. The minimum length of pipe sections shall be twenty (20) feet, except for the last section as required to complete the designated length.

E. Stub ends and pipe fittings for butt fusion shall be fabricated of the same parent material as the HDPE pipe, and shall be of at least the same wall thickness and pressure rating as the pipe to be joined, unless otherwise recommended by the manufacturer.

F. Joining techniques and operating procedures shall follow written instructions provided by the pipe manufacturer and the joint equipment supplier. A copy of such instructions shall be present at any location in which butt fusion is being carried out.

G. Poly-Cam fittings shall be used for joining between HDPE and other materials or non-HDPE fittings. Fittings shall have a pressure rating equal to or greater than the pressure rating of the pipe on which they are to be installed.

H. The pipe shall be installed with uniform bearing under the full length of the pipe.

I. The pipe shall be plugged at the end of each work day, or period of work suspension.

J. Safety tracer tape shall be installed 12" above pipe where buried.

3.03 PRELIMINARY CLEANING AND FLUSHING

A. The Contractor shall flush the pipeline as the work progresses by a means in accordance with good practice to ensure that sand, rocks, or other foreign material are not left in any of the pipeline. If possible the flushing shall be made with an open pipe end.

3.04 TESTING OF PIPELINE

A. Pipeline testing shall be in accordance with Section 15063 - Pipeline Testing and Disinfection.

B. System test pressure shall be 160 psi.

C. Source of Water

1. CONTRACTOR shall assume all responsibility to obtain the necessary water supplies for pressure testing of the pipeline.

D. Testing Procedure

1. HDPE Pipe shall be tested in accordance with the AWWA standards.

2. Testing prior to pipe installation outside of the trench.
   a. CONTRACTOR shall test all piping either in sections or as a unit. The test shall be made by placing temporary bulkheads as needed in the pipe and filling the line slowly with water. Care shall be taken to see that all air vents are open during the filling. After the piping or section thereof has been filled, subject the pipe to a hydrostatic test pressure that equal to 1.5 times the system design pressure for a maximum of three hours. During this time, add water periodically to maintain the test pressure; this compensates for the initial stretching of the pipe. The line-pressure tightness is determined by visual observation; therefore, it is not necessary to measure the make-up water. Examine every fused joint; any leakage must be repaired and then retested.
   b. CONTRACTOR shall be responsible to ensure that appropriate safety precautions are observed during the hydrostatic testing above ground.

3. Testing in the trench. Fill the pipeline with water after it has been laid; bleed off any trapped air. Subject the lowest element in the system to a test pressure that is 1.5 times the design pressure, and check for any leakage. When, in the opinion of the engineer, local conditions require that the trenches be backfilled immediately after the pipe has been laid, apply the pressure test after backfilling has been completed but not sooner than a time which will allow sufficient curing of any concrete that may have been used.
   a. The test procedures consist of two steps: the initial expansion and the test phase. When test pressure is applied to a water-filled pipe, the pipe expands. During the initial expansion of the pipe under test, sufficient make-up water must be added to the system at hourly intervals for three hours to maintain the test pressure. After about four hours, initial expansion should be complete and the actual test can start.
   b. When the test is to begin, the pipe is full of water and is subjected to a constant test pressure of 1.5 times the system design pressure. The test phase should not exceed three hours, after which time any water deficiency must be replaced and measured. Add and measure the amount of make-up water required to return the test pressure and compare this to the maximum allowance in Table 15064-1 below.

TABLE15064-1 ALLOWANCE FOR EXPANSION UNDER TEST PRESSURE							
Nominal Pipe Size	U.S. Gal/100 ft of Pipe			Nominal Pipe Size	U.S. Gal/100 ft of Pipe		
	1-Hour	2-Hour	3-Hour		1-Hour	2-Hour	3-Hour
2	0.08	0.12	0.15	20	2.80	5.50	8.00
3	0.10	0.15	0.25	22	3.50	7.00	10.50
4	0.13	0.25	0.40	24	4.50	8.90	13.30
5	0.21	0.41	0.63	28	5.50	11.10	16.80
6	0.30	0.60	0.90	30	6.20	12.60	19.10
8	0.50	1.00	1.50	32	7.00	14.30	21.50
10	0.75	1.30	2.10	36	9.00	18.00	27.00
12	1.10	2.30	3.40	42	12.00	24.00	36.00
14	1.40	2.80	4.20	48	15.00	27.00	43.00
16	1.70	3.30	5.00	54	18.00	30.00	50.00
18	2.20	4.30	6.50				

4. ENGINEER shall be notified at least 48 hours before the pipeline is to be tested so that he may be present during the test.

5. An alternate leakage test consists of maintaining the test pressure over a period of four hours, and then dropping the pressure by 10 psi. If the pressure then remains within 5% of the target value for one hour, this indicates there is no leakage in the system.

6. Under no circumstances shall the total time under test exceed eight hours at 1.5 times the system pressure rating. If the test is not complete within this time limit (due to leakage, equipment failure, etc.), the test section shall be permitted to "relax" for eight-hours prior to the next test sequence

3.05 DISINFECTING

A. Disinfection shall be in accordance with Section 15063 - Pipeline Testing and Disinfection.

- END OF SECTION -

SECTION 15065

POLYVINYL CHLORIDE (PVC) PIPE

PART 1 GENERAL

1.01 DESCRIPTION

A. CONTRACTOR shall furnish and install all pipe, fittings, closure pieces, supports, gaskets, jointing material, skids, seals, and appurtenances as shown and specified, and as required for a complete and workable piping system.

1.02 RELATED WORK

A. Related work specified in other sections:

Section 01500 - Temporary Construction Utilities and Environmental Controls
Section 02221 - Excavation and Backfill for Pipelines
Section 15063 - Pipeline Testing and Disinfection
Section 15100 - Mechanical Appurtenances

1.03 REFERENCES

A. Work covered by this Specification shall meet or exceed the provisions of the latest editions of the following Codes and Standards in effect at the time of award of the Contract:

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C 651	Standard for Disinfecting Water Mains
AWWA C 900	Standard for Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. Through 12 In., for Water Distribution
AWWA M 23	Manual of Water Supply Practices - PVC Pipe - Design and Installation

1.04 SUBMITTALS

A. Submit manufacturer's affidavit certifying product was manufactured, tested and supplied in accordance with applicable references in this section together with a report of the test results and the date each test was completed.

1.05 MEASUREMENT AND PAYMENT

A. Polyvinyl Chloride Pipe shall not be measured or paid as a separate item, but shall be included as part of the various items to which it relates.

PART 2 PRODUCTS

2.01 POLYVINYL CHLORIDE PIPE

A. All polyvinyl chloride pipe intended for use in public drinking water supply pipelines or in pressure pipeline systems shall be manufactured of material conforming to AWWA C900 or C905 PVC materials for the size and class required. All plastic pipe must be approved for potable water use by the National Sanitation Foundation and must bear the logo "NSF-pw" or "NSF-61" indicating such approval. Pipe sections shall be clearly marked to:

1. Identify manufacturer's name or trademark.
2. Nominal pipe size and OD base.
3. AWWA material code designation.
4. Dimension ratio.
5. AWWA pressure class.
6. AWWA specification designation.
7. Product record code.

B. All fluoridation and chlorination piping for this project shall be PVC Schedule 80, unless otherwise noted.

C. All polyvinyl chloride pipe intended for use in drain pipelines **not** conveying public drinking water supply shall be manufactured of material conforming to ASTM D 3034 with a maximum SDR of 35 and shall be furnished with bell and spigots with flexible elastomeric gasket joints in accordance with ASTM D 3212.

2.02 POLYVINYL CHLORIDE JOINTS

A. All joints and accessories shall be as manufactured and furnished by the pipe supplier and shall be socket solvent weld or threaded as noted on the drawings and have compatible pressure ratings with that of the pipe.

2.03 SAFETY TAPE AND TRACER WIRE

A. Safety tracer tape shall be a minimum of 3" wide by 5.0 mil overall thickness, with no less than a 50 gauge solid aluminum foil core. It shall be Safety Blue in color and shall be clearly labeled with the word “WATER”. Safety tape shall be as manufactured by Magnatec or approved equal.

B. Tracing wire shall be #12 insulated solid copper wire with underground weather and water proof connectors.

PART 3 EXECUTION

3.01 INSTALLATION

A. Polyvinyl Chloride pipe shall be installed in accordance with the "American Water Works Association Manual of Water Supply Practices - PVC Pipe - Design and Installation" (AWWA No. M23).

B. The pipe shall be plugged at the end of each work day, or period of work suspension.

C. Safety tracer tape shall be installed 12" above pipe where buried.

D. All Threaded joints shall be teflon taped.

3.02 PRELIMINARY CLEANING AND FLUSHING

A. CONTRACTOR shall flush the pipeline as the work progresses by a means in accordance with good practice to insure that sand, rocks, or other foreign material are not left in any of the pipeline. If possible the flushing shall be made with an open pipe end.

3.03 TESTING OF PIPELINE

A. Pipeline testing shall be in accordance with Section 15063 - Pipeline Testing and Disinfection

B. Source of Water

1. CONTRACTOR shall assume all responsibility to obtain the necessary water supplies for pressure testing of the pipeline.

C. Testing Procedure

1. Polyvinyl Chloride pipe shall be tested in accordance with the "American Water Works Association Manual of Water Supply Practices - PVC Pipe -Design and Installation" (AWWA No. M23).

2. In the case of pipelines that fail to pass the leakage test, CONTRACTOR shall determine the cause of the excessive leakage, shall take corrective measures necessary to repair the leaks, and shall again test the pipelines, all at no additional cost to OWNER.

3. ENGINEER shall be notified at least 48 hours before the pipeline is to be tested so that he may be present during the test.

3.04 PIPELINE TESTING AND DISINFECTING

A. Disinfection shall be in accordance with Section 15063 - Pipeline Testing and Disinfection

- END OF SECTION -

SECTION 15100

MECHANICAL APPURTENANCES

PART 1 GENERAL

1.01 SUMMARY

A. CONTRACTOR shall furnish and install all piping and equipment.

1.02 RELATED WORK

A. Related work specified in other sections:

Section 01300 - Contractors Submittals
Section 15061 - Steel Pipe
Section 15062 - Stainless Steel pipe
Section 15063 - Pipeline Testing and Disinfection
Section 15064 - High Density Polyethylene Pipe
Section 15065 - Polyvinylchloride Pipe

1.03 MEASUREMENT AND PAYMENT

A. Measurement and payment for mechanical appurtenances shall not be paid as an unit item, but shall be included in the item of work to which it pertains.

1.04 REFERENCES

A. The latest edition of the following publications form a part of this specifications to the extent referenced. The publications are referred to in the text to by basic designation only.

B. AMERICAN WATER WORKS ASSOCIATION (AWWA)

1. C-500 Metal-Seated Gate Valves for Water Supply Services
2. C-504 Standard for Rubber-Seated Butterfly Valves
3. C-509 Resilient-Seated Gate Valves for Water Supply Service
4. C-512 Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service

1.05 SUBMITTALS

A. Submit catalog cuts on all mechanical appurtenances including: fittings, valves, or other items shown on the Drawings referencing each item by mark number. Information shall indicate manufacture specification compliance and dimensional data.

B. Submittals for the electric motor operators for the butterfly valves shall include calculations verifying the selected actuator output torque and computed valve opening and closure times under the conditions specified herein.

PART 2 PRODUCTS

2.01 GATE VALVES

A. Gate valves shall conform to the "Standard for Resilient-Seated Gate Valves for Ordinary Water Works Service" (AWWA C-500 and C-509). Valves shall be of the resilient-seat type with non-rising stem, opening to the left, and provided with a 2-inch square operating nut for buried valves or handwheel for valves located in structures. Buried valves shall be of flange or mechanical joint design to match pipe joint system.

B. Valves, valve-operating units, stem extensions and other accessories shall be installed by the CONTRACTOR where shown, or where required in the opinion of the ENGINEER, to provide for convenience in operation. Where buried valves are indicated, the CONTRACTOR shall furnish and install valve boxes to 3-inches above grade in unimproved areas, or at grade with concrete collar in improved areas. All valves and gates shall be new and of current manufacture (except those provided by the OWNER).

   1. Concrete Collars shall be 10" thick x 2'6" in diameter centered over the valve box. They shall have two circumscribing #4 bars, one at three inches from the outside edge and a second bar nine inches from the outside edge each centered in the concrete.

C. The valve shall have an FDA, EPA, AWWA C550 and ASTM D1763 approved two part thermosetting epoxy protective coating (10 mil minimum inside and out) system that is non-toxic and imparts no taste to water.

D. The flanges of valves may be raised or plain faced. Flanges of valves shall be faced and drilled to 125-lb American Standard template.

E. All valves shall be furnished with pressure classes equal to or better than the pressure class of the pipe with which the valves are to be used. Unless otherwise specified, each valve body shall be tested under a test pressure equal to twice its design water-working pressure.

F. Valves shall be Mueller Resilient Seat or approved equal.

2.02 PRESSURE REDUCING VALVES

A. The 1" pressure reducing valves shall be manufacture by Cla-Val Co., Model #990, for installation at the location shown on the drawings. The pressure class shall be 150 lb, and the valve shall be set to operate at 45 psi.

2.03 BALL VALVES

A. Ball Valves shall be full-port, with materials of construction as specified on the Drawings, and have an adjustable stem packing gland, as applicable.

   1. Stainless Steel Ball Valves shall have all wetted materials composed of 316 SS.

2. PVC Ball Valves shall be True Union style and have all wetted materials composed of PVC.

2.04 AIR/VACUUM VALVES

A. Air/Vacuum valves shall be ARI Series D-040 for 1-inch and 2-inch opening, and shall be installed as shown on the drawings.

2.05 AIR VENT VALVES

A. Air Vent valves shall be ARI Series S-050 with a 1/2-inch with low pressure orifice rated for 1.5 x working pressure, and shall be installed as shown on the drawings.

2.06 CORPORATION STOP

A. Corporation Stop type Ball Valves shall be full port, bronze body, PTFE coated ball and have a double O-ring stem. Outlets shall match the connection specified. Valves shall be rated at 300 psig maximum working pressure. They shall be Mueller Series 300 or approved equal.

2.07 CHECK VALVES

A. The 1-inch and 2-inch 316 Stainless Steel check valves shall be Discover Valve with rating of 200 WOG or approved equal.

B. The 1-inch PVC check valves shall be Spears Industrial Ball Check Valve Model 4521, with a pressure rating of 235 psi.

2.08 HYDRO PNEUMATIC BOOSTER PUMP, COMPRESSORS, AND PNEUMATIC TANK

A. Hydro pneumatic booster pump shall be Grainger 32ZN63. Pump shall have heavy-duty cast-iron body, brass impellers, and mechanical seal with stainless steel, Buna N and carbon/ceramic parts. Pump shall provide a minimum of 27 gpm at 40 psi, and 20 gpm at 50 psi. The motor shall be single phase, 120/240 volt, 1 HP.

B. Compressor shall be a Rol-Air D2002 HPV5 (or approved equal) 1.5 HP 115 VAC 125 PSI, with 4.5 gallon receiver. Pneumatic system shall also include ½" ball valve and ½” needle valve to control vacuum pump speed.

C. Pneumatic tank shall be a pre-charge bladder type, 119 gallon capacity, with 35.1 gallons drawdown between 40 to 60 psi. Tank shall be Grainger #3GVU2, or equal.

D. Pressure Switch for the hydro-pneumatic pump system shall be 1/4" port, 30-50 psi factory setting DPST, Grainger # 2PYA1 or approved equal.

2.09 PRESSURE GAUGES

A. Pressure gauges shall be provided where shown. Gauges shall be industrial type with stainless steel movement, liquid filled, and stainless steel or Phenolic case. Unless otherwise shown, pressure gauges shall have a 4-1/2 inch dial, ½ inch threaded connection and a shut-off valve. Gauges shall be calibrated to read in applicable units, with an accuracy of ± 1 percent, to 150 percent of the working pressure. Gauges shall be manufactured by Ashcroft, Foxboro, Marsh, or equal.

B. Pressure gauges for chemical service lines shall be 2-1/2-inch diameter with integral diaphragm seal. These gauges shall be manufactured by Plastomatic, or equal.

C. Pressure gauges that connect to lines other than potable water shall have gauge guards to prevent corrosion and clogging. Gauge guards shall have a durable flexible diaphragm which serves as a protective barrier between the process fluid and instrument. The diaphragm shall be either elastomer or Teflon and rated for the pressure of the gauge.

2.10 PIPE SUPPORTS

A. Pipe supports shall be manufactured by Grinnell, and shall be Grinnell Adjustable Pipe Support Model No. 264 (no equal). All pipe supports shall have a 1-inch high grouted pad to be used as a leveling base.

2.11 TAPPING SADDLES

A. Tapping saddles shall be provided where shown. Tapping saddles shall be JCM Industries JCM 402 Double Strap Service Saddle or approved equal.

2.12 STRAINERS

A. Strainers shall be bronze, wye-pattern with flush valve as manufactured by Watts, Model No. 777 or Eaton Model No. 85Y or approved equal. Strainers shall have isolation blow down valves rated for the system pressure.

2.13 HOSE BIBBS AND SAMPLING TAPS

A. Hose bibbs shall be as-manufactured by Watts, or approved equal, and shall include anti-siphon devices.

B. Sampling taps shall be as manufactured by Watts, or approved equal, and shall be smooth nosed.

PART 3 EXECUTION

3.01 INSTALLATION

A. Valves, valve-operating units, stem extensions and other accessories shall be installed by

the Contractor where shown, or where required in the opinion of the Engineer, to provide for convenience in operation. Where buried valves are indicated, the Contractor shall furnish and install valve boxes to 3-inches above grade in unimproved areas, or at grade with concrete collar in improved areas. All gate valves and boxes shall be new and recently manufactured.

B. Install mechanical appurtenances as indicated on the plans and in accordance with the manufacturer's written instructions.

C. Valve boxes in asphalt shall be installed with concrete collars.

- END OF SECTION -

SECTION 15200

BUILDING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Installation of building water piping and drain piping, and related work.

B. Installation of pipe hangers, sleeves, supports, brackets, and related items.

C. Testing of piping systems and correction of any problems found to exist.

1.02 RELATED WORK

A. Related work specified in other sections includes but is not limited to:

Section 02221 - Excavation and Backfill for Buried Pipelines
Section 02222 - Excavation and Backfill for Structures
Section 11300 - Fluoridation Chemical Process Equipment
Section 15016 - ABS Pipe
Section 15061 - Steel Pipe
Section 15062 - Stainless Steel Pipe
Section 15063 - Pipeline Disinfection
Section 15065 - Polyvinyl Chloride Pipe

1.03 MEASUREMENT AND PAYMENT

A. Building piping shall not be measured or paid as a separate item, but shall be included as part of the various items to which it relates.

1.04 REFERENCES

A. The latest edition of the following publications form a part of this specification to the extent referenced. The publication is referred to in the text by basic designation only.

B. AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

1. B31.1 Power Piping

1.05 PIPING SYSTEM LAYOUTS

A. Piping system drawings are diagrammatic and are intended to show approximate location of equipment and piping. Verify dimensions, whether in figures or scaled, in the field. CONTRACTOR is responsible for the installation of complete and workable systems whether completely detailed on the plans or not.

B. Ascertain locations of apparatus, fixtures, equipment, and piping in the field, and layout work accordingly. ENGINEER reserves the right to make minor changes in location of piping and equipment up to the time of installation without additional cost to OWNER.

1.06 REQUIREMENTS OF REGULATORY AGENCIES

A. Install work per applicable provisions of codes, rules, regulations, statutes, and ordinances of authorities having jurisdiction.

PART 2 PRODUCTS

2.01 PIPE

A. Pipe shall be of the type and class noted.

B. Do not substitute different pipe unless approved in writing prior to substitution.

2.02 PIPE HANGERS AND SUPPORTS

A. Pipe hangers and supports shall meet the requirements of IMC Section 305 Pipe Support and the following.

B. Properly support, suspend, or anchor all piping and fittings to prevent sagging, over stressing, or longitudinal movement of piping, and to prevent thrust or loads on or against other equipment.

C. Support horizontal piping on adjustable split steel ring or clevis hangers. The following schedule shows minimum spacing.

1. Steel and Copper:
   a. 1-1/4" and smaller — 6'-0" on center
   b. 1-1/2" thru 3" — 8'-0" on center
   c. 4" and larger — 12'-0" on center

2. PVC, CPVC, AND ABS:
   a. 1" and smaller — 4'-0" on center
   b. 1-1/4" thru 2" — 5'-0" on center
   c. 2-1/2" thru 4" — 6'-0" on center
   d. 5" and larger — 8'-0" on center

3. Chemical tubing or hose along walls shall be supported at 2'-0" on center.

D. Support insulated piping with pipe saddles and hangers that fit on outside of insulation. Do not compress or damage pipe insulation with hangers or supports.

E. Provide all rigid hangers with a means of vertical adjustment after erection.

F. Use copper or copper plated hangers for supporting uninsulated copper pipe.

G. All vertical and horizontal piping supports shall be fiberglass EnduroStrut system as manufactured by Enduro Systems, Inc., or approved equal.

2.03 INSERTS

A. Furnish and set inserts in concrete forms; provide reinforcing rods for pipe sizes over 3 inches or equivalent.

B. Furnish concrete inserts as follows: Black, malleable iron, universal type for threaded connections with lateral adjustment.

2.04 SHIELDS

A. Provide shields to protect insulation in all areas.

B. Provide approved galvanized form shields to protect insulation at areas of contact with hangers and supports.

C. Furnish low compressive insulation protector shields. Size per shield manufacturer's recommendations.

2.05 SLEEVES

A. Where pipes pass through floors, footings, foundations, walls, or ceilings, furnish and install pipe sleeves. Sleeves for concealed piping shall be PVC or galvanized iron as noted, and for exposed piping on I.P.S. black steel pipe installed so as to be completely covered by escutcheons. Extend sleeves through floors ½" above finish floor or as noted on Drawings..

2.06 ESCUTCHEONS

A. Fit pipe passing through walls, floors, or ceilings with escutcheons with set screws.

B. Use prime painted escutcheons where surface is to receive a paint finish; otherwise, use escutcheons that are nickel or chromium plated.

C. Where piping is insulated, use escutcheon outside the insulation.

2.07 JOINTS

A. For screwed pipe make ends with sharp, clean tapered threads using teflon tape on the male thread only. Do not use mill cut threads ream cut pipe to full inside diameter.

B. Welding may be done by either the arc or acetylene process conforming to the requirements for the ASME B31.1.

C. For solder joints use fittings specifically made for low lead soldering. Clean all burrs and roughen pipe to clean; solder complete around joint.

D. For grooved pipe jointing systems use mechanical pipe couplings and fittings.

E. For no-hub cast iron pipe use double screw joint neoprene coupler.

2.08 UNIONS

A. Furnish and install unions necessary for installation and necessary to permit removal of equipment.

PART 3 EXECUTION

3.01 PREPARATION

A. Prior to installation of piping, verify that it will not interfere with clearances required for the erection and finish of structural members, architectural members, electrical, sprinkler, or mechanical items.

B. Hang or support piping materials from roof support system whenever possible.

C. Do not cut any structural members for installation of piping.

3.02 INSERTS

A. Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.

B. Set inserts in position in advance of concrete work. Provide reinforcement rod in concrete for inserts carrying pipe over 4 inches in diameter.

C. Where concrete slabs form finished ceiling, finish inserts flush with slab surface.

D. Where inserts are omitted, drill through concrete slab from below and provide rod with recessed squared steel plate and nut above slab.

3.03 SLEEVES

A. Set sleeves in position in advance of concrete work. Provide suitable reinforcing around sleeves.

B. Extend sleeves through potentially wet floors 1 inch above finished floor level. Caulk sleeves full depth and provide floor plate.

C. Where piping passes through floor, ceiling, or wall, close-off space between pipe and construction with noncombustible insulation. Provide tight-fitting metal caps on both sides and caulk.

3.04 PIPE HANGERS AND SUPPORTS

A. Support all piping and make adequate provisions for expansion, contraction, slope and anchorage.

B. The use of pipe hooks, chains, or perforated metal for pipe support will not be permitted.

C. Suspend all piping in the building as indicated.

D. Install hangers to provide minimum ½ inch clear space between finished covering and adjacent work.

E. Place a hanger within 1 foot of each horizontal elbow.

F. Use hangers which are vertically adjustable 1-1/2 inch minimum after piping is erected.

G. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

H. Where practical, support riser piping independently of connected horizontal piping.

3.05 PIPING INSTALLATION

A. Cut piping accurately for fabrication to measurements established at the construction site and work into place without springing or forcing.

B. Remove burrs and cutting slag from pipe by reaming or other approved cleaning methods.

C. Make changes in direction with proper fittings.

D. Arrange piping so as not to interfere with the removal of other equipment, ducts, or devices. Do not block doors, windows, or access openings. Provide unions in the piping at connections to all equipment. Unions must be accessible.

E. Cap or plug open ends of pipes and equipment with PVC caps or expanding neoprene plugs to keep dirt and other foreign materials out of the system. Plugs of rags, wool, cotton, waste, or similar materials are not acceptable.

F. Install all piping systems so they can easily by drained. Provide anti-siphon hose bibbs at low points on water lines.

G. Slope all soil and waste lines within the building at 1/4 inch per foot fall in the direction of flow unless indicated otherwise.

3.06 PRIMING AND COATING

A. Prime coat exposed steel hangers and supports and hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces.

3.07 PIPE LABELING

A. Exposed pipe shall be labeled in accordance with Utah State Regulation R309-525-8 and IPC.
   1. Piping systems shall have flow arrows and chemical designations.
   2. Placards shall be installed on all storage tanks.

3.08 DISINFECTION AND TESTING

A. Disinfect culinary water piping in accordance with Section 15063 - Pipeline Testing and Disinfection.

B. Test Culinary water piping.

C. Repair defects which develop under tests promptly and repeat tests. No caulking or screwed joints, cracks, or holes will be permitted. Replace pipe or fitting or both with new material when repairing leaks in screwed joints.

D. Repair leaks in copper tubing by melting out joint, thoroughly cleaning both tubing and fitting, and resoldering.

- END OF SECTION -

SECTION 15281

SPLIT SYSTEM AIR-CONDITIONING UNITS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:

1. Split System Air Conditioning Units.

1.02 SUBMITTALS

A. Submit “Letter of Conformance” in accordance with Section 01330 indicating specified items selected for use in Project with the following supporting data:

1. Product data for each type of product specified.
2. Wiring diagrams detailing power and control wiring and differentiating clearly between manufacturer-installed wiring and field-installed wiring.
3. Samples of cabinet finish colors for approval.
4. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of Owner’s Representatives and owners, and other information specified.
5. Field test reports from a qualified independent inspecting and testing agency indicating and interpreting test results relative to compliance with performance requirements of split system air conditioning units.

1.03 QUALITY ASSURANCE

A. The system components shall be tested by a Nationally Recognized Testing Laboratory (NRTL) and shall bear the ETL label.

B. All wiring shall be in accordance with the National Electrical Code (N.E.C.).

C. The units shall be rated in accordance with Air-conditioning, Heating and Refrigeration Institute’s (AHRI) Standard 240 and bear the AHRI Certification label.

D. The units shall be manufactured in a facility registered to ISO 9001 and ISO 14001, which is a set of standards applying to product and manufacturing quality and environmental management and protection set by the International Standard Organization (ISO).

E. A dry air holding charge shall be provided in the indoor section.

1.04 DELIVERY, STORAGE AND HANDLING

A. Unit shall be stored and carefully handled according to the manufacturer’s recommendations.

B. The wireless remote controller, for the wall mounted and floor standing indoor units, shall be shipped inside the carton and packaged with the indoor unit and shall be able to withstand 105°F storage temperatures and 95% relative humidity without adverse effect.

1.05 WARRANTY

A. The units shall have a manufacturer's parts and defects warranty for a period five (5) years from date of installation. The compressor shall have an extended warranty of seven (7) years from date of installation.

B. If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer. This warranty will not include labor.

C. Manufacturer shall have a minimum of thirty-eight (38) years continuous experience in the U.S. market.

D. All manufacturer technical and service manuals must be readily available for download by any local contractor should emergency service be required

PART 2 PRODUCTS

2.01 GENERAL

A. SYSTEM DESCRIPTION MXZ PORTED - The heat pump air conditioning system shall be a Mitsubishi Electric MXZ-C variable capacity multi-zone series. The system shall consist of two (2), three (3), four (4) or five (5) wall mounted, ceiling suspended, ceiling recessed, horizontal ducted, floor standing and/or multi-position ducted indoor units with a wired or wireless remote controller, connected to a compact horizontal discharge outdoor unit which shall be of an inverter driven heat pump design.

2.02 OUTDOOR UNITS

A. General:

1. The MXZ-C ported outdoor units shall be specifically designed to work with the wall mount, floor mount, ducted, 4-way ceiling recessed, 1-way ceiling recessed, ceiling suspended and multi-position air handler indoor unit types. The outdoor unit shall be completely factory assembled, piped and wired. Each unit shall be run tested at the factory prior to shipment.
2. If an alternate manufacturer is selected, any additional material, cost, and labor to install additional lines shall be incurred by the contractor. Contractor responsible for ensuring alternative brand compatibility in terms of availability, physical dimensions, weight, electrical requirements, etc.
3. Outdoor unit shall have a sound rating no higher than 58 dB(A). If an alternate manufacturer is selected, any additional material, cost, and labor to meet published sound levels shall be incurred by the contractor.
4. Refrigerant lines from the outdoor unit to the indoor units shall be insulated in accordance with the installation manual.
5. The outdoor unit shall meet performance requirements per schedule and be within piping limitations & acceptable ambient temperature ranges as described in respective manufacturers' published product catalogs. Non-published product capabilities or performance data are not acceptable.
6. The outdoor unit shall be capable of guaranteed operation in heating mode down to -13°F ambient temperatures and cooling mode up to 115°F without additional restrictions on line length & vertical separation beyond those published in respective product catalogs. Models with capacity data for required temperature range

published as “for reference only” are not considered capable of guaranteed operation and are not acceptable. If an alternate manufacturer is selected, any additional material, cost, and labor to meet ambient operating range and performance shall be incurred by the contractor.

7. The outdoor unit shall be provided with a manufacturer supplied 20-gauge hot dipped galvanized snow /hail guard. The snow/hail guard protects the outdoor coil surfaces from hail damage and snow build-up in severe climates.
8. Four-legged outdoor unit mounting systems shall be provided by manufacturer. Stand shall be made from 7-gauge plate steel with thermally fused polyester powder coat finish that meets ASTM D3451-06 standards. Stands shall be provided with galvanized mounting hardware and meets all ASCE 7 overturning safety requirement.

B. Unit Cabinet:

1. The casing shall be fabricated of galvanized steel, bonderized, finished with an electrostatically applied, thermally fused acrylic or polyester powder coating for corrosion protection. Assembly hardware shall be cadmium plated for weather resistance.
2. Cabinet color shall be Munsell 3Y 7.8/1.1.
3. Two (2) mild steel mounting feet, traverse mounted across the cabinet base pan, welded mount, providing four (4) slotted mounting holes shall be furnished. Assembly shall withstand lateral wind gust up to 155 MPH to meet applicable weather codes.

C. Fan:

1. The unit shall be furnished with a direct drive, high performance propeller type fan. The condenser fan motor shall be a variable speed, direct current (DC) motor and shall have permanently lubricated bearings.
    a. Fan speed shall switch automatically according to the number of operating indoor units and the compressor operating frequency.
    b. The fan motor shall be mounted with vibration isolation for quiet operation.
    c. The fan shall be provided with a raised guard to prevent contact with moving parts.
    d. The outdoor unit shall have horizontal discharge airflow.

D. Refrigerant and Refrigerant Piping:

1. R410A refrigerant shall be required for systems.
    a. Polyolester (POE) oil—widely available and used in conventional domestic systems—shall be required. Prior to bidding, manufacturers using alternate oil types shall submit material safety data sheets (MSDS) and comparison of hygroscopic properties for alternate oil with list of local suppliers stocking alternate oil for approval at least two weeks prior to bidding.
    b. Refrigerant piping shall be phosphorus deoxidized copper (copper and copper alloy seamless pipes) of sufficient radial thickness as defined by the equipment manufacturer and installed in accordance with manufacturer recommendations.
    c. All refrigerant piping must be insulated with ½” closed cell, CFC-free foam insulation with flame-Spread Index of less than 25 and a smoke-development Index of less than 50 as tested by ASTM E 84 and CAN / ULC S-102. R value of insulation must be at least 3.
    d. Refrigerant piping limits shall be in accordance with manufacturer specifications.

E. Coil:

1. The outdoor unit coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing.
   a. The coil shall be protected with an integral guard.
   b. Refrigerant flow from the outdoor unit to the indoor units shall be independently controlled by means of individual electronic linear expansion valves for each indoor unit.
   c. All refrigerant lines between outdoor and indoor units shall be of annealed, refrigeration grade copper tubing, ARC Type, meeting ASTM B280 requirements, individually insulated in twin-tube, flexible, closed-cell, CFC-free (ozone depletion potential of zero), elastomeric material for the insulation of refrigerant pipes and tubes with thermal conductivity equal to or better than 0.27 BTU-inch/hour per Sq Ft / °F, a water vapor transmission equal to or better than 0.08 Perm-inch and superior fire ratings such that insulation will not contribute significantly to fire and up to 1" thick insulation shall have a Flame-Spread Index of less than 25 and a Smoke-development Index of less than 50 as tested by ASTM E 84 and CAN / ULC S-102.
   d. All refrigerant connections between outdoor and indoor units shall be flare type.

F. Compressor:

1. The compressor shall be a high performance, hermetic, inverter driven, variable speed, dual rotary type manufactured by Mitsubishi Electric Corporation.
   a. The compressor motor shall be direct current (DC) type equipped with a factory supplied and installed inverter drive package.
   b. The compressor will be equipped with an internal thermal overload.
   c. The outdoor unit shall be equipped with a suction side refrigerant accumulator.
   d. There shall be no need for line size changes. Filters, sight glasses, and traps shall not be used, and no additional refrigerant oil shall be required.
   e. The compressor shall be mounted to avoid the transmission of vibration.

G. Basepan Heater:

1. Each outdoor unit module shall be equipped with a basepan heater to protect the coil against ice build-up during prolonged winter operation. Basepan heater shall activate only if compressor is operating in heating mode at an outdoor ambient temperature of 36F or below.

H. Operating Range:

1. Operating Range shall be in accord with the Table below:

Operating Range		Indoor Intake Air Temp	Outdoor Intake Air Temp
Cooling	Maximum	95°F (35°C) DB, 71°F(21°C) WB	115°F (46°C) DB
	Minimum	67°F (19°C) DB, 57°F(14°C) WB	14°F (-10°C) DB
Heating	Maximum	80°F (27°C) DB, 67°F(19°C) WB	75°F (24°C) DB, 65°F(18°C) WB
	Minimum	70°F (21°C) DB, 60°F(16°C) WB	6°F (-14°C) DB, 5°F(-15°C) WB
			-12°F (-24°C) DB, -13°F(-25°C) WB*

I. Electrical:

1. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
    a. The unit shall be capable of satisfactory operation within voltage limits of 198 volts to 253 volts.
    b. The outdoor unit shall be controlled by the microprocessors located in the indoor unit and in the outdoor unit communicating system status, operation, and instructions digitally over A-Control – a system directing that the indoor unit be powered directly from the outdoor unit using a 3-wire, 14-gauge AWG connection plus ground.
    c. The outdoor unit shall be equipped with Pulse Amplitude Modulation (PAM) compressor inverter drive control for maximum efficiency with minimum power consumption.

2.03 INDOOR UNITS

A. General:

1. MSZ-FS WALL MOUNTED INDOOR UNIT - The wall-mounted indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

B. Unit Cabinet:

1. The casing shall have a white finish – Munsell 1.0Y 9.2/0.2.
2. Multi directional drain and refrigerant piping offering four (4) directions for refrigerant piping and two (2) directions for draining are required.
3. There shall be a separate back plate which secures the unit firmly to the wall.

C. Fan:

1. The indoor fan shall be statically and dynamically balanced to run on a single motor with permanently lubricated bearings.
2. An integral, motorized, multi-position, horizontal air sweep vane shall provide for uniform air distribution, up and down. Vane shall have 5 selectable positions plus AUTO (Controls position based upon mode, microprocessor shall automatically determine the vane angle to provide the optimum room temperature distribution) and SWING (Continuously moves up and down). In OFF mode the horizontal vane shall return to the closed position.
3. A motorized adjustable vertical guide vane shall be provided with the ability to change the airflow from side to side (left to right). Vane shall be positioned by a stepper motor driven by the indoor unit control microprocessor. Vane shall have 5 selectable positions and SWING (Continuously moves left and right).
4. The indoor unit shall include an AUTO fan setting capable of maximizing energy efficiency by adjusting the fan speed based on the difference between controller set-point and space temperature. The indoor fan shall be capable of six (6) speed settings, Quiet, Low, Med, High, Super High and Auto (2-ton unit does not have Quiet setting).

D. Filter:

1. Return air shall be filtered by means of two (2) easily removable, washable Nano Platinum Filters, an Electrostatic Anti-Allergy Enzyme Filter and a Deodorizing Filter with ceramic surface and nanotechnology for high-powered odor absorption.

E. Coil:

1. The indoor unit coil shall be of nonferrous construction with smooth plate fins on copper tubing.
   a. The tubing shall have inner groves for high efficiency heat exchange.
   b. All tube joints shall be brazed with silver alloy.
   c. The coils shall be pressure tested at the factory.
   d. A sloped, corrosion resistant condensate pan with drain shall be provided under the coil.
   e. A drain-pan level switch (SS610E), designed to connect to the control board, shall be provided, if required, and installed in the condensate pan to prevent condensate from overflowing.

F. Electrical:

1. The unit electrical power shall be 208-230 volts, 1-phase, 60 hertz.
2. The system shall be equipped with A-Control – a system directing that the indoor unit be powered directly from the outdoor unit using a 3-wire, 14-gauge AWG connections plus ground.
3. The indoor unit shall not have any supplemental electrical heat elements.

G. Controls:

1. The unit shall include an IR receiver for wireless remote-control flexibility
   a. The unit shall ship with a backlit wireless handheld remote with the unit.
   b. Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.
   c. Control board shall include contacts for control of external heat source. External heat may be energized as second stage when the space temperature is 1.8°F from set point.

2.04 CONTROLS

A. Overview

1. The control system shall consist of a minimum of one microprocessor on each indoor unit and one in the outdoor unit, communicating via A-Control data over power transmission.
2. The microprocessor located in the indoor unit shall have the capability of monitoring return air temperature and indoor coil temperature, receiving and processing commands from the wired or wireless controller, providing emergency operation and controlling the outdoor unit. The control signal between the indoor and outdoor unit shall be pulse signal 24 volts DC. Indoor units shall have the ability to control supplemental heat via connector CN24 and a 12 VDC output.
3. 5.For A-Control, a three (3) conductor 14-gauge AWG wire with ground shall provide power feed and bi-directional control transmission between the outdoor and indoor units. If code requires a disconnect mounted near the indoor unit, a TAZ-MS303 3-Pole Disconnect shall be used – all three conductors must be interrupted.

4. The system shall be capable of automatic restart when power is restored after power interruption. The system shall have self-diagnostics ability, including total hours of compressor run time. Diagnostics codes for indoor and outdoor units shall be displayed on the wired controller panel.
5. A remote controller needs to be selected and ordered separately from the unit unless the indoor unit is a wall mounted (excludes PKA), floor mounted or one-way ceiling recessed unit.

B. Remote Controllers

1. Backlit Simple MA Remote Controller:
    a. On wall mount (excludes PKA), floor mount and one-way ceiling recessed units the Backlit Simple MA Remote Controller shall require a MAC-334IF-E Interface for communication.
    b. The Backlit Simple MA Remote Controller shall be capable of controlling up to 16 indoor units (defined as 1 group). When grouping M-Series units each unit requires a MAC-334IF-E Interface.
        1) The Backlit Simple MA Remote Controller shall only be used in same group with another Backlit Simple MA Remote Controller, with up to two remote controllers per group.

Simple MA Remote Controller			
Item	**Description**	**Operation**	**Display**
ON/OFF	**Part 1 -** Run and stop operation for a single group	Each Group	Each Group
Operation Mode	**Part 2 -** Switches between Cool/Drying/Auto/Fan/Heat. **Part 3 -** Operation modes vary depending on the air conditioner unit.	Each Group	Each Group
Temperature Setting	**Part 4 -** Sets the temperature from 40°F – 95°F depending on operation mode and indoor unit.	Each Group	Each Group
Fan Speed Setting	Available fan speed settings depending on indoor unit.	Each Group	Each Group
Permit / Prohibit Local Operation	**Part 5 -** Individually prohibit operation of each local remote-control function (Start/Stop, Change operation mode, Set temperature, Reset filter). **Part 6 -** *1: Centrally Controlled is displayed on the remote controller for prohibited functions.	N/A	Each Group *1
Display Indoor Unit Intake Temp	**Part 7 -** Measures and displays the intake temperature of the indoor unit when the indoor unit is operating.	N/A	Each Group
Display Backlight	**Part 8 -** Pressing the button lights up a backlight. The light automatically turns off after a certain period of time. (The brightness settings can be selected from Bright, Dark, and Light off.)	N/A	Each Unit
Error	**Part 9 -** When an error is currently occurring on an air conditioner unit, the afflicted unit and the error code are displayed	N/A	Each Unit

c. CMCN REMOTE CONTROLLERS: SYSTEM INTEGRATION

1) The CMCN shall be capable of supporting integration with Building Management Systems (BMS).

END OF SECTION

SECTION 15450
UNIT HEATERS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Unit Heaters.

1.2 SUBMITTALS

A. Submit “Letter of Conformance” in accordance with Section 01330 indicating specified items selected for use in Project with the following supporting data:

1. Product data for each type of product specified.
2. Wiring diagrams detailing power and control wiring and differentiating clearly between manufacturer-installed wiring and field-installed wiring.
3. Samples of cabinet finish colors for approval.
4. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of Owner’s Representatives and owners, and other information specified.
5. Field test reports from a qualified independent inspecting and testing agency indicating and interpreting test results relative to compliance with performance requirements of unit heaters.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: Firm experienced in manufacturing unit heaters similar to those indicated for this Project and that have a record of successful in-service performance.

B. Comply with NFPA 70 for components and installation.

C. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Approved Manufacturers:

1. Emerson Electric Co. (314-553-2000)
2. Q-Mark, Marley Engineered Products, An SPX Company (843-479-4006)
3. Markel Products Company (800-682-3398)

2.2 ELECTRICAL UNIT HEATERS

A. Heating Elements: Nickel-chromium heating wire element; free from expansion noise and 60-Hz hum; embedded in magnesium oxide, insulating refractory; and sealed in high-mass steel or corrosion-resistant metallic sheath with fins no closer than 0.16 inch. Element ends are enclosed in terminal box. Fin surface temperature does not exceed 550 deg F at any point during normal operation.

B. Heater Circuit Protection: One-time fuses in terminal box for overcurrent protection and limit controls for overtemperature protection of heaters.

C. Fan and Motor: Direct-drive propeller fan and manufacturer's standard motor. Motors sized 1 hp and less include motor overload protection.

D. Wiring Terminations: Match conductor materials and sizes indicated.

E. Discharge Configuration: Horizontal discharge with horizontal, adjustable louvers.

F. Optional Accessories: Include the following:

1. Wall thermostat.
2. Safety-switch disconnect on cover of terminal box.
3. Voltage – See electrical drawings.
4. Fan-delay relay.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and supports to receive unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of units. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install heaters as indicated, according to manufacturer's written instructions and NFPA 90A.

B. Connect heaters and components to wiring systems and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals according to tightening requirements specified in UL 486A.

3.3 FIELD QUALITY CONTROL

A. Testing: After installing unit heaters and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

B. Remove and replace malfunctioning units with new units and retest.

3.4 CLEANING

A. Replace filters in each cabinet unit heater at project closeout.

- END OF SECTION -

SECTION 15524

HORIZONTAL DIRECTIONAL DRILLING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the construction of the following items, complete and in place in accordance with the Contract Documents:

1. Excavation for approach trenches and pits.
2. Horizontal directional drilling.
3. Pipe.

1.2 RELATED WORK

A. Related work specified in other sections:

1. Section 01300 Contractor Submittals
2. Section 01500 Temporary Construction Utilities and Environmental Controls
3. Section 02221 Excavation and Backfill for Buried Pipelines
4. Section 02319 Dewatering
5. Section 15063 Pipeline Testing and Disinfection
6. Section 15064 High Density Polyethylene Pipe

1.3 REFERENCES

A. The latest edition of the following publications form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

B. AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION (AASHTO)

1. AASHTO T180 Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-inch) Drop

C. AMERICAN SOCIETY FOR TESTING MATERIALS (ASTM)

1. ASTM D698 Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))

2. ASTM D1557 Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (6,000 ft-lbf/ft3 (2,700 kN-m/m3))

3. ASTM D6938 Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

4. ASTM F1962 Standard Guide for Use of Maxi-Horizontal Directional Drilling for Placement of Polyethylene Pipe or Conduit Under Obstacles, Including River Crossings

D. NATIONAL UTILITY CONTRACTORS ASSOCIATION (NUCA)

1. NUCA - HDD Installation Guidelines.

1.4 DESIGN REQUIREMENTS

A. Design Criteria:

1. Drilling Steering System: Remote with continuous electronic monitoring of boring depth and location.

2. Directional Change Capability: 90 degree with 35 foot radius curve.

3. Minimum distance for single bores and between boring pits:

Pipe Size	Boring Distance
1 to 1-1/2 inches	400 feet
2 to 2-1/2 inches	350 feet
3 to 6 inches	300 feet
Greater than 6 inches	As recommended by equipment manufacturer and approved by ENGINEER

4. Ratio of Reaming Diameter to Pipe Outside Diameter:

a. Nominal Pipe Diameter of 6 Inches and Smaller: 1.5 maximum.
b. Nominal pipe diameter larger than 6 Inches: Submit recommended ratio and reaming procedures for review.

1.5 SUBMITTALS

A. Provide submittals in accordance with Section 01300 – Contractor Submittals.

B. Shop Drawings:

1. Submit technical data for equipment, method of installation, and proposed sequence of construction.

2. Include information pertaining to pits, dewatering, method of spoils removal, equipment size and capacity, equipment capabilities including installing pipe on radius, type of drill bit, drilling fluid, method of monitoring line and grade and detection of surface movement, name plate data for drilling equipment and mobile spoils removal unit.

C. Product Data:

1. Identify source of water used for drilling.

2. Submit copy of approvals and permits for use of water source.

D. Installer Qualifications: Submit history of previous work completed of equivalent nature and scope. Include qualification and experience of key personnel.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.6 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of pipe and invert elevations.

B. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

C. Record actual depth of pipe at 25 feet intervals.

D. Record actual horizontal location of installed pipe at 25 feet intervals.

E. Show depth and location of abandoned bores.

F. Record depth and location of drill bits and drill stems not removed from bore.

1.7 QUALITY ASSURANCE

A. Perform work in accordance with the following:

1. NUCA HDD Installation Guidelines.

2. ASTM F1962.

B. Maintain one copy of each document on site.

1.8 QUALIFICATIONS

A. Installer: Company specializing in performing work of this section with minimum 5 years of experience.

1. Work Experience: Include projects of similar scope and conditions.

2. Furnish list of references upon request.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Provide temporary end caps and closures on piping and fittings until pipe is installed.

B. Protect pipe from entry of foreign materials and water by temporary covers, completing sections of work, and isolating parts of completed system.

C. Accept products on site in manufacturer’s original containers or configuration. Inspect for damage.

D. Use shipping braces between layers of stacked pipe. Stack piping lengths no more than 3 layers high.

E. Support pipes with nylon slings during handling.

1.10 ENVIRONMENTAL REQUIREMENTS

A. Conduct operations so as not to interfere with, interrupt, damage, destroy, or endanger integrity of surface or subsurface structures or utilities, and landscape in immediate or adjacent areas.

1.11 COORDINATION

A. Coordinate work with the local jurisdiction and other utilities within the construction area.

PART 2 PRODUCTS

2.1 DRILLING FLUID

A. Drilling Fluid: Liquid bentonite clay slurry; totally inert with no environmental risk.

2.2 PIPE

A. Pipe shall comply with the requirements of Section 15064 – High Density Polyethylene Pipe (green stripe for chlorine and red stripe for fluoride solution pipelines – no required stripe for the 20-inch pipeline).

2.3 FILL MATERIALS

A. Trench excavation and backfill shall comply with the requirements of Section 02221 - Excavation and Backfill for Buried Pipelines.

2.4 WATER SOURCE

A. Water: Potable, to be arranged by CONTRACTOR.

2.5 UNDERGROUND PIPE MARKERS

A. Trace Wire: All HDPE piping installed by horizontal directional drilling shall be installed with continuous tracer wire, 12 AWG **SoloShot Extra High Strength (EHS) 1245B by Copperhead Industries**, or approved equal, with 45 mil HDPE jacket with minimum 1150 pound break load, or approved equal.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify connection to existing piping system, size, location, and invert elevations are in accordance with Drawings.

3.2 PREPARATION

A. Locate, identify, and protect from damage utilities indicated to remain.

B. Identify required lines, levels, contours, and datum locations.

C. Protect plant life, lawns, rock outcroppings and other features remaining as portion of final landscaping.

D. Protect bench marks, survey control points and existing structures from excavating equipment and vehicular traffic.

E. Establish pipe elevations with not less than 3 feet of cover and as designated on the Drawings.

3.3 DEWATERING

A. Dewatering shall be in accordance with Section 02319 - Dewatering.

B. Intercept and divert surface drainage, precipitation, and groundwater away from excavation through use of dikes, curb walls, ditches, pipes, sumps or other means.

C. Develop and maintain substantially dry subgrade during drilling and pipe installation.

D. Comply with City requirements for discharging water to watercourse, preventing stream degradation, and erosion and sediment control.

3.4 EXISTING WORK

A. Maintain access to existing services indicated to remain.

3.5 EXCAVATION

A. Excavate approach trenches and pits as site conditions require. Minimize number of access pits.

B. Provide sump areas to contain drilling fluids.

C. Install excavation supports as required for safety

D. Restore areas after completion of drilling and carrier pipe installation to an acceptable condition.

3.6 DRILLING

A. Drill pilot bore with vertical and horizontal alignment as indicated on Drawings.

B. Guide drill remotely from ground surface to maintain alignment by monitoring signals transmitted from drill bit.

1. Monitor depth, pitch, and position.

2. Adjust drill head orientation to maintain correct alignment.

C. Inject drilling fluid into bore to stabilize hole, remove cuttings, and lubricate drill bit and pipe.

D. Continuously monitor drilling fluid pumping rate, pressure, viscosity, and density while drilling pilot bore, back reaming, and installing pipe to ensure adequate removal of soil cuttings and stabilization of bore.

1. Provide relief holes when required to relieve excess pressure.

2. Minimize heaving during pullback.

E. After completing pilot bore, remove drill bit.

3.7 DRILLING OBSTRUCTIONS

A. When obstructions are encountered during drilling, notify ENGINEER immediately. Do not proceed around obstruction without ENGINEER's approval.

B. For conditions requiring more than 3 feet deviation in horizontal alignment, submit new shop drawings to ENGINEER for approval before resuming work.

C. Maintain adjusted bore alignment within easement or right-of-way.

3.8 PIPE INSTALLATION

A. After completing pilot bore, remove drill bit. Install reamer and pipe pulling head.

1. Select reamer with minimum bore diameter required for pipe installation.

B. Attach pipe to pipe pulling head. Pull reamer and pipe to entry pit along pilot bore.

C. Inject drilling fluid through reamer to stabilize bore and lubricate pipe.

D. Install piping with horizontal and vertical alignment as shown on Drawings.

E. Protect and support pipe being pulled into bore so pipe moves freely and is not damaged during installation.

F. Do not exceed pipe manufacturer’s recommended pullback forces.

G. Install 12-gauge tracer wire continuous with each bore. Splice trace wire only at intermediate bore pits. Tape or insulate trace wire to prevent corrosion and maintain integrity of pipe detection.

1. Terminate trace wire for each pipe run at structures along pipe system.

2. Provide extra length of trace wire at each structure, so trace wire can be pulled 3 feet out top of structure for connection to detection equipment.

3. Test trace wire for continuity for each bore before acceptance.

H. Provide sufficient length of pipe to extend past termination point to allow connection to other pipe sections.

I. Allow minimum of 24 hours for stabilization after installing pipe before making connections to pipe.

3.9 SLURRY REMOVAL AND DISPOSAL

A. Contain excess drilling fluids at entry and exit points until recycled or removed from site. Provide recovery system to remove drilling spoils from access pits.

B. Remove, transport and legally dispose of drilling spoils.

1. Do not discharge drilling spoils in sanitary sewers, storm sewers, or other drainage systems.

2. When drilling in suspected contaminated soil, test drilling fluid for contamination before disposal.

C. When drilling fluid leaks to surface, immediately contain leak and barricade area from vehicular and pedestrian travel before resuming drilling operations.

D. Complete cleanup of drilling fluid at end of each work day.

3.10 BACKFILL

A. Install backfill as specified in Section 02221 - Excavation and Backfill for Buried Pipelines.

B. Backfill approach trenches and pits with subsoil fill to original elevations of surrounding existing grade.

C. All excavations done within travel lanes of UDOT Right of Way shall be backfilled with flowable fill material (UDOT Section 03575).

D. All excavations done within non-travel lanes (i.e. shoulders) of UDOT Right of Way shall be backfilled with 3/4" Untreated Base Course(UTBC) (UDOT Section 02721)

3.11 ERECTION TOLERANCES

A. Maximum Variation From Horizontal Position: 12 inches

B. Maximum Variation From Vertical Elevation: 2 inches

C. Minimum Horizontal and Vertical Clearance From Other Utilities: 12 inches

D. When pipe installation deviates beyond specified tolerances, abandon bore, remove installed pipe, re-bore, and reinstall pipe in correct alignment.

E. Fill abandoned bores greater than 3 inches in diameter with grout.

3.12 FIELD QUALITY CONTROL

A. Upon completion of pipe installation, test pipe in accordance with the following:

1. Section 15064 - High Density Polyethylene Pipe.

3.13 CLEANING

A. Upon completion of drilling and pipe installation, remove drilling spoils, debris, and unacceptable material from approach trenches and pits. Clean up excess slurry from ground.

B. Restore approach trenches and pits to original condition.

C. Remove temporary facilities for drilling operation.

3.14 DISINFECTION

A. Disinfection shall be in accordance with Section 15063 - Pipeline Testing and Disinfection.

- END OF SECTION –

SECTION 16050

ELECTRICAL GENERAL REQUIREMENTS

PART 1 GENERAL

1.01 DESCRIPTION

A. It is the intent of this part of the Contract Documents to cover all work and materials necessary for erecting complete, ready for continuous use, a tested and working electrical system, substantially as indicated on the Plans and as hereinafter specified.

1.02 GENERAL PROVISIONS

A. Minimum sizes of equipment, electric devices, etc., 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. All work indicated on the Plans is approximately to scale, but actual dimensions and detailed drawings should be followed as closely as field conditions permit. Field verification of scale dimensions on Plans is directed since actual locations, distances, levels, etc. will be governed by field conditions.

C. 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 a decision.

D. The alignment of equipment and conduit shall be varied due to architectural changes, or to avoid work of other trades, without extra expense to OWNER.

E. CONTRACTOR shall furnish and install all 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.

F. All items not specifically mentioned in these Contract Documents or noted on the Plans or accepted shop drawings, but which are obviously necessary to make a complete working installation, shall be deemed to be included herein.

G. CONTRACTOR shall lay out and install electrical work prior to placing floors and walls. He shall furnish and install all sleeves and openings through floors and walls required for passage of all conduits. Sleeves shall be rigidly supported and suitably packed or sealed to prevent ingress of wet concrete.

H. CONTRACTOR shall furnish and install all inserts and hangers required to support conduits and other electrical equipment. If the inserts, hangers, sleeves, etc. are improperly placed or installed, CONTRACTOR shall do all necessary work, at his own expense, to rectify the errors.

I. All electrical equipment shall be capable of operating successfully at full-rated load,

without failure, at an ambient air temperature of 40 degrees C, and specifically rated for an altitude of 4500 feet.

J. CONTRACTOR shall submit shop drawings, data and details to the ENGINEER on all controls, fixtures, wiring, electrical equipment, conduit, etc. for review and acceptance prior to use of any components in the work.

K. All 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 to the state of the art. Damaged materials, equipment and parts are not considered to be new and unused and will not be accepted.

1.03 REGULATIONS AND CODES

A. Electrical work, including connection to electrical equipment integral with mechanical equipment, shall be performed in accordance with the latest published regulations of each of the following as well as all State and local codes.

- NATIONAL ELECTRICAL CODE (NEC)
- NATIONAL ELECTRICAL SAFETY CODE (NESC)
- INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS (IEEE)
- AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)
- AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)
- INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)
- NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)
- NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION (NECA)
- FEDERAL OCCUPATIONAL SAFETY AND HEALTH ACT (OSHA)
- UNDERWRITERS' LABORATORIES, INC. (UL)

1.04 COORDINATION OF THE ELECTRICAL SYSTEM

A. CONTRACTOR shall verify all actual equipment and motor full-load and locked-rotor current ratings. The necessary minimum equipment, wire, and conduit sizes are indicated on the Plans. If CONTRACTOR furnishes equipment of different ratings, CONTRACTOR shall coordinate the actual current rating of equipment furnished with the branch circuit conductor size, the overcurrent protection, the controller size, the motor starter, and the branch circuit overcurrent protection. The branch circuit conductors shall have a carrying capacity of not less than 125 percent of the actual full-load current rating. The size of the branch circuit conductors shall be such that the voltage drop from the overcurrent protection devices up to the equipment shall not be greater than 2 percent when the equipment is running at full-load and rated voltage.

B. The motor running overcurrent protection devices shall be rated or selected to trip at no more than 125 percent of the motor full-load current rating for motors marked to have a temperature rise not over 40 degrees C or motors marked with a service factor not less than 1.15 and at no more than 115 percent for all other types of

motors. The motor controller size shall be coordinated to the current rating and horsepower size of the installed motor.

C. The motor-branch-circuit overcurrent protection device shall trip open in 30 seconds or less on locked-rotor current of the motor. This device shall also protect the motor-branch-circuit conductors and the motor control apparatus against overcurrent due to short-circuits or grounds. The motor control circuits shall have overcurrent protection of the type indicated on the Plans.

1.05 TEST

A. The electrical work shall be free from improper grounds and from short circuits. The correctness of the wiring shall be verified first by visual comparison of the conductor connections with connection diagrams. Individual circuit continuity checks shall next be made by using electrical circuit testers. Last, the correctness of the wiring shall be verified by the actual electrical operation of the electrical and mechanical devices. Any deviation from the wiring indicated on the Plans or accepted drawings shall be corrected and indicated on the Plans.

1.06 CONFORMS TO RECORD DOCUMENTS DRAWINGS

A. Prior to completion of the Contract, CONTRACTOR shall furnish the ENGINEER with a set of electrical plans marked with any changes, deviations or additions to any part of the electrical work.

B. Each conductor shall be identified as required by the Contract Documents. This identification shall be indicated on the record documents drawings to enable rapid and accurate circuit tracing by maintenance personnel.

1.07 SUBMITTALS

A. Submittals shall be in accordance with Section 01300, CONTRACTOR Submittals.

PART 2 PRODUCTS

2.01 **NAMEPLATES**

A. Where indicated on the Plans, CONTRACTOR shall furnish and install nameplates which shall be black lamicoid with white letters. The nameplates shall be fastened to the various devices with round head brass screws. Each disconnect means for service, feeder, branch, or equipment conductors shall have nameplates indicating its purpose. All nameplates shall have 3/8-inch high lettering.

2.02 **AUTOMATIC EQUIPMENT WARNING SIGNS**

A. Permanent warning signs shall be mounted at all mechanical equipment which 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

PART 3 EXECUTION - Not Used

- END OF SECTION -

SECTION 16060

GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes Grounding Electrodes, Conductors, Equipment Grounding Conductors and Bonding.

B. Related Sections:

1. Section 03200 - Concrete Reinforcement.
2. Section 03300 - Cast-In-Place Concrete.

1.2 REFERENCES

A. International Electrical Testing Association

1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

B. National Fire Protection Association:

1. NFPA 70 - National Electrical Code.

1.3 GROUNDING SYSTEM DESCRIPTION

A. Metal underground water pipe.

B. Concrete encased electrode.

C. Rod electrode

1.4 PERFORMANCE REQUIREMENTS

A. Grounding System Resistance: 5 ohms.

1.5 SUBMITTALS FOR REVIEW

A. Section 01300 - Contractor Submittals.

B. Product Data: Provide for grounding electrodes and connections.

1.6 SUBMITTALS FOR INFORMATION

A. Section 01300 - Submittals Procedures.

B. Manufacturer's Instructions: Indicate application conditions and limitations of use

stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.7 SUBMITTALS FOR CLOSEOUT

A. Section 01700 – Project Closeout.

B. Project Record Documents: Record actual locations of components and grounding electrodes.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years experience.

1.9 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.1 ROD ELECTRODES

A. Manufactures:

1. Priority Wire and Cable, P11R22.
2. T&B, 75103.
3. Joslyn.
4. Heary Brothers.
5. Eritech, 613400.

B. Material: Copper-clad steel.

C. Diameter: 3/4 inch.

D. Length: 10 feet.

2.2 MECHANICAL CONNECTORS

A. Manufacturers:

1. Burndy
2. T&B
3. Heary Brothers
4. Joslyn

B. Material: Bronze.

2.3 EXOTHERMIC CONNECTIONS

A. Manufactures:

1. Burndy
2. Caldweld.

2.4 WIRE

A. Material: Tin coated, stranded copper:

B. Grounding Electrode Conductor: Copper conductor as shown on project drawings.

C. Foundation Electrodes: 4 AWG.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that final backfill and compaction has been completed before driving rod electrodes.

3.2 INSTALLATION

A. Instal rod electrodes at locations as shown on drawings

B. Provide bonding to meet Regulatory Requirements.

C. Equipment Grounding Conductor: Provide separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

D. Grounding conductors and bonding jumper conductors shall be continuous from terminal to terminal without splice. Provide grounding for following.

1. Electrical service, its equipment and enclosures.
2. Conduits and other conductor enclosures.
3. Neutral or identified conductor of interior wiring system.
4. Main panelboard, power and lighting panelboards.
5. Non-current-carrying metal parts of fixed equipment such as motors, starter and controller cabinets, instrument cases, and lighting fixtures.

E. Provide concrete-encased electrode system by embedding 20 feet minimum of No. 4 AWG bare copper conductor in concrete footing, 2 inches minimum below concrete surface. Extend No.4 AWG copper conductor to main panel as shown on Drawings.

F. All buried connections shall be exothermic only.

G. All raceways shall include a ground wire.

3.3 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS, Section 7.13.

- END OF SECTION -

SECTION 16070

ELECTRICAL HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Hangers and supports for electrical equipment and systems.

B. Construction requirements for concrete bases

C. Anchors and fasteners.

1.2 RELATED SECTIONS

A. Section 01440 - Quality Control and Materials Testing

B. Section 03300 - Cast - In - Place Concrete

C. Section 16111 - Conduit

1.3 REFERENCES

A. NECA Standard of Installation (National Electrical Contractors Association).

B. NFPA 70 - National Electrical Code.

1.4 SYSTEM DESCRIPTION

A. Contractor shall furnish and install conduit and equipment supports as required by this section.

B. The materials covered by this specification are to be standard equipment of proven ability. Supports shall be designed, constructed and installed in accordance with these specifications, the best practice of the industry and all manufacturers' recommendations and instructions.

1.5 SUBMITTALS FOR REVIEW

A. Section 01300 - Contractor Submittals: Procedures for submittals.

B. Product Data: Provide manufacturer's catalog data for fastening systems.

1.6 SUBMITTALS FOR INFORMATION

A. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation,

and installation of Product.

1.7 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2 .1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel and Fiberglass Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
   a. Allied Tube & Conduit.
   b. Cooper B-Line, Inc.; a division of Cooper Industries.
   c. ERICO International Corporation.
   d. GS Metals Corp.
   e. Thomas & Betts Corporation.
   f. Unistrut; Tyco International, Ltd.
   g. Wesanco, Inc.
2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
4. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel. PVC and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A36, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened

portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

a. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
   (1) Hilti Inc.
   (2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
   (3) MKT Fastening, LLC.
   (4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

a. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
   (1) Cooper B-Line, Inc.; a division of Cooper Industries.
   (2) Empire Tool and Manufacturing Co., Inc.
   (3) Hilti Inc.
   (4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
   (5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for PVC and RMC as required by NFPA 70. Minimum rod size shall be 1/4-inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with single-bolt conduit clamps.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and

communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.

B. Raceway Support Methods: In addition to methods described in NECA 1, PVC and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
3. To Existing Concrete: Expansion anchor fasteners.
4. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete four (4) inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than four (4) inches thick.
5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69
6. To Light Steel: Sheet metal screws.
7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 03300.

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.4 PAINTING

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

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

B. Touchup: Comply with requirements in Division 09 painting sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780. Locate and install anchors, fasteners, and supports in accordance with NECA "Standard of Installation".

1. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.
2. Do not use spring steel clips and clamps.
3. Do not use powder-actuated anchors.
4. Obtain permission from Engineer before drilling or cutting structural members.
5. Do not use plastic tie wrap’s to support or attach sealtite to piping or supports.

D. Fabricate supports from structural steel or formed steel members. Rigidly weld members or use hexagon-head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.

E. Install surface-mounted cabinets and panelboards with minimum of four anchors.

F. Paint all cut surfaces with galvanized paint.

- END OF SECTION -

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SECTION 16075

ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.1 SUMMARY

A. Section includes nameplates and labels; wire and cable markers; conductor colors.

B. Related sections:

1. Section 16123 - Building Wire and Cable

1.2 REFERENCES

A. National Fire Protection Association

1. NFPA 70 - National Electrical Code.

1.3 SUBMITTALS

A. Submit under provisions of Section 01330, Contractor Submittals.

B. Product Data: Provide catalog data for nameplates, labels, and markers.

C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under regulatory requirements. Include instructions for storage, handling, protection, examination, preparation and installation of Product.

1.4 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

PART 2 PRODUCTS

2.1 NAMEPLATES AND LABELS

A. Nameplates: Engraved three-layer laminated plastic, white letters on black background.

B. Locations:

1. Each electrical distribution and control equipment enclosure.
2. Letter Size:
   a. Use 1/8 inch letters for identifying individual equipment and loads.

b. Use 1/4 inch letters for identifying grouped equipment and loads.

3. Labels: Embossed adhesive tape, with 3/16 inch white letters on black background. Use only for identification of individual wall switches and receptacles and control device stations

2.2 WIRE MARKERS

A. Manufacturers:

1. Thomas & Betts, Shur-Code

B. Description: Tubing type wire markers.

C. Locations: Each power and instrumentation conductor/cable shall be marked at panelboard gutters, outlet and junction box load connections. Heat shrink labels to conductors/cables.

D. Legend:

1. Power and Lighting Circuits: Branch circuit or feeder number indicated on drawings.
2. Control Circuits: Control wire number indicated on shop drawings.

2.3 UNDERGROUND WARNING TAPE

A. Manufacturers:
1. Thomas & Betts, Protect-A-Line.
2. Description: 6 inch wide plastic tape, detectable type, colored red with suitable warning legend describing buried electrical lines.

PART 3 EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive nameplates and labels.

3.2 APPLICATION

A. Install nameplates and labels parallel to equipment lines.

B. Secure nameplate to equipment front using screws or rivets.

C. Heat shrink all wire labels.

D. Secure nameplate to inside surface of door on panelboard that is recessed in finished locations.

E. Identify underground conduits using underground warning tape. Install one tape per trench at 3 inches below finished grade.

F. Do not provide concrete encasement for all duct banks. Install underground warning tape 12 inches above duct bank.

3.3 COLOR CODING OF CONDUCTORS

A. All conductors rated at 120/208 volts shall be color and coded as follows:

1. A-Phase Black
2. B-Phase Red
3. C-Phase Blue
4. NeutralWhite
5. Ground Green

B. All conductors rated at 120/240 volts shall be color and coded as follows:

1. A-Phase Black
2. B-Phase Red
3. NeutralWhite
4. Ground Green

C. All conductors rated at 277/480 volts shall be color and coded as follows:

1. A-Phase Brown
2. B-Phase Orange
3. C-Phase Yellow
4. NeutralWhite or Gray
5. Ground Green

D. Instrumentation Cables shall be color and coded as follows:

1. + Clear or Red
2. - Black
3. Triad: Red (+), Black (-), Clear or White (Signal)
4.

- END OF SECTION -

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3SECTION 16100

ELECTRICAL EQUIPMENT

PART 1 GENERAL

1.1 DESCRIPTION

A. This section includes general electrical equipment used to complete the electrical system.

1.2 RELATED SECTIONS

A. Related work specified in other sections includes but is not limited to:

Section 16050 - Electrical General Requirements
Section 16111 - Conduit
Section 16123 - Building Wire and Cables
Section 01700 - Project Closeout

1.3 SUBMITTALS

A. Submittals will be required for all electrical equipment and shall be made in accordance with Section 01300, Contractors Submittals.

PART 2 PRODUCTS

2.1 ENCLOSURES

A. Manufacturers:

1. Hammond
2. Hoffman
3. Or approved equal

B. This specification includes enclosures to house electrical controls, instruments, terminal blocks, etc. If not indicated otherwise they shall be NEMA 12 for indoor and NEMA 3R for vault or outdoor installations.

C. 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.

D. Enclosures shall be 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. They shall be as manufactured by Hoffman, Fischer & Porter, or equal.

E. Finish - Steel: Finish shall be white enamel interior, light grey enamel, ANSI 61 exterior, over phosphatized surfaces. Special finishes and colors shall be furnished for wet locations. Plans shall be checked for special conditions.

2.2 CONTROL PANELS

A. ENCLOSURES

1. Manufacturers:
   a. Hammond Manufacturing
   b. Hoffman
   c. Rittal
   d. Or approved equal.
2. This specification includes enclosures to house electrical controls, instruments, terminal blocks, etc. If not indicated otherwise they shall be NEMA 12 for indoor and NEMA 3R for outdoor installations.
3. 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.
4. Enclosures shall be 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. They shall be as manufactured by Hoffman, Fischer & Porter, or equal.
5. Finish - Steel: Finish shall be white enamel interior, light grey enamel, ANSI 61 exterior, over phosphatized surfaces. Special finishes and colors shall be furnished for wet locations. Plans should be checked for special conditions.

B. PILOT DEVICES:

1. Manufacturers:
   a. Allen-Bradley, Bulletin 800T, 30 mm
   b. Eaton
   c. Square D, Type K, 30 mm - Class 9001
   d. Or equal.
2. Indicating lights, pushbuttons and selector switches shall be miniature oiltight units. Contact blocks in control circuits shall be NEMA ICS, B150, rated 5 amperes inductive at 120 volts AC. Contact blocks for signal circuits shall be rated 0.06 amperes at 30 volts AC or DC and shall be hermetically sealed and reed switches. Pilot lights for 120 volt AC circuits shall be LED type. Where group lamp test circuits are not specified, individual pilot light assemblies shall be "push-to-test" type. Pilot lights shall be capable of being changed from the front of the panel without special tools.

C. TERMINAL BLOCKS:

1. Manufacturers:
    a. Entrelec (ABB) M4/6
    b. Square D Co.,
    c. Buchanan,
    d. Allen-Bradley,
    e. Or equal
2. Terminal blocks shall be of the size required for conductors therein and a minimum of 50 percent spares shall be provided in each terminal box.

D. FUSE BLOCKS:

1. Manufacturers:
    a. Entrelec (ABB), M10/13.SF2
    b. Or approved equal.
2. DIN rail mounted.
3. Terminals shall accommodate 22-10 AWG solid or stranded wires.
4. Provide terminals rated for 600 VAC/VDC and 15 amperes.
5. Device shall be UL listed.

E. DIN RAIL CIRCUIT BREAKERS

1. Manufacturer/Model:
    a. Eaton/FAZ-NA
    b. Approved Equal.
2. DIN Rail mounted.
3. Trip Characteristics: UL C or D.
4. UL Listed under UL 489.
5. Dual rated for AC or DC applications.
6. Single-pole, two-pole or three-pole models.
7. Current limiting design.
8. Thermal-magnetic overcurrent protection.
9. Trip-free design.

F. DIN-RAIL DUPLEX RECEPTACLE

1. Manufacturer/Model:
    a. Phoenix Contact/EM-DUO
    b. Approved Equal.
2. Color: Ivory.
3. UL: 508
4. Voltage: 125 VAC
5. Amps: 15A.
6. Mounting: Din rail.

G. CONTROL RELAYS:

1. Manufacturer:
    a. Idec RH series.
    b. Allen-Bradley

c. Or equal.

2. Control relays shall be general purpose “midget” relays, 10 ampere contact rating, with 1, 2, 3 or 4 Form C contacts as shown on the drawings.
3. Relay shall be provided with blade style terminals.
4. Provide LED indicator light with relay.
5. Provide a standard DIN rail mount relay socket.
6. Relay life expectancy shall be in excess of 500,000 operations at 120 VAC.
7. Device shall be UL listed.

2.3 PROCESS SWITCHES

A. LEVEL SWITCH - FLOAT

1. Manufacturer/Model:
   a. IMO Industries, Inc. Gems Sensors Division, LS-270.
   b. No Equals.
2. Stem: 316 Stainless Steel
3. Float: Buna N
4. Operating Temperature:
   a. Water: to 180-degrees F.
5. Minimum Liquid Specific Gravity: .65
6. Pressure (MAX): 150 PSI
7. Switch Rating: 20 VA
8. Electrical Termination: No. 22 AWG, 24-inches long, Polymeric Lead Wires.
9. Selectable Normally Open (NO) or Normally Closed (NC) by inverting float on unit stem.

B. ELECTRO-OPTIC LIQUID LEVEL SWITCH

1. Manufacturer/Model:
   a. Gems ELS Series Level switches w/Opto-Pak Controller
   b. Approved Equal.
2. Switch shall be small size with no moving parts. Unit to be installed in the inner spatial space in the storage tank. Unit shall offer ±1mm repeatability.
3. Unit shall operate with an infrared LED light source and receiver.
4. Unit shall provide TTL signal to an Electro-Optic Converter.
5. The Opto-Pak controller shall convert 120 VAC to the power requirement for the optical sensor. The unit shall have a SPDT, 5 amp relay output. Unit shall be supplied with a self-contained NEMA 4X enclosure.
6. Install optical sensor in tank inner spatial space. Install optical relay in the control panel and/or RTU enclosure.

2.4 MISCELLANEOUS

A. ALARM LIGHT

1. Manufacturer/Model:
   a. Federal Signal/FB2PST
   b. Or approved equal.

2. Power: 120VAC
3. Lens Color: Red.
4. Tube: 10,000 hour strobe.
5. Suitable for indoor or outdoor use.
6. UL Listed.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install as required by the manufacturer.

- END OF SECTION -

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SECTION 16111

CONDUIT AND ACCESSORIES

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes all conduit, fittings, boxes and accessories.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Rigid Steel Conduit (RMC):

1. Allied Tube and Conduit Corporation
2. Triangle PWC, Incorporated
3. Republic Steel Corporation
4. Occidental Coating Company
5. Robroy Industries Incorporated

B. Rigid Non-metallic Conduit:

1. Carlon Products Division, Continental Oil Company
2. Kraloy Plastic Pipe Company
3. Certain-Teed Products Corporation

C. Liquid Tight Flexible Metal Conduit (LFMC)

1. Anamet, Inc.
2. Electri-Flex Company.
3. International Metal Hose Company.

D. Liquid Tight Flexible Non-Metallic Conduit (LFNC)

1. AFC Cable Systems, Inc. (Liquid Tuff)
2. Or Equal.

E. Conduit Fittings for Rigid Metallic Conduit:

1. Heavy-duty Fittings:
   a. Appleton Electric Company
   b. Crouse-Hinds Company
   c. O.Z. Gedney Company
2. Conduit Expansion and Deflection Fittings:
   a. O.Z. Gedney Company
3. Wall Entrance Seals:
   a. O.Z. Gedney Company
   b. Spring City Electrical Manufacturing Company

4. Conduit Boxes for Rigid Metallic Conduit:
   a. E.M. Wiegmann and Company

F. Supports:

1. Occidental Coating Company, Ostrut
2. Unistrut Products Corporation
3. Van-Huffel Tube Corporation, Power-Strut
4. Super Strut, Inc.

2.2 DESIGN REQUIREMENTS

A. Each length of conduit furnished with coupling on one end and metal or plastic thread protector on other end.

B. UL listed and labeled on each conduit length, fitting and accessory.

C. Sizes of conduit, fittings and accessories as required by the National Electrical Code (NEC).

2.3 RIGID STEEL CONDUIT

A. Mild ductile steel, circular in cross section with uniform wall thickness sufficiently accurate to cut clean threads.

B. Each length threaded on both ends and threads protected.

C. All scale, grease, dirt, burrs and other foreign mater removed from inside and outside prior to application of coating materials.

D. Galvanized by the hot-dip process as follows:

1. Interior and exterior surfaces coated with a solid, unbroken layer of 99 percent virgin zinc by dipping.
2. Coating not to show fixed deposits of copper after four 1-minute immersions in a standard copper sulfate solution.
3. One coat of zinc chromate finish on inside and outside surfaces to prevent oxidation and white rust.

E. Couplings and elbows fabricated, coated and finished by the same process as conduit.

2.4 RIGID NON-METALLIC CONDUIT

A. Fabricate from self-extinguishing high-impact polyvinyl chloride.

B. Fittings and accessories fabricated from same material as conduit.

C. Solvent-cement-type joints as recommended by manufacturer.

D. Inside diameter no less than that of rigid steel conduit.

E. Dielectric strength a minimum of 400 volts per mil.

F. Rated and labeled for use with 90 degrees C rated conductors.

2.5 LIQUID TIGHT FLEXIBLE METAL CONDUIT

A. Conduit shall be suitable for wet and dry locations, direct burial applications, concrete embedment area, and outdoor rated areas. Applications include connections to vibrating equipment.

B. Conduit shall be rated for special applications where needed such as low smoke/zero halogen, extra oil resistant, extreme temperature, corrosion resistant, and color identification.

C. Shall be in compliance with UL 360.

D. Shall be suitable for hazardous installation and meet NEC Code articles 501, 502, and 503 requirements.

E. Conduit shall integral bond wire allowing the armor to be used as a ground in accordance with NFPA 70 (NEC).

F. Fittings for LFNC shall be in compliance with UL 514B.

2.6 LIQUID TIGHT FLEXIBLE NON-METALLIC CONDUIT

A. Conduit shall be suitable for wet and dry locations, direct burial applications, concrete embedment area, and outdoor rated areas. Locations are in a corrosive environment and when a non-metallic conduit is required.

B. Conduit shall be rated for special applications where needed such as corrosion resistant and color identification.

C. Shall be compliance with UL 1660.

D. Shall be suitable for hazardous installation and meet NEC Code articles 501, 502, and 503 requirements.

E. Fittings for SFNC shall be in compliance with UL 514B.

2.7 CONDUIT FITTINGS FOR RIGID METALLIC CONDUIT

A. Heavy-duty cast malleable iron or aluminum for all types of fittings:

1. Mogul type for conduit sizes 2 inches and larger.
2. LBD or roller action type LB for right angle fittings for conduit sizes 2 inches and larger.
3. Full-threaded hubs and rubber-gasketed covers.

4. Zinc, cadmium-plated or bronze hardware bolts, screws and bushings for assembly.
5. Iron type fittings to be cadmium-plated or galvanized.
6. Standard and junction fittings.
7. Coupling and elbows fabricated from the same material as conduit and each treated as required for the conduit.
8. All fittings and couplings shall be full-threaded type. Split or set screw types are not allowed.

B. Conduit expansion and deflection fittings:

1. Expansion fittings:
   a. Galvanized expansion fittings for conduit movement up to 1/2-inch.
   b. Insulated metal bushing on ends of the conduit, bonding jumper, and with expansion head sealed with a high-grade graphite packing.
2. Deflection fittings:
   a. Fitting shall provide for a movement of 1/2-inch from the normal in all directions. When used for angular movement, fitting shall allow for a deflection of 30-inches from the normal in any direction.
   b. Fitting shall have copper alloy coupling at both ends, a neoprene sleeve with stainless steel bands and a tinned flexible copper braid bonding jumper internal to the neoprene sleeve and terminating on the copper alloy couplings.

C. Wall Entrance Seals:

1. O.Z. Gedney Company, Type WDP, or
2. Spring City Electrical Manufacturing Company, Type WDP.

2.8 CONDUIT BOXES FOR RIGID METALLIC CONDUIT

A. Steel Boxes:

1. Electro-galvanized steel boxes
2. Galvanized steel covers
3. Cadmium-plated or bronze screws and bolts

B. Minimum gauge requirements:

No surface area exceeds	No single dimension exceeds	Aluminum Steel (MSG)	(B&S)	
360 sq in	24 i	16	12	
1,000 sq I	20	20 in	14	10
1,500 sq in	60 in	12	8	
over 1,500 sq in	over 60 in	10	6C	

C. Threaded conduit entrances or waterproof hubs outdoors and in other areas subject to moisture.

D. Include provisions for mounting cable supports as required by NEC.

E. Nonmetallic Outlet and Device Boxes:

1. Boxes shall be sized in accordance with NEC.
2. Comply with NEMA 0S2 and UL 514C.
3. Box Dimensions: 3 inches square by 1-1/2 inches deep or 4 inches square by 2-1/8 inches deep, depending on device depths and wiring fill. Provide wider boxes for applications where more than two devices will be installed.
4. Gangable boxes (using multiple single-gang boxes to assemble multi-gang boxes) are prohibited.

2.9 SUPPORT SYSTEM

A. Use galvanized steel conduit clamps to support all exposed metallic conduit.

B. Use non-metallic clamps to support non-metallic conduits.

C. Fabricated from structural steel or manufactured framing members equal to "Unistrut" P-1000 series as manufactured by Unistrut Corporation unless otherwise indicated.

D. All necessary rods, anchors, inserts, clamps, spacers, shims, bolts and miscellaneous steel.

E. Galvanized or cadmium-plated members.

F. Use non-corrodible metal, galvanized metal or cadmium-plated metal for nuts, bolts, washers, shims and other small accessories.

PART 3 EXECUTION

3.1 INSTALLATION

A. General Requirements

1. Conduit shall be no smaller than 3/4 inch, except ½ inch may be used for connection to control devices, and light fixture stem hangers where necessary.
2. Size conduit in accordance with NEC requirements.
3. Holes and sleeves:
   a. Provide holes and sleeves through floors, walls, ceilings and roofs as necessary for conduit runs, including weatherproofing at outside walls and on roofs.
   b. Furnish sleeves for all holes and forms for all openings in new work.
   c. Core drill all holes in existing work using a dustless method. All core drilling locations shall be approved by the OWNER before Work commences.
   d. Seal all conduit penetration with an approved material.
   e. Provide air seals for holes and openings in floors, walls, ceilings,

and roofs between interior and exterior areas and between temperature controlled and non-temperature controlled areas.

f. All holes cut in fire-rated structures shall be properly sealed with materials that will provide the same fire rating.

4. Make connections including any required punching to boxes, panels and other equipment as follows:
   a. Indoors: Double locknuts, one inside and outside.
   b. Outdoors: Use threaded conduit fittings or waterproof hubs.
   c. Due to wire sizing requirements, conduit sizes may be larger than attachment means provided on equipment. In those instances, furnish necessary reducing fittings or boxes.
5. Drill and tap motor main and auxiliary terminal boxes as required, and make connections as follows:
   a. Indoors: Double locknuts, one inside and outside.
   b. Outdoors: Use threaded conduit fittings or waterproof hubs.
6. Running threads are not acceptable.
7. Coat all field cut threads, scars, or wrench abrasions in galvanized conduit with an approved organic zinc rich primer.

B. Do not exceed the following number of bends between cable pulling points:

Max. Length of Run in Feet	Max. No. of 90-degree Bends
0-49	4
50-99	3
100-149	2
150-199	1

1. Place drainage fittings or weep holes (for boxes only) at low points where moisture can collect, except in hazardous areas.
2. Metallic conduit systems shall be electrically continuous in their entirety, with bonding jumpers provided as required by NEC.
3. Provide suitable protection for conduit risers against damage during construction.
4. Carefully ream ends of all conduit lengths after cutting to eliminate sharp burrs.
5. Clean out all conduit before pulling wire.
6. Cap all spare conduits after cleaning where conduits are to be left empty. Install a 200-pound nylon pull cord before capping.

C. In finished areas, install conduit concealed in walls and above ceilings (or in ceiling slab where suspended ceiling is not specified).

1. Field bends and offsets shall be made without flattening, kinking, rippling or destroying the smooth internal bore or surface of the conduit and to not less than NEC minimum radius. Conduit that shows signs of rippling or kinking shall not be used.
2. Conduits shall not be installed closer than 12-inches to any hot water or steam line, measured from outside of insulation.
3. Aluminum flexible conduit shall not be used.

D. Exposed Installation:

1. Conduits into panels shall be surface mounted from above ceiling.
2. Install horizontal runs as high above floor as possible, and in no case lower than 7 feet above floor, walkway, or platform in passage area.
3. Run conduit parallel or perpendicular to walls, ceilings, beams and columns unless indicated otherwise.
4. Route to clear all doors, windows, access wells and openings.
5. Group parallel runs in neatly aligned banks where possible with minimum of 1-inch clearance between conduits.

E. Cast-In-Concrete Installation:

1. Limit underfloor conduits to those entering building from outside.
2. Do not install conduit in concrete when diameter exceeds one-third of concrete thickness.
3. Install parallel runs with a minimum spacing of three conduit diameters between conduits.
4. Install in floor slabs in as straight a run as possible.
5. Use long radius elbows except on risers where curved portion of elbow would extend above the finished floor or foundation.
6. Make all joints watertight after installation by coating all finished joints with Koppers Bitumastic No. 50 coating.
7. Use expansion fittings with bonding jumpers at all concrete expansion joints.
8. Tie securely in place to prevent movement when concrete is poured.
9. Cap ends of all conduit before concrete is poured.
10. Slope finished floor away from conduit risers.
11. Clean out all conduits immediately after concrete work is finished.
12. Furnish to the OWNER a drawing showing as-built locations of all cast-in-concrete conduits.

F. Buried Installation

1. Limit underfloor conduits to those entering building from outside.
2. Bury conduits a minimum of 24 inches below finish grade unless otherwise approved by OWNER.
3. Before burying or trenching check with the OWNER as to existing grade conditions and the possibility of future coordination problems.
4. Slope conduits away from conduit risers where possible.
5. Use long radius bends at all risers unless otherwise indicated.
6. Provide wall entrance seals where conduit enters the building or sub-grade walls/floors from exterior underground.
7. Maintain 2-foot separation from underground piping.
8. Make all joints watertight after installation by coating all finished joints with Koppers' Bitumastic No. 50 coating on galvanized conduit.
9. Cap ends of all conduit before backfilling.
10. All direct buried conduit in an area outside a building shall have a magnetic "Yellow Warning" ribbon 12-inches directly above and 6-inches below

finished grade measured from the top of the conduit or duct bank.

11. After conduits have been installed in trench, carefully backfill trench in layers of 4 to 8 inches of friable sandy or silty clay containing fine material sufficient to provide a dense mass free of voids and capable of satisfactory compaction and tamp each layer with a power tamp. Backfill material shall be free of roots or other organic matter, refuse, ashes, cinder, frozen earth or other unsuitable material.
12. Furnish to OWNER a Mylar reproducible drawing showing as-built locations of all buried conduit.

G. Rigid Steel Conduit

1. All conduits in the Flow Control Vault shall be Rigid Steel Conduit.
2. Permitted for exposed, concealed, and cast-in-concrete applications.
3. Permitted for buried applications if encased with a minimum of 3-inches of concrete.
4. Embed conduits in masonry walls for light switches, receptacles, and security devices.

H. Rigid Non-metallic Conduit

1. All conduits and device boxes in the Chemical Building shall be PVC schedule 80.
2. Use Type DB conduit for use in direct burial applications. Use Type EB conduit for concrete-encased applications.

I. Conduit Fittings

1. The use of indenter-type fittings shall be prohibited. Die-cast fittings shall not be allowed on any conduit run of any size conduit.
2. Box connectors 1-inch and larger shall be insulated, throat-type or equal type plastic busing.
3. Double lock nuts and plastic bushing shall be used with all rigid conduit.
4. Grounding bushings shall be used on all service conduit and conduits installed in concentric/eccentric knock-outs or reducing washers.
5. Conduit bodies shall not contain splices.

J. Boxes:

1. Install boxes as required by NEC.
2. Provide with 1/4 inch drain holes where installed at indoor termination of duct banks or outdoor conduit run.
3. Indoors, conform to NEMA Type 1 enclosure in all non-hazardous locations.
4. Outdoors and below grade vaults/structures, conform to NEMA Type 3R except in manholes and handholes NEMA Type 4.
5. Furnish 4-inch octagon or square boxes with raised simplex receptacle covers for light fixture outlets
6. Metallic Barriers
    a. Designed not to separate phases of a power circuit.

b. Provide as necessary for the isolation of power circuits from other type circuits.

K. Supports

1. Conduits shall be strapped within 12 inches of couplings, fittings and boxes, minimum of two straps per ten-foot run. Each run shall be strapped at each 90-degree bend.
2. Construct with sufficient rigidity to hold all mounted equipment and material in permanent and neat alignment.
3. Conduit, tubing and boxes shall be supported in an approved manner by means of expansion shields or other approved anchors in concrete or solid masonry, toggle bolts, on hollow masonry units, wood screws or wood and metal screws on metal. Wooden plugs inserted in concrete or masonry units shall not be used as a base for fastening conduits, tubing, boxes, cabinets etc.
4. Design to provide 1/4-inch space between equipment housings and walls or columns upon which they are mounted.
5. Do not exceed load requirements in NEC and NEMA standards.
6. Paint all field cuts or welding of supports with an approved organic zinc rich primer.
7. Use electro-galvanized steel conduit clamps and non-magnetic conduit clamps to support electro-galvanized steel conduit and non-magnetic conduit, respectively.

- END OF SECTION -

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SECTION 16123

BUILDING WIRE AND CABLE

PART 1 GENERAL

1.1 SUMMARY

A. Section includes building wire and cable; wiring connectors and connections.

B. Related sections

1. Section 16075 - Electrical Identification

1.2 SYSTEM DESCRIPTION

A. Six hundred volt lighting and power circuits.

1.3 REFERENCES

A. National Electrical Contractors Association

1. NECA Standard of Installation.

B. International Electrical Testing Association

1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

C. National Fire Protection Association

1. NFPA 70 - National Electrical Code.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years experience.

1.5 REGULATORY REQUIREMENTS

A. Conform to NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.6 PROJECT CONDITIONS

A. Verify that field measurements are as indicated.

B. Conductor sizes are based on copper.

C. Wire and cable routing indicated is approximate unless dimensioned.

1.7 COORDINATION

A. Where wire and cable destination is indicated and routing is not shown, determine exact routing and lengths required.

PART 2 PRODUCTS

2.1 BUILDING WIRE

A. Manufacturers:

1. American Insulated Wire Corporation.
2. Cablec Corporation.
3. Carol Cable Company, Inc.
4. Rome Cable Corporation.
5. Southwire.

B. Description: Single conductor insulated wire.

C. Conductor: Copper, stranded.

D. Insulation Voltage Rating: 600 volts.

E. Insulation: NFPA 70, Type THW/THHN/THWN.

2.2 INSTRUMENTATION WIRE

A. Manufacturers:

1. Alpha Wire Corporation.
2. American Insulated Wire Corporation
3. Belden Wire and Cable.
4. Carol Cable Company, Inc.

B. Description: Twisted Shielded Pair, Twisted Shielded Triad, #18 AWG or larger.

C. Conform to UL 2092, Communications Cable, NEC type CM, tinned copper conductors, 100 percent shielded coverage, polyethylene insulated with PVC jacket.

D. Insulation Voltage Rating: 300 volts.

2.3 WIRING CONNECTORS

A. Manufacturers:

1. 3M.

2.4 ELECTRICAL TAPE

A. Pressure sensitive vinyl

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that interior of building has been protected from weather.

B. Verify that mechanical work likely to damage wire and cable has been completed.

C. Verify that raceway installation is complete and supported.

3.2 PREPARATION

A. Completely and thoroughly swab raceway before installing wire.

3.3 WIRING METHODS

A. Concealed Dry Interior Locations: Use only building wire THHN/THWN insulation, in raceway.

B. Exposed Dry Interior Locations: Use only building wire THHN/THWN insulation, in raceway.

C. Above Accessible Ceilings: Use only building wire THHN/THWN insulation, in raceway.

D. Wet or Damp Interior Locations: Use only building wire, Type THW THHN/THWN insulation, in raceway.

E. Exterior Locations: Use only building wire, Type THW THHN/THWN insulation, in raceway.

F. Underground Installations: Use only building wire, Type THW THHN/THWN insulation, in raceway.

G. Use wiring methods indicated.

3.4 INSTALLATION

A. Route wire and cable as required to meet Project Conditions.

B. Install cable in accordance with the NECA "Standard of Installation."

C. Use stranded conductors only. Solid conductors shall not be permitted on project.

D. Use stranded conductors for control circuits.

E. Use conductor not smaller than 12 AWG for power and lighting circuits, or as shown on drawings.

F. Use conductor not smaller than 16 AWG for control circuits.

G. Use 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 75 feet.

H. Pull all conductors into raceway at same time.

I. Use suitable wire pulling lubricant for building wire 4 AWG and larger.

J. Protect exposed cable from damage.

K. Use suitable cable fittings and connectors.

L. Neatly train and lace wiring inside boxes, equipment, and panelboards.

M. Clean conductor surfaces before installing lugs and connectors.

N. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

O. Use split bolt connectors for copper conductor splices and taps, 6 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of insulation rating of conductor.

P. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.

Q. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

R. Identify and color code wire and cable under provisions of Section 16075. Identify each conductor with its circuit number or other designation indicated.

S. Feeder, branch, control and instrumentation circuits shall not be combined in conduit, wireway, junction or pull boxes; except as permitted in the following:

1. Where specifically indicated on the drawings or field conditions dictate and written permission is obtained from the Owner.
    a. Feeder and branch circuits shall be isolated from each other and from all control and instrumentation circuits.
    b. Control circuits shall be isolated from feeder, branch and instrumentation circuits.
        (1) Where combining control circuits is permitted the combinations shall comply with the following:
            (a) 12 VDC, 24 VDC and 48 VDC may utilize a common raceway.

(2) 120 VDC shall be isolated from all other AC and DC circuits.
(3) AC control circuits shall be isolated from all DC circuits.

c. Instrumentation circuits shall be isolated from feeder, branch and control circuits.
(1) Certain instrumentation equipment are “two-wire” devices which accept a 24 VDC input and produce a 4-20 mA DC output. This wiring shall be in a common raceway.
(2) Where combining of instrumentation circuits is permitted the combinations shall comply with the following:
(a) 4-20 mA DC and 0-10 VDC analog signal circuits may utilize a common raceway.

2. For lighting circuits, multiple branch circuits may be installed in a raceway as allowed by the NEC, with the wire ampacity derated in accordance with the requirements of the NEC. Raceway fill shall not exceed the limits established by the NEC.

T. Ground the drain wire of shielded cables at one end only.

1. The required grounding location is at the RTU or load, not the source.

U. Maintain electrical continuity of the shield when splicing twisted shielded conductors.

3.5 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS, Section 7.3.1.

3.6 TESTING

A. After installation test for cable 600 volts and below:

1. Prior to energization, test cable and wire for continuity of circuiting and short circuits. Megger all feeders and branch circuits rated 100 amps and greater. Submit record in triplicate of megohmeter readings to Engineer.

- END OF SECTION -

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SECTION 16140

WIRING DEVICES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes wall switches; receptacles and device plates.

B. Related Sections

1. Section 16111 - Conduit and accessories.

1.2 REFERENCES

A. National Electrical Contractors Association

1. NECA - Standard of Installation.

B. National Electrical Manufacturers Association:

1. NEMA WD 1 - General Requirements for Wiring Devices.
2. NEMA WD 6 - Wiring Device -- Dimensional Requirements.

C. National Fire Protection Association:

1. NFPA 70 - National Electrical Code.

1.3 SYSTEM DESCRIPTION

A. Interior and exterior devices located as shown on the drawings.

1.4 SUBMITTALS FOR REVIEW

A. Section 01330 – Contractor Submittals.

B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.

1.5 SUBMITTALS FOR INFORMATION

A. Section 01330 – Contractor Submittals.

B. Submit manufacturer's installation instructions.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years experience.

1.7 REGULATORY R REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Provide Products listed and classified by Underwriters Laboratories, Inc., as suitable for the purpose specified and indicated.

1.8 EXTRA MATERIALS

A. Section 01700 - Project Closeout.

PART 2 PRODUCTS

2.1 WALL SWITCHES

A. Manufacturers:

1. Hubbell, 1221W
2. Or equal.

B. Description: NEMA WD 1, Heavy-Duty, AC only general-use snap switch, backwired only.

C. Ratings:

1. Voltage: 120-277 volts, AC.
2. Current: 20 amperes.

D. Body and Handle: White plastic with toggle handle.

2.2 RECEPTACLES

A. Manufacturers:

1. Hubbell, 5362W
2. Or equal.

B. Description: NEMA WD 1, Heavy-duty general use receptacle, back wired only.

C. Ratings:

1. Voltage: 125 volts, AC.
2. Current: 20 amperes.

D. Device Body: White plastic.

E. Configuration: NEMA WD 6, type as specified and indicated.

F. Convenience Receptacle: Type NEMA 5-20R.

2.3 GFCI RECEPTACLES

A. Manufacturers:

1. Hubbell, GF5362W
2. Leviton, 5362-W
3. Or equal.

B. Description: NEMA WD 1, duplex 2-pole, 3-wire grounded receptacle.

C. Ratings:

1. Voltage: 125 volts, AC.
2. Current: 20 amperes.

D. Device Body: White plastic.

E. Configuration: NEMA WD 6, type as specified and indicated.

2.4 WALL PLATES

A. Decorative Cover Plate: Smooth stainless steel.

B. Weatherproof Cover Plate: Gasketed cast metal with hinged gasketed device cover.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that outlet boxes are installed at proper height.

B. If recessed boxes are approved, verify that wall openings are neatly cut and will be completely covered by wall plates.

C. Verify that floor boxes are adjusted properly.

D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

E. Verify that openings in access floor are in proper locations.

3.2 PREPARATION

A. If recessed boxes are approved, provide extension rings to bring outlet boxes flush with finished surface.

B. Clean debris from outlet boxes.

3.3 INSTALLATION

A. Install in accordance with NECA "Standard of Installation."

B. Install devices plumb and level.

C. Install switches with OFF position down.

D. Install receptacles with grounding pole on bottom.

E. Connect wiring device grounding terminal to branch circuit equipment grounding conductor, shall be by a compression lug.

F. Install plates on switch, receptacle, and blank outlets in finished areas.

G. Do not connect wiring devices by wrapping stranded conductor around screw terminal.

H. If recessed boxes are approved, use jumbo size plates for outlets Install led in masonry walls.

I. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.

J. Install protective rings on active flush cover service fittings.

3.4 INTERFACE WITH OTHER PRODUCTS

A. Coordinate locations of outlet boxes to obtain mounting heights indicated on drawings.

B. Install wall switch 48 inches above finished floor.

C. Install convenience receptacle 48-inches above finished floor.

3.5 FIELD QUALITY CONTROL

A. Inspect each wiring device for defects.

B. Operate each wall switch with circuit energized and verify proper operation.

C. Verify that each receptacle device is energized.

D. Test each receptacle device for proper polarity.

E. Test each GFCI receptacle device for proper operation.

3.6 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

3.7 CLEANING

A. Clean exposed surfaces to remove splatters and restore finish.

- END OF SECTION -

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SECTION 16210

UTILITY SERVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Under ground and above ground electrical service systems.

1.2 REFERENCES

A. NFPA 70: National Electrical Code.

B. UL: Underwriters' Laboratories Inc.

1.3 RELATED WORK

A. Inspect, splice, and test continuity for all special telemetry cables prior to backfilling trenches.

1.4 PERFORMANCE REQUIREMENTS

A. Conform to:
   1. NFPA 70.
   2. Electrical authority having jurisdiction.

PART 2 PRODUCTS

2.1 COMPONENTS

A. Conduit: Refer to Section 16111.

B. Concrete: Class 3000 minimum per Section 03300.

C. Cable Lugs: Suitable for application.

D. Duct Spacers: Fabricated plastic, UL approved.

E. Meter Sockets: Provide meter sockets which comply with requirements of power utility company.

F. Metering: Size metering to capacity of main switch or bus as applicable.

2.2 COMMERCIAL METERING PEDESTAL

A. Manufacturers:

   1. Milbank
   2. No equal.

B. Voltage: 480 VAC, 3-phase, 4-wire.

C. Rating: 100A

D. Pedestal shall comply with utility company metering requirements.

2.3 BACKFILL

A. Backfill as required by Rocky Mountain Power.

PART 3 EXECUTION

3.1 PREPARATION

A. As required by the utility company.

3.2 INSTALLATION

A. Slope service to drainage point.

B. Terminate service conduit in main panel and riser pole.

C. Install on undisturbed soil where possible.

3.3 CONDUIT

A. Adjust final slopes on site to coordinate with existing utilities.

B. Tape each conduit to prevent entrance of concrete.

C. After installation, clean and swab ducts.

3.4 SERVICE INSTALLATION

A. Provide conduit from utility pole to power pedestal as required.

B. Coordinate with utility company to install conductor from source to meter. Coordinate trenching, supplying and placing of sand and backfilling with power utility company.

- END OF SECTION -

SECTION 16411

ENCLOSED SWITCHES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes fusible and nonfusible switches.

B. Related Sections:

1. Section 16491 - Fuses.

1.2 REFERENCES

A. National Electrical Contractors Association

1. NECA - Standard of Installation.

B. National Electrical Contractors Association

1. NEMA FU1 - Low Voltage Cartridge Fuses.
2. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

C. International Electrical Testing Association

1. NET ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.3 SUBMITTALS

A. Section 01300 - Contractor Submittals.

1. Product Data: Submit switch ratings and enclosure dimensions.

1.4 CLOSEOUT SUBMITTALS

A. Section 01700 - Project Closeout.

B. Project Record Documents: Record actual locations of enclosed switches and ratings of installed fuses.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

PART 2 PRODUCTS

2.1 FUSIBLE SWITCH ASSEMBLIES

A. Manufacturers:

1. Eaton
2. Square D Company
3. General Electric.
4. Approved equal.
5. Product Description: NEMA KS 1, Type HD enclosed load interrupter knife switch. Handle lockable in OFF position.
6. Fuse clips: Designed to accommodate NEMA FU1, Class R fuses.

2.2 SWITCH RATINGS

A. Switch Rating: Horsepower rated for AC and/or DC as indicated.

B. Short Circuit Current Rating: UL listed for 10,000 rms symmetrical amperes when used with or protected by Class H or K fuses (30-600 ampere) 200,000 rms symmetrical amperes when used with or protected by Class R or Class J fuses (30-600 ampere switches employing appropriate fuse rejection schemes).

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with NECA "Standard of Installation."

B. Install enclosed switches plumb. Provide supports in accordance with Section 16050.

C. Provide fuses for fusible disconnect switches.

D. Locate and install engraved plastic nameplates under the provisions of Section 16075.

E. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

- END OF SECTION -

SECTION 16442

PANELBOARDS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Panelboards

1.2 RELATED SECTIONS

A. Section 16060 - Grounding and Bonding.

B. Section 16075 - Electrical Identification

1.3 SUMMARY

A. Contractor shall furnish and install panelboards as indicated on the drawings.

1.4 REFERENCES

A. Institute of Electrical and Electronics Engineers:

1. IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.

B. National Electrical Manufacturers Association:

1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
2. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
3. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
4. NEMA PB 1 - Panelboards.
5. NEMA PB 1.1 - General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less.

C. International Electrical Testing Association:

1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

D. National Fire Protection Association:

1. NFPA 70 - National Electrical Code.

E. Underwriters Laboratories Inc.:

1. UL 67 - Safety for Panelboards.
2. UL 1449 - Transient Voltage Surge Suppressors.

1.5 SUBMITTALS

A. Section 01300 - Contractor Submittals.

B. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes.

C. Product Data: Submit catalog data showing specified features of standard products.

1.6 CLOSEOUT SUBMITTALS

A. Section 01700 - Project Closeout.

B. Project Record Documents: Record actual locations of panelboards and record actual circuiting arrangements.

C. Operation and Maintenance Data: Submit spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

1.8 MAINTENANCE MATERIALS

A. Section 01700 - Project Closeout.

B. Furnish two of each panelboard key. Panelboards keyed alike

PART 2 PRODUCTS

2.1 ARRANGEMENT AND CONSTRUCTION

A. GENERAL:

1. Panelboard interiors shall be completely factory assembled with individually mounted bolt-on devices. Panelboard interiors shall be designed such that individual switching and protective devices can be removed without disturbing adjacent units and without removing the main bus connectors.
2. Panelboard enclosures shall be sized to provide wire bending space in compliance with the requirements of NFPA 70. Gutter space shall be provided on all sides of the panelboard interior to permit marshalling and connection of branch circuit wiring.
3. A directory holder with clear plastic plate and metal frame shall be mounted on the inside of the door.

2.2 GENERAL PURPOSE (NEMA 1) CONSTRUCTION:

A. Panelboard assembly shall consist of a galvanized back box, interior deadfront panel, and front trim and hinged door. The panelboard trim piece shall be provided concealed trim clamps and hinges. The locks shall be flush with cylinder tumbler-type with spring loaded door pulls. Panelboard trim piece shall not be removable with doors in the locked position. All panelboard locks shall be keyed alike.

B. Panelboard mounting shall be as indicated in the panelboard schedule on the Drawings. Panelboard trim shall have a gray, baked enamel finish.

2.3 DRIPROOF (NEMA 12) CONSTRUCTION:

A. Panelboard assembly shall consist of a NEMA 12 enclosure with an interior deadfront panel. Enclosure shall be 14 gauge, minimum, sheet steel construction with continuous hinge, door clamps, and padlocking hasp and staple. Interior deadfront panel shall prevent access to live parts with the panel in place.

B. Panelboard enclosure shall be suitable for surface mounting and shall have a gray, baked enamel finish.

2.4 WATERTIGHT, CORROSION-RESISTANT (NEMA 4X) CONSTRUCTION:

A. Panelboard assembly shall consist of a NEMA 4X enclosure with an interior deadfront panel. Enclosure shall be 14 gauge, minimum, stainless steel construction with stainless steel continuous hinge, door clamps, and padlocking hasp and staple. Interior deadfront panel shall prevent access to live parts with the panel in place.

B. Panelboard enclosure shall be suitable for surface mounting.

2.5 BUS

A. Bus shall be tin plated copper and shall have current ratings as shown on the panelboard schedules, sized in accordance with UL 67. Ratings shall be determined by temperature rise test. Minimum bus size shall be 100 amperes. Panel minimum integrated short circuit rating shall be as shown on the panelboard schedules and shall be equal to or greater than the short circuit interrupting rating of the lowest rated device in the panel.

B. Panelboards shall be provided with a separate copper ground bus and, where specified or indicated, with a full capacity neutral bus.

C. The neutral bus of instrument power panels shall be mounted on insulated stand-offs.

2.6 CIRCUIT BREAKERS

A. Circuit breakers shall be molded-case type provided for the current ratings and pole configurations specified on the panelboard schedule. Circuit breakers shall

have a minimum interrupting current rating as shown on the panelboard schedules.

B. Circuit breakers shall be bolt-on type. Circuit breakers shall be listed in accordance with UL 489 for the service specified. Circuit breakers load terminals shall be solderless connectors.

C. Circuit breakers shall be provided with manufacturer- furnished, machine-printed, circuit number labels on the deadfront of the panelboard.

2.7 NAMEPLATES

A. Nameplates shall be provided in accordance with the requirements of Section 16075 - Electrical Identification.

2.8 EXISTING PANELBOARD MODIFICATIONS

A. Existing circuit breaker panelboards shall be modified as indicated on the Drawings. Where new circuit breakers are installed in existing panelboards, the circuit breakers shall be of the same manufacturer as the panelboard. New circuit directory cards shall be provided and all new and existing circuits typed on the directory.

2.9 Manufacturers:

A. General Electric,

B. Eaton

C. Square D,

D. Or approved equal.

2.10 AIC Rating:

A. Minimum Integrated Short Circuit Rating: 10,000 amperes rms symmetrical for 240 volt panelboards. 42,000 amperes rms for 480 vac panelboards. Or as shown on the drawings.

2.11 CIRCUIT BREAKERS:

A. Molded Case Circuit Breakers: NEMA AB 1, bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles, listed as Type SWD for lighting circuits, Type HACR for air conditioning equipment circuits, Class A ground fault interrupter circuit breakers as indicated on Drawings. Do not use tandem circuit breakers.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install panelboards in accordance with NEMA PB 1.1.

B. Height: top of panelboard +72" above finished floor.

C. Install filler plates for unused spaces in panelboards.

D. Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes to balance phase loads.

E. Install engraved plastic nameplates in accordance with Section 16075 - Electrical Identification.

F. Install spare conduits out of each recessed panelboard to accessible location above ceiling.

G. Ground and bond panelboard enclosure according to Section 16060 - Grounding and Bonding. Connect equipment ground bars of panels in accordance with NFPA 70.

3.2 FIELD QUALITY CONTROL

A. Section 01440 - Quality Control and Materials Testing: Testing and Inspection Services 01700 - Project Closeout.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform circuit breaker inspections and tests listed in NETA ATS, Section 7.6.

D. Perform switch inspections and tests listed in NETA ATS, Section 7.5.

E. Perform controller inspections and tests listed in NETA ATS, Section 7.16.1.

3.3 ADJUSTING

A. Section 01700 - Project Closeout: Requirements for starting and adjusting.

B. Measure steady state load currents at each panelboard feeder; rearrange circuits in panelboard to balance phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.

- END OF SECTION -

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SECTION 16461

DRY TYPE TRANSFORMERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Dry type transformers

1.2 SUMMARY

A. Contractor shall furnish and install transformer as shown on the drawings.

1.3 REFERENCES

A. National Electrical Manufacturers Association

1. NEMA ST 1 (National Electrical Manufacturers Association) - Specialty Transformers (Except General-Purpose Type).
2. NEMA ST 20 (National Electrical Manufacturers Association) - Dry-Type Transformers for General Applications.

B. International Electrical Testing Association

1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.4 SUBMITTALS

A. Section 01300 - Contractor Submittals.

B. Product Data: Submit outline and support point dimensions of enclosures and accessories, unit weight, voltage, kVA, and impedance ratings and characteristics, tap configurations, insulation system type, and rated temperature rise.

C. Test Reports: Indicate loss data, efficiency at 25, 50, 75 and 100 percent rated load, and sound level.

1.5 CLOSEOUT SUBMITTALS

A. Section 01700 - Project Closeout.

B. Project Record Documents: Record actual locations of transformers.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

PART 2 PRODUCTS

2.1 TWO-WINDING TRANSFORMERS

A. Manufacturers:

1. Acme Transformer
2. Square D Company
3. General Electric

B. Product Description: NEMA ST 20, factory-assembled, air-cooled, dry type transformers, ratings as indicated.

C. Primary Voltage: 480 volts, 3 phase.

D. Secondary Voltage: 208/120 volts, 3 phase.

E. Insulation system and average winding temperature rise for rated kVA as follows:

1. 1-15 kVA: Class 185 with 115 degrees C rise.
2. 16-500 kVA: Class 220 with 115 degrees C rise.

F. Case temperature: Do not exceed 35 degrees C rise above ambient at warmest point at full load.

G. Winding Taps:

1. Transformers Less than 15 kVA: Two 5 percent below rated voltage, full capacity taps on primary winding.
2. Transformers 15 kVA and Larger: NEMA ST 20.

H. Sound Levels: NEMA ST 20.

I. Basic Impulse Level: 10 kV.

J. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

K. Mounting:

1. 1-15 kVA: Suitable for floor mounting.
2. 16-75 kVA: Suitable for floor mounting.

L. Coil Conductors: Continuous copper windings with terminations brazed or welded.

1. Enclosure: NEMA ST 20, Type 1 ventilated. Provide lifting eyes or brackets.
2. Isolate core and coil from enclosure using vibration-absorbing mounts.
3. Nameplate: Include transformer connection data and overload capacity based on rated allowable temperature rise.

2.2 SOURCE QUALITY CONTROL

A. Production test each unit according to NEMA

PART 3 EXECUTION

3.1 INSTALLATION

A. Install transformer as shown on drawings.

B. Provide seismic restraints.

C. Provide grounding and bonding in accordance with Section 16060.

3.2 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS, Section 7.2.1.

3.3 ADJUSTING

A. Section 01700 - Project Closeout.

B. Measure primary and secondary voltages and make appropriate tap adjustments.

- END OF SECTION -

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SECTION 16510

LUMINAIRES

PART 1 GENERAL

1.1 SCOPE

A. Furnish all labor, materials, equipment, appliances and perform all operations in connection with, and complete in strict accordance with, this section of specifications and the applicable drawings and subject to the terms and conditions of the contract for the following work:

1. Luminaires and accessories.
2. Lighting Controls.

1.2 APPLICABLE SECTIONS

A. The General Conditions, Supplementary General Conditions, alternates and Addenda, applicable drawings and the technical specification including but not limited to the following:

1. Section 01300 - Contractor Submittals
2. Section 01700 - Project Closeout
3. Section 16050 - Electrical General Requirements.
4. Section 16111 - Conduit and Accessories
5. Section 16123 - Building Wire and Cable

1.3 REFERENCES

A. NEMA WD 6 - Wiring Devices-Dimensional Requirements.

B. NFPA 70 - National Electrical Code.

C. NFPA 101 - Life Safety Code.

1.4 SUBMITTALS FOR REVIEW

A. Section 16050 - Electrical General Requirements

B. Shop Drawings: Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.

C. Product Data: Provide dimensions, ratings, and performance data.

1.5 SUBMITTALS FOR CLOSEOUT

A. Section 16050 - Electrical General Requirements

B. Submit manufacturer's operation and maintenance instructions for each product.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.

1.7 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Conform to requirements of NFPA 101.

C. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

1.8 EXTRA PRODUCTS

A. Section 01700 - Project Closeout.

B. Furnish two of each plastic lens type.

PART 2 PRODUCTS

2.1 LUMINAIRES

A. Furnish Products as scheduled.

1. Lighting Fixtures: Shall be as shown in the Lighting Fixture Schedule on the Drawings.

2.2 LIGHTING

A. Lighting fixtures shall be as described below and as indicated on the Plans.

B. Fixtures shall include lamps, ballasts, poles, mounting hardware, etc. to provide complete operating units.

C. Catalog data including applicable coefficients of utilization tables, Isolux chart of illumination on a horizontal plane, beam efficiency, horizontal and vertical beam spread, and beam lumens shall be submitted to the ENGINEER for review and acceptance for all fixtures before fixtures are manufactured. Substitutions will be permitted only if acceptable to the ENGINEER.

D. Light Emitting Diode (LED) Lighting

1. The LED Fixture shall consist of a LED Luminaire Assembly, LED Driver and mounting hardware.
2. LED Fixture requirements are as described below:
   a. The input to the LED Lighting Fixture shall be 120 to 277VAC (±10%), 60HZ or as indicated in the Contract Document.

b. Correlated Color Temperature (CCT) shall be minimum 4000K or as indicated in the Contract Document.
c. Color Rendering Index (CRI) shall be 70.
d. A minimum of 50,000 operating hours before reaching the L70 lumen output degradations point without catastrophic failure, or as indicated in the Contract Document.
e. Conform with UL 8750.
f. Compliance to FCC CFR Section 15.

3. LED Luminaire Assembly
   a. Definition: Luminaire Assembly is the LED assembly without LED driver.
   b. Input voltage shall be 24VDC, 36VDC or as indicated in the Contract Document.
   c. CCT, CRI, Minimum life and UL conformity requirements are as defined in above article LED Lighting Fixture.
4. LED Driver
   a. Must operate input voltage between 120VAC to 277VAC (±10%).
   b. Operating frequency must be 60Hz.
   c. Must be rated to operate between -40ºC to +50ºC.
   d. Must have a minimum efficiency of 85%.
   e. Self-protected including short circuit protection.
   f. Compliance to FCC CFR Section 15.
   g. Driver must have a Power Factor (PF) of 0.90.

E. Types and ratings: As shown on "Lighting Fixture Schedule" on Drawings.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install suspended luminaires using pendants supported from swivel hangers. Provide pendant length required to suspend luminaire at indicated height.

B. Support luminaires independent of ceiling grid, if lay in type ceilings or concealed spline ceilings are used.

C. Locate recessed ceiling luminaires as indicated on reflected ceiling plan.

D. Install surface mounted luminaires plumb and adjust to align with building lines and with each other. Secure to prevent movement.

3.2 INSTALLATION OF LIGHTING FIXTURES

A. Install all lighting fixtures complete and ready for service, in accordance with the Fixture Schedule on the Drawings.

B. Wire all fixtures with fixture wiring of at least 150 degree C rating. Conductors in wiring channels of fixtures mounted in rows shall be the same size as the circuit wiring supplying the rows.

C. Install all fixtures straight and true with reference to adjacent walls.

D. Install all lighting fixtures, including those mounted in continuous rows, so that the weight of the fixture is supported either directly or indirectly by a sound and safe structural member of the building, using adequate number and type of fasteners to ensure a safe installation. Screwed fastenings and toggles through ceiling or wall material are not acceptable. Provide suitable connectors or collars to connect adjoining fixtures in continuous rows.

E. Do not support fixtures from roof deck. Provide Unistrut channels spanning space between roof joists to support fixtures and outlets.

F. Fixtures mounted in lay-in grid ceilings shall have safety support wires to structural roof members as detailed for seismic restraint.

G. All single outlets shall be properly centered in each room. Where two or more outlets occur, they shall be spaced uniformly and in straight lines with each other.

H. Provide plaster frames and support channels around ceiling openings for recessed fixtures. Securely fasten to ceiling structural members.

I. Terminate circuits for recessed fixtures in an extension outlet box adjacent to ceiling opening and connect to fixtures with flexible steel conduit.

J. Where lighting fixtures and other electrical items are shown in conflict with locations and structural members and mechanical or other equipment, provide all required supports and wiring to clear the encroachment.

3.3 ADJUSTING

A. Section 01700 - Project Closeout.

3.4 CLEANING

A. Section 01700 - Project Closeout.

B. Clean electrical parts to remove conductive and deleterious materials.

C. Remove dirt and debris from enclosures.

D. Clean photometric control surfaces as recommended by manufacturer.

E. Clean finishes and touch up damage.

3.5 DEMONSTRATION AND INSTRUCTIONS

A. Section 01700 - Project Closeout.

B. Demonstrate luminaire operation for 12 hours.

3.6 PROTECTION OF FINISHED WORK

A. Re-lamp luminaires that have failed at substantial completion.

- END OF SECTION -