

**CONTRACT DOCUMENTS
AND
SPECIFICATIONS
FOR
PROJECT NO. ES 2019-01
CITYWIDE LIFT STATION IMPROVEMENTS
FRANCIS HILLS RELIEF SEWER AND VENSEL CREEK
LIFT STATION**

ATTENDANCE AT PRE-BID CONFERENCE IS MANDATORY

PREPARED BY:
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**CITY OF
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ENGINEERING SERVICES DEPARTMENT**

Account Numbers: 193320017Z.SewerTreat.75003122-541104; 203320017Z.SewerTreat.7500.75003122-541101; 213150010Z.SewerTreat.Sewer.7500.75003122-541101

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VOLUME II

Technical Specifications

for

CITYWIDE LIFT STATION IMPROVEMENTS
203320017Z.SewerTreat.75003122.541101

**FRANCIS HILLS RELIEF SEWER AND
VENSEL CREEK LIFT STATION**

Project No. ES 2019-01

By The

**Tulsa Metropolitan Utility Authority
Tulsa, Oklahoma**



Holloway, Updike and Bellen

**Consulting Engineers
Muskogee · Broken Arrow**

(918) 251-0717

**HUB Project No. 19TMUACITYLS
C.A. No. 219, Expires 6/30/21**

OCTOBER, 2020

TECHNICAL SPECIFICATIONS
FOR
CITYWIDE LIFT STATION IMPROVEMENTS
FRANCIS HILLS RELIEF SEWER AND VENSEL CREEK LIFT STATION
PROJECT NO. ES 2019-01

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Tulsa Metropolitan Utility Authority
Tulsa, OK

Citywide Lift Station Improvements
Francis Hills Relief Sewer and Vensel Creek Lift Station Improvements
Project No. ES 2019-01


Specification Certification Sheet

1.1	Special Conditions	 <p>Stephen Tolar, P.E. OK 20679</p> <p>Holloway, Updike and Bellen, Inc. C.A. No. 219 Expires June 30, 2021</p>
1.2	Project Storage and Handling Requirements	
1.3	Equipment and Valve Identification	
1.4	Submittals	
2.1	Sitework	
2.2	Chain Link Fence	
2.3	Excavation and Backfill for Structures	
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3.2	Concrete Reinforcement	
3.3	Construction Joints, Expansion Joints and Waterstops	
3.4	Concrete Formwork	
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9.1	Protective Coatings – Ferrous Metals	
9.2	Protective Coatings – Concrete Structures	
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11.2	Submersible Grinder	
S-1.1	Lift Station Construction Standards	

Tulsa Metropolitan Utility Authority
Tulsa, OK

Citywide Lift Station Improvements
Francis Hills Relief Sewer and Vensel Creek Lift Station Improvements
Project No. ES 2019-01

Specification Certification Sheet

16.1	Electrical – General Provisions	 Bruce Brown, P.E. OK 20995 Brown Engineers of Arkansas, LLC. C.A. No. 4933 Expires June 30, 2022
16.2	Electrical – Raceways, Boxes, Fittings and Supports	
16.3	Electrical – Wires and Cables (600 Volt Maximum)	
16.4	Electrical – Miscellaneous Equipment	

1.1 PROJECT TITLE:

Citywide Lift Station Improvements
Francis Hills Relief Sewer and Vensel Creek Lift Station

1.2 PROJECT IDENTIFICATION:

Project No. ES 2019-01

1.3 OWNER:

Tulsa Metropolitan Utility Authority

1.4 PLANS AND SPECIFICATIONS PREPARED BY:

Stephen Tolar, P.E.
Holloway, Updike & Bellen, Inc.
905-A South 9th Street
Broken Arrow OK 74012
(918)-251-0717

1.5 MEASUREMENTS AND PAYMENT:

It is the intent of the Proposal and these Special Conditions that the total bid, as submitted, shall cover all work shown on the contract drawings and required by the Specifications and other Contract Documents. All costs in connection with the work, including furnishing of all materials, equipment, supplies and appurtenances; providing all construction equipment and tools, and performing all necessary labor to fully complete the work, shall be included in the unit and lump sum prices named in the Proposal. No item of work that is required by the Contract Documents for the proper and successful completion of that contract will be paid for outside of or in addition to the prices submitted in the Proposal. All work not specially set forth in the Proposal as a pay item shall be considered a subsidiary obligation of the Contractor and all costs in connection therewith shall be included in the Lump Sum Prices named in the Proposal.

1.6 OWNERS ALLOWANCE:

An allowance has been provided in the contract for various mechanical, electrical, and plumbing (MEP) work.

- A. The Owners Allowance shall be used for the cost of materials, labor, installation, and overhead and profit, in accordance with GC-26, for additional MEP work that is not identified in the Construction Documents / Plans, and not included in the base bid lump sum.

- B. The allowance shall be used only at the discretion of the Authority.
- C. The Contractor shall provide, to the Authority Representative, a written request for the use of the allowance, with a schedule of values, and associated backup information.
- D. Contractor shall proceed with work included in the allowance only after receiving a written order, from the Authority Representative, authorizing such work. Proceeding with work in the allowance without a written order from the Authority Representative will be at the Contractor's cost.

1.7 SCHEDULE OF VALUES:

The Contractor shall prepare a Schedule of Values for the work covered by the Agreement.

- A. Generally, the Schedule of Values should reflect the format of the Proposal and include specified allowances, alternates and any alternate equipment selected by the Owner as applicable.
 - B. For Lump Sum items the Schedule of Values should include breakdowns for major portions of the work including bid proposal and the additional minimum following breakdown:
 - 1. Vensel Creek Lift Station
 - a. Force Main Valve
 - b. Submersible Grinder, Basket Screen and Hatch
 - c. Odor Control Equipment Relocation
 - d. Suction Pipe Improvements
 - e. Concrete resistant coatings
 - f. Electrical and Controls
 - C. An unbalanced or front-end loaded schedule will not be acceptable.
 - D. Summation of the Complete Schedule of Values representing all Work shall equal the Contract Price.
 - E. The Schedule of Values shall be presented to the Owner at the pre-construction meeting.
- #### 1.8 COORDINATION:
- A. Continuous operation of Owner's facilities is of critical importance. Schedule and conduct activities to enable existing facilities to operate continuously, unless otherwise specified, and to minimize the number of shutdowns.

SPECIAL CONDITIONS

1.1 - 3

- B. Perform Work continuously during critical connections and changeovers, as required, to prevent interruption of Owner's operations.
- C. Conduct Work outside regular working hours on prior written consent of Owners to Project schedule and avoid undesirable conditions.
- D. Be responsible for planning, designing, and providing various temporary services, utilities, connections, temporary piping, bypass facilities and temporary connections, and similar items to maintain continuous operations of Owner's facility. Sequences other than those specified will be considered upon written request to Owner and Engineer, provided they afford equivalent continuity of operations.
- E. Do not close lines, open or close valves, or take other action which would affect the operations of existing systems, except as specifically required by the Contract Documents and after authorization by Owner and Engineer. Such authorization will be considered within 48 hours after receipt of Contractor's written request.
- F. Any tanks or pipelines requiring drainage prior to construction will be drained by the Owner's staff to the maximum extent possible utilizing existing piping and drains where they exist. Contractor shall provide temporary pumping and effort to complete drainage of tank or pipeline as required. Provide minimum 7 days notice to Engineer and Owner of need to drain a facility, unless otherwise specified.
- G. Power outages will be considered upon 48 hours written request to Owner and Engineer. Describe the reason, anticipated length of time, and areas affected by the outage in the written request. Provide temporary provisions for continuous power supply to critical existing facility components, as requested by Owner.
- H. Coordinate proposed work with Engineer and Owner before implementing shutdowns. Under no circumstances shall Work end if such actions may inadvertently cause a cessation of any facility operation. In such cases, remain onsite until necessary repairs are complete and facility is brought back online.
- I. Relocation of Existing Facilities:
 - 1. During construction, it is expected that minor relocations of Work will be necessary.
 - 2. Provide complete relocation of existing structures and Underground Facilities, including piping, utilities, equipment and structures, electrical conduit wiring, electrical duct tape, and other necessary items.

SPECIAL CONDITIONS

1.1 - 4

3. Use only new material for relocated facility. Match materials of existing facility, unless otherwise shown or specified.
4. Perform relocations to m minimize downtime of existing facilities.
5. Install new portions of existing facilities in their relocated position prior to removal of existing facilities, unless otherwise accepted by Engineer.

1.7 GENERAL:

The Contractor shall give the Engineer seven (7) calendar days notice prior to starting any work so that a Pre-construction conference can be held with the Owner's representative, the Contractor, and the Engineer. The pre-construction conference will be held at the job site at a time mutually agreed upon, but prior to starting any work.

The Contractor shall provide description for hauling, handling, loading, unloading, stringing, cutting, joining, laying, backfilling or other operations. All technical specifications herein shall be mandatory and shall be followed to the fullest extent.

Deviations from the technical specifications herein, without prior approval from the Engineer, will be cause for the Contractor to perform corrective action as deemed necessary by the Engineer, including the furnishing of additional lengths of replacement pipe if necessary.

1.8 STANDARD SPECIFICATIONS:

The Oklahoma State Highway Commission "Standard Specifications for Highway Construction" edition of 2009 are hereby adopted as part of these specifications where reference is made. Said specifications will be hereinafter referred to as the "Standard Specifications". However, no portion of the Standard Specifications referring to Basis of Payment will be adopted as part of these specifications.

The City of Tulsa standards and other specification sections are hereby adopted as part of these specifications.

Any conflict between the two standards noted above are unintentional and the City of Tulsa standards and specifications shall govern.

1.9 CONTRACTOR'S FIELD OFFICE:

During the performance of this contract, the CONTRACTOR shall maintain a suitable office at or near the site of the work, which shall be headquarters of a representative authorized to receive drawings, instructions, or other communication or articles. Any communication given to the said representative or delivered at the CONTRACTOR's office at the site of the work in his absence shall be deemed to have been delivered to the

CONTRACTOR.

Copies of the Drawings, SPECIFICATIONS, and other CONTRACT DOCUMENTS shall be kept at the CONTRACTOR's office at the site of the work available for use at all times.

The OWNER has no provisions for the CONTRACTOR's field office to be located upon City property. The CONTRACTOR shall be responsible for obtaining a location for his office and stored materials/stockpile facility. This location shall be fenced with a minimum 6' security chain link fence, kept in an orderly fashion, and located in an area where its use by the CONTRACTOR will be in strict accordance with the area zoning requirements and applicable building line set-backs.

1.10 OPERATIONS AND MAINTENANCE MANUALS:

Three (3) hard copies and four (4) digital copies, unless otherwise stated, of a manual containing table of contents, specifications, drawings, descriptions and factory literature of each individual item of equipment; installation instructions; operating and maintenance instructions; Manufacture's inspection reports, initial set points and certifications; and parts lists shall be provided. The manual shall be a single manual covering complete operating installation; separate sheets or brochures for equipment not manufactured by the major supplier shall all be included. These manuals shall be in addition to any instructions packed with the equipment and shall be submitted not later than the date of shipment of the equipment. Each manual shall be bound in a "notebook style" cover having indicated thereon the manufacturer's name and date of purchase, along with a City equipment summary sheet in front of the table of contents. Include photographs of the completed specific equipment with equipment number system and photograph of their equipment tag number in their respective O&M package(s).

All part numbers listed shall be OEM Manufacturer numbers suitable to identify and purchase replacement parts.

O&M Manuals shall include copies of Manufacturer's start up reports and copies of all field notes and set point values.

1.11 CONSTRUCTION PHOTOGRAPHS:

Contractor shall take construction photographs throughout the project and submit monthly to the Engineer. At the end of the project with the record drawings, the Contractor shall submit the complete package of construction photos to the Owner. Photos shall be digital and be 1 megapixel or better. Full construction duration photographs should be provided; including preconstruction, buried piping, buried electrical, abandoned in place items defined by contract, concrete work, plumbing, electrical, equipment, equipment tags and providing a full overview of the construction project from start to finish. Buried piping, duct bank and services shall have special

attention and include all alignments, fittings, bends, quantity of items and any other record information. Exterior photos, including trench lines shall also have special attention and be taken during the time of the day to minimize shadows and provide useful good photos. Construction photos should include not less than seven (7ea) photos per week or more during active construction work onsite.

1.12 OPERATIONAL AND MAINTANENCE TRAINING:

Training shall also be provided for the equipment and systems installed. Submit a draft training agenda, draft handouts, power point/video and a Manufacture's Technical Representative's resume for acceptance prior to scheduling the start-up and training. Provide one train day for each equipment, as coordinated with the Plant to accommodate both day and night shifts. The duration of the training should be a minimum of 4 hours per training day of classroom and field training, or more, if recommended by the Manufacturer. A professional video services shall also be provided to cover both the complete class room and field training sessions. Deliverables are to Include; the full training video on DVD transmittal with the final O&Ms to the City. Provide any additional standard Manufacturer's videos, if available on the same DVD.

1. Grinder
2. Fall Prevention and Retrieval System

END OF SECTION

1.1 SCOPE. This section covers delivery, storage, and handling of materials and equipment.

1.2 DELIVERY. Contractor shall bear the responsibility for delivery of equipment, spare parts, special tools, and materials to the site and shall comply with the requirements specified herein and shall provide required information concerning the shipment and delivery of the materials specified in this Contract. These requirements also apply to any sub-contractor suppliers making direct shipments to the Site.

Contractor shall, either directly or through contractual arrangements with others, accept responsibility for the safe handling and protection of the equipment and materials furnished under this Contract before and after receipt at the port of entry. Acceptance of the equipment shall be made after it is installed, tested, placed in operation and found to comply with all the specified requirements.

All items shall be checked against packing lists immediately on delivery to the site for damage and for shortages. Damage and shortages shall be remedied with the minimum of delay.

Delivery of portions of the equipment in several individual shipments shall be subject to review of Engineer before shipment. When permitted, all such partial shipments shall be plainly marked to identify, to permit easy accumulation, and to facilitate eventual installation.

1.3 STORAGE. Upon delivery, all equipment and materials shall immediately be stored and protected until installed in the Work.

Stacked items shall be suitably protected from damage by spacers or load distributing supports that are safely arranged. No metalwork (miscellaneous steel shapes and reinforcing steel) shall be stored directly on the ground. Masonry products shall be handled and stored in a manner to hold breakage, chipping, cracking, and spalling to a minimum. Cement, lime, and similar products shall be stored off the ground on pallets and shall be covered and kept completely dry at all times. Pipe, fittings, and valves may be stored out of doors, but must be placed on wooden blocking. PVC pipe, geomembranes, plastic liner, and other plastic materials shall be stored off the ground on pallets and protected from direct sunlight.

Pumps, motors, electrical equipment, and all equipment with antifriction or sleeve bearings shall be stored in weathertight structures maintained at a temperature above 60°F. Electrical equipment, controls, and insulation shall be protected against moisture and water damage. All space heaters furnished in equipment shall be connected and operated continuously.

PRODUCT STORAGE AND HANDLING REQUIREMENTS

1.2 - 2

Equipment having moving parts, such as gears, bearings, and seals, shall be stored fully lubricated with oil, grease, etc., unless otherwise instructed by the manufacturer. Manufacturer's storage instructions shall be carefully followed by Contractor.

When required by the equipment manufacturer, moving parts shall be rotated a minimum of twice a month to ensure proper lubrication and to avoid metal to metal "welding". Upon installation of the equipment, Contractor shall, at the discretion of Engineer, start the equipment at one-half load for an adequate period of time to ensure that the equipment does not deteriorate from lack of use.

When required by the equipment manufacturer, lubricants shall be changed upon completion of installation and as frequently as required thereafter during the period between installation and acceptance. New lubricants shall be put into the equipment by Contractor at the time of acceptance.

Equipment and materials shall not show any pitting, rust, decay, or other deleterious effects of storage when installed in the Work.

In addition to the protection specified for prolonged storage, the packaging of spare units and spare parts shall be for export packing and shall be suitable for long-term storage in a damp location. Each spare item shall be packed separately and shall be completely identified on the outside of the container.

- 1.4 HANDLING. Stored items shall be laid out to facilitate their retrieval for use in the Work. Care shall be taken when removing the equipment for use to ensure the precise piece of equipment is removed and that it is handled in a manner that does not damage the equipment.

END OF SECTION

PART 1 – GENERAL

- 1.1 SCOPE. This section covers the furnishing and installation of nameplates and tags for identification of equipment, valves, gates, panels, and instruments.
- 1.2 GENERAL. Except as otherwise specified in equipment, valve, and instrumentation sections, nameplates and tags shall be as specified herein. Nameplates or tags shall be provided for all equipment, valves, operator interfaces, control and electrical panels, cabinets, instruments, and instrument racks that have been named and/or tagged on the Drawings.
- 1.3 SUBMITTALS. Drawings and data shall be submitted in accordance with the requirements of the Submittals Procedures section for each type of tag provided including materials, colors, sizes, letter sizes, and installation instructions.

PART 2 - PRODUCTS

- 2.1 EQUIPMENT NUMBER PLATES. All Equipment tagged on the drawings, except for submerged equipment shall be provided with number plates bearing the equipment tag number and general description of item identified on the Drawings. The number plate and the description plate shall be two plates with number mounted one above the other as coordinated with the Engineer. Number plates shall be bevelled, 1/8th inch thick laminated blue phenolic plastic engraving stock with white core. Lettering on number plates shall be capitalized block letters 3/4 inch high. Number plate height shall be twice the letter height. Number plate length shall be as needed, with suitable margins all around. Lettering shall be placed in one row where practicable; however, where necessary due to excessive length, lettering shall be placed on more than one row and centered.

Number plates shall be attached with stainless steel panhead screws, stainless steel rivets, or stainless steel drive screws.

When a number plate cannot be installed due to the physical size, space, other limitations or mounting surface geometry of the equipment, the Contractor shall provide a 12 gauge stainless steel tag with engraved or imprinted equipment tag number. Lettering on tags shall be 1/4 inch high. Tags shall be rectangular with smooth edges, and shall be fastened to the equipment with stainless steel mechanical fasteners or with a stainless steel chain.

Additional tags showing the primary Equipment Number (ID number) and a secondary equipment description tag shall be provided for ancillary equipment that does not have an individual Equipment Number assigned. Ancillary equipment includes electrical control panels, power panels, transformers, disconnects, seal water stations, valves and other miscellaneous equipment as determined by the Owner.

2.2 VALVE AND GATE TAGS.

- A. Temporary Tags. Each valve and gate with an identifying number indicated on the Drawings or listed in the valve or gate schedule, shall be tagged or marked in the factory with the identifying number.
- B. Permanent Tags. All valves and gates, except buried or submerged valves, that have been assigned a number on the Drawings or in the valve or gate schedule, shall be provided with a permanent number plate. Tags shall be permanently attached to valves and gates with stainless steel mechanical fasteners or with stainless steel chains. Numerals shall be $\frac{3}{4}$ inch high and shall be black baked enamel on an anodized aluminum plate.

All buried valves shall be tagged with a 304 stainless steel $\frac{1}{32}$ " plate with embed anchoring cast into a 18"x18"x6" concrete collar pad at grade around valve box. The numbers and service description shall be engraved in the plate with lettering and numerals at least 1 inch [25 mm] high.

Valve and gate tags shall at a minimum contain the following information:

"Descriptive System or Equipment Name", as applicable

"Equipment Number"

"Plan ID (if different from Equipment Number)"

2.3 EQUIPMENT, PANELS, INSTRUMENTS.

- A. Temporary Tags. Each equipment, panel or instrument with an identifying number indicated on the Drawings or listed in plan sheet schedule as applicable, shall be tagged or marked in the factory, by the factory with the identifying number and description tag.
- B. Permanent Tags. All equipment, panel or instrument that have been assigned a number on the Drawings, City equipment numbering system schedule as applicable, shall be provided with a permanent number and descriptive plate. Tags shall be permanently attached to equipment or item with stainless steel mechanical fasteners. Numerals shall be $\frac{3}{4}$ inch high and shall be black baked enamel on an anodized aluminum plate.

Valve and gate tags shall at a minimum contain the following information:

"Descriptive System or Equipment Name", as applicable

"Equipment Number"

"Plan ID (if different from Equipment Number)"

PART 3 – EXECUTION

Not used. See City of Tulsa standards and other specification sections as applicable.

END OF SECTION

EQUIPMENT NAMEPLATE AND SUMMARY DATA

Equipment Number: _____

Description (Include size): _____

Project #: _____

Spec. #: _____

Vendor: _____

Manufacturer: _____

Model #: _____

*Item or Drawing # _____

*Serial #: _____

Purchase Price: \$ _____

Date Placed in Service (for 1-yr Warranty): _____

Manufacturer's Warranty Period and End Date: _____

Parts / Associated Details: _____

Maintenance Schedule

(May be an attached sheet from O&M Manual; do not use "See O&M Manual")

✓ Initial: _____

✓ Weekly: _____

✓ Monthly: _____

✓ Semi-Annual: _____

✓ Annual: _____

Applicable Motor Information:

N.A. (Circle if not applicable)

Vendor: _____

Manufacturer: _____

Model #: _____

Item #: _____

Serial #: _____

Frame: _____ Insul. Class: _____

Volts/Hz/Amps: _____

HP / RPM / SF: _____

Manufacturer's Warranty Period and End Date: _____

*Item or Drawing # may not be unique. For example, it may be the same for a group of same size valves or gates, each one having this same number that is unique to the group. The Serial # should be listed only when unique to this individual piece of equipment, otherwise it is N.A.

1. SHOP DRAWINGS, SAMPLES AND PRODUCT DATA

- 1.1 GENERAL - Submittals on component parts forming a system, or that are interrelated, shall be submitted at one time as a single submittal in order to demonstrate that the items have been properly coordinated and will function as a unit.
- 1.2 Shop Drawings - Identify details by reference to sheet and detail numbers shown on Contract Drawings. Use same symbols wherever practicable. Reproductions of Contract Drawings are acceptable as shop drawings only when specifically authorized in writing by the Engineer.
- 1.3 Samples - Includes all required physical examples to illustrate materials, equipment or workmanship, which establish standards by which completed work is urged. Must be of sufficient size and clarity, and in sufficient quantity to clearly illustrate functional characteristics and full range of colors, patterns, textures or other properties which will be actually produced.
- 1.4 Product Data - Includes manufacturer's schematic drawings, catalog sheets, brochures, diagrams, schedules, performance charts, illustrations, test reports, certificates of compliance, and other descriptive data not included on shop drawings. Modify standard descriptive data to delete information which is not applicable, and clearly identify pertinent data.
- 1.5 SUBMISSION REQUIREMENTS - Submittals shall be made with a letter of transmittal to the Engineer by the Contractor, and not by sub-contractors, suppliers or manufacturers.
- 1.6 Submit samples in number specified, or if not so specified, in triplicate.
- 1.7 Submit Project Data in sufficient quantity for required distribution and record, allowing two copies to be retained by Engineer.
- 1.8 Identify all submittals with the following information, as applicable:
- Project title and Engineer's project number.
Name of Contractor, Engineer, originating sub-contractor or supplier.
Submittal date, and all revision dates.
Identify each product or material submittal by reference to Specification section and page no., drawing no., or any other contract document reference applicable thereto.
- Applicable conformance standards.

Include certification of Contractor review and conformity to contract requirements per General Conditions, Paragraph 6.25. Identify any deviations from Contract Documents. Provide 3" x 3" minimum space for Engineer's review stamp.

2. PROJECT RECORD DOCUMENTS

- 2.1 MAINTENANCE OF DOCUMENTS - Maintain at jobsite one record copy of Contract Drawings, Specifications, Addenda, approved Shop Drawings, Change Orders, other modifications to the Contract, field test records and other approved documents submitted by Contractor in compliance with Specification requirements.
- 2.2 Maintain documents at the project apart from documents used for construction. Do not use record documents for construction purposes. Maintain documents in clean, legible condition. Make documents available at all times for inspection of the Engineer and Owner.
- 2.3 RECORDING - Label each document "PROJECT RECORD COPY" in 2" high printed letters. Keep record documents current. Do not permanently conceal any work until required information has been recorded.
- 2.4 CONTRACT DRAWINGS - Legible mark most appropriate drawing to record, where applicable:
- Depths of various elements of foundation in relation to first floor level.
 - Horizontal and vertical location of underground utilities and appurtenances referenced to permanent surface improvements.
 - Location of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of structure.
 - Field changes of dimension and detail made during construction process.
 - Changes made by Change Order or Field Order.
 - Details not on original Contract Drawings.
 - Any change in location of facilities. Use City Survey Control System.
- 2.5 SPECIFICATIONS AND ADDENDA - Legibly mark up each Section to record:
- Manufacturer, trade name, catalog number, and supplier of each product and item of equipment actually installed.
 - Changes made by Change Order or Field Order.
 - Other matters not originally specified.
- 2.6 SHOP DRAWINGS - Maintain as record drawings. Legibly annotate shop drawings to record changes made after review. Use red felt tip marking pen for all recording.

2.7 SUBMITTALS- At completion of project, deliver record documents to the Engineer. Accompany submittal with transmittal letter, in duplicate, containing:

- Date, project title and number.
- Contractor's name and address.
- Title and number of each record document.
- Certification that each document as submitted is complete and accurate.
- Signature of Contractor or his authorized representative.

3. PROJECT SUBMITTAL LOG

3.1 Contractor shall provide draft submittal log prior to the first monthly meeting identifying and listing by specification number, description and other submittal information for use on the project. Contractor will incorporate comments provided by the Owners Representative. Log shall separately list the preliminary O&Ms also. Contractor shall maintain and provide a copy of the submittal log at each Monthly Progress Meeting.

END OF SECTION

PART 1- GENERAL

1.1 CLEARING AND GRUBBING

- A. This item shall consist of the clearing and/or grubbing, including the disposal of materials for all areas within the construction limits of work reflected on the plans and any other areas designated on the plans.
- B. Clearing shall consist of the removal of all trees, brush, stumps, logs, or other objects in the designated area(s).
- C. Grubbing shall consist of the removal of all stumps, roots, buried logs, brush, grass, and other unsatisfactory materials to a depth of at least 18 inches unless the object if left would be detrimental to the purpose of the site in which case the object shall be totally removed to at least a depth which would not be detrimental to the purpose of the site.
- D. Depressions left from the clearing and grubbing operations shall be filled using suitable fill material. The fill operation shall be done in six-inch lifts and compacted to 90% in non-paved areas of maximum as determined by the Standard Proctor Test (ASTM D698).

1.2 EXCAVATION AND EMBANKMENT

- A. This item shall consist of the excavation, placement, compaction, and disposal of earth materials within the project area to the lines and grades shown on the plans. The contractor shall remove and dispose of excess excavation off site or provide borrow material from off site, both at his expense.
- B. All excavation and embankment shall be unclassified with respect to pay purposes and shall be included in the lump sum contract price including any rock excavation.
- C. Before beginning excavation, grading and embankment operations in any area, the area shall be completely cleared and/or grubbed.
- D. The suitability of material to be placed in embankments shall be subject to approval by the Engineer. All unsuitable material shall be suitably disposed of by the Contractor. Waste areas shall be graded to allow positive drainage of the area and adjacent areas.
- E. If it is necessary to interrupt existing surface drainage, sewers or under-drainage, conduits, utilities, or similar underground structures the Contractor shall be responsible for and shall take all necessary precautions to preserve them or provide temporary services. When such facilities are encountered, the Contractor

shall notify the Engineer, who shall arrange for their removal if necessary. The Contractor shall, at his/her own expense, satisfactorily repair or pay the cost of all damage to such facilities or structures which may result from any of the Contractor's operations during the period of the contract.

- F. The contractor shall provide drains, pumps, well points or other equipment as necessary to dewater the site as required to perform the sitework.
- G. All fill or embankment shall be placed in six-inch lifts and compacted, using suitable equipment to 95% of maximum as determined by the Standard Proctor Test (ASTM D698). Compliance with this requirement shall be evidenced by independent laboratory tests performed by and paid for by the Owner.
- H. Rock in size or quantities such that a well compacted embankment cannot be assured will not be permitted in the fill material.

Stones or rocks in excess of four inches in their greatest dimension shall not be permitted in the top 24 inches of fill unless specifically required on the Construction Drawings. No rocks or debris larger than 6 inches in their greatest dimension shall be used as backfill.

- I. Blasting will not be permitted
- J. When an embankment is to be constructed on existing grade, all sod and vegetation shall first be removed and the cleared surface scarified to a depth of six inches and compacted to the same density as the fill to be placed.
- K. The Contractor shall provide all necessary water and equipment to assure optimum moisture of fill material.

1.3 TOPSOIL

- A. This item shall consist of the furnishing and placement of topsoil on embankments, excavations or areas directly or indirectly disturbed by the project work. If sufficient topsoil is not available on site the contractor shall obtain topsoil from offsite.
- B. Topsoil shall be the surface layer of soil with no admixture of refuse or material toxic or inhibitive to plant growth and shall be reasonably free of sub-soil, brush, roots, rocks, clay lumps, or similar objects.

The topsoil used from on site or otherwise furnished shall have a pH range of 5.5 to 7.6 when tested in accordance with the "Methods of Testing" of the Association of Official Agricultural Chemists. The organic content shall be not less than 3% nor more than 20% as determined by the Wet Combustion Method (chronic acid

reduction). There shall be not less than 20% nor more than 80% of the material passing the 200 mesh sieve as determined by the Wash Test in accordance with AASHTO T11.

- C. Immediately prior to dumping and spreading topsoil, the surface shall be loosened by disc to a minimum depth of two inches. Prior to placing topsoil the area shall be cleared of rocks in excess of 1½ inches in one dimension and any other debris or trash.
- D. Topsoil shall be spread evenly on the prepared areas to a uniform depth of three inches after compaction.

Spreading shall not be done when ground conditions are too wet or otherwise in a condition detrimental to the work.

After spreading clods shall be broken up and rocks in excess of two inches, and any debris shall be removed.

After spreading and debris removal is complete, the topsoil shall be compacted by rolling with a multi-packer.

1.4 SEEDING

A. General:

This item shall consist of seedbed preparation, furnishing and planting seeds in those areas topsoiled under Item 1.3 of this specification. At Contractor option, established sod can be provided in-lieu-of seeding. Established growth would be considered as healthy green 3" growth for both seeding option and sod option.

B. Materials and Construction Methods:

1. Seed - Seed shall be furnished in sealed bags with each "lot" in separate bags even though mixtures may be called for in this specification. All labeling shall be intact and legible.

The contractor shall furnish the Engineer one (1) copy of the invoices for the seed. The invoice shall describe each specie by name, variety, and treatment (hulled, scarified, etc.) if any.

Each lot of seed furnished shall have been sampled and tested by the Oklahoma State Board of Agriculture, and one (1) copy of the report shall be supplied the Engineer by the Contractor. Each seed test shall have been completed not more than nine (9) months prior to delivery of the seed. The information furnished in the seed report for a particular "lot number" shall

agree with information appearing on the seed tags having the same "lot number".

The seed and tags shall not be removed from the original tagged and sealed bag until approved by the Engineer. After approval, the seed may be mixed, sacked and batched as required to facilitate planting, but shall be tagged for identification and weight. The mixing or batching shall be performed in the presence of the Engineer.

Seed or seed mixture shall be of seed meeting the following specification:

<u>Seed</u>	<u>PLS *Index</u> <u>(Min.)</u>	<u>Purity Min.</u> <u>(%)</u>	<u>Germination Min.</u> <u>(%)</u>	<u>Weed Seeds</u> <u>Max. (%)</u>
Bermuda Grass (Common, Hulled)	82	-	-	0.2
Fescue, Tall	80			0.5

* The P.L.S. (Pure Live Seed) Index shall be calculated from information given on the seed tag as follows:

$$\text{PLS Index} = \% \text{ Purity} \times (\% \text{ Germination} + \% \text{ Firm Seed}) / 100$$

The pounds of seed to be applied is stated as pounds of bulk seed.

Seed shall be applied by the method herein after stated at the following rates.

If seeding operations fall in the months of June, July, or August, the seed shall be common Bermuda grass applied at the rate of 1.5 pounds 1,000 square feet.

If seeding operations fall in the months of September or October seed shall be tall Fescue applied at the rate of 1.5 pounds 1,000 square feet.

No seeding operations shall be carried out in other months of the year with the exception of temporary rye grass seeding.

2. Fertilizer - Fertilizer shall be applied in liquid form with the seed at a concentration to provide the equivalent of a 10-20-10 commercial fertilizer applied at the rate of two hundred (200) pounds per acre.
3. Seeding - Seeding shall be carried out by hydraulic seeding methods utilizing a hydraulic seeder meeting the following minimum requirements.

- a. This equipment shall be factory designed and built with sufficient pump capacity to apply specified quantities. The tank shall hold a minimum of 1,000 gallons and be equipped with a mechanical agitation system with an operating capacity sufficient to suspend and homogeneously mix the seed and water. The distribution hoses shall be large enough to prevent clogging and be equipped with spray nozzles that will provide even distribution on designated areas.
 - b. The equipment shall be mounted on a traveling unit which may be either self-propelled or pulled, capable of getting the tank and nozzles within sufficient proximity of the area to be seeded without the wheels operating on the areas to be seeded.
4. Mulching - In areas where the finished slope exceeds 3% the contractor shall hydromulch the area with wheat straw by adhesive spray methods which shall be applied at the rate of two tons per acre. The cost of mulching shall be included in the lump sum price.
5. Excelsior Mat - The inner slopes and bottom of all drainage diversion ditches shall be hydro sodded with native Bermuda mulch and then covered with excelsior mat. The mat shall conform to Oklahoma Department of Transportation Standard Specifications for Highway Construction, Section 735.05, and installation details per Oklahoma Department of Transportation Standard Drawing NICM

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE

- A. This section covers chain link fencing and gates. Fencing shall be provided in the alignment indicated on the drawings and for the following locations:

- As shown on the Construction Drawings.

1.2 SUBMITTALS

- A. Complete detail drawings and specifications for the fence, gates, and accessories shall be submitted in accordance with the Submittals section.

PART 2 - PRODUCTS

2.1 FENCE TYPES

- A. Fencing shall conform to the details indicated on the drawings and shall be of the following general types.
1. Fencing shall consist fabric as specified herein, with a top rail, bottom tension wire, and three strands of barbed wire mounted on 45-degree extension arms. The upper strand of barbed wire shall be approximately the 18 inches out from the fence and the same distance above the top of the fabric. Posts shall be set in concrete or sleeves as indicated on the drawings.
 2. Fencing Fabric and Heights. Fencing heights, unless otherwise specified on the drawings, shall be as follows:

<u>Location</u>	<u>Fabric</u>	<u>Height</u>
Perimeter	Galvanized steel	6 ft

Fence posts shall be set in earth.

2.2 MATERIALS

- A. Steel Fencing. All steel or malleable iron parts and accessories shall be as follows hot-dip galvanized or aluminum coated after fabrication.

Fabric	9 gauge thick, 2-inch mesh. Galvanized per ASTM A392, Class 2, or aluminum coated per ASTM A491.
Fabric Finish	Knuckled both edges for fabric widths of 60 inches or less. Knuckled one edge and twisted one edge for fabric widths of 72 inches or more.
Posts	Steel pipe, ASTM F1043, Group IC, with ASTM F1043, Type B or D interior and Type B exterior protective coating.
Line Posts	
For 6 foot and 7-foot fencing	2-3/8-inch OD pipe, 3.12 lb./ft.
For 42-inch fencing	1-7/8-inch OD pipe, 1.83 lb./ft.
Terminal Posts (End, corner, and pull posts)	
For 6 foot and 7-foot fencing	2-7/8-inch OD pipe, 4.64 lb./ft.
For 42-inch fencing	1-7/8-inch OD pipe, 1.83 lb./ft.
Gate Posts	
For gate or leaf 6 feet or less	2-7/8-inch OD pipe 4.64 lb./ft.
For gate or leaf wider than 6 feet	4-inch OD pipe, 6.56 lb./ft.
For gate or leaf wider than 13 feet	6-5/8-inch OD pipe, 18.97 lb./ft.
For gate or leaf wider than 18 feet	8-5/8-inch OD pipe, 28.55 lb./ft.
Top Rails	1-5/8-inch OD pipe, 1.40 lb./ft.
Rail Couplings	Sleeve type, 6 inches long, ASTM F626.
Bracing, required when fence height is greater than 6 feet.	Pipe brace same as top rail, with 3/8-inch diameter steel rod truss and tightener.
Post Tops (with barbed wire)	Pressed steel, malleable iron with pressed steel extension arm, or one-piece aluminum casting, ASTM F626.
Post Tops (without barbed wire)	Pressed steel, malleable iron, or cast aluminum, ASTM F626.

Barbed Wire	Each strand shall consist of two 12.5 gage steel wires with four-point barbs; galvanized per ASTM A121, Class 3, or aluminum coated per ASTM A585, Type I.
Stretcher Bars	Steel, ASTM F626, 3/16 by 3/4 inch, or equivalent area.
Fabric Ties	Aluminum bands or wire, ASTM F626.
Gate Frames	Steel tubing, 1-7/8-inch OD, 2.28 lb./ft.
Tension Wire	ASTM A824, galvanized or aluminum coated coil spring wire, 7 gauge.
Handrail-Setting Cement	Minwax "Super Por-Rok Cement" or Master Builders "Set 45".

- B. Aluminum Alloy Fencing - Not Used
- C. Padlocks - Not used.

2.3 GATES

- A. Gates shall be swing type, hinged to swing an angle of 180 degrees from closed to open, complete with frames, latches, hinges, braces, three strands of barbed wire if specified for fencing, and fabric. Stops, keepers, and padlocks shall be provided where specified.
- B. Gate leaves shall have intermediate members and diagonal truss rods where necessary for rigid construction and shall be free from sag or twist. When adjacent fence is topped with barbed wire, gates shall be fitted with vertical extension arms or shall have frame end members extended to carry barbed wire. Joints between frame members shall be made by welding or by means of heavy fittings, and shall be rigid and watertight. Gate fabric shall be same as fence fabric and shall be attached to frame ends by stretcher bars, bolt hooks, or other mechanical means.
- C. Hinges shall be of heavy pattern, with large bearing surfaces, and shall not twist or turn under the action of the gate. Latches shall be plunger bar type, full gate height, and arranged to engage the gate stop, except single gates less than 10 feet wide shall be provided with a forked latch. Latches shall be arranged for padlocking, with the padlock accessible from both sides of the gate.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The installed fence shall conform to the alignment and finished grade indicated. All posts shall be plumb. Unless otherwise indicated on the drawings, posts shall be spaced approximately 10 feet apart. Where necessary, the fence grade shall be adjusted to fit the ground contour by slipping the fence fabric links. Ground surface irregularities shall be graded to maintain not more than 2-inch clearance below the bottom of the fence fabric.
- B. Where the fencing is supported by a concrete structure, posts shall be set in sleeves that provide at least 1/4-inch clearance all around. Sleeves shall be fabricated from Schedule 40 black steel pipe and shall be hot-dip galvanized after fabrication. Sleeves shall be 5 inches long unless otherwise indicated on the drawings. Sleeves shall be rigidly supported in accurate alignment in the forms and shall be positioned vertically so that the top of the sleeve is approximately 1/2 inch below the finished concrete surface. Posts shall be wedged in accurate alignment, and the annular space between posts and sleeves shall be filled with handrail-setting cement to the top of the steel sleeve. Filling of the remaining space with sealant, as indicated on the drawings, is covered in the Caulking section.
- C. Where posts are set in earth, concrete foundations 36 inches deep shall be provided. If bedrock is encountered, post excavation shall be continued to the 36-inch depth or 18 inches into the rock, whichever is less. Concrete foundations shall be circular in horizontal section, not less than 10 inches in diameter for line posts, and with a diameter not less than the post OD plus 9 inches for terminal and gate posts, except that foundations in bedrock shall be at least 6 inches larger than the outside dimension of the post. Foundations shall extend above the ground surface and shall be crowned approximately 1 inch. Concrete for foundations shall conform to the Cast-in-Place Concrete section. Each foundation shall be cured for at least 72 hours before further work is done on the post. If posts are subject to season standing water, creek crossings, adjacent to ponds or other swamp like conditions, the post shall have a 48" burry depth with concrete foundations.
- D. Top rails and bottom tension wires shall be installed before the fabric. Top rails shall be furnished in at least 18-foot lengths and shall be securely connected to gate and terminal posts. Tension wires shall be installed approximately 6 inches above grade and shall be attached to each post and securely anchored at terminal and gate posts. Straight runs between braced posts shall not exceed 250 feet. A terminal post shall be provided at each change in slope.

- E. Fabric shall be attached to the top rail and bottom tension wire at 24-inch centers, and to the line posts at 15-inch centers. Barbed wire, when necessary, shall be fastened to each extension arm by internal clips or external fabric ties. Stretcher bars shall be provided at each gate post and terminal post. Each stretcher bar shall be threaded through the fabric and anchored to the post at 15-inch centers by positive mechanical means.
- F. When necessary, each gate post and terminal post shall be braced by a horizontal pipe brace and an adjustable truss extending to an adjacent line post. Corner posts shall be braced in both directions.
- G. Fabric shall be stretched taut and anchored so that a pull of 150 lbs. at the middle of a panel will not lift the bottom of the fabric more than 6 inches.
- H. Gates shall be installed so that they cannot be removed without disassembly of the hardware. Hardware attachment bolts shall be peened so that removal will be difficult.
- I. Interior and exterior surfaces of aluminum which will be in contact with concrete, mortar, or dissimilar metals shall be given a heavy coat of coal tar paint. The end of each aluminum post to be set in concrete shall be dipped in a container of coal tar paint before installation.

END OF SECTION

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A DESCRIPTION OF WORK

This Section includes the following:

Preparation of subgrade for building slabs and foundation.

Grading, excavation and fill for the site and building pad shall be performed by the contractor to the grades indicated on drawings. The site plan shows approximate existing and proposed finish grades and elevations.

Granular base for support of building slabs is included as part of this work.

Excavating and backfilling of trenches for underground mechanical and electrical utilities and buried mechanical and electrical appurtenances.

Undercut areas of subgrade that are spongy and yielding as designated by the engineer.

B DEFINITIONS

1. Excavation consists of removal of material encountered to subgrade elevations indicated and subsequent disposal of materials removed.
2. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of Engineer. Unauthorized excavation, as well as remedial work directed by Engineer shall be at Contractor's expense.
3. Additional Excavation: When excavation has reached required subgrade elevations, notify Engineer, who will make an inspection of conditions. If Engineer determines that bearing materials at required subgrade elevations are unsuitable, continue excavation until suitable bearing materials are encountered and replace excavated material as directed by Engineer.
4. Subgrade: The undisturbed earth or the compacted soil layer immediately below granular subbase, granular base, or topsoil materials.
5. Structure: Buildings, foundations, slabs, tanks, curbs, or other man-made stationary features occurring above or below ground surface.

C SUBMITTALS

1. Product data for the following:

Each type of plastic warning tape.

Vapor barrier.

2. Samples of the following:

Coordinate, provide access to and provide equipment for selected sample(s) and/or deliver samples to City's Independent Testing lab as required for new work. Submit Reports for products intended for backfill use.

3. Test reports: In addition to test reports required under field quality control, submit the following:

Laboratory analysis of each soil and base course material proposed for fill and backfill from on-site and borrow sources.

One optimum moisture-maximum density curve for each soil material.

Report of actual unconfined compressive strength and/or results of bearing tests of each stratum tested.

D QUALITY ASSURANCE

1. Codes and Standards: Perform excavation work in compliance with applicable requirements of authorities having jurisdiction.
2. Retesting of work: When initial testing indicates unacceptable work or materials, retesting will be paid for by the Contractor until acceptable results are achieved.
3. Codes and Regulations: All operations shall conform to applicable local and state codes and regulations including OSHA requirements.

E PROJECT CONDITIONS

1. Site Information: A soil and foundation investigation is attached to the specifications.
2. Existing Utilities: It is the Contractor's responsibility to locate existing underground utilities in areas of excavation work prior to beginning the excavation. If utilities are indicated to remain in place, provide adequate means of support and protection

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during earthwork operations. The Contractor shall notify the appropriate utility for field location of all utilities.

3. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.
4. Do not interrupt existing utilities serving facilities occupied by Owner or others, during occupied hours, except when permitted in writing by Engineer and then only after acceptable temporary utility services have been provided.
5. Provide minimum of 48-hour notice to Engineer, and receive written notice to proceed before interrupting any utility.
6. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies for shutoff of services if lines are active.
7. Protection of Persons and Property: Barricade open excavations occurring as part of this work and post with warning lights.
8. Operate warning lights as recommended by authorities having jurisdiction. Construction within street right-of-way may require an approved barricade and maintenance of traffic plan.
9. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
11. Perform excavation by hand within drip line of large trees to remain. Protect root systems from damage or dry out to the greatest extent possible. Maintain moist condition for root system and cover exposed roots with moistened burlap.

F SOIL MATERIALS

1. It is acceptable to utilize the on-site soil materials for subgrade construction not indicated to be "backfill or fill" if the material can be successfully proof-rolled with a 20,000 pound pneumatic tired roller or loaded dump truck without excessive rutting or "pumping".
2. Granular Base Course: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, with 100% passing a 3/4" sieve and not more than 5%

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passing a No. 4 sieve. Acceptable material will include coarse aggregate for concrete. Washed Concrete sand may also be used.

3. Backfill and Fill Materials: Soil materials having a liquid limit less than 45 free of rock or gravel larger than 2 inches in any dimension, debris, waste, frozen materials, vegetation and other deleterious matter is designated "satisfactory" and may be used for backfill and fill material.
4. Subbase Material: Soil material designated "satisfactory".
5. Vapor Barrier: Vapor Barrier required under all interior concrete slabs on grade and where noted in Drawings shall be polyethylene sheet, 6 mil thickness conforming to ASTM E-154.

G EXCAVATION

1. Excavation is unclassified and includes excavation to subgrade elevations indicated, regardless of character of materials and obstructions encountered.
2. Under footings, foundation bases, or retaining walls, fill unauthorized excavation by extending indicated bottom elevation of footing or base to excavation bottom, without altering required top elevation. Lean concrete fill may be used to bring elevations to proper position, when acceptable to Engineer.
3. Elsewhere, backfill and compact unauthorized excavations as specified for authorized excavations of same classification, unless otherwise directed by Engineer. If unsuitable bearing materials are encountered at required elevations, carry excavation deeper and replace excavated material as directed by Engineer.
4. Additional Excavation: When excavation has reached required subgrade elevations, notify Engineer who will make an inspection of conditions.
5. Stability of Excavations:
 - a. Slope sides of excavations to comply with local codes, ordinances, and requirements of agencies having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated. Maintain sides and slopes of excavations in safe condition until completion of backfilling.
 - b. Shoring and Bracing: Establish requirements for trench shoring and bracing to conform with local codes and authorities having jurisdiction. Provide materials for shoring and bracing, such as sheet piling, uprights, stringers, and cross braces, in good serviceable condition. Maintain shoring and

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bracing in excavations regardless of time period excavations will be open. Extend shoring and bracing as excavation progresses.

6. Trench and Excavation Safety Systems

- a. Description: This section covers trench and excavation safety system required for constructing improvements that necessitate open excavations on the project. All work under this item shall be in accordance with the current edition of the "Occupational Safety and Health Administration Standard for Excavation and Trenches Safety System", 29 CFR 1926, Subpart P.
- b. Notifications Required: The Contractor, prior to beginning any excavation, shall notify the State Department of Labor (Safety Division) that work is commencing on a project with excavations greater than five feet.
- c. The Contractor shall notify all Utility Companies and Owners in accordance with OSHA Administration 29 CFR 1926.651(b) (2) for the purpose of locating utilities and underground installations.
- d. Existing Structures and Utilities: Where the trench or excavation endangers the stability of a building, wall, street, highway, utilities or other installation, the Contractor shall provide support systems such as shoring, bracing, or underpinning to ensure the stability of such structure or utility. The Contractor may elect to remove and replace or relocate such structures or utilities with the written approval of the Owner of the structure of utility and the Project Owner.
- e. The Contractor shall be responsible for keeping up to date with the most current and updated versions of all standards that apply to their contracted work under this specification section.

H DEWATERING

1. Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area. No fill shall be placed in water or upon saturated soils.
2. Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades and foundations. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.

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3. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to collecting or runoff areas. Do not use trench excavations as temporary drainage ditches.
4. Any dewatering efforts and costs during construction are born to the Contractor and costs shall be included in other items of work.

I STORAGE OF EXCAVATED MATERIALS

1. Stockpile excavated materials satisfactory for backfill and fill where directed. Place, grade, and shape stockpiles for proper drainage.
2. Locate and retain soil materials away from edge of excavations. Do not store within drip line of trees indicated to remain.
3. Dispose of excess excavated soil material and materials not satisfactory for use as backfill or fill.

J EXCAVATION FOR STRUCTURES

1. Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot, and extending a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services, and other construction and for inspection.
2. Excavations for footings and foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed. Trim bottoms to required lines and grades to leave solid base to receive other work.

K TRENCH EXCAVATION FOR PIPES AND CONDUIT

1. Excavate trenches to uniform width, sufficiently wide to provide ample working room and a minimum of 6 to 9 inches of clearance on both sides of pipe or conduit.
2. Excavate trenches and conduit to depth indicated or required to establish indicated slope and invert elevations and to support bottom of pipe or conduit on undisturbed soil. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.
3. Where rock is encountered, carry excavation 6 inches below required elevation and backfill with a 6-inch layer of crushed stone or gravel prior to installation of pipe.

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4. For pipes or conduit less than 6 inches in nominal size, and for flat-bottomed, multiple-duct conduit units, do not excavate beyond indicated depths. Hand-excavate bottom cut to accurate elevations and support pipe or conduit on undisturbed soil.
5. For pipes and equipment 6 inches or larger in nominal size, shape bottom of trench to fit bottom of pipe for 90 degrees (bottom 1/4 of the circumference). Fill depressions with tamped sand backfill. At each pipe joint, dig bell holes to relieve pipe bell of loads ensure continuous bearing of pipe barrel on bearing surface.

L BACKFILL AND FILL

1. General: Place satisfactory soil material in layers to required subgrade elevations, for each area classification listed below, using materials specified herein.
2. Under building slabs, Provide satisfactory non-expansive soils or graded base rock over an acceptable subbase material and provide a granular base immediately under slabs. Backfill under structure slabs and footings if not specifically noted otherwise shall be compacted to 98% standard proctor. Submit backfill material to Engineer for approval.
3. Under piping and conduit and equipment, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation. Shape excavation bottom to fit bottom 90 degrees of cylinder.
4. Backfill trenches with concrete where trench excavations pass within 18 inches of column or wall footings and that are carried below bottom of such footings or that pass under wall footings. Place concrete to level of bottom of adjacent footing.
5. Backfill trenches for utility and piping as required for the area adjacent to the trench.
6. Do not backfill trenches until tests and inspections have been made and accepted. Use care in backfilling to avoid damage or displacement of pipe systems.
7. Backfill excavations as promptly as work permits, but not until completion of the following:
 - a. Acceptance of construction below finish grade including, where applicable, dampproofing, waterproofing, and perimeter insulation.
 - b. Inspection, testing, approval, and recording locations of underground utilities have been performed and recorded.

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- c. Removal of concrete formwork.
- d. Removal of shoring and bracing, and backfilling of voids with satisfactory materials.
- e. Removal of trash and debris from excavation.
- f. Permanent or temporary horizontal bracing is in place on horizontally supported walls.

M PLACEMENT AND COMPACTION

1. Ground Surface Preparation: Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fills. Plow strip, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so that fill material will bond with existing surface.
2. Proof roll all existing soil areas under pavements, buildings and other structural site improvements with a 20,000 pound pneumatic tired roller or loaded dump truck. Areas which can be successfully proof rolled without excessive rutting or "pumping" are acceptable. Where proof rolling cannot be successfully accomplished, scarify and compact to stable condition. If stable condition cannot be achieved, notify Engineer.
3. Place backfill and fill materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
4. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
5. Place backfill and fill materials evenly adjacent to structures, piping, or conduit to required elevations. Prevent wedging action of backfill against structures or displacement of piping or conduit by carrying material uniformly around structure, piping, or conduit to approximately same elevation in each lift.
6. Control soil and fill compaction, providing minimum percentage of density specified for each area classification indicated below. Correct improperly compacted areas or lifts as directed by Engineer if soil density tests indicate inadequate compaction.
 - a. Under pavements, and exterior slabs, compact the upper portion of the

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natural subgrade soils and fill material to not less than 95% of maximum Standard Proctor dry density (ASTM D-698). Compact select fill layer to not less than 95% of maximum modified Proctor dry density (ASTM D-1557).

- b. Under structures and building areas, compact upper 8" of natural subgrade soils; fill and backfill materials (each layer) to 98 % of maximum modified Proctor dry density (ASTM D-1557).
7. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade or layer of soil material. Apply water in minimum quantity as necessary to prevent free water from appearing on surface during or subsequent to compaction operations.
8. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.

N GRADING

1. General: Uniformly grade areas within limits of grading under this section, including adjacent transition areas. Smooth finished surface within specified tolerances, compact with uniform levels or slopes between points where elevations are indicated or between such points and existing grades.
2. Grading Outside Building Lines: Grade areas adjacent to building lines to drain away from structures and to prevent ponding.
3. Surface of fill under Building Slabs: Grade smooth and even, free of voids, compacted as specified, and to required elevation. Provide final grade within a tolerance of 1/2 inch when tested with a 10-foot straightedge.

O BUILDING SLAB BASE

1. General: Building slab base consists of placement of vapor barrier and granular base in layers of indicated thickness, over subgrade surface to support concrete building slabs. Where thickness is not indicated, provide 6 inches compacted thickness.
2. Placing: Place granular base material on prepared subgrade in layers of uniform thickness, conforming to indicated cross-section and thickness. Compaction shall be by powered or hand tampers to 98% maximum density and then install vapor barrier.

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STRUCTURES & UNDERFLOOR UTILITIES

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P FIELD QUALITY CONTROL

1. Quality Control Testing During Construction: Allow testing service to inspect and approve each subgrade and fill layer before further backfill or construction work is performed. Provide 24 hour notice to the Owners representative for any and all upcoming testing. Testing frequency, unless noted specifically otherwise will be provided by and at the discretion of the Owners Representative.
2. If in opinion of Engineer, based on testing service reports and inspection, subgrade or fills that have been placed are below specified density, additional compaction and testing shall be performed at the Contractor's expense until specified density is obtained.

Q EROSION CONTROL AND STORM WATER CONTROL

Provide erosion control and storm water runoff control methods in accordance with requirements of local and state authorities having jurisdiction.

R MAINTENANCE

1. Protection of Graded Areas: Protect newly graded areas from traffic and erosion. Keep free of trash and debris.
2. Repair and reestablish grades in settled, eroded, and rutted areas to specified tolerances.
3. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, reshape, and compact to required density prior to further construction.
4. Settling: Where settling is measurable or observable at excavated areas during general project warranty period, remove surface (pavement, lawn, or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

S DISPOSAL OF EXCESS AND WASTE MATERIALS

Remove trash, debris, and waste materials becomes the property of the Contractor and must be disposed of it off Owner's property.

END OF SECTION

A. GENERAL

This work shall cover the composition, mixing, construction upon the prepared subgrade, and the protection of hot asphalt concrete pavement. The hot asphalt concrete pavement shall consist of an aggregate or asphalt base course and asphalt surface course constructed in conformity with the lines, grades, thickness, and cross sections as shown. Each course shall be constructed to the depth, section, or elevation required by the drawings and shall be rolled, finished, and approved before the placement of the next course.

1. Inspection of plant and equipment

The Engineer shall have access at all times to all parts of the material producing plants for checking the mixing operations and materials and the adequacy of the equipment in use.

2. Alignment and grade control

The contractor's land surveyor shall establish and control the pavement (aggregate or asphalt base course and asphalt surface course) alignments, grades, elevations, and cross sections as shown on the drawings.

3. Submittals

a. Data and Test Reports:

1. Aggregate Base Course: Sources, gradation, liquid limit, plasticity index, percentage of wear, and other tests required by State Highway Department.
2. Asphalt Base/Surface Course: Aggregate source, gradation, soundness loss, percentage of wear, and other tests required by State Highway Department.
3. Job-mix formula.

b. Certifications:

1. Asphalt prime and tack coat material certificate of conformance to State Highway Department requirements.
2. Asphalt cement certificate of conformance to State Highway Department requirements.

3. Job-mix certification - Submit plant mix certification that mix equals or exceeds the State Highway Specification.
- c. One copy of State Highway Department Specifications.
- d. Provide MSDS (Material Safety Data Sheets) for all chemicals used on ground.

B. PRODUCTS

1. Aggregate base and asphalt concrete materials shall conform to the requirements of the following and other appropriate sections of the latest version of the state highway material specifications, including amendments, addenda and errata. Where the term "engineer" is referenced in the state highway specifications, it shall mean the project engineer.
2. Aggregates
 - a. Provide aggregates consisting of crushed stone, gravel, sand, or other sound, durable mineral materials processed and blended, and naturally combined.
 - b. Subbase aggregate (where required) maximum size: (1-1/2").
 - c. Base aggregate maximum size:
 1. Base course over (6") thick: (1-1/2");
 2. Other base courses: (3/4").
 - d. Asphaltic base course:
 1. Maximum particle size not to exceed (1").
 2. Where conflicts arise between this specification and the requirements in the latest version of the State Highway Specifications, the State Specifications shall control.
 - e. Aggregates for asphaltic concrete paving: Provide a mixture of sand, mineral aggregate, and liquid asphalt mixed in such proportions that the percentage by weight will be within:

<u>Sieve Sizes</u>	<u>Percentage Passing</u>
(3/4")	100
(3/8")	67 to 85
(1/4")	50 to 65
(No. 8 mesh)	37 to 50
(No. 30 mesh)	15 to 25
(No. 200 mesh)	3 to 8

plus 50/60 penetration liquid asphalt at 5 percent to 6-1/2 percent of the combined dry aggregates.

3. Asphalts

a. Comply with provisions of Asphalt Institute Specification SS2:

1. Asphalt cement: Penetration grade 50/60
2. Prime coat: Cut-back type, grade MC-250
3. Tack coat: Uniformly emulsified, grade SS-1H

4. Sealer

- a. Provide a sealer consisting of suitable fibrated chemical type asphalt base binders and fillers having a container consistency suitable for troweling after thorough stirring, and containing no clay or other deleterious substance.
- b. Where conflicts arise between this specification and the requirements in the latest version of the State Highway Specifications, the State Specifications shall control.

C. EXECUTION

The Asphalt Concrete Paving equipment, weather limitations, job-mix formula, mixing, construction methods, compaction, finishing, tolerance, and protection shall conform to the requirements of the appropriate sections of the State Highway Specifications for the type of material specified.

1. Mixing Asphaltic Concrete Materials

a. Provide hot plant-mixed asphaltic concrete paving materials.

1. Temperature leaving the plant: 143 degrees C(290 degrees F) minimum, 160 degrees C(320 degrees F) maximum.

2. Temperature at time of placing: 138 degrees C(280 degrees F) minimum.

2. Subgrade

- a. Shape to line and grade and compact with self-propelled rollers.
- b. All depressions that develop under rolling shall be filled with acceptable material and the area re-rolled.
- c. Soft areas shall be removed and filled with acceptable materials and the area re-rolled.
- d. Should the subgrade become rutted or displaced prior to the placing of the subbase, it shall be reworked to bring to line and grade.
- e. Proof-roll the subgrade with maximum (50 ton) gross weight dump truck as directed by Engineer. If pumping, pushing, or other movement is observed, rework the area to provide a stable and compacted subgrade.

3. Base Courses

- a. Subbase (when required)
 1. Spread and compact to the thickness shown on the drawings.
 2. Rolling shall begin at the sides and continue toward the center and shall continue until there is no movement ahead of the roller.
 3. After completion of the subbase rolling there shall be no hauling over the subbase other than the delivery of material for the top course.
- b. Base
 1. Spread and compact to the thickness shown on the drawings.
 2. Rolling shall begin at the sides and continue toward the center and shall continue until there is no movement ahead of the roller.
 3. After completion of the base rolling there shall be no hauling over the base other than the delivery of material for the top course.
- c. Thickness tolerance: Provide the compacted thicknesses shown on the Drawings within a tolerance of minus (0.0") to plus (0.5").

- d. Smoothness tolerance: Provide the lines and grades shown on the Drawings within a tolerance of (3/16 inch in ten feet).
- e. Moisture content: Use only the amount of moisture needed to achieve the specified compaction.

4. Placement Of Asphaltic Concrete Paving

- a. Remove all loose materials from the compacted base.
- b. Apply the specified prime coat, and tack coat where required, and allow to dry in accordance with the manufacturer's recommendations as approved by the Engineer.
- c. Receipt of asphaltic concrete materials:
 - 1. Do not accept material unless it is covered with a tarpaulin until unloaded, and unless the material has a temperature of not less than 130 degrees C(280 degrees F).
 - 2. Do not commence placement of asphaltic concrete materials when the atmospheric temperature is below 10 degrees C (50 degrees F), not during fog, rain, or other unsuitable conditions.
- d. Spreading:
 - 1. Spread material in a manner that requires the least handling.
 - 2. Where thickness of finished paving will be (3") or less, spread in one layer.
- e. Rolling:
 - 1. After the material has been spread to the proper depth, roll until the surface is hard, smooth, unyielding, and true to the thickness and elevations shown on the drawings.
 - 2. Roll in at least two directions until no roller marks are visible.
 - 3. Finished paving smoothness tolerance:
 - a. No depressions which will retain standing water.
 - b. No deviation greater than (1/8" in six feet).

5. Application Of Seal Coat

- a. Prepare the surfaces, mix the seal coat material, and apply in accordance with the manufacturer's recommendations as approved by the Engineer.
- b. Apply one coat of the specified sealer.
- c. Achieve a finished surface seal which, when dry and thoroughly set, is smooth, tough, resilient, of uniform black color, and free from coarse textured areas, lap marks, ridges, and other surface irregularities.

6. Protection

Protect the asphaltic concrete paved areas from traffic until the sealer is set and cured and does not pick up under foot or wheeled traffic.

7. Testing

The Owner shall engage an independent testing laboratory to conduct onsite tests. Contractor will be responsible for assisting in sampling for test at the field directed by the Owners Representative. The Contractor shall be responsible for the costs of work performed by the laboratory required for any retesting or rework resulting in materials placed determined to be unacceptable by the Owner. Additional requirements are defined by City standards as applicable.

At least one test shall be made per placement day (or fraction thereof) placed on any one day and in any event, not less than one test for each type of material utilized that day. One test per 50 tons of materials placed. Additional tests beyond requirements may be pulled at the sole discretion of the Owners Representative,

8. Final Clean-Up

Remove all debris, rubbish, and excess material from the work area.

END OF SECTION

PART 1 - GENERAL

1.1 STANDARDS

- A. Concrete work shall conform to all requirements of ACI 301-89 "Specifications for Structural Concrete for Buildings", ACI 318-89 "Building Code Requirements for Reinforced Concrete" except as modified herein. All ASTM and ACI Standards shall be the latest editions.

1.2 SCOPE

- A. Work consists of furnishing all plant, labor, materials, equipment and appliances, and performing all operations in connection with installation of the concrete work, complete, in strict accordance with the Specifications and Drawings.

1.3 INSPECTION

- A. Embedded items must be inspected and tests for concrete and other materials shall have been completed and approved by the Engineer before concrete is placed.

1.4 SLAB ON EARTH

- A. Before proceeding to construct concrete slabs on earth, all pipes under concrete floor on earth shall have received the required tests. All backfill and fill material under slabs on grade shall be compacted in 6" layers to 95% maximum density as measured by AASHTO T99 test method. Unsuitable material encountered in subgrade shall be removed and replaced with material approved by the Engineer. Subgrade shall be brought to true, even plane and compacted to solid bearing. Gravel drainage fill shall be placed and compacted where shown on Drawings.

PART 2 - MATERIALS

- 2.1 All concrete materials shall conform to the latest revised ASTM Designations listed below and shall be subject to the approval of the Engineer:

- A. Coarse Aggregate shall be crushed stone conforming to ASTM C-33 with a maximum size of 1".
- B. Fine Aggregate shall conform to ASTM C-33 and shall be washed river sand composed of clean, uncoated grains of strong materials.
- C. Cement shall be Portland cement conforming to ASTM Specification C-150, Type I, Type IA, Type III, or Type IIIA. Only one brand of cement shall be used for exposed concrete.

CAST-IN-PLACE CONCRETE

3.1 - 2

- D. Water: Clean, fresh and free from oil, acids, alkali, vegetable, sewage, organic or other deleterious matter.
- E. Cement reducing admixture may be used for all concrete at the contractor's option. Admixture shall be a cement dispersing agent used in conformance with manufacturer's directions. This shall be, or equal to, "No. 3 Pozzolith", as manufactured by Master Builder's Co. Contractor shall notify Engineer that he is taking this option. No other admixtures shall be used without the written permission of the Engineer.
- F. Air-Entraining Admixtures shall conform to ASTM C-260.
- G. Premolded Expansion Joint Filler Strips shall be non-extruding type conforming to the current AASHTO Designation M213.
- H. Non-Shrink Grout shall be Pre-mixed "Embeco" as manufactured by Master Builder's, "Ferrolith G" as manufactured by Sonneborn-Contech, or approved equal. Type as recommended by the manufacturer for the particular applications.
- I. Liquid Curing Compound/Sealer shall be "MC 429" as manufactured by Master Builder's, "Kure-N-Seal" as manufactured by Sonneborn-Contech, "Thompson's Water Seal" as manufactured by E. A. Thompson, Inc. or approved equal.
- J. Granular Drainage Fill: Required under all interior building concrete slabs on grade and where noted on the drawings. It shall be either:
 - 1. Clean, washed gravel with particle sizes grading from maximum of 1" down to not more than 5% passing a No. 4 sieve.
 - 2. Clean, washed coarse sand with particular sizes ranging from pea gravel down to largest grains permitted in concrete sand.
- K. Joint Waterproofing for existing structures or as required on the plans shall be Ironite (Metallic) Waterproofing as manufactured by the Ironite Company of Chicago, Illinois or approved equal.
- L. Vapor Barrier required under all interior concrete slabs on grade and where noted in drawings shall be polyethylene sheet, 6 mil thickness conforming to ASTM E-154.
- M. Liquid Chemical Hardener shall be the magnesium fluosilicate and zinc fluosilicate type "Lapidolith" as manufactured by Sonneborn-Contech, Inc., "Symons Quad Cure" as manufactured by Symons Corp., "Hornolith" as manufactured by W. R. Grace & Co., or approved equal.

- N. Cementitious Waterproofing and Finish Compound shall be "Thoroseal Plaster Mix" with "Acryl 60" as manufactured by Standard Dry Wall Products or equal.

2.2 QUALITY AND CONTROL

A. Design

Concrete shall be composed of Portland cement, fine aggregate, coarse aggregate and water. All concrete shall be designed by an independent testing laboratory, approved by the Engineer, in accordance with the A.C.I. Standard "Recommended Practice for Selecting Proportions for Concrete" (ACI 211) to produce the strength for each class of concrete specified, and with slumps and maximum sizes of coarse aggregate in accordance with the requirements outlined below. The concrete shall be so designed that the concrete materials will not segregate and excessive bleeding will not occur. Submit laboratory trial mix designs and test results for each class of concrete to be used to the Engineer for approval before any concrete is placed. Any costs of the testing laboratory for designing concrete mixes shall be borne by the Contractor. Concrete strengths shall be as follows:

Class A Concrete - 4000 psi minimum @ 28 days (Air entrained) - six (6) sacks cement minimum

Class B Concrete - 3500 psi @ 28 days - five (5) sacks cement minimum

Class C Concrete - 2000 psi @ 28 days

Class D Concrete - 3000 psi @ 28 days (3/8" Max. Aggregate Size "Pea Gravel")

MAXIMUM SLUMPS FOR VARIOUS TYPES OF CONSTRUCTION

<u>Types of Construction</u>	<u>Hand Placed Maximum</u>	<u>High Frequency Vibrator Used - Maximum</u>
Reinforced Foundation & Footings and Base Slabs of Tanks	5"	3"
Slabs, Beams and Reinforced Walls	6"	5"
Building Columns	6"	5"
Pavements	3"	3"

The slump shall not exceed the maximum specified above for the type of

construction for which it is to be used. The 28 day compressive strength determined in accordance with current ASTM Specifications C-39 and C-31 and with specimens cured in accordance with C-31 shall not be less than that shown above for the specified class of concrete. No water will be added after the amount specified by the mix design.

B. Production of Concrete

All ready-mix concrete shall be batched, mixed and transported in accordance with "Specifications for Ready-Mixed Concrete (ASTM C-94)". Plant equipment and facilities shall conform to the "Check List for Certification of Ready-Mixed Concrete Production Facilities" of the National Ready-Mixed Concrete Association. Site mixed concrete shall conform to the requirements of "Specifications for Structural Concrete" (ACI 301). The Contractor may elect to use either ready-mixed or site mixed concrete for this project provided he informs the Engineer of his choice.

C. Laboratory Testing

The Owner shall engage an independent testing laboratory to conduct concrete tests. Contractor will be responsible for sampling concrete for test cylinders, recording, and delivering them to the laboratory, providing all materials required, and for making all slump and air tests in the field directed by the Engineer. All costs in connection with work performed by the independent testing laboratory will be paid by the Owner. The Contractor shall be responsible for the costs of work performed by the laboratory required for redesign of concrete proportions and additional testing of in place concrete when cylinders indicate low strength concrete has occurred.

At least one test shall be made on fresh concrete for each one hundred (100) cu. yds. of each class of concrete (or fraction thereof) placed on any one day and in any event, not less than one test for each class of concrete each day it is used. Testing shall be done in accordance with the following ASTM Specifications, latest edition:

C172- Standard Method of Sampling Fresh Concrete

C31 - Standard Method of Making and Curing Concrete Compression and Flexure Test Specimens in the Field

C39 - Standard Method of Test of Compressive Strength of Molded Concrete Cylinders

C143- Standard Method of Slump Test for Consistency of Portland Cement Concrete

Before any concrete is poured, the Contractor shall construct a storage box in accordance with ASTM Specification C31. Each set of tests shall consist of one slump test and four compression test cylinders. All cylinders shall be kept in the storage box for the first 24 hours. The four cylinders shall be laboratory cured and tested for adequacy of the design for strength of the concrete in accordance with ASTM Specification C31. One cylinder shall be tested at 7 days and two at 28 days.

The fourth cylinder will be retained for subsequent testing if required by the Engineer.

- D. Failure of Concrete to Meet Strength Requirements: The concrete shall be considered acceptable if, for any one class of concrete, the average of all tests of any five consecutive sets is equal to or greater than the specified strength, provided that no more than one test in ten falls between 90% and 100% of the specified strength. The only cylinders to be used for determination of concrete acceptability will be those laboratory cured and tested at 28 days. When it appears the tests of laboratory-cured cylinders will fail to meet these requirements, the Engineer may require changes in the proportions of concrete for the remainder of the work in order to meet the strength requirements. In addition, the Engineer may also require additional curing on portions of the concrete already poured.

The Engineer may also require tests in accordance with Methods of Securing, Preparing and Testing Specimen from Hardened Concrete for Compressive and Flexural Strengths (ASTM Specifications C42) when the concrete cylinder tests fail to meet strength requirements. In the event there still is question as to the quality of the concrete in the structure, the Engineer may require load tests for that portion where the questionable concrete has been placed. Such load tests will be made as outlined in American Concrete Institute Building Code, (ACI 318), and shall be at the expense of the Contractor. In-place testing shall be at the expense of the Contractor.

- E. Removal of Under Strength Concrete: If the above tests indicate that a particular batch of previously placed concrete is under strength, the Engineer may direct that the under strength batch be removed and replaced. The removal of the under strength concrete shall also include the removal of concrete that has obtained the required strength if the Engineer deems this necessary to obtain structural or visible continuity when the concrete is replaced.

The removal, and replacement of any under strength concrete, shall be made at no additional cost to the Owner. This shall include any new formwork required or any reinforcing steel that may be required. The Owner shall not be charged any additional costs for any extra work that is required because of the failure of any concrete to meet the minimum test requirements.

F. Concrete Strengths: The various strengths of concrete shall be installed as follows:

1. Class A, 4000 psi, Air-Entrained shall be used for all liquid containing structures, (footings, base slabs, walls and roofs.)
2. Class B, 3500 psi shall be used for all non-liquid containing structures.
3. Class C, 2000 psi shall be used for all non-structural fill concrete, mud slabs, over excavation concrete, etc.
4. Class D, 3000 psi pea gravel concrete (maximum aggregate size of 3/8") shall be used for all masonry fill, masonry columns, and masonry bond beams.

PART 3 - INSTALLATION

3.1 PREPARATION BEFORE PLACING

- A. Water shall be removed from excavations before concrete is deposited. Hardened concrete, wood chips, shavings, and all other debris shall be removed from interior of forms and inner surfaces of mixing and conveying equipment. Wood forms shall be oiled or, except in freezing weather, wetted with water in advance of pouring. Position of waterstop shall receive any required final adjustments and cleaned of any previous concrete placement "slobbers", if any. See SECTION 3.3, CONSTRUCTION JOINTS, EXPANSION JOINTS, & WATERSTOPS for additional requirements. Reinforcement shall be secured in position, inspected and approved by the Engineer before starting pouring of concrete.

3.2 CONVEYING

- A. Concrete shall be conveyed from mixer to forms as rapidly as practicable and by methods, which will prevent segregation or loss of ingredients. It shall be deposited as nearly as practicable in its final position. Chutes used shall be such that concrete slides in them and does not flow. Chutes, if permitted, shall have a slope of less than 1 on 2. Where a vertical drop greater than five (5) feet is necessary, placement shall be through elephant trunks or similar devices to prevent segregation. Ready-mixed concrete shall be delivered with a load ticket showing mix proportions and the time mixing began for each load. The load ticket shall be furnished to the Engineer.

3.3 PLACING

- A. Concrete shall be placed before initial set has occurred and in no event after it has contained its water content for more than 30 minutes for site mixed concrete or 1 hour for ready-mixed concrete. Unless otherwise specified, all concrete shall be placed upon clean, damp surfaces free from running water, or upon properly consolidated fills, but never upon soft mud or dry, porous earth. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within the section.
- B. If a section cannot be placed continuously, provide construction joints as herein specified. The concrete shall be compacted and worked in an approved manner into all corners and angles of the forms and around reinforcement and embedded fixtures as to prevent segregation of the coarse aggregate. Construction of forms for the lifts of vertical walls shall be such as to make all parts of the walls easily accessible for the placement, spading, and consolidation of the concrete as specified herein.
- C. No "finish water" shall be surface applied during finishing efforts.
- D. Curing methods shall be submitted to the Engineer and applied per manufacture's recommendations.

3.4 VIBRATION

- A. All concrete shall be placed with the aid of mechanical vibration equipment as approved by the Engineer. Vibration shall be transmitted directly to the concrete; in no case shall it be transmitted through forms. The duration of vibration at any location in the forms shall be held to the minimum necessary to produce thorough compaction. Vibrations shall be supplemented by forking or spading by hand, and adjacent to the forms on exposed faces in order to secure smooth, dense and even surfaces, with particular care being taken to prevent coarse aggregate from becoming set too near any surfaces that are to receive rubbed finish.

3.5 CONSTRUCTION JOINTS

- A. Construction joints shall be formed as indicated on the drawings or as approved or directed by the Engineer. Contractor shall submit a joint location plan for each structure to the Engineer for approval 28 days prior to commencing concrete operations on that structure. Where indicated or required, greased dowel rods shall be used. All concrete at the joints shall have been in place not less than 2 days, and longer if so directed by the Engineer, before concrete resting thereon is placed. Before placing is resumed, or commenced, excess water and latence shall be removed, and concrete shall be cut away, where necessary, to insure a strong dense concrete at the joint. In order to secure adequate bond, the surface of

concrete already in place shall be cleaned, roughened, and lightly sprayed with clean potable water for 3hr prior to placement to achieve saturated surface dry conditions, (SSD), immediately before the new concrete is deposited. Construction joints, if required, shall be located near the mid-point spans for slabs, beams or girders. Joints in columns or piers shall be made at the underside of the deepest beam or girder at least five (5) hours before any overhead work is placed thereon. Joints not shown or specified shall be so located as to least impair strength and appearance of work. Vertical joints in wall footings shall be reduced to a minimum. Placement of concrete shall be at such a rate that surfaces of concrete not carried to joint levels will not have attained initial set before additional concrete is placed thereon.

- B. Girders, beams and slabs shall be placed in one operation. To insure a level straight joint in exposed vertical surfaces, a strip of dressed lumber may be tacked to the inside of the forms at the construction joint. The concrete shall be poured to a point one (1) inch above the underside of the strip. The strip shall be removed one (1) hour after concrete has been placed and any irregularities in the joint line leveled off with a wood float and all latence removed. Waterstops shall be installed in all construction joints below grade or in liquid containing structures as noted on the Plans. Install as per SECTION 3.3, CONSTRUCTION JOINTS, EXPANSION JOINTS, & WATERSTOPS.

3.6 PATCHING

- A. Any concrete which is not formed as shown on the Plans, or for any reason is out of alignment or level or shows a defective surface shall be considered as not conforming with the intent of these Specifications and shall be removed from job by Contractor at his expense, unless the Engineer grants permission to patch defective area, which shall be done in accordance with the following procedure. Permission to patch any such area shall not be considered a waiver of the Engineer's right to require complete removal of defective work if patching does not, in his opinion, satisfactorily restore quality and appearance of surface. Suitable non-shrink, latex or epoxy mortar shall be used for patching and repairing defective surface if permitted by the Engineer.
- B. After removing forms, all concrete surfaces shall be inspected and any poor joints, voids, stone pockets, all tie holes, or other defective areas shall be patched, if permitted by the Engineer. Where necessary, defective areas shall be chipped away to a depth of not less than one (1) inch with edges perpendicular to the surface. Area to be patched and a space at least six (6) inches wide entirely surrounding it shall be wetted to prevent absorption of water from the patching mortar. A grout of equal parts Portland cement and sand, with sufficient water to produce a brushing consistency, shall then be well brushed into the surface followed immediately by the patching mortar. The patch shall be made of the same material and of approximately the same proportions and shall not be richer

than 1 part cement to 3 parts sand. White Portland cement shall be substituted for a part of the gray Portland cement to match color of the surrounding concrete. The proportion of white and gray cements shall be determined by making a trial patch. The amount of mixing water shall be as little as consistent with the requirements of handling and placing. The mortar shall be retempered without the addition of water by allowing it to stand for a period of one (1) hour during which time it shall be mixed occasionally with a trowel to prevent setting.

- C. The mortar shall be thoroughly compacted into place and screened off so as to leave patch slightly higher than surrounding surface. It shall then be left undisturbed for a period of 1 to 2 hours to permit initial shrinkage before being finally finished. The patch shall be finished in such a manner as to match the adjoining surface. On surfaces where unlined forms have been used, the final finish shall be obtained by striking off the surface with a straightedge spanning the patch and held parallel to the direction of the form marks.
- D. Tie holes left by withdrawal of rods or the holes left by removal of ends of ties shall be filled solid with mortar after first being thoroughly wetted within 7 days of placement and prior to any area backfill.

3.7 SLAB FINISHES

A. Exterior Concrete Walks:

After thoroughly consolidating the concrete the top surface shall be struck off with a straight edge and tamped or vibrated sufficiently to bring mortar to the surface. Finish with a wood float to a smooth, even surface and lightly broomed to provide "slip resistant" surface. Edges shall be rounded with a 1/4" radius.

- B. Interior slabs to receive grout fill or mortar setting bed shall be finished by tamping concrete with special tools to force coarse aggregate below the surface, and screened with straightedges to bring surface to finish plane with a tolerance not exceeding 1/8" in 2 feet. Surface shall be left roughened sufficiently to produce good bond with topping material. Use stiff brushes, brooms or rakes as necessary to provide 1/8 inch deep grooves at maximum of 1/2 inch on center.

- C. Top and bottom slabs of all structures and water carrying conduits except as noted otherwise on the Plans shall be finished as follows: The top of the slab shall be screened to grade and cross section; lightly tamped as required to bring up a good bed of mortar for finishing and re-screened as necessary. The surface shall then be finished with a wood float and leveling darby. No further finish will be required on top slabs of structures or conduits, which are to be buried. In the case of all exposed top slabs of structures and conduits, they shall be given a final wood float and a lightly broomed, slip resistant finish to a uniform surface, which conforms with accuracy to required shape, slope and grade. Slabs shall be edged

as appropriate. No liquid hardener is to be applied to these surfaces.

- D. Interior floor slabs that are not to receive any finish floor covering shall be "slip resistant finish" as follows: The top surface shall be steel troweled and have a final finish applied by brushing lightly with a soft bristle brush to form a slightly roughened surface.
- E. Liquid Hardener and acid color stain shall be applied to the floors where scheduled to be exposed concrete where specifically are not called out otherwise. Concrete surfaces to be treated must be thoroughly set and dry, clean and free of dust. Three applications of the liquid hardener are required, using one gallon per 100 square feet for the complete treatment. Apply hardener strictly according to the manufacturer's printed instructions. Coordinate curing compound and/or separating compound with surface hardener and stain Manufacturer's requirements. Submit material and method to be used for Engineer's approval.

3.8 FINISH OTHER THAN SLABS

- A. All top surfaces, other than slabs, not covered by forms, and which are not to be covered by additional concrete or fill shall receive a wood float finish without additional mortar. Care shall be taken that no excess water is present when the finish is made. Other surfaces shall be brought to finished elevations and left true and regular. All exposed top surface interior concrete shall be grouted smooth and given a cement wash of one part light colored Portland cement and two parts fine aggregate mixed with water to consistency of thick paint. Grout shall be cork or wood floated to fill all pits, air bubbles, and surface holes. Excess grout shall be scraped off with a trowel and rubbed with burlap to remove any visible grout film. Surface shall be kept damp during setting period. The finish for any area shall be completed in the same day and the limits of a finished area shall be made at natural breaks in finished surface. Painting of exposed-to-view concrete surfaces is specified under SECTION 9.1 - PAINTING of these Specifications.

- B. Rubbed Finish:

Unless otherwise indicated, all faces (except top surfaces of slabs) exposed to view, such as walls, grade beams, columns, beams, walls of water carrying conduits to a point 1'-0" below normal water level, canopy soffits and fascias, etc. shall be finished as follows:

Forms shall be removed, as specified in SECTION - CONCRETE FORMWORK, and all fins removed, off-sets leveled, damaged places and depressions resulting from the removal of metal ties or other causes shall be carefully pointed with a mortar of sand and cement in the proportion which has been employed for the particular class of concrete treated. The surface film of all such pointed places shall be carefully removed before setting occurs. After the point has set

sufficiently to permit it, all exposed surfaces shall be dampened and rubbed with a No. 16 Carborundum stone, to a smooth even plane. Final rubbing shall be done with a No. 30 Carborundum stone, or an abrasive of equal quality, to obtain an entire surface of a smooth texture and uniformity in color. Mortar or grout worked up during rubbing shall be promptly removed by sacking with burlap or other suitable means so that no visible grout film or paste will remain. A cement wash or plaster coat shall not be used. All surfaces shall be finished uniformly smooth and washed clean. The rubbed finish for any area shall be completed in the same day and the limits of a finished area shall be made at natural breaks in the finished surface. If the Contractor does not provide suitable surface finish using Carborundum stones specified above, the Engineer, without additional cost to the Owner, may require the use of a power operated grinding machine or other methods to produce the desired finish.

C. Cementitious Waterproofing and Finish:

As an option to the rubbed finish, as specified herein, all faces (except top surfaces of slab) exposed to view, such as walls, grade beams, columns, beams, canopy soffits and facias, etc., shall be finished using "Thoroseal" coating or approved equal as described in the following paragraphs.

1. General

Forms shall be removed, as specified in SECTION - CONCRETE FORMWORK, and all fins removed, off-sets leveled, damaged places and depressions resulting from the removal of metal ties or other causes shall be carefully pointed with a mortar of sand and cement in proportion which has been employed for the particular class of concrete treated. The surface film of all such pointed places shall be carefully removed before setting occurs. After the point has set sufficiently to permit it, all exposed surfaces shall receive the following treatment.

2. Mixing

Thoroseal plaster mix shall be prepared using a solution composed of not less than one part Acryl 60 (approximately two quarts Acryl 60 per bag) and three parts of clean, potable water (for ceilings, use 1 part Acryl 60 to 2-1/2 parts of the water). This solution shall then be added to the Thoroseal plaster mix slowly in sufficient quantity so that the mixture is the consistency of a heavy batter suitable for application by method specified. Color to be selected by the Owner.

3. Application

At Contractor's option, one of the following methods of application shall be selected:

- a. Sprayed-on finish should be applied with plaster-type spray gun, not high pressure paint type. Spray on evenly distributed coat of Thoroseal plaster mix. To spot-fill deep holes, float or brush first coat before starting second spray application.

Thoroseal plaster mix shall be applied on average surfaces in two coats at the rate of 5 to 6 lbs. per square yard for concrete walls, 6 to 9 lbs. per square yard for masonry walls; but sufficient material shall be applied to fill all holes and voids.

- b. Trowel and float finish - Apply light trowel coat of Thoroseal plaster mix over entire surface to be treated. The workman shall make sure the material is firmly pressed into all voids and leveled. Allow this coat to cure thoroughly before applying the regular trowel application. When surface is set so it will not roll or lift, float uniformly using a sponge float.

Thoroseal plaster mix shall be applied on average surfaces at the rate of 4 to 6 lbs. per square yard for concrete walls, 6 to 9 lbs. for masonry walls. If concrete is rough or untrue, 6 to 9 lbs. per square yard may be required, but sufficient material shall be applied to fill and seal all pores and voids. This application will be approximately 1/8" thick. Leveling uneven surfaces will require more material per square yard.

To prevent shadowing of struck or deep masonry joints, or areas of unequal absorption (like some form marks), after key coat has cured for 5 days, apply a light trowel coat of Thoroseal plaster mix with Acryl 60 in the mixing water over the entire surface to be treated. Allow this coat to set thoroughly before applying the regular trowel application as outlined above.

Do not apply when temperatures are 40°F or due to fall below 40°F within 24 hours or to frozen or frost-filled surfaces.

3.9 CURING

- A. General - Immediately following placing, all Class A and Class B concrete shall be protected from premature drying, hot and cold temperatures, rain, flowing water and mechanical injury. Maintain above 50°F and in moist condition for at least seven (7) days after placing for normal concrete and three (3) days for high

early strength concrete. Comply with "Recommended Practice for Curing Concrete" ACI 308, unless otherwise indicated. Curing compound of satisfactory composition and characteristics may be used except on surfaces to which new concrete is to be bonded or surfaces scheduled to be painted or to receive other coating and provided such compound does not stain or discolor any surface which will be exposed. Cure formed concrete surfaces, including undersides of beams, supported slabs and other similar surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.

B. Cold Weather Procedures - Protect concrete work from physical damage or reduced strength, which could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 306, "Cold Weather Concreting", and as herein specified.

1. When air temperature has fallen to or is expected to fall below 40°F, uniformly heat water and aggregates before mixing as required to obtain a concrete mixture temperature of not less than 50°F, and not more than 80°F at point of placement.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials. Cover and/or protect work area against frost, frozen rebar, snow or ice prior to placement and warm forms/work area as required.
3. Do not use calcium chloride, salt and other materials containing antifreeze agents or chemical accelerators, unless otherwise accepted in mix designs.
4. Contractor shall obtain and keep on the Project site a copy of the current edition of ACI 306, "Recommended Practice for Cold Weather Concreting", for reference during all concrete operations in cold weather.

C. Hot Weather Procedures:

When hot weather conditions exist that would seriously impair the quality and strength of concrete, place concrete in compliance with ACI 305, "Hot Weather Concreting", and as herein specified.

1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90°F and within 60 minutes from time of concrete batching. Mixing water may be chilled, or chopped ice may be used to control the concrete temperature provided the water equivalent of the ice is calculated to the total amount of mixing.
2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so

that the steel temperature will not exceed the ambient air temperature immediately before embedment in concrete. Spray with clean water to cool water as necessary prior to placement.

3. Wet forms thoroughly and cool before placing concrete.
4. Do not use retarding admixtures unless otherwise accepted in mix designs.
5. Contractor shall obtain and keep on the project site a copy of ACI 305R, "Hot Weather Concreting" for reference during all concreting operations in hot weather.

D. Protection from the Sun:

All concrete shall be adequately protected from injurious action of sun in a manner satisfactory to the Engineer.

E. Temperature Control:

During and at the conclusion of the specified curing period, means shall be provided to insure that the temperature of the air immediately adjacent to the concrete does not fall more than 3°F in any 1 hour nor more than 30°F in any 24 hours.

3.10 NON-SHRINKING GROUT

- A. Where non-shrinking grout is called for on the Plan, it shall be mixed in strict accordance with the manufacturer's directions. It shall be of a type as recommended by the manufacturer for the particular application.

END OF SECTION

PART 1 – GENERAL

1.1 SCOPE

- A. The extent of concrete reinforcement is shown on the drawings and in schedules.
- B. The work includes fabrication and placement of reinforcement for cast-in-place concrete, including bars, welded wire fabric, ties and supports.

1.2 QUALITY ASSURANCE

- A. Codes and Standards:

Comply with requirements of the latest edition of the following codes and standards, except as herein modified:

American Welding Society (AWS), AWS D1.4 "Recommended Practices for Welding Reinforcing Steel, Metal Inserts and Connections in Reinforced Concrete Construction".

Concrete Reinforcing Steel Institute (CRSI), "Manual of Standard Practice". (Current Ed.)

American Concrete Institute (ACI), ACI 318 "Building Code Requirements for Reinforced Concrete".

- B. Mill Certificates; Concrete Reinforcement:

Submit steel producer's certificates of mill analysis, tensile and bend tests for reinforcing steel.

1.3 DELIVERY, HANDLING AND STORAGE

- A. Deliver reinforcement to the project site bundled, tagged and marked. Use metal tags indicating bar size, lengths, and other information corresponding to markings shown on placement diagrams.
- B. Store concrete reinforcement materials at the site to prevent damage and accumulation of dirt or excessive rust.

1.4 MATERIALS

- A. Steel reinforcement shall conform to the "Specification for Deformed Billet Steel Bars for Concrete Reinforcement," ASTM A615, Grade 60.

- B. Wire fabric reinforcement shall conform to the current "Specifications for Welded Steel Wire Fabric for Concrete Reinforcement," ASTM A-185, or "Specifications for Welded Deformed Steel Wire Fabric for Concrete Reinforcement," ASTM A-497.
- C. Supports for Reinforcement shall be bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcement in place. Use only wire bar type supports complying with CRSI recommendations, unless otherwise indicated. Do not use wood, brick, and other unacceptable materials.

1.5 SPLICES

- A. No splices of bars, except when shown on the Plans, will be permitted without the approval of the Engineer. Minimum lap splice shall be 48 bar diameters unless specifically detailed or noted otherwise on drawings. Splices in adjacent bars shall be staggered a minimum distance equal to the lap splice length. Bars shall be rigidly clamped or wired at all splices in a manner approved by the Engineer. Welding may not be used except with the specific approval of the Engineer. Welding, when approved, shall conform to the AWS D1.4. Welded wire fabric shall be lap spliced a minimum of 2 inches plus the wire spacing at edge laps and end laps.

1.6 DETAILING & FABRICATION

- A. Furnish Shop Detail and Field Placing Drawings for all reinforcing steel for approval of the Engineer. Shop Drawings shall include reinforcing, placing plans and details indicating size, location, arrangement, splice locations, bending diagrams, placing sequence, etc. Placing Drawings shall be in sufficient detail to allow field personnel to accurately place reinforcing. Shop and Placing Drawings shall be prepared in accordance with "Manual of Standard Practice for Detailing Reinforced Concrete Structures" ACI 315, current edition. Photographic copies of engineering drawings shall not be used as placing drawings.
- B. Reinforcement bars shall be bent cold to the shapes indicated on the Plans. Fabrication tolerances, fabrication, and detailing of steel reinforcement shall conform to the "Manual of Standard Practice for Detailing Reinforced Concrete Structures" (ACI-315).
- C. Steel reinforcement shall be of the type and size, cut to lengths and bent to shapes as indicated on the Plans. Unless otherwise indicated, hooks, lap splices, embedment lengths, and other details of reinforcement shall be provided as set forth in the ACI Building Code (ACI 318) to develop the full tensile strength of the bar.

1.7 PLACING REINFORCEMENT

- A. All reinforcement at the time concrete is placed shall be free from mud, oil, paint, excessive rust and excessive mill scale or any other coating that would destroy or reduce its bond with the concrete.
- B. All reinforcement shall be secured in place true to lines and grades indicated by use of metal or concrete supports, spacers, or ties as approved by the Engineer. The bars and mesh shall be tightly secured against displacement by ties of annealed wire, or suitable clips at intersections. Wall reinforcement shall be supported and held securely against displacement in its proper position clear of the forms as indicated on the Plans. Placing tolerance shall conform to ACI 318.
- C. Nails shall not be driven into the wall forms to support reinforcement nor shall any other device used for this purpose come in contact with the form on the liquid side of any liquid containing structure. Metal devices used to provide the required clear distances from reinforcing steel to liquid side of concrete surfaces shall be galvanized, or shall be as approved by the Engineer.
- D. The main reinforcement of slabs in contact with the ground shall be supported in its proper position, as indicated on the Plans, by means of precast cement mortar blocks, of approved dimensions, resting on the slabs' subbase. Such precast blocks shall be made of mortar composed of 1 part cement to 2 parts sand and shall have a loop of No. 16 black annealed wire cast into each block. The length of the wire loop shall be sufficient to allow the block to be tied to the reinforcement. Blocks shall be spaced at the intervals required to maintain the reinforcement in its required position in the slab during the placing of the concrete. The slab reinforcement shall not be used to support planking or runways used in placing concrete.
- E. Bending of bars embedded in hardened concrete will not be permitted except when specifically approved by the Engineer for the field condition encountered. Field cutting of bars will only be permitted when specifically approved by the Engineer. If field cutting of bar is permitted, it is limited to "quickie" saw, chop saw, reciprocating saw or similar construction tool. Torch cutting will not be permitted.
- F. In the case of exposed finish surfaces of floor slabs, galleries, deck slabs, and beams, metal chairs, spacers and other metal accessories necessary to provide the required clear distances and proper alignment and spacing between bars shall be galvanized or shall have plastic protective covering over portions in contact with forms.

1.8 CONCRETE PROTECTION FOR REINFORCEMENT

A. Steel reinforcement shall be placed and held in position so that the concrete cover, as measured from the surface of the bar shall be the following, except as otherwise shown, on the drawings:

1. Slabs:

- 1½ inches, in general, top and bottom.
- 1½ inches at surfaces troweled as floor finish, walkway, or driveway.
- 2 inches on bottom for slabs over water and where exposed to the weather.

2. Footings:

- 2 inches at top of footings or other adjacent concrete surface.
- 3 inches at bottom, sides, and end of footings against earth or base rock.
- 2" inches at grade beams to stirrup steel.

3. Walls:

- 2 inches on surfaces against earth.
- 1 inches on interior surfaces.
- 2 inches on interior surfaces contacting water.

4. Beams and Girders in Contact with Water:

- 2 inch minimum to stirrup steel.
- 2½ inch minimum to main longitudinal steel.

5. Columns:

- 2 inches, in general, to main vertical reinforcement.
- 2½ inches, to main reinforcement on surfaces in contact with water.

6. Beams and Girders: General:

- 1½ inch minimum to stirrup steel.
- 2 inches minimum to longitudinal steel.

1.9. ADDITIONAL REINFORCEMENT

- A. The Contractor shall provide on the job site additional reinforcement to be used at locations as directed by the Engineer. The contract price shall include all labor and material charges for handling, field cutting and bending, bar supports, and placing of said reinforcement. Cost shall be included in other items of work. Additional reinforcement shall be ASTM A615, Grade 60. Field bending will be limited to right angle bends and standard 90 degree hooks on No. 3 & No. 4 Bar sizes. Additional steel shall be as follows:

No. 4 bars - 30 pieces 20'-0" long

No. 5 bars - 20 pieces 20'-0" long

No. 6 bars - 20 pieces 20'-0" long

END OF SECTION

CONSTRUCTION JOINTS, EXPANSION JOINTS
AND WATERSTOPS

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PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Construction joints, expansion joints, and the placing of waterstops where such are indicated on the plans.
- B. Construction joints shall be of the type indicated on the drawings and shall be located as shown on the plans unless otherwise approved by the Engineer. Contractor shall submit a joint location plan as specified in SECTION 3.1 - CAST-IN-PLACE CONCRETE.

1.2 WATERSTOPS

- A. Waterstops shall be installed in construction joints as required by the Plans. All waterstops shall be continuous throughout their length.
- B. The waterstops shall be heavy duty polyvinyl waterstop conforming to Corps of Engineers Specification CRD-C-572, latest edition, as manufactured by Serviced Products Division of W.R. Grace and Company; Vinylstops by Sonneborn-Contech; Sealtight Duo-PVC Waterstops by W. R. Meadows, Inc.; Vinylex Corporation; "labyrinth" waterstop, Type B-2 as manufactured by Water Seals, Inc.; or an approved equal of the same type and material and approximately equal in dimensions and weight but not necessarily of exactly the same shape. Waterstops shall be of the size and type designated on the Plans.
- C. "Rib Type" waterstops shall be of ribbed construction with a center bulb, 6" wide, capable of resisting a maximum pressure load of 65 feet of water and meet Manufacture's recommendations for cover requirements and application.
- D. All waterstops shall be installed so that one-half its width will be embedded on one side of the joint and one-half on the other. The Contractor shall employ a method of holding the waterstop in position for the first pour that is satisfactory to the Engineer. The method selected must insure that the waterstop will be held securely in true vertical or horizontal position and in straight alignment in the joint.
- E. Care shall be exercised to insure that the waterstop is completely encompassed in good mortar.
- F. Preformed Plastic Waterstops:

Preformed Plastic Waterstop, when approved by the Engineer, shall meet or exceed all requirements of Federal Specifications SS-S-00210, "Sealing Compound, Preformed Plastic for Expansion Joints", Type I or Type II. Such

CONSTRUCTION JOINTS, EXPANSION JOINTS
AND WATERSTOPS

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plastic waterstop shall be equal to SYNKO-FLEX as manufactured by Synko-Flex Products Company, Houston, Texas, or "CenSeal GS-231" by Concrete Sealants, Inc., New Carlisle, Ohio and shall meet the following requirements:

The plastic waterstop shall be produced from blends of refined hydrocarbon resins and plasticizing compounds reinforced with inert mineral filler, and shall contain no solvents, irritating fumes or obnoxious odors. The plastic waterstop shall not depend on oxidizing, evaporating or chemical action for its adhesive or cohesive strength. It shall be supplied in extruded form of suitable cross-section and of a size to seal the joint areas of concrete sections. The plastic waterstop shall be protected by a suitable removable two-piece wrapper. The two-piece wrapper shall be so designed that one-half may be removed longitudinally without disturbing the other half, to facilitate application of the sealing compound.

1.3 JOINTS IN WATERSTOPS

- A. All waterstops shall be continuous and so joined at all points of contact in the same plane, or at intersections with waterstops in different planes, as to form a complete barrier to the passage of water through any construction or contraction joint. 90 bend, cross intersections and other connections joined shall be mitered to maintain rib orientation per Manufacture's recommendations. No side butt-welds will be permitted.
- B. Joints in the waterstops, whether made for the purpose of continuity in a straight strip or for the purpose of securing a watertight junction between strips in different planes, shall be made by heat welding as hereinafter specified.
- C. Joints in PVC waterstops shall be made by heating the two surfaces to be jointed until the material has softened to the point where it is just short of being fluid and then bringing the two softened surfaces together with a slight rubbing motion followed by firmly pressing them together so that a solid and tight bond is made.
- D. The joints in strips of waterstop made in the above manner shall be such that the entire cross section of the joint shall be dense, homogeneous and free of all porosity. All finished joints shall have a tensile strength of not less than 75 percent of the material of the strip as extruded.
- E. The heating of the surfaces to be joined shall be done by means of an electric splicing iron designed for the specified purpose and controlled by means of a voltage regulator.
- F. In use, the heat of the hot plate shall be so regulated as to prevent too rapid melting and accompanying charring of the waterstop material.
- G. The use of makeshift hot plates will not be permitted nor will other means of

CONSTRUCTION JOINTS, EXPANSION JOINTS
AND WATERSTOPS

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heating the strips to be joined be allowed except in a case of emergency, as determined by the Engineer.

- H. The Contractor shall provide such jigs as will assist in making the joints in a proper and workmanlike manner and in holding the strips so that the alignment of jointed strips is correct and angles are true to those required.
- I. Prior to embedment all joints in the waterstop strips will be inspected by the Engineer and any found defective shall be remedied without delay.

1.4 PROTECTION OF WATERSTOP BETWEEN POURS

- A. The Contractor shall take such steps as are necessary to protect exposed waterstops in the interim period between concrete pours. The exposed waterstop for receiving subsequent placement(s) but be cleaned completely of concrete "slobbers", paste and prepared for future placement.

1.5 EXPANSION JOINTS

- A. Expansion joints of the size and type shown on the plans, or specified herein, shall be placed in concrete pavement or structure as shown on the plans.

1. Materials:

a. Preformed Asphalt Fiber Joint Material

Asphalt fiber sheet filler shall consist of preformed strips of inert material impregnated with asphalt. It shall be of the thickness shown on the Plans or indicated in these Specifications.

The sheet filler shall conform to the requirements of AASHTO Specification M-213 with the following additional provisions.

The sheet filler shall be of such character that it will not be deformed by ordinary handling during hot weather nor become hard and brittle in cold weather. It shall be of a tough, resilient, durable material not affected by weathering.

b. Hot Poured Rubberized Tar Joint Sealer

Hot poured rubberized mastic joint sealer shall consist of a mixture of durable, elastic rubber, coal tar pitch and other materials which will form a resilient and adhesive compound capable of effectively sealing concrete joint surfaces against repeated expansion and

CONSTRUCTION JOINTS, EXPANSION JOINTS
AND WATERSTOPS

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contraction. The material shall be installed in accordance with the manufacturer's directions. Hot poured tar sealer shall be used for pavement and sidewalk expansion joints.

B. Joint Surface Preparation:

1. Clean joint surfaces immediately before installation of sealant or caulking compound. Remove dirt, insecure coatings, moisture and other substances which would interfere with bond of sealant or caulking compound.
2. For all sealants, do not proceed with installation of sealant over joint surfaces which have been painted, lacquered, waterproofed or treated with water repellent or other treatment or coating unless a laboratory test for durability (adhesion), in compliance with Paragraph 4.3.9 of FS TT-S-00227, has successfully demonstrated that sealant bond is not impaired by coating or treatment. If laboratory test has not been performed, or shows bond interference, remove coating or treatment from joint surfaces before installing sealant.
3. Etch concrete and masonry joint surfaces to remove excess alkalinity, unless sealant manufacturer's printed instructions indicate that alkalinity does not interfere with sealant bond and performance. Etch with 5% solution of muriatic acid; neutralize with diluted ammonia solution, rinse thoroughly with water and allow to dry before sealant installation.

C. Installation:

1. Comply with sealant manufacturer's printed instructions except where more stringent requirements are shown or specified and except where manufacturer's technical representative directs otherwise.
2. Prime or seal joint surfaces where shown or recommended by sealant manufacturer. Do not allow primer/sealer to spill or migrate onto adjoining surfaces.
3. Employ only proven installation techniques, which will insure that sealants will be deposited in uniform, continuous ribbons without gaps or air pockets, with complete "wetting" of joint bond surfaces equally on opposite sides. Except as otherwise indicated, fill sealant rabbet to a slightly concave surface, slightly below adjoining surfaces. Where horizontal joints are between a horizontal surface and a vertical surface, fill joint to form a slight cove, so that joint will not trap moisture and dirt.
4. Install sealants to depths as shown or, if not shown, as recommended by sealant manufacturer but within the following general limitations,

CONSTRUCTION JOINTS, EXPANSION JOINTS
AND WATERSTOPS

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measured at center (thin) section of bead.

5. For sidewalks, pavements and similar joints sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposures, fill joints to a depth equal to 75% of joint width, and neither more than 5/8" deep nor less than 3/8" deep.
6. For normal moving joints sealed with elastomeric sealants, but not subject to traffic, fill joints to a depth equal to 50% of joint width, but neither more than 1/2" deep nor less than 1/4" deep.
7. Do not allow sealants or compounds to overflow or spill onto adjoining surfaces, or to migrate into voids of adjoining surfaces. Use masking tape or other precautionary devices to prevent staining of adjoining surfaces, by either primer/sealer or the sealant.
8. Remove excess and spillage of compounds promptly as the work progresses. Clean adjoining surfaces by whatever means may be necessary to eliminate evidence of spillage, without damage to adjoining surfaces or finishes.

D. Cure and Protection

1. Cure sealants in compliance with manufacturer's instructions and recommendations, to obtain high early bond strength, internal cohesive strength and surface durability. Do not cure in a manner which would significantly alter material's modules of elasticity or other characteristics.
2. Installer shall advise Contractor of procedures required for curing and protection of sealants during construction period, so that they will be without deterioration or damage (other than normal wear and weathering) at time of Owner's acceptance.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE

- A. Work in this section includes all labor, plant and material necessary to furnish and install all concrete formwork required by the project. Concrete formwork shall conform to all requirements of current editions of ACI 301 "Specifications for Structural Concrete for Buildings" and ACI 318 "Building Code Requirements for Reinforced Concrete" and ACI 347 "Recommended Practice for Concrete Formwork" and ACI 350 "Concrete Sanitary Engineering Structures" except as modified herein.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Forms shall be of wood, metal, highly water resistant plywood, or other material approved by the Engineer. Forms for sections greater than 18" thick shall be of wood. Form surfaces shall be smooth and free from irregularities, dents, sags, or holes when used for permanently exposed surfaces. Bolts and rods used for internal ties shall be so arranged that, when the forms are removed, all metal will not be less than two (2) inches from any concrete surface. Wire ties will not be permitted where concrete surface will be exposed to weathering, and discoloration would be objectionable. Exposed concrete shall have approved form liners of Masonite or plywood, or shall be constructed of smooth surfaced plywood.
- B. Corner forms forming 3/4 inch chamfers or as otherwise specified on plans, shall be used on all outside corners that are to be exposed in the finished structure. Chamfer forms shall be of molded plastic or polyvinyl chloride chamfer strips. Use one style of form throughout the project. The type to be used shall be submitted to the Engineer for approval.
- C. Rustication and Score Line Strips shall be a non-absorbent material such as extruded polyvinyl chloride, plastic, fiberglass or metal or they may be milled from a good quality lumber and well sealed to prevent moisture absorption, wood strips may not have protruding splinters which may become embedded in the concrete. Sealing wood shall be accomplished by emersion or brushing on two coats of form coating.
- D. Form Ties for concrete shall have an approved waterstop barrier to prevent seepage of moisture along the ties. The ends of the metal after breaking off shall be minimum of 2 inches from the finished wall face. Submit samples to the Engineer for review.

- E. Form Coatings: Provide commercial formulation form-coating compounds that will not bond with, stain, nor adversely affect concrete surfaces, and will not impair subsequent treatment of concrete surfaces requiring bond or adhesion, nor impede the wetting of surfaces to be cured with water or curing compounds.
- F. Cylindrical Columns and Supports: Form round-section members with paper or fiber tubes, constructed of laminated plies using water-resistant type adhesive with wax-impregnated exterior for weather and moisture protection. Provide units with sufficient wall thickness to resist loads imposed by wet concrete without deformation.
- G. Inserts: Provide metal inserts, anchor bolts and other embedded items for anchorage of materials or equipment to concrete construction, not supplied by other trades and as required for the work.
- H. Provide sheet metal reglets formed of the same type and gauge as the flashing metal to be built into the reglets, unless otherwise indicated. Where resilient or elastomeric sheet flashing or bituminous membranes are terminated in reglets, provide reglets of not less than 26 gauge galvanized sheet steel. Fill reglet or cover face opening to prevent intrusion of concrete or debris.
- I. Stay-in-Place Corrugated Steel Forms: Fabricate of galvanized steel sheets complying with AISC "Specification for Design of Light Gauge Cold-Formed Steel Structures". Depth of ribs and metal gauge as indicated or, if not indicated, not less than 22 ga. unless heavier gauge required due to project conditions.
- J. Side forms of footings may be omitted and concrete placed directly against excavation only when requested by Contractor and accepted by Engineer. When forms are omitted, provide additional concrete required beyond the minimum design profiles and dimensions of the footings as indicated to provide minimum concrete coverage for reinforcement. Contractor shall maintain the earth form to proper alignment with no sloughing of material into the minimum design profile shown on the drawings.
- K. Dovetail Anchor Slots at surfaces to receive masonry veneer to be Heckman #100 or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Forms shall be built true to line and grade, and be mortartight and sufficiently rigid to prevent displacement or sagging between supports. All formwork and shoring shall be designed for the construction loads to be placed on them, and the design and construction of said forms shall be in accordance with ACI Standard

"Recommended Practice for Concrete Formwork" (ACI 347). The structural adequacy of the formwork shall rest with the Contractor. All forms shall be so constructed that they can be removed without hammering or prying against the concrete.

- B Before concrete placement check the lines and levels of erected formwork. Make corrections and adjustments to ensure proper size and location of concrete members and stability of forming systems.
- C During concrete placement check formwork and related supports to ensure that forms are not displaced and that completed work will be within specified tolerances.
- D Provide temporary openings in wall forms, columns forms and at other locations necessary to permit inspection and clean-out.

3.2 EMBEDDED ITEMS

- A. Before placing concrete, care shall be taken to determine that any embedded metal or wood parts are firmly and securely fastened in their correct location as indicated. Use setting drawings, diagrams, instruction and directions provided by suppliers of items attached thereto. They shall be thoroughly clean and free from coating, rust, scale, oil, or any foreign matter. Embedding of wood in concrete shall be avoided whenever possible, metal being used instead. If wood is allowed, it shall be thoroughly wetted before concrete is placed.
- B. All aluminum embedded items shall be coated with epoxy paint where in contact with concrete.

3.3 FORM REMOVAL

- A. Forms shall not be removed without approval of the Engineer. Forms shall not be removed before the minimum times given below, or longer if job control tests indicate the concrete has not attained strength specified below, except when specifically authorized by the Engineer.

Slabs on grade	1 day if minimum daily temperature is above 50°F, 2 days otherwise.
Beams and Elevated Slabs	14 days and proof of strength requirements met.
Walls up to 12" Thick and Vertical Surfaces	1 day if minimum daily temperature is above 50°F, 3 days otherwise with proof of strength requirements met.

CONCRETE FORMWORK

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Columns	5 days or proof of strength requirements met.
Walls greater than 12" Thick	3 days if minimum daily temperature is above 50°F, 7 days otherwise with proof of strength requirements met.

- B. In general, forms or shores for supported slabs and beams shall not be removed until the concrete, so supported, has acquired 70% of its design strength; except where loads other than the dead weight of the concrete are added, the shores shall not be removed until 24 hours after the concrete has obtained 90% of its design strength. Forms shall be removed immediately after expiration of the lapsed times specified above or sooner, if required by the Engineer, where concrete is to receive a rubbed finish.

END OF SECTION

A. SCOPE

This section covers the furnishing and installation of all miscellaneous metals, including stainless steel, cast iron, and aluminum items not covered in other sections of the Specifications. Work generally included but is not limited to ladders, gratings, handrails and railings, anchorage devices, metal fabrications, and metal stairs.

B. GENERAL

Furnish all miscellaneous items such as anchor bolts, tie down bolts, nuts and washers, supports, connections, expansion and toggle bolts, etc., required by the work. Supplementary parts necessary to complete each item, though such work is not definitely shown or specified, shall be included. Furnish to appropriate trades all anchors, sockets or fastenings required for securing metal work to other constructions and wood items to concrete. Details and specifications of items for which standard products are available are representative guides of requirements for such items. Standard products generally meeting such requirements, will be accepted. Welding shall be continuous along entire area of contact, except where tack welding is permitted. Tack welding will not be permitted on exposed surfaces. All exposed welds shall be ground smooth. Riveting, where exposed, shall be flush type.

C. QUALITY ASSURANCE

Take field measurements prior to preparation of shop drawings and fabrication, where possible. Do not delay job progress; allow for trimming and fitting wherever taking field measurements before fabrication might delay work.

Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

D. SUBMITTALS

Submit for Engineer's review, 4 sets of shop drawings for fabrication and erection of miscellaneous metal items. Include plans, elevations, and details of sections and connections. Show anchorage and accessory items. Provide templates for anchor and bolt installation by others. Submit duplicate samples of all prefinished or shop finished items for approval of finishes. See specification section 1.3 for additional requirements.

E. MATERIALS AND COMPONENTS

1. Metal Surface, General: For fabrication of miscellaneous metal work which will be exposed to view, use only materials which are smooth and free of surface

MISCELLANEOUS METALS

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blemishes including pitting, seam marks, roller marks, rolled trade names and roughness.

2. Ferrous Metals: Except as otherwise specified herein or noted on the Plans, stainless steel and wrought metals shall meet the requirements of the following standards (current edition):

Gray Iron Castings: ASTM A 48, Class 30.

Malleable Iron Castings: ASTM A 47, grade as selected.

Stainless Steel Plates, Shapes, Bars, Tubes shall be AISI Type 304 (18-8) mill finish.

Stainless Steel Castings shall be AISI Type 304 conforming to ASTM A 296, Iron-Chromium-Nickel Alloy.

3. Non-Ferrous Metals:

Aluminum Bar Grating: ASTM B 221, Alloy 6061 or 6063-T6 for bearing bars; ASTM B 221 or B 210 for cross bars or bent connecting bars.

Aluminum Extrusions: ASTM B 221; alloy 6063-T5, except alloy 6005-T5 for pipe; unless otherwise indicated.

Clear anodized finish AA-M21C11A41, unless otherwise indicated.

Aluminum Sheet or Plate: ASTM B 209; alloy 6061-T4; unless otherwise indicated. Mill finish.

4. Fasteners:

General: Provide zinc-coated fasteners for exterior use or where built into exterior walls. Provide AISI Type 303, stainless steel fasteners where exposed to liquids of treatment process, for connecting aluminum or where noted to be stainless steel. Select fasteners for the type, grade and class required.

Bolts and Nuts: Regular hexagon head type, ASTM A 307, Grade A.

Machine Screws: Cadmium plated steel, FS FF-S-92.

Plain Washers: Round, carbon steel, FS FF-W-92.

Concrete & Masonry Anchorage Devices: Expansion shields, FS FF-S325, Galvanized or Stainless Steel. Wedge type expansion anchors take "Kwik-Bolt" by HILTI Tulsa, Oklahoma or equal, size as noted on the Drawings. Length shall provide minimum embedment in concrete as specified by manufacturer's literature.

Toggle Bolts: Tumble-wing type, FS FF-B-588, type, class, and style as required.

Lock Washers: Helical spring type carbon steel, FS FF-W-84.

F. FABRICATION, GENERAL

Use materials of size and thickness shown or, if not shown, of required size and thickness to produce strength and durability in finished product. Work to dimensions shown or accepted on shop drawings, using industry proven details of fabrication and support. Use type of materials shown or specified for various components of work.

Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges. Ease exposed edges to a radius of approximately 1/32" unless otherwise shown. Form bent metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

Weld corners and seams continuously, complying with AWS recommendations. At exposed connections, grind exposed welds smooth and flush to match and blend with adjoining surfaces.

Form exposed connections with hairline joints, flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of type shown or, if not shown, use phillips flat-head (countersunk) screws or bolts.

Provide for anchorage of type shown, coordinated with supporting structure. Fabricate and space anchoring devices to provide adequate support for intended use.

Cut, reinforce, drill and tap miscellaneous metal work as indicated to receive finish hardware and similar items.

G. PAINTING/COATING

All aluminum surfaces that will be in contact with concrete, steel or other dissimilar material shall be coated with asphaltic paint or aluminum impregnated caulking

compound or other approved permanent insulation to prevent electrolytic action.

Additionally, Contractor shall be familiar with dissimilar metals corrosive issues and provide isolation materials or coatings appropriate to the installed project equipment and components to minimize future corrosion issues.

H. CHECKERED PLATE

Shall be standard checkered aluminum plate complete with angle frames and fasteners of thickness shown and located where shown on the drawings.

I. LADDERS

All ladders unless otherwise indicated, shall have flat bar side rails with eased edges spaced 20" o.c. with 3/4" diameter bar rungs welded to siderails at 12" o.c. maximum vertical spacing. Ladders shall be securely attached to supporting construction and extend at least 42" above top rung except where prohibited by overhead or other construction. Where steel ladders are required by the drawings, provide galvanized anchor bolts or expansion anchors. Where aluminum ladders are required by the drawings provide stainless steel anchor bolts or expansion anchors.

J. GRATING

1. General: Use materials of the size and thickness shown, or if not shown, of the size recommended by NAAMM tables. Work to the dimensions shown or accepted on shop drawings, using proven details of fabrication and support. Use the type of materials shown or specified for the various components of the work. Comply with NAAMM "Metal Bar Grating Manual" and as herein specified.

Except where noted otherwise, provide removable grating sections with end-banding bars for each panel, 4 saddle clip anchors designed to fit over 2 bearing bars, and 4 stud bolts with washers and nuts, unless otherwise indicated.

Notch gratings for penetrations as indicated. Layout units to allow grating removal without disturbing items penetrating grating. All grating to be removable unless otherwise noted.

Provide banding for openings in grating separated by more than 4 bearing bars, of same material and size as bearing bars, unless otherwise indicated.

Notching of bearing bars at supports to maintain elevations will not be permitted.

Weld stud bolts to receive saddle clip anchors to supporting metal members.

2. Aluminum Grating: All aluminum grating shall be "Rectangular Pressure locked", KPL-19-4 Series, type as manufactured by Klemp Corporation; or equal. Bearing bar shall be 1 1/4" deep x 1/8" thick minimum spaced at 1-3/16" centers unless noted otherwise on the drawings. Provide aluminum clip anchors and stud bolts where grate is supported by aluminum members and stainless steel slip anchors and stud bolts where grade is supported by steel members. Coat surfaces in contact with concrete or steel with asphaltic paint or aluminum impregnated caulking compound or other approved permanent insulation. Stair treads to have checkered plate or abrasive nosings.
3. Aluminum Grating Treads: All aluminum grating treads shall be pressure-locked rectangular bar "KPL-19-4" as manufactured by "Klemp Corp." or equal. Bearing bars shall be 1-1/2" x 3/16" minimum unless noted otherwise on drawings. Treads shall have cast aluminum abrasive nosings.
4. To be considered equal a grating or tread must have the same load capacity as the size grating noted on the drawings. One type of grating shall be used throughout the job. The depth may vary from that shown on the drawings, provided adequate provisions are made to make modifications to the bearing and anchorage details.

K. PIPE RAILINGS

1. General: Fabricate pipe railings to dimensions and details shown, with smooth rounded bends and welded joints ground smooth and flush.

Adjust railings prior to anchoring to ensure matching alignment at butting joints. Space posts not more than 6'-0" on centers, unless otherwise shown. Plumb posts in each direction. Secure posts and rail ends to supporting construction as follows:

Anchor posts and rail ends into concrete with epoxy grout as detailed.

Provide removable railing sections as indicated. Furnish slip-fit metal socket or sleeve for casting into concrete. Accurately locate sleeves to match post spacing.

Secure single rail handrails to walls with wall brackets and end fittings. Provide brackets with not less than 3" clearance from inside face of handrail to the finish wall surface. Drill wall plate portion of bracket to receive bolt, unless indicated for concealed anchorage. Locate brackets as indicated or, if not indicated, at not more than 6' - 0' o.c. Provide flush-type wall return fittings with same projection as that specified for wall brackets. Secure wall brackets and wall return fittings to

supporting construction as follows:

For concrete and solid masonry anchorage, use bolt anchor expansion shields and lag bolts.

For hollow masonry anchorage, use toggle bolts having square heads.

2. Aluminum Pipe Railings: Pipe handrails of aluminum shall be installed in the locations shown on the drawings.

Horizontal aluminum handrails shall be 1 ½" schedule 40 pipe of aluminum alloy 6005-T5. Vertical posts to be 1 ½" schedule 80 pipe 6005-T5. Fittings shall be attached to the posts by internal welding. The various pieces of the rail shall be joined together by welding. After fabrication finish shall be a 180 grit belt grind with an Alumilite No. 204 Anodizing.

Contractor may submit, for approval, 1 ½" square tube section handrail of the same strength as the 1 ½" pipe. Contractor shall be responsible for design of modifications to handrail anchor details to fit tube handrail. Submit modifications for approval of the Engineer.

L. STAIR NOSINGS

Provide cast aluminum abrasive nosings for all concrete stairs. All nosings are to be three (3) inches wide and have a one (1) inch lip. Nosings shall be the length of the tread less 3" at each end and have integral imbed anchors.

Abrasive is to be #20 aluminum oxide (AL203), integrally cast into the walking surface to a minimum depth of 1/32". Fastener screws shall not protrude above that tread surface. Cross-hatching and fluting shall be 1/16" deep minimum and shall be clean, sharp, well-defined and free from washes, scabs, buckles, blow holes, knots, cuts, cracks and pin-holes. Abrasive cast aluminum to have sand blasted finish. Abrasive cast iron to have one coat of shop black paint.

M. CONSTRUCTION CASTINGS

Provide cast iron manhole ladder rungs as detailed. See drawings for locations, sizes, types and details. Unless otherwise indicated, units shall be McKinley Iron Works, or Neenah Foundry Co, castings or equal. Castings shall also meet ODOT standard requirements.

END OF SECTION

A. SCOPE

The work covered by this section includes the furnishing of all labor, materials and equipment for all caulking of doors, and for all joint sealants where required. All materials shall be brought on the job in labeled original containers and shall show quality, kind and manufacturer's name. Materials incorporated into the project shall be new and be installed within the Manufacturer's "use by date".

B. SUBMITTALS

Within sixty (60) days after award of Contract, and before any material are delivered to the job site, submit to the Engineer a complete list of all materials proposed to be furnished and installed under this portion of the work, making the submittal in accordance with the provisions of the General Conditions of these Specifications.

C. MATERIALS

Caulking Compound shall be an elastic waterproof acrylic latex caulking compound. Caulking compound shall be "Sonolac" as manufactured by Sonneborn Building Products Division, Contech, Inc., Minneapolis, Minnesota; "AC-20 Acrylic Latex" by Pecora Corp., Harleysville, Pennsylvania, or approved equal.

Color shall match adjacent work. Deliver caulking compound in manufacturer's original sealed containers.

Sealant: Polysulfide base sealant based on liquid polysulfide polymer manufactured by Thiokol Chemical Corporation, bearing Thiokol Chemical Corporation's "Tested and Approved Seal". Sealant shall be delivered to the job site in sealed containers, each bearing a "Tested and Approved" seal, manufacturer's name, and product designation. Sealant shall be two (2) part polysulfide base sealant conforming to Thiokol's Building Trade Performance Specification as follows:

- Class A (self-leveling) for joints in horizontal surfaces.
- Class B (non-sag) for joints in vertical surfaces.

Type I (Hardness: 20 35 Shore A) for caulking, glazing and sealing vertical surfaces and non-traffic bearing horizontal surfaces.

Type II (Hardness: 35 45 Shore A) for caulking and sealing horizontal surfaces subject to foot and light vehicular traffic, or abrasion.

Thiokol shall be "Synthacaulk GC-5" by Pecora Corp., Harleysville, Pennsylvania; "Sonolastic Two Part" by Sonneborn Building Products Division, Contech, Inc., or approved equal. Color shall match the adjacent materials as closely as possible. Colors shall be selected by the Engineer. Where stock colors are not acceptable, special colors shall be prepared and furnished, as approved by the Engineer. Submit cured samples for Engineer's color selection.

Joint Filler: Back-up material for caulking and sealant shall be compressible in nature and shall have a proven record of compatibility with the sealant used. Glassyrod, PVC, Butyl or neoprene rod is acceptable -- expanded polyethylene foam, polyurethane foam, and similar gas-expanded foams are not acceptable.

D. INSTALLATION

Location: Polysulfide sealant shall be used for caulking all exterior joints of any type and elsewhere as indicated. Elastic caulking may be used for interior joints not requiring polysulfied sealant. Set all exterior thresholds in caulking. Caulk all joints in masonry walls; between masonry and concrete intersections; around all windows, door frames, louvers, pipes and other penetrations through walls, floors, and ceilings; joints in metal panels, fascias, etc., and all other joints required for a weathertight and/or neat workmanlike installation.

Application: Thoroughly clean all surfaces to be caulked so they will be clean, free from loose dirt, grease, etc., and dry. Surfaces that are to be caulked with polysulfide sealant must first be cleaned with Methyl-Ethyl- Keytone in strict accordance with manufacturer's directions. Install joint filler back-up material to provide proper caulking depth to width ratio according to sealant manufacturer's recommendations. Apply caulking with a gun with proper size nozzle. Use sufficient pressure to fill all voids and joints solidly. Remove excess caulking and leave surfaces neat, even, smooth, and clean; free of sags, blisters and irregularities. Application shall be according to manufacturer's directions and at least three (3) weeks ahead of painting. Where and to extent possible, caulk joints shall be applied to joint being put together and to joint after components are installed. An example of this would be at an exterior door jamb would have caulk under the threshold jamb area and outside threshold jamb area after door installation is completed. Other areas might include flashing set in a bed of caulk or surface mounted frames where required.

E. CLEAN-UP

Upon completion of the work, all caulking and sealing compounds shall be removed from surrounding areas and all joints checked for water tightness and touched up as required. It shall be the Contractor's responsibility to provide a weathertight building.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Preparing surfaces, providing adequate conditions for proper workmanship, and furnishing and applying the protective coating materials required for non-galvanized ferrous metals.

1.2 UNIT PRICES

- A. No separate payment will be made for labor and materials covered under this Section. Include cost in unit price for appropriate work.

1.3 REFERENCES

- A. NACE Standard TM-01-70 – Visual Standard for Surfaces of New Steel Airblast Cleaned with Sand Abrasive.
- B. SSPC-PA1 – Paint Application Specification No. 1.
- C. SSPC-PA2 – Paint Application Specification No. 2.
- D. SSPC – SP1 – Solvent Cleaning.
- E. SSPC – SP2 – Hand Tool Cleaning.
- F. SSPC – SP3 – Power Tool Cleaning.
- G. SSPC – SP5 – White Metal Blast Cleaning.

1.4 DEFINITIONS

- A. DFT means minimum dry film thickness.

1.5 PERFORMANCE

- A. Coat new and modified surfaces in conformance with this Section.
- B. Do not apply protective coatings to the following surfaces unless specifically named or shown to be coated:

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1. Stainless steel, bronze, copper, or brass. (Bronze or brass shall be coated in water and wastewater applications where corrosion potential is present, such as water service fittings, valves and other components)
2. Machined surfaces.
3. Grease fittings.
4. Equipment nameplates.
5. Platform gratings, stair treads, door thresholds, and other walk surfaces.
6. Galvanized steel electrical conduit and associated galvanized and factory-coated junction boxes and electrical panels.
7. Galvanized surfaces inside buildings and not exposed to view.
8. Manhole and valve covers and rings, storm water inlet gratings, covers and frames.

1.6 SUBMITTALS

- A. Submit under provisions of Section 200 - Submittals.
- B. Samples:
 1. Submit one 15-pound sample of each abrasive proposed to be used for surface preparation.
- C. Submit schedule for products under Part 2, Products. Define location of application for each product. As part of coatings schedule, submit color chart for Owner and Engineer's selection.

1.7 QUALIFICATIONS

- A. Where protective coatings are to be applied by a subcontractor, employ a subcontractor who possesses a valid state license as required for performance of painting and coating work called for in this Specification.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Ventilate area where coating is being applied. Post and enforce "NO SMOKING OR OPEN FLAME" signs until coating has been cured.
- B. Provide lighting level of 80-foot candles (860lx) measured mid-height at substrate surface.
- C. Restrict worker access and construction traffic from area where coating is being applied or is curing.

1.9 WARRANTY INSPECTION AND MAINTENANCE

- A. Warranty Inspection:
 - 1. In conjunction with item 1.9A-2, Provide and coordinate an onsite Paint-Coating Kick-off Meeting to discuss project scope, materials, applications and special project details unique to this project. Manufacture Representative onsite time should consist of four (4) hours minimum, on two separate site visits, one during Kick-Off Meeting and one for final inspections.
 - 2. A warranty inspection will be conducted following completion of coating. The Contractor and a representative of the coating material manufacturer shall attend this inspection.
 - 3. Repair defective work discovered during the warranty inspection in accordance with these Specifications.

PART 2 - PRODUCTS

2.1 COATINGS CRITERIA

- A. Suitability: Use suitable coating materials as recommended by the manufacturer.
- B. Compatibility: In any coating system, use only compatible materials from a single manufacturer. Give particular attention to compatibility of primers and finish coats. If necessary, apply a barrier coat or tie coat between existing prime coat and subsequent field coats to ensure compatibility.

- C. Containers: Supply coating materials in sealed container that plainly show the designated name, formula or specification number, batch number, color, date of manufacture, and name of manufacturer, all plainly legible at the time of use.
- D. Substitute or Equal Products:
1. To establish equality furnish satisfactory documentation from the manufacturer of the proposed substitute product that the material meets the indicated requirements and is equivalent or better in the following properties:
 - a. Resistance to abrasion and physical damage
 - b. Resistance to chemical attack
 - c. Life expectancy
 - d. Ability to recoat in future
 - e. Solids content by volume
 - f. Dry film thickness per coat
 - g. Compatibility with other coatings
 - h. Suitability for the intended service
 - i. Temperature limitations in service and during application
 - j. Type and quality of recommended undercoats and topcoats
 - k. Ease of application
 - l. Ease of repairing damaged areas
 2. For substitutions submit protective coating materials which are standard products produced by recognized manufacturers who are regularly engaged in production of such materials for essentially identical service conditions. Where requested, provide the City with the names of not less than 10 successful applications of the proposed manufacturer's products which comply with these requirements.

2.2 COATING SYSTEM

- A. Materials Sources: The manufacturer's products listed in this paragraph are materials which satisfy the material description of this paragraph and have a documented successful record for long-term submerged or severe service conditions. Proposed substitute products will be considered as indicated under paragraph 2.01.D.
- B. System 100 – Amine-Cured Epoxy: High-build, amine-cured, epoxy resin with a solids content of at least 80 percent by volume. Suitable for long-term immersion service on potable water and municipal wastewater. For potable water service, select a coating material listed by the NSF International as in compliance with NSF Standard 61.
 - 1. Prime coat and finish coats (3 or more):
 - a. DFT=16 mils
 - b. Products system: Ameron 39, Tnemec Series N69 (non-potable),
 - 2. For coating of valves and nonsubmerged equipment, DFT=12 mils minimum or per Manufacture recommendations.

PART 3 - EXECUTION

3.1 MANUFACTURER'S SERVICES

- A. Require the protective coating manufacturer to furnish a qualified technical representative to visit the project site for technical support throughout the project and as may be necessary to resolve field problems attributable or associated with manufacturer's products. The Contractor shall also schedule and coordinate a coating/painting kick off meeting with the Manufacture Representative, Contractor, Subcontractor(s) and Owners Representative prior to any work starting to review, coordinate and discuss the projects work.

3.2 WORKMANSHIP

- A. Use skilled craftsmen and experienced supervision.

- B. Apply coating to produce an even film of uniform thickness. Give special attention to edges, corners, crevices, and joints. Ensure thorough cleaning and an adequate thickness of coating material. Apply coatings to produce finished surfaces free from runs, drops, ridges, waves, laps, brush marks, and variations in texture, and finish. Effect complete hiding so that the addition of another coat would not increase the hiding. Give special attention to ensure that edges, corners, crevices, welds, and similar areas receive a film thickness equivalent to adjacent areas. Protect installations by use of drop cloths or other precautionary measures.
- C. If surfaces are damaged, clean, repair, and refinish to original condition.
- D. Provide a completed copy of a Daily Coating Inspection Report documenting the 3.7 application details and including, but not limited to: Manufacturer's material product information being applied, project information, application location, date, ambient temperature, surface temperature, humidity, dew point, work hours applied and other relevant application information. Submit applicator signed Daily Coating Inspection Report form to Owners Representative at the end of each workday's activities. Submit Daily Coating Inspection Report "form" with the paint submittal(s) for approval. Transmit complete package of the Daily Coating Inspection Report, as submittal package at the end of the project.

3.3 STORAGE, MIXING, AND THINNING OF MATERIALS

- A. Manufacturer's Recommendations: Unless otherwise indicated, strictly comply with the coating manufacturer's printed recommendations and instructions for thinning, mixing, handling, applying, and protecting its coating materials, for preparation of surfaces for coating, and for all other procedures relative to coating.
- B. Use protective coating materials within the manufacturer's recommended shelf life.
- C. Storage and Mixing: Store coating materials in accordance with Section 108 – Protection of Materials. Keep coating materials thoroughly stirred, strained, and with uniform consistency during application. Do not mix coatings of different manufacturers.

3.4 PREPARATION FOR COATING

- A. **Cleaning and Touch-Up:** Clean surfaces to receive protective coatings. Examine surfaces to be coated. Correct surface defects before application of any coating material. Touch up marred or abraded spots on shop-primed and on factory-finished surfaces prior to coating application. Verify that surfaces to be coated are dry and free of visible dust.
- B. **Protection of Surfaces Not to be Coated:** Protect surfaces which are not to receive protective coatings during surface preparation, cleaning, and coating operations.
- C. **Remove, mask or otherwise protect hardware, lighting fixtures, switchplates, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces to be painted.** Provide drop cloths to prevent coating materials from falling on or marring adjacent surfaces. Protect the working parts of mechanical and electrical equipment from damage during surface preparation and coating operations. Mask openings in motors to prevent entry of coating or other materials.
- D. **Do not damage adjacent work during blast cleaning operations.** Conduct spray painting under carefully controlled conditions. Promptly repair any damage to adjacent work of adjoining property occurring from blast cleaning or coating operations.
- E. **Protection of Coated Surfaces:** Coordinate cleaning and coating so that dust and other contaminants from the cleaning process will not fall on wet, newly-coated surfaces.
- F. **Temperature of the surface to be coated should be maintained between 50 deg F and 120 deg F during application or as required by the Manufactures recommendations.** Prior to and during application, care should be taken to avoid exposure of direct sunlight or other intense heat source to the structure being coated. Where varying surface temperatures do exist, care should be taken to apply the coating when the surface temperature is falling versus rising (ie. late afternoon into evening ... as opposed to ... morning into afternoon).

3.5 SURFACE PREPARATION STANDARDS

- A. The following referenced surface preparation standards of the Steel Structures Painting Council form a part of this Specification:
1. Solvent Cleaning (SSPC-SP1): Removal of oil, grease, soil, salts, and other soluble contaminants by cleaning with solvent, vapor, alkali, emulsion, or steam.
 2. Hand Tool Cleaning (SSPC-SP2): Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by hand chipping, scraping, sanding, and wire brushing.
 3. Power Tool Cleaning (SSPC-SP3): Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by power tool chipping, descaling, sanding, wire brushing, and grinding.
 4. White Metal Blast Cleaning (SSPC-SP5): Removal of visible rust, oil, grease, soil, dust, mill scale, paint oxides, corrosion products, and foreign matter by blast cleaning.

3.6 METAL SURFACE PREPARATION (UNGALVANIZED)

- A. Provide the minimum abrasive-blasting surface preparation in accordance with SSPC-SP5. Where there is a conflict between these specifications and the coating manufacturer's printed recommendations for the intended service, the higher degree of cleaning applies.
- B. Perform metal surface preparation in conformance with the current SSPC Standards and this Section. Blast-clean surfaces match standard samples in NACE Standard TM-01-70.
- C. Remove oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning using solvent cleaning in SSPC-SP1.
- D. Have sharp edges rounded or chamfered and burrs, surface defects and welded splatter ground into smooth prior to blast cleaning.

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- E. Select the type and size of abrasive to produce a surface profile that meets the coating manufacturer's recommendation for the particular coating and service conditions. As abrasives for submerged and severe service coating systems use clean, hard, sharp-cutting crushed slag. Do not use automated blasting systems for surfaces that will be in submerged service. Do not use metal shot or grit for surfaces that will be in submerged service, even if subsequent abrasive blasting is planned with hard, sharp-cutting crushed slag.
- F. Do not reuse abrasive except when an automated blasting system is used for surfaces that will be in nonsubmerged service. For automated blasting systems, use clean, oil-free abrasives. In the abrasive mix use at least 50 percent grit.
- G. Comply with the applicable federal, state, and local air pollution control regulations for blast cleaning.
- H. For air-blast cleaning supply compressed air at adequate pressure from well-maintained compressors equipped with oil and moisture separators which remove at least 95 percent of the contaminants.
- I. Clean surfaces of dust and residual particles of the cleaning operation using dry air-blast cleaning, vacuuming, or another approved method prior to painting.
- J. In enclosed areas and other areas where dust may settle, vacuum the surface clean and wipe it with a tack cloth.
- K. Remove damaged or defective coating by the specified blast cleaning to meet the clean surface requirements before recoating.
- L. If the specified abrasive blast cleaning will damage adjacent work, the area to be cleaned is less than 100 square feet, and the coated surface will not be submerged in service, then SSPC-SP2 – Hand Tool Cleaning or SSPC-SP3 – Power Tool Cleaning, may be used.
- M. Completely remove shop-applied coatings of unknown composition before the specified coatings are applied. Examine valves, castings, ductile or cast-iron pipe, and fabricated pipe or equipment for the presence of shop-applied temporary coatings. Completely remove temporary coatings by solvent cleaning per SSPC-SP1 before starting abrasive blast cleaning.
- N. Use the solvent cleaning method to clean shop-primed equipment in the field before finish coats are applied.

3.7 APPLICATION OF COATINGS

- A. Apply protective coatings to steel substrates in accordance with SSPC-PA1 – Paint Application Specification No. 1.
- B. Inspect cleaned surface and each coat prior to succeeding coats. Schedule inspections with the City in advance.
- C. Paint blast-cleaned ferrous metal surfaces before rusting or other deterioration of the surface occurs. Limit blast cleaning to only those surfaces that can be coated in the same working day.
- D. Apply coatings in accordance with the manufacturer's instructions and this Section, whichever has the most stringent requirements.
- E. Give special attention to edges, angles, weld seams, flanges, nuts and bolts, and other places where insufficient film thicknesses are likely to occur. Use tripe painting for these areas.
- F. Give special attention to materials which will be joined so closely that proper surface preparation and application are not possible. Coat such contact surfaces prior to assembly or installation.
- G. Apply finish coats, including touch-up and damage repair coats, in a manner which will present a uniform texture and color matched appearance.
- H. Do not apply coatings under the following conditions:
 - 1. Temperature outside of the manufacturer's recommended minimum and maximum range.
 - 2. Dust or smoke laden atmosphere.
 - 3. When the substrate or air temperature is less than 5 degrees F above dew point.
 - 4. When air temperature is expected to drop below 40 degrees F or less than 5 degrees F above the dew point within 8 hours after application of coating.
 - 5. When wind conditions are not calm.

6. Provide a completed copy of a Daily Coating Inspection Report to the City at the end of each workday documenting the above 3.7 application details and including: Manufacture's material product information being applied, project information, application location, date, ambient temperature, surface temperature, humidity, dew point, work hours applied and Daily signed by the Applicator.
 - I. Determine the dew point by use of a sling psychrometer in conjunction with U.S. Department of Commerce, Weather Bureau psychrometric tables.
 - J. For steel piping which will not be buried, have the surface abrasive blast cleaned and primed before installation.
 - K. Apply finish coats after concrete, masonry, and equipment installation is complete and the work areas are clean and dust free.
 - L. Color selection shall be approved by the Owner.
 - M. Apply color code requirements as applicable. All exposed process piping, interior and exterior fall under color code requirements and shall be painted appropriate colors per City and/or applicable color requirements. Colors shall be submitted for approval.
 - N. Provide piping signage in conjunction with item M.
 - O. Pumps, motors and other items with a factory applied and intended to be a finish coating, do not require painting, as approved by the Owner. Check valves and isolation valves shall be painted service piping color as directed by the Owners Representative.
 - P. All items shall receive a finish coating or paint as final finish. Primed surfaces and bare carbon based metals are not considered a final finished.
- 3.8 curing of coatings
- A. Maintain curing conditions in accordance with the recommendations of the coating material manufacturer and this Section, whichever is the most stringent. Complete curing before placing the coating systems into service.
 - B. In the case of enclosed areas, forced air ventilation using heated air if necessary, may be required until the coatings have fully cured.

- C. Forced Air Ventilation of Enclosed Hydraulic Structures: Forced air ventilation is required for the application and curing of coatings on the interior surfaces of enclosed hydraulic structures. During application and curing periods, continuously exhaust air from the lowest level of the structure using portable ducting. After interior coating operations have been completed, provide a final curing period for a minimum of 10 days, operating the forced air ventilation system continuously.

3.9 SHOP AND FIELD INSPECTION AND TESTING

- A. Give the City a minimum of 3 days advance notice of the start of any field surface preparation work or coating application work, and a minimum of 7 days advance notice of the start of any shop surface preparation work.
- B. Perform surface preparation and coating applications in the presence of the City, unless the City has granted prior approval to perform such Work in his absence.
- C. Inspection by the City, or the waiver of inspection of any particular portion of the work, does not relieve the Contractor of his responsibility to perform the Work in accordance with these Specifications.
- D. Erect and move scaffolding where requested by the City to facilitate inspection. Provide additional illumination to light areas to be inspected.
- E. Film Thickness Testing: On ferrous metals, measure the dry-film coating thickness in accordance with the SSPC Paint Application Specification No. 2 using a magnetic-type dry-film thickness gauge such as Mikrotest Model FM, Elcometer Model 111/1EZ, or equal. Test each coat for the correct thickness. Do not take measurements and other substrates, measure the coating thicknesses at the time of application using a wet-film gauge. Provide a spark test in the presence of the Owners Representative. A visual pin hole will be considered a holiday and the imperfection or entire coated area shall be repaired in accordance with the Manufacture's recommendations.
- F. Surface Preparation: Evaluation of blast-cleaned surface preparation work will be based upon comparison of the blasted surfaces with standard samples using NACE Standard TM-01-70.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Requirements for surface preparation, repairs and solventless epoxy coating application to interior walls and ceiling of manholes, wet wells and vaults.
- B. Protective coating shall be applied to all interior surfaces of the following structures:
 - 1. Vensel Creek Wet Well (Complete, less floor)

1.2 REFERENCES

- A. ASTM D638 - Tensile Properties of Plastics.
- B. ASTM D790 - Flexural Properties of Unreinforced and Reinforced Plastics.
- C. ASTM D695 - Compressive Properties of Rigid Plastics.
- D. ASTM D4541 - Pull-off Strength of Coatings Using a Portable Adhesion Tester.
- E. ASTM D2584 - Volatile Matter Content.
- F. ASTM D2240 - Durometer Hardness, Type D.
- G. ASTM D543 - Resistance of Plastics to Chemical Reagents.
- H. ASTM C109 - Compressive Strength Hydraulic Cement Mortars.
- I. ASTM C348 - Flexural Strength Hydraulic Cement Mortars.
- J. ASTM C396 - Compressive Strength of Cement Mortars.
- K. ACI 506.2-77 - Specifications for Materials, Proportioning, and Application of Shotcrete.
- L. ASTM C579 - Compressive Strength of Chemically Setting Silicate and Silica Chemical Resistant Mortars.
- M. ASTM - The published standards of the American Society for Testing and Materials, West Conshohocken, PA.

- N. NACE - The published standards of National Association of Corrosion Engineers (NACE International), Houston, TX.
- O. SSPC - The published standards of the Steel Structures Painting Council, Pittsburgh, PA.

1.3 SUBMITTALS

A. The following items shall be submitted:

1. Technical data sheet on each product used, including ASTM test results indicating the product conforms to and is suitable for its intended use per these specifications.
2. Safety Data Sheets (SDS) for each product used.
3. Project specific guidelines and recommendations.
4. Qualification of Applicator:
 - a. Manufacturer certification that Applicator has been trained and approved in the handling, mixing and application of the products to be used.
 - b. Certification by the protective coating manufacturer that the equipment to be used for applying the products has been approved and Applicator personnel have been trained and certified for proper use of the equipment.
 - c. Five (5) recent references of Applicator indicating successful application of a high-build solventless epoxy coating by spray application.
 - d. Proof of any necessary federal, state or local permits or licenses necessary for the project.
5. Design details for any additional ancillary systems and equipment to be used in site and surface preparation, application and testing.
6. Daily Coating Inspection Report Form.

B. Samples:

1. Submit one product sample coupon.

- C. Submit schedule for products under Part 2, Products. Define location of application for each product. As part of coatings schedule, submit color chart for Owner and Engineer's selection.

1.4 QUALITY ASSURANCE

- A. Applicator shall initiate and enforce quality control procedures consistent with applicable ASTM, NACE and SSPC standards and the protective coating manufacturer's recommendations.
- B. A protective coating manufacturer's representative shall provide at least two days of on-site observation, including a Coating Kick-off Onsite Meeting prior to any work and site specific recommendations relative to surface preparation, handling, application and curing of its products. In addition, the manufacturer shall provide written certification that Applicator has been trained and certified by the manufacturer to handle and apply their products. The Manufacturer's Representative shall also provide a final site visit during final inspections, as applicable and required to resolve any outstanding topics.
- C. Provide a completed copy of a Daily Coating Inspection Report documenting the 3.7 application details and other pertinent application information including, but not limited to: Manufacture's material product information being applied, project information, application location, date, ambient temperature, surface temperature, humidity, dew point, surface preparation achieved, work hours applied and other relevant application information. Submit Daily Coating Inspection Report "form" with the paint submittal(s) for approval. At the end of each workday's activities, submit the applicator signed and dated Daily Coating Inspection Report form to the Owners Representative. Transmit a complete package of the Daily Coating Inspection Reports as an informational submittal package at the end of the project to the Engineer.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Materials are to be kept dry, protected from weather and stored under cover.
- B. Protective coating materials are to be stored between 50 deg F and 90 deg F. Do not store near flame, heat or strong oxidants.
- C. Protective coating materials are to be handled according to their material safety data sheets.

1.6 SITE CONDITIONS

- A. Applicator shall conform with all local, state and federal regulations including those set forth by OSHA, RCRA and the EPA and any other applicable authorities.

1.7 WARRANTY

- A. Applicator shall warrant all work against defects in materials and workmanship for a period of one (1) year, unless otherwise noted, from the date of final acceptance of the project. Applicator shall, within a reasonable time after receipt of written notice thereof, repair defects in materials or workmanship which may develop during said one (1) year period, and any damage to other work caused by such defects or the repairing of same, at his own expense and without cost to the Owner.
- B. Provide and coordinate an onsite Paint-Coating Kick-off Meeting to discuss project scope, materials, applications and special project details unique to this project. Manufacture Representative onsite time should consist of four (4) hours minimum, on two separate site visits, one during Kick-Off Meeting and one for final inspections.

PART II - MATERIALS

2.1 EXISTING PRODUCTS

- A. Standard Portland cement or new concrete (not quick setting high strength cement) must be well cured prior to application of the protective coating. Generally, 28 days is adequate cure time for standard Portland. If earlier application is desired, compressive or tensile strength of the concrete can be tested to determine if acceptable cure has occurred. (Note: Bond strength of the coating to the concrete surface is generally limited to the tensile strength of the concrete itself. Engineer may require Elcometer pull tests to determine suitability of concrete for coating)
- B. Cementitious patching and repair materials should not be used unless their manufacturer provides information as to its suitability for topcoating with an epoxy coating. Project specific submittals should be provided including application, cure time and surface preparation procedures, which permit optimum bond strength with the epoxy coating.
- C. Remove existing coatings prior to application of the new protective coating. Applicator is to maintain strict adherence to applicable NACE and SSPC recommendations with regard to proper surface preparation and compatibility with existing coatings.

2.2 REPAIR MATERIALS

- A. Repair materials shall be used to fill voids, structurally reinforce and/or rebuild surfaces, etc. as determined necessary by the engineer and protective coating

applicator. Repair materials must be compatible with the specified epoxy coating and shall be applied in accordance with the manufacturer's recommendations.

B. As an example, the following products may be accepted and approved by the protective coating manufacturer and could be used within the specifications:

1. 100% solids epoxy grout that can be troweled or sprayed and specifically formulated for optimum epoxy topcoating compatibility. The epoxy grout manufacturer shall provide instructions for epoxy topcoating procedures.
2. Factory blended, rapid setting, high early strength, fiber reinforced, non-shrink repair mortar that can be trowelled or pneumatically spray applied may be approved if specifically formulated to be suitable for epoxy topcoating. Such repair mortars should not be used unless their manufacturer provides information as to its suitability for topcoating with an epoxy coating. Project specific submittals should be provided including application, cure time and surface preparation procedures which permit optimum bond strength with the epoxy coating.
3. Shotcrete shall conform to all requirements of ACI-506.2-77 as published by the American Concrete Institute, Detroit, MI except as modified by these specifications. Shotcrete composed of Portland Cement, aggregate and water so proportioned as to produce a concrete suitable for pneumatic application. Shotcrete ingredients shall be selected, proportioned in such a manner as will produce sound concrete that is strong, dense and suitable for polymer topcoating. Cured shotcrete shall have a minimum surface tensile strength of 300 psi. No coatings shall be applied prior to a full 28 day cure unless test patches of coatings exhibit acceptable bonding characteristics and no outgassing as prescribed herein or the repair mortar manufacturer certifies acceptable topcoating parameters.

2.3 PROTECTIVE COATING MATERIAL

A. Protective Coating System shall be a 100% solid, solventless two-component epoxy resin system filled with select fillers to minimize permeability and provide sag resistance. Coating shall be light reflective, bright light blue in color. Acceptable coating systems are as follows:

1. Raven 405 as manufactured by Raven Lining Systems, Inc., Tulsa, Oklahoma. Total Thickness: 80 mils minimum per Manufacture's recommendations. Two coats minimum.
2. SLS-30 Ultra-Build Epoxy Lining System, as manufactured by Citadel Technologies, Tulsa, Oklahoma. Total Thickness: 80 mils minimum per Manufacture's recommendations. Two coats minimum.

3. Tnemec Series 434 Perma-Shield H2S as manufactured by Tnemec, Inc Kansas City, MO. Total Thickness: 80 mils minimum per Manufacture's recommendations. Two coats minimum.
4. Saueriesen Sewergard 210S system with Saueriesen 120 and 500 PenePrine as manufactured by Saueriesen Inc. Total Thickness: 80 mils minimum per Manufacture's recommendations. Two coats minimum.
5. Pre-Approved Equal (10 days before bid date). Coating system must be light reflective, light blue in color.

Product type	Amine cured epoxy
Color	<i>White, tan, blue or product base.</i>
Solids Content (vol %)	100
Mix Ratio	3:1
Compressive Strength, psi	18,000
Tensile Strength, psi	7,600
Flexural Modulus, psi	600,000
Hardness, Type D	88
Bond Strength – Concrete	> Tensile Strength of Concrete
Chemical Resistance to:	
<i>{Examples}</i>	
Sulfuric Acid, 10%	Immersion Service
Sodium Hydroxide, 20%	Immersion Service

2.4 PROTECTIVE COATING APPLICATION EQUIPMENT

- A. Specifically designed, or approved for use by the protective coating manufacturer, heated plural component spray equipment for use in the application of the specified protective coating.

2.5 REPAIR MORTAR SPRAY APPLICATION EQUIPMENT (if spray applied)

- A. Specifically designed, or approved for use by the repair mortar material manufacturer, for continuous mixing and spraying of the material.

PART III - EXECUTION

3.1 ACCEPTABLE APPLICATORS

- A. Repair mortar applicators should be trained to properly apply the cementitious mortar according to manufacturer's recommendations.

- B. Protective coating must be applied by a Certified Applicator of the protective coating manufacturer and according to manufacturer specifications.

3.2 EXAMINATION

- A. All structures to be coated shall be readily accessible to Applicator.
- B. Appropriate actions shall be taken to comply with local, state and federal regulatory and other applicable agencies with regard to environment, health and safety.
- C. Any active flows shall be dammed, plugged or diverted as required to ensure that the liquid flow is maintained below the surfaces to be coated.
- D. Installation of the protective coating shall not commence until the concrete substrate has properly cured and been prepared in accordance with these specifications.
- E. Temperature of the surface to be coated should be maintained between 50 deg F and 120 deg F during application or as required by the Manufacturers recommendations. Prior to and during application, care should be taken to avoid exposure of direct sunlight or other intense heat source to the structure being coated. Where varying surface temperatures do exist, care should be taken to apply the coating when the surface temperature is falling versus rising (ie. late afternoon into evening ... as opposed to ... morning into afternoon).

3.3 SURFACE PREPARATION

- A. Applicator shall inspect all surfaces specified to receive a protective coating prior to surface preparation. Applicator shall notify Owner of any noticeable disparity in the surfaces which may interfere with the proper preparation or application of the repair mortar and protective coating.
- B. All concrete that is not sound or has been damaged by chemical exposure shall be removed to a sound concrete surface.
- C. All contaminants including: oils, grease, unsound or incompatible existing coatings, waxes, form release, curing compounds, efflorescence, sealers, salts, or other contaminants shall be removed.
- D. Surface preparation method(s) should be based upon the conditions of the substrate and the requirements of the epoxy protective coating to be applied.
- E. All surfaces shall be repaired as required by the epoxy protective coating system in the intended service condition.

- F. Surfaces to receive protective coating shall be cleaned and abraded to produce a sound concrete surface with adequate profile and porosity to provide a strong bond between the protective coating and the substrate. Generally, this can be achieved with a high pressure water cleaning using equipment capable of 5,000 psi at 4 gpm. Other methods such as high pressure water jetting (refer to NACE Standard No. 5/SSPC-SP12), abrasive blasting, shotblasting, grinding, scarifying or acid etching may also be used. Detergent water cleaning and hot water blasting may be necessary to remove oils, grease or other hydrocarbon residues from the concrete. Whichever method(s) are used, they shall be performed in a manner that provides a uniform, sound clean neutralized surface that is not excessively damaged.
- G. A mild chlorine solution may be used to neutralize the surface to diminish microbiological bacteria growth prior to final rinse and coating.
- H. Infiltration shall be stopped by using a material which is compatible with the specified repair mortar and is suitable for topcoating with the specified epoxy protective coating.
- I. Test prepared surfaces after cleaning but prior to application of the epoxy coating to determine if a specific pH or moisture content of the concrete is required according to manufacturer's recommendations.
- J. Special attention shall be made to remove all form panel and formwork "slobbers" by grinding or other method acceptable to the coating manufacturer. Additionally, all concrete corner which receive concrete resistant coating shall have chamfered corners and additional grinding to make them "softer" edges for coatings at all exposed edges which receive coating.
- K. All surfaces should be inspected during surface preparations and before the repair mortar is applied.
- L. Contractor shall provide termination details per Manufacturer's recommendations at all imbedded items. Areas of "sharp", chamfered corner or corners shall be ground with mechanical grinding to provide smooth surface for coating application.

3.4 APPLICATION OF REPAIR MATERIALS

- A. Areas where structural steel has been exposed or removed shall be repaired in accordance with the Project Engineer's recommendations.
- B. Repair materials shall meet the specifications contained herein. The materials shall be trowel or spray applied utilizing proper equipment on to specified

surfaces. The material thickness shall be specified by the Project Engineer according to Owner's requirements and manufacturer's recommendations.

- C. Cementitious repair materials shall be trowelled to provide a smooth surface with an average profile equivalent to coarse sandpaper to optimally receive the protective coating. No bugholes or honeycomb surfaces should remain after the final trowel procedure of the repair mortar.
- D. The repair materials shall be permitted to cure according to manufacturer recommendations.
- E. Application of the repair materials, if not performed by the coating certified applicator, should be inspected by the protective coating manufacturer's representative or certified applicator to ensure proper finishing for suitability to receive the specified coating.
- F. After abrasive blast and leak repairs have been performed, all surfaces shall be inspected for remaining laitance prior to protective coating application. Any evidence of remaining contamination or laitance shall be removed by additional abrasive blast, shotblast or other approved method. If repair materials are used, refer to these specifications for surface preparation. Areas to be coated must also be prepared in accordance with these specifications after receiving a cementitious repair mortar and prior to application of the epoxy coating.
- G. All surfaces should be inspected during and after preparation and before the protective coating is applied.

3.6 APPLICATION OF PROTECTIVE COATING

- A. Application procedures shall conform to the recommendations of the protective coating manufacturer, including material handling, mixing, environmental controls during application, safety, and spray equipment.
- B. The spray equipment shall be specifically designed to accurately ratio and apply the specified protective coating materials and shall be regularly maintained and in proper working order.
- C. The protective coating material must be spray applied by a Certified Applicator of the protective coating manufacturer.
- D. Specified surfaces shall be coated by spray application of a moisture tolerant, solventless, 100% solids, self-priming epoxy protective coating as further described herein. The coating will be applied to minimum and average wet film thicknesses of 100.

- E. Airless spray application equipment approved by the coating manufacturer shall be used to apply each coat of the protective coating to avoid any potential contamination from compressed air oil which may encourage inter-coat delamination. Air assisted spray application equipment may be acceptable, especially for thinner coats (<10 mils), only if the air source is filtered to completely remove all oil and water.
- F. If necessary, subsequent topcoating or additional coats of the protective coating should occur as soon as the basecoat becomes tack free, ideally within 12 hours but no later than 24 hours after the prior coat has been applied at 75 deg F unless additional prior coat surface preparation is performed. The protective coating manufacturer must be consulted for any additional-coat surface preparation guidelines if necessary.
- G. (Optional) Fiberglass woven-roving fabric may be rolled into the resin or chopped glass spray applied with the resin for added tensile and flexural strength where desired, such as the crown of pipes. Sloped surfaces of the floor may be made non-skid by broadcasting aluminum oxide or silica sand into the surface prior to gelation.
- H. Provide a completed copy of a Daily Coating Inspection Report to the City at the end of each workday documenting application details, including: Manufacture's material product information being applied, project information, application location, date, ambient temperature, surface temperature, humidity, dew point, work hours applied and Daily signed by the Applicator.
- I. Coatings shall be installed completely prior to the installation of any surface mounted anchoring, fasteners, devices or equipment. All bug holes and imperfections in the cast concrete shall be repaired prior to coating application per Manufacture's recommendations.

3.7 TESTING AND INSPECTION

- A. During application a wet film thickness gage, such as those available through Paul N. Gardner Company, Inc. meeting ASTM D4414 - Standard Practice for Measurement of Wet Film Thickness of Organic Coatings by Notched Gages, shall be used to ensure a monolithic coating and uniform thickness during application.
- B. After the protective coating has set hard to the touch it shall be inspected with high-voltage holiday detection equipment. An induced holiday shall be made on to the coated concrete surface and shall serve to determine the minimum/maximum voltage to be used to test the coating for holidays at that particular area. The spark tester shall be initially set at 100 volts per 1 mil (25 microns) of film thickness applied but may be adjusted as necessary to detect the

induced holiday. All detected holidays shall be marked and repaired by abrading the coating surface with grit disk paper or other hand tooling method. A visual pin hole will be considered a holiday and the imperfection shall be repaired in accordance with the Manufacturer's recommendations. After abrading and cleaning, additional protective coating material can be hand applied to the repair area. All touch-up/repair procedures shall follow the protective coating manufacturer's recommendations. A visual "pin hole" is considered a holiday and shall be repaired.

- C. Measurement of bond strength of the protective coating to the substrate can be made at regular intervals and along different sections of the structure (i.e., crown of pipe, wall, invert -- every 200 ft). Bond strength can be measured in accordance with ASTM D4541. Any areas detected to have inadequate (less than 300 psi to concrete) bond strength shall be evaluated by the Project Engineer. Further bond tests may be performed in that area to determine the extent of potentially deficient bonded area and repairs shall be made by Applicator in strict accordance with manufacturer's recommendations.
- D. A final visual inspection shall be made by the Inspector and manufacturer's representative. Any deficiencies in the finished coating shall be marked and repaired according to the procedures set forth herein by Applicator.
- E. The system may be put back into non-severe operational service as soon as the final inspection has taken place. However, for severe corrosion duty such as high concentrations of acids, bases or solvents, 3 to 7 days and/or force cure by heat induction to the coated surfaces may be necessary prior to returning to service. Consult coating manufacturer for further details.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. This specification section covers the work necessary to furnish all labor, materials equipment and incidentals required to provide valves complete and operational with all appurtenances as specified herein and/or as shown on the plans. The equipment to be provided shall include, but not be limited to the following items, valves, valve boxes, stems, gaskets and operators.
- B. A single coordinating supplier will be responsible for furnishing the valves. The coordinating supplier shall be a manufacturer or supplier who is regularly engaged in the business. The coordinating supplier will prepare data required for complete description. The manufacturer will verify each valve is compatible with other components and all pipe materials and sizes are appropriate and all devices necessary for a proper functioning system have been provided. System supplier will furnish all equipment as a complete, integrated package, with a single responsibility for proper function.
- C. The single supplier shall provide spare parts, maintenance and manufacturer's service as specified herein.

1.2 DELIVERY, STORAGE, HANDLING

- A. Individual components shall be crated in structurally adequate packing containers to prevent damage during shipping, facilitate ease of handling and to provide suitable protection from weather for extended storage at the jobsite prior to installation. Packing containers shall be permanently labeled with appropriate equipment identification, shipping address and return address. Packing list shall be provided with equipment at time of delivery.
- B. Electrical equipment and equipment to be installed inside shall be kept thoroughly dry at all times and shall be stored indoors and protected from freezing conditions. Equipment storage shall be protected and maintained in accordance with the manufacturer's recommendations. Equipment shall not be stored directly on the ground.
- C. Contractor shall utilize equipment and tools of adequate size suitable for unloading, transportation, storing and supporting the equipment during installation. Caution shall be employed to prevent equipment damage resulting from abrupt contact with other materials or equipment.

1.3 QUALITY ASSURANCE

- A. Manufacturers regularly engaged in the manufacture of the type of valves specified

and can demonstrate valves of their manufacture in actual service for a period of not less than 15 years will be considered as an acceptable manufacturer. Manufacturers not named in the specifications meeting the minimum experience time requirement must submit to the Engineer 15 working days prior to the bid date detailed information describing the equipment proposed to furnish. The detailed information shall include but not be limited to dimensional data, materials of construction and in installation list with address, telephone number, and an individual's name directly employed by the Owner of the equipment. Plan holders will be notified of approved manufacturer by addendum five (5) working days prior to bid date.

- B. The valves shall comply with applicable provisions and recommendations for recognized standards, except as otherwise shown or specified.
- C. Acceptable check valve manufacturer is AVK or approved equal. Acceptable plug, gate, ball valve manufacturers are DeZurik Inc., Henry Pratt Company, Valmatic Corporation, AVK or approved equal.

1.4 WARRANTY

- A. The manufacturer shall warrant the valves to be of quality construction, free from defects in materials and workmanship. The warranty shall become effective upon acceptance by the Owner or Owner's authorized agent.
- B. The valves, apparatus, and parts furnished shall be warranted for a period of one (1) year, excepting only those items that are normally consumed in service, such as grease, gaskets, O-rings, etc. The manufacturer shall be solely responsible for the warranty of the equipment and all components.
- C. Upon request from the Engineer and/or the Owner, the manufacturer shall demonstrate proof of financial responsibility with respect to performance and delivery date. In addition, the manufacturer shall provide proof of evidence of facilities, equipment, and skills required to produce the equipment specified herein and provide technical service and replacement parts.
- D. Components failing to perform as specified, or proven defective in service during the warranty period, shall be replaced, repaired, or satisfactorily modified by the manufacturer without cost of parts or labor to the Owner.

PART 2 - PRODUCTS

2.1 DESCRIPTION

- B. Design Requirements
 - 1. Plug Valves

- a. Non lubricated eccentric type
- b. Resilient faced plugs
- c. 4 to 20 " valves shall have 80% full pipe area)
- d. Plug face shall be neoprene suitable for use with sewage.

C. Painting

1. Valves shall have surface preparation, primer and finish coats applied in the manufacturer's shop and painting shall be in accordance with Painting Section.
2. In some applications, process piping color coding applies and the valve in those instances shall be painted in the field as coordinated with the Owners Representative. This would be typically in gallery, exposed above ground and vault areas for example.

2.2 COMPONENTS

A. Plug Valves

1. Plug valves shall be non-lubricated eccentric type with 80% of full pipe area.
2. The plug valve shall be furnished with end connections as shown on the plans. Flanged ends shall be faced and drilled to the ANSI 125/150 lb. standard. Mechanical joint ends shall be to the AWWA standard C111-64. Bell ends shall be to the AWWA standard C100-55 Class B. Screwed ends shall be to the NPT standard.
3. Valve bodies shall be of ASTM A126 Class B cast iron in compliance with AWWA C504, Section 2.2. Bodies in 4" and larger plug valves shall be furnished with a raised welded-in overlay, cylindrical shaped seat of not less than 90% pure nickel in accordance with AWWA C507, Section 7.2. Seat area shall be raised, with raised surface completely covered with weld to insure that the plug face contacts only nickel. Valves utilizing resilient seat attached to the body shall be not acceptable. As per AWWA C504-80, Section 3.5.2 and AWWA C507-73, Section 7.2, sprayed or plated seats are not acceptable nor shall screwed-in seats be acceptable.
4. The plugs shall be of ASTM A126 Class B cast iron in compliance with AWWA C504, Section 2.2. The plug shall be of one piece construction and shall be capable of withstanding the full pressure rating of the valve without

the use of additional structural reinforcing ribs that extend beyond the profile of the plug itself. Plugs with cast inlays shall not be acceptable. Plugs shall be resilient faced, neoprene suitable for use with raw sewage.

5. Upper and lower journal bearings shall be sleeve type metal bearings conforming to AWWA C504-80, Section 3.16 and AWWA C507-73, Section 8. Journal bearing shall be of sundered, oil impregnated and permanently lubricated Type 316 ASTM A743 Grade CF-8M or AISI Type 317L stainless steel in 2" -36" plug valve sizes. In plug valves larger than 36", the upper and lower plug journals shall be fitted with ASTM A240 Type 316 stainless steel sleeves with bearings of ASTM B30, Alloy C95400 aluminum bronze. Thrust bearing shall be of Teflon. Non metallic journal bearings shall not be acceptable.
6. Plug valve shaft seals shall be of the multiple V-ring type and shall be externally adjustable, repackable without removing the bonnet or actuator from the valve, and repackable under pressure. Shaft seals shall be Buna Vee. Shaft seals shall conform with AWWA C504-80, Section 3.7 and AWWA C507-73, Section 10.2. Valves utilizing O-ring seals or non-adjustable packing shall not be acceptable. All exposed nuts, bolts, springs, washers, etc., shall be stainless steel.
7. Valve pressure ratings shall be 175 psi for 2" through 12" and 150 psi for 14" through 72". Each valve shall be given a hydrostatic test and seat test with test results being certified. Certified copies of proof-of-design test reports shall be furnished as outlined in AWWA C504-80, Section 5.5.
8. Manual vales shall have lever or worm gear actuators with handwheels, chainwheels, tee wrenches, extension stems, floorstands, etc., as shown on the plans or as called for in a valve schedule. Lever actuators shall be furnished for valves 8" or smaller where the maximum shutoff pressure is 25 psi or less as indicated on the plans or in a valve schedule. Worm gear actuators shall be furnished for all valves 4" or larger where the maximum reverse shutoff pressure is greater than 25 psi as indicated on the plans or in a valve schedule. Worm gear actuators shall be sized for pressure as indicated on the plans. All gearing shall be enclosed in a semi-steel housing and be suitable for running in a lubricant with seals provided on all shafts to prevent entry of dirt and water into the actuator. The actuator shaft and the quadrant shall be supported on permanently lubricated bronze bearings. Actuators shall clearly indicate valve position and an adjustable stop shall be provided to set closing torque. This adjustable stop shall be the only adjustment necessary to set the clearance between the valve plug and the seat while the valve is in line and under pressure. Handwheel and chainwheel sizes for worm gear actuators shall be no smaller than 6" in diameter and no larger than twice the diameter of the actuator's gear sector. All exposed nuts, bolts,

and washers shall be zinc plated. Chainwheel chains shall be hot dipped galvanized, weldless, single loop, lock link style chain unless shown specifically otherwise.

9. Valves and gear actuators for buried or submerged service shall have seals on all shafts and gaskets on the valve and actuator covers to prevent the entry of water. Actuator mounting brackets for buried or submerged service shall be totally enclosed and shall have gasket seals. All exposed nuts, bolts, springs, and washers shall be stainless steel. Furnish adjustable valve boxes, and extension stems to within 12 inches of ground surface.

B. Check Valves

1. Swing check valves shall be of the flanged type in full compliance with AWWA C-508-93 and MSS SP-71. Valves may be supplied with external lever with weight or spring to assist closure if required by customer. The pressure rating shall be at least 200 for valves 12" and smaller and 150 psi for valves 14" through 24".
2. Valve bodies shall be of ASTM 536 Ductile iron. Flanges shall be in full compliance with ANSI B16.1 Class 125. Seats shall be constructed of ASTM B-62 bronze and be mechanically retained in the valve body.
3. Disc shall be of carbon steel encapsulated with EPDM with mechanically secured bronze disc seat of ASTM B-62 material.
4. The hinge shall be constructed of AISI 316 stainless steel or fusion bonded epoxy coated ductile iron with a stainless steel hinge pin. Minimum of 2 O-rings to seal the hinge pin.
5. Check valves shall be drilled and tapped for accessories as required.
6. Protective coatings. All exposed ferrous surfaces except stainless steel shall be coated with fusion bonded epoxy that shall comply with AWWA C550.
7. End Connections shall be flanged ends that comply with ANSI/ASME B16.1, class 125.
8. Maintenance: The Check Valve shall be designed such that the disc, hinge and bonnet can be removed as one assembly.
9. Testing: Testing and performance shall be in accordance with AWWA C508. Test results shall be furnished to the Owner upon request.

C. Painting

1. Valves shall have surface preparation, primer and finish coats applied in the manufacturer's shop and painting shall be in accordance with Painting Section.
2. In some applications, process piping color coding applies and the valve in those instances shall be painted in the field as coordinated with the Owners Representative. This would be typically in gallery, exposed above ground and vault areas for example.

PART 3 - EXECUTION

3.1 GENERAL

- A. The General Contractor shall assume full responsibility for coordination of the entire project, including verification all structures, piping, coating systems and equipment components are compatible. The General Contractor shall initially operate each equipment system, and shall make all necessary adjustments so that each system is placed in proper operating condition.
- B. Equipment and materials utilized for this project must be approved by the Engineer prior to installation. Approval for installation or incorporation in this project will be made only after submittal or manufacturer's shop and installation drawings, test results or other data as specified herein.
- C. Installation of equipment shall be in full conformance with the manufacturer's shop drawings and requirements as approved by the Engineer.
- D. Valves shall be installed so that when closed the plug seats against the normal operating head and when open the plug is rotated upward and out of the path of flow. Reference Manufacturer's recommendations for seat side orientation for proper installation.

3.2 WORKMANSHIP

- A. Handle carefully and protect the equipment and appurtenances to avoid damage.
- B. The equipment shall be safely installed in accordance with the manufacturer's instructions. All plumbing and electrical shall be in accordance with state and federal codes to ensure proper operation.
- C. Any evidence of improper installation shall be corrected by the Contractor. Care during storage, installation and start-up shall be in strict accordance with manufacturer's recommendations.

PART 1 - GENERAL

1.1 SUMMARY

- A. This section of the specification describes the sewage grinder(s) and motor controller(s). The equipment shall be installed as shown on the plans, as recommended by the supplier, and in compliance with all OSHA, local, state and federal codes and regulations.
- B. The number of grinder(s) and motor controller(s) shall be one (1).
- C. The grinder shall be capable of processing 3270 GPM with a maximum headloss of 12 inches with an unrestricted discharge.

1.2 REFERENCES

- A. Grinder(s) shall, as applicable, meet the requirements of the following industry standards:
 - 1. American Society for Testing and Materials (ASTM) A36: Standard Specification for Carbon Steel Plate
 - 2. American Society for Testing and Materials (ASTM) A536-84: Standard Specification for Ductile Iron Castings
 - 3. American Iron and Steel Institute (AISI) 303 Stainless Steel
 - 4. American Iron and Steel Institute (AISI) 304 Stainless Steel
 - 5. American Iron and Steel Institute (AISI) 4130 Heat Treated Alloy Steel
 - 6. American Iron and Steel Institute (AISI) 4140 Heat Treated Hexagon Steel
 - 7. Rockwell C
- B. Motor controllers shall, as applicable, meet the requirements of the following Regulatory Agencies.
 - 1. National Electrical Manufacturer's Association (NEMA) Standards
 - 2. National Electrical Code (NEC)
 - 3. Underwriters Laboratory (UL and cUL)

1.3 DOCUMENTS

A. Shop Drawing(s)

Supplier shall submit six (6) set(s) of shop drawings. Shop drawings shall include equipment descriptions, specifications, dimensional and assembly drawings, parts lists, and job specific drawings.

B. Operation and Maintenance Manuals

Supplier shall submit three (3) set(s) of Operation and Maintenance manuals prepared using best commercial practices. The manuals shall include equipment descriptions, operating instructions, drawings, troubleshooting techniques, a recommended maintenance schedule, and the recommended lubricants. See Special Conditions 1.10 Operations and Maintenance Manual for additional requirements.

1.4 QUALITY ASSURANCE

Qualified suppliers shall have a minimum 25 years experience at manufacturing, support systems, two-shafted grinding equipment and motor controls with a minimum of 5,000 installations with similar equipment. Supplier shall provide a list of names and dates of installations for verification by the Engineer or Owner's Representative.

Supplier shall provide the services of a factory-trained representative to check the installation and to start-up each grinder and controller. The factory representative shall have complete knowledge of proper installation, operation, and maintenance of equipment supplied. Representative shall inspect the final installation and supervise a start-up test of the equipment.

Each grinder and controller shall be factory tested to ensure satisfactory operation.

1.5 DELIVERY, STORAGE AND HANDLING

A. The equipment shall be packaged in containers constructed for normal shipping, handling and storage.

B. The containers shall provide adequate protection for the equipment in a dry indoor environment between +40°F (+4.5°C) and +100°F (+37.8°C) until time for installation.

1.6 IDENTIFICATION

Each unit of equipment shall be identified with a corrosion resistant nameplate, securely affixed in a conspicuous place. Nameplate information shall include equipment naming, equipment model number, serial number, supplier's name, and location. Provide one

spare tag for each unit installed in the final O&M provided to the Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Support system(s), grinder(s), and motor controller(s) shall be in compliance with these specifications and plans and shall be supplied by one of the following manufacturers:
 - 1. JWC Environmental® Channel Monster® grinder model No. CMD3210-XDS2.0 and heavy-duty seals.
 - 2. Approved equal.
- B. Manufacturers requesting to be selected as an approved equal shall submit certified documentation showing compliance with these specifications a minimum of ten (10) days prior to bid opening. Selected equipment manufacturers shall be added to the list of approved manufacturers.
- C. The manufacturer must certify that the unit can be returned for maintenance to the factory or a local repair facility. The certification shall include a statement that there will be no charge for repair labor.

2.2 SUPPORT SYSTEM(S)

A. GENERAL

A grinder support frame with adjustable mounting brackets shall be provided for a 21" circular pipe. Contractor shall confirm inlet pipe diameter prior to preparing equipment submittal. Support frame shall be designed to operate with a retrievable rail system to be supplied by the equipment manufacturer. Refer to construction drawings for details.

B. COMPONENTS

The support frame, additional supports and retrievable rail system shall be of welded square tube, angle, and plate construction. The construction material shall be 316 stainless steel. Provide a self-centering bail or long reach cleaves for retrieval.

2.3 GRINDER(S)

A. GENERAL

- 1. Each grinder shall include cutters, spacers, shafts, 10 inch (254 mm)

diameter perforated screen drum, bearings and seals, side rails, end housings, covers, reducer, and motor.

2. The grinder shall be of two (2)-shaft design and be capable of continuous operation, processing wet or dry. Bar screens or single-shaft devices utilizing a single rotating cutter bar with stationary cutters shall not be acceptable. Grinders designed with cutter and spacer cartridges rather than individual cutters and spacers, shall not be acceptable.
3. Two (2)-shaft design shall consist of two (2) parallel shafts alternately stacked with individual intermeshing cutters and spacers positioned on the shaft to form a helical pattern. The two (2) shafts shall counter-rotate with the driven shaft operating at approximately two-thirds ($2/3$) the speed of the drive shaft.
4. The ten (10) inch (254-mm) diameter rotating $\frac{1}{2}$ " perforated screen drum shall consist of vertical supports and stub shafts. The rotating drum shall direct all solids toward and into the counter-rotating dual-shaft grinder. The perforated drum shall be driven by the grinder drive mechanism.

B. COMPONENTS

1. Individual Cutters and Spacers
 - a. The cutting chamber shall be a nominal height of 32 inches (457 mm).
 - b. Individual cutters and spacers shall be server duty with monster metal hardened cutter stack Monster Metal™ Chromium alloy steel, surface ground for uniformity and through-hardened to a minimum 55-60 Rockwell C
 - c. The inside configuration of both the individual cutters and the individual spacers shall be hexagonal so as to fit the shafts with a total clearance not to exceed 0.015 inch (0.38 mm) across the flats to assure positive drive, minimize wear on the cutters.
 - d. Cutter configuration shall consist of individual 11 tooth cam cutters on both shafts. To maintain particle size, the height of the tooth shall not exceed $\frac{1}{2}$ inch (13 mm) above the root diameter. Cutter to cutter root diameter overlap shall be not less than $\frac{1}{16}$ inch (1.6 mm) or greater than $\frac{1}{4}$ inch (6 mm) to maintain the best possible cutting efficiency while incurring the least amount of frictional losses.
 - e. The cutters shall exert a minimum force at the tooth tip of 2051

lbs/hp (12,234 N/kW) during momentary load peaks.

2. Shafts

- a. Grinder drive and driven shafts shall be made of 4140 heat treated hexagon steel with a tensile strength rating of not less than 149,000 psi (1,027 kPa).
- b. Each hexagonal shaft shall measure a nominal 2 inches (51 mm) across parallel surfaces.

3 Perforated Screen Drum

- a. The 10 inch (254 mm) diameter perforated screen drum shall be made of 304 stainless with ½" perforations. .
- b. Perforated screen drum shall have center ring supports, end flanges, and stub shafts to properly support the perforated screen.
- c. Perforated screen drum shall have no shaft in center of drum.
- d. Perforated screen drum shall be electropolished

4. Shaft Bearings and Seals

- a. Dynamic tungsten carbide seal with 6 percent nickel binder primary seal face with a secondary dynamic seal. No external flushing required for dry or wet operation. Bearing protection without secondary seals are not acceptable.
- b. Seal Pressure: 150 psi maximum.
- c. Bearing Cartridge Housings: AISI 304 stainless steel

5. Cutter Side Rail

- a. The inside profile of the cutter side rail shall be concave to follow the radial arc of the cutters.
- b. Clearance between the major diameter of the cutter and the concave arc of the side rail shall not exceed 5/16 inch (7.9 mm).
- c. The cutter side rail shall have evenly-spaced slots that increase flow and decrease head loss.

- d. The cutter side rail shall be cast of A536-84 ductile iron.

6. Drum Side Rail

- a. The inside profile of the drum side rail shall be concave, with an adjustable UHMW plastic extension strip to minimize clearance at the front of the drum. This clearance shall not exceed 1/16 inch (1.6 mm) from the major diameter of the coil screen drum.
- b. The drum side rail shall be cast of A536-84 ductile iron.

7. End Housings and Covers

- a. Grinder end housings shall be of cast A536-84 ductile iron with a cast-in-place flow deflector, designed to protect the bushings while guiding particles directly into the cutting chamber.
- b. Top covers shall be A536-84 ductile iron and bottom covers shall be A36 hot rolled plates.

8. Reducer

- a. The speed reducer shall be a grease-filled planetary-type of reducer with a 500% shock load capacity. The reduction ratio shall be 29:1.
- b. The input shaft of the reducer shall be directly coupled to the motor using a three-piece coupling, and the output shaft of the reducer shall be directly coupled with the grinder using a two-piece coupling.

9. Immersible Motor

- a. The motor shall be 5 hp (3.75 kW), Immersible XPNV, 1770 rpm, 230/460 volt, 3 phase, 60 Hz, class F insulation.
- b. Motor service factor shall be 1.15, the efficiency factor not less than 91% at full load and the power factor not less than 76% at full load.
- c. Motor shall have a casing surface temperature no greater than 185 F (85 C) at an ambient temperature of 86 F (30 C). Others wishing to be approved as equals shall conduct an on site test no more than 10 days after installation demonstrating compliance with temperature specification.

- d. Motor shall be U.L. rated NEMA 6P, Class I, Div. I Groups C&D, Class II Div. II, Groups F&G, Class III Div. I
- e. Motors utilizing oil filled chambers to lubricate seals shall not be acceptable.

2.4 MOTOR CONTROLLER(S)

A. GENERAL

- 1. The controller shall provide independent control of the grinder.
- 2. Controller shall be the City of Tulsa standard UL/cUL listed JWC Model PC2220.
- 3. The controller shall be rated for 5 hp (3.75 kW), 460 volts, 3 phase, 60Hz.
- 4. The controller shall incorporate a phase monitor (Timemark C2644) with fused disconnect switch Mersen number USCC1I integral to the control panel.
- 5. Provide a normally open contact from the phase monitor in parallel with the e-stop button.
- 6. Provide a dry contact from the HOA switch (open in OFF position, closed in AUTO or HAND position).
- 7. Provide 30 mm LED pilot lights for POWER "amber", RUN "green", FAIL "red". Flash fail indicator – Grinder jammed "red" – overload tripped "red", over temp "red". Phase monitor tripped "red".
- 8. PLC shall be Allen-Bradley Micrologics 1400.
- 9. General purpose relay shall be IDEC RHUBL series.
- 10. Motor overload reset fuses must use Ferraz Shawmut fuse holder Part# USC1I or equal.

B. OPERATION

- 1. The controller shall be equipped with a GRINDER ON-OFF/RESET-REMOTE three (3) position selector switch.
 - a. In the ON position the grinder will run.

- b. In the OFF/RESET position grinder shall not run.
 - c. In the REMOTE position the grinder shall start and stop as controlled by a remotely-located dry contact.
 - d. The grinder shall only be reset by switching the GRINDER ON-OFF/RESET-REMOTE switch to the OFF/RESET position.
- 2. The controller shall also be equipped with a push button allowing for momentary reverse of the cutter stacks. Reverse operation shall only initiate while button is depressed with the HOA in the off position and shall cease when button is released. The controller shall not allow for constant reverse operation.
 - 3. Hand/OFF/AUTO switch must be "OFF" to operate the reverse jog.

C. COMPONENTS

- 1. Enclosure
 - a. Enclosures shall be NEMA 4X, fabricated of fiberglass-reinforced polyester resins, and shall be suitable for wall mounting. Doors shall have corrosion-resistant hinges and latches.
 - b. Enclosure shall house the control devices, relays, terminal blocks and reversing motor starters.
- 2. Control Devices
 - a. Pilot devices shall be mounted on the enclosure front panel door.
 - b. The controller shall have 30 mm L.E.D. indicator lights for POWER ON "amber", RUN "green", and FAIL "red". Square D or approved equal.
 - c. Indicator lights shall be 30 mm L.E.D. type pilot lights. Lights and selector switches shall be heavy duty NEMA 4X type. Square D or approved equal.
 - d. Control transformer shall be protected by two primary fuses and one secondary fuse. The 120 volt secondary shall have one leg grounded.
 - e. Relay contacts shall be included for GRINDER run and FAIL signal outputs. The contacts shall be rated 2 ampere, 240 VAC,

resistive load.

3. Motor Starter

- a. Starter shall be a full-voltage, NEMA Rated SQ.D reversing type for the H.P. of the supplied motor with 120 volt operating coils.
- b. Forward and reverse contactors on the starters shall have both mechanical and electrical interlocks.
- c. Overload relays (OL) shall be adjustable so that the range selected includes the FLA (full load amperes) rating and service factor. Overloads shall be reset by a "through the door" reset operational overload. All resets must be labeled correctly on outside of the control panel door.
- d. All motor starters, indicator lights, H.O.A. switches, reset buttons, reset operator and overload units shall be Square-D.

D. SAFETY FEATURES

1. When a grinder jam condition occurs in the grinder ON or REMOTE mode the controller shall stop the grinder, then reverse the grinder rotation to clear the obstruction. If the jam is cleared, the controller shall return the grinder to normal operation. Up to two (2) additional reversing cycles (3 times total) may occur within 30 seconds before the controller de-energizes the grinder motor and activates the grinder fail indicator and relay.
2. If a power failure occurs while a grinder is running, operation will resume when power is restored.
3. If a power failure occurs while the grinder is in a fail condition the fail indicator shall reactivate when power is restored.
4. The controller shall provide overload protection for the motor through an overload relay mounted directly on the grinder starter with isolated N.O. contact that close when overload trips. All overload units shall be resettable from the panel front.
5. Provide short-circuit protection in the panel with a properly-sized Square-D circuit breaker and a "through the door" operator.
6. Controller reset shall be from the local panel controls only.

PART 3 - EXECUTION

3.1 INSTALLATION

Grinder(s) and motor controller(s) shall be installed in accordance with the supplier's installation instructions, and in compliance with all OSHA, local, state, and federal codes and regulations.

3.2 MANUFACTURER'S SERVICES

A. The Contractor shall require the manufacturer to furnish the services of a qualified field engineer to perform the following functions in the designed periods of time. These services are to be performed at the jobsite. A minimum of one (1) visit to the job site totaling a minimum of four (4) hours shall be required or necessary visits to inspect and certify installed equipment.

1. Check-out of installation, start-up of equipment and initial operator instruction. This service shall take place after all mechanical equipment and the control system is installed and mechanically operable.
2. After equipment is fully operational, and before Owner will assume responsibility for the operation of the equipment, the equipment manufacturer's representative shall instruct the Owner's operating personnel in the care, maintenance and proper operation of the equipment. Training time required shall be in addition to time required for start-up activities. Training should include field training and class room training, as required to provide sufficient Manufacturer's recommended training. Reference Special Conditions Specification section 1.1 for additional information.

END OF SECTION

SUPPLEMENTAL SPECIFICATION
LIFT STATION CONSTRUCTION STANDARDS

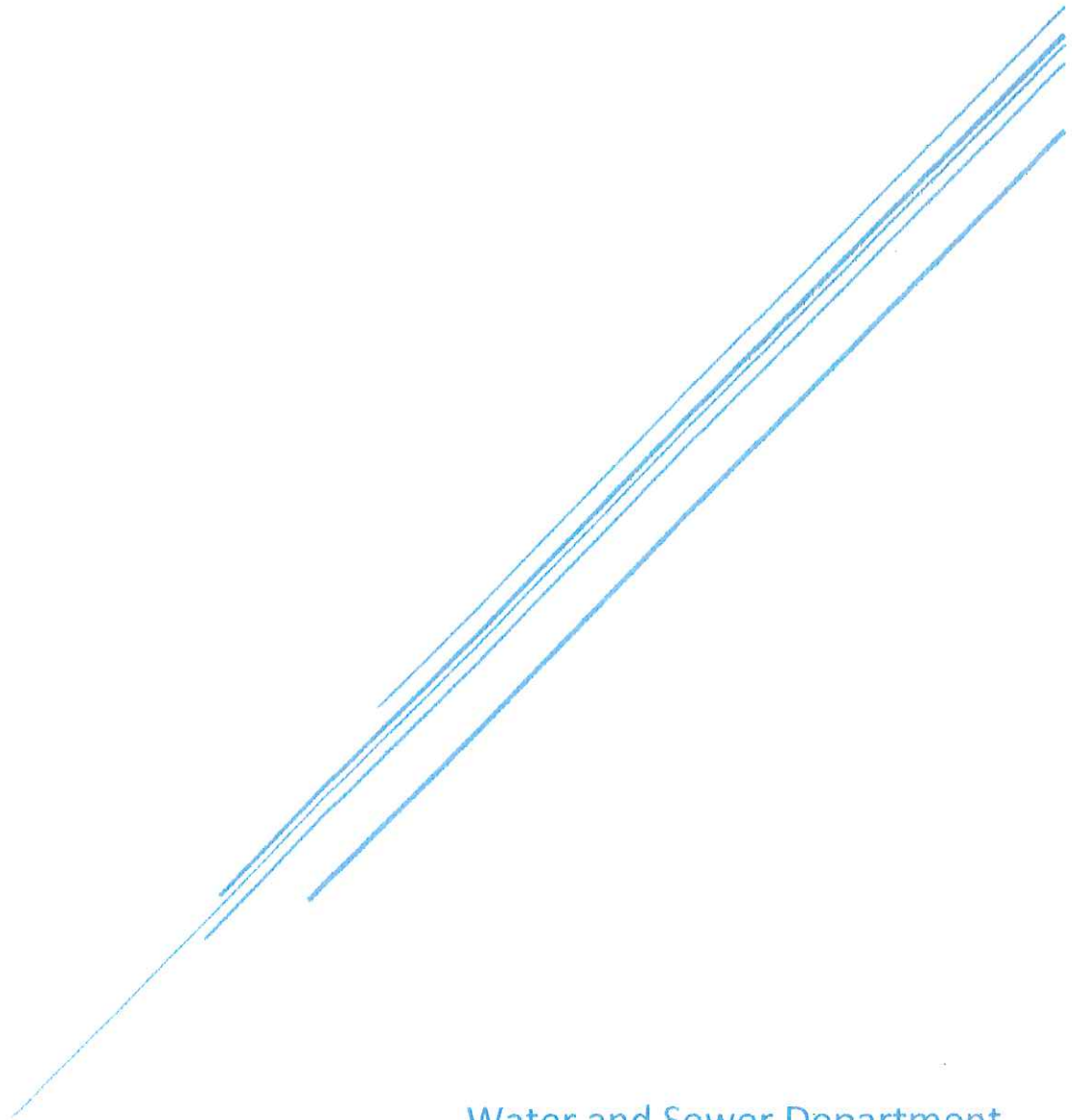
S-1.1 - 1

This following supplemental specification (City of Tulsa 2018 Lift/Pump Station Construction Standards) establishes minimum standards governing construction of sanitary sewer lift stations for the Tulsa Metropolitan Utility Authority (TMUA). These requirements are intended to supplement but not necessarily duplicate information provided in the Technical Specifications and Construction Drawings; so that any work exhibited in one and not the other shall be executed just as if it had been set forth in both, in order that the work shall be completed according to the complete design as decided and determined by the Owner and Engineer. Where conflicts exist between requirements set forth in these standards and requirements of the Technical Specifications and Construction Drawings, these standards shall govern.

Names, manufacturers and models of equipment and materials listed in these standards are provided in order to establish a basis of design by providing an approved model, material or manufacturer. Alternate manufacturers and models may be acceptable and may be submitted to the Owner for approval. No alternate materials or equipment may be utilized without explicit, written approval from the Owner.

CITY OF TULSA

2018 Lift/Pump Station Construction Standards



Water and Sewer Department
Sewer Operations & Maintenance

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General

The following are the standard specifications for all lift/pump stations to be installed and connected to the City of Tulsa's sewer collection system. The purpose of these specifications is to provide a minimum standard for lift/pump stations governing construction for the Tulsa Metropolitan Utility Authority (TMUA). These standards comply with the guidelines set out by the Oklahoma Department of Environmental Quality (ODEQ) and incorporates the most cost effective and reliable design for maintenance and operation.

Names, manufacturers, and models of equipment and materials listed in these standards are provided in order to establish a basis of design by providing an approved model, material or manufacturer. Alternate manufacturers and models may be acceptable and may be submitted to Sewer Operations and Maintenance (SOM) for approval. No alternate materials or equipment may be utilized without explicit, written approval from (SOM). Most specific requirements need to be compatible with our existing equipment.

All sanitary sewer pump stations shall consist of a wet well, a minimum of 3 pumps, control systems, electrical systems (normal and emergency), control structures, site security, grading, and access. The contractor shall be responsible for extending all necessary utilities to the pump station site (electrical, communications, water, gas, sewer, etc.).

All pump/lift stations shall be equipped with a minimum of 8 hours of emergency storage or an emergency generator.

INSPECTION/ACCEPTANCE PROCEDURES

Before final approval of or acceptance of any lift/pump station by the City, there shall be weekly field inspections made by an approved SOM representative. The field inspections shall show that the station is fully operable and all necessary appurtenances have installed and constructed in accordance with the plans, designs, and specifications approved by the SOM before the start of the construction.

All installations shall be inspected by Protective Inspections. (ie: electrical/electric, plumbing, mechanical). Both a preliminary and final inspections are required. Photos of inspection stickers shall be included in the closeout documents.

If requested by the City, representatives from equipment manufacturers and the installing electrical contractor shall be present at the station site for final inspection.

Upon completion of construction and prior to SOM acceptance of the installation, the contractor shall subject all the pumping equipment to a 72 hour operating test as to demonstrate satisfactory performance of the equipment. If tests do not demonstrate satisfactory performance of

the equipment, deficiencies shall be corrected and equipment shall be retested. Each retest will start a new 72 hour requirement.

Since sufficient wastewater to test the pump may not be available when the water test is scheduled, the contractor shall arrange to obtain water, at the contractor's own expense, from the public water supply for the test. The minimum quantity of water to be pumped for the test is equivalent to 1.5 minutes of continuous pumping at rated pump capacity for each pump operating alone. Each pump shall be tested a minimum of 2 times.

SITE TESTING

All station equipment shall be tested at start-up. At a minimum each pump started with the voltage, current and other significant parameters being recorded. The manufacturer shall provide a formal test procedure and forms for recording data. The pump tests shall be performed by the contractor in the presence of City representatives. The City reserves the right to require representatives from the pumping equipment manufacturers to be present for these tests. The recorded data shall be submitted to the Sewer Utility Department, Engineering Division in conjunction with the as-built electrical schematics before the pump station inspection is called for.

CONSTRUCTION, OPERATION AND MAINTENANCE

It is the responsibility of the developer/contractor to construct the station according to the approved construction plans. When the pump station has received construction approval and all operation manuals, specification literature, and electrical diagrams have been received, the pump station and related appurtenances will be accepted by the City of Tulsa for operation and maintenance.

Software, software keys, cables, & licenses shall be supplied and become property of the City of Tulsa. A copy of P. L. C. programs shall be supplied, on C.D and/or thumb drive.

Each project shall require a wall mounted storage cabinet, large enough to store one set of O&M manuals in 3 ring binders, a one line electrical drawing, the required spare fuses, small lamps, control system diagrams, as built drawings, any included small parts, software, programming cable, etc.

SALVAGE EQUIPMENT

All equipment must be saved in a reusable condition and stored against the weather. Any equipment damaged in removal shall be replaced or repaired to useable condition. Salvaged equipment will be delivered at no additional cost to 9319 E 42nd St N, Tulsa OK 74115

TRAINING

Each attendee shall be provided a training certificate showing the system or item trained on, the instructors' name, company, and company affiliation. Length of training rounded to the nearest whole hour.

Training in the maintenance and repairs shall be provided for each system installed such as but not limited to: pumps, grinders, pump level controls, grinder controls, generator, generator controls, transfer switch, transfer switch controls, heating/AC/heat pump, pump VFD's and bypass controls, safety equipment, valves(to include check valves & air relief valves), sluice gate, etc.

FINAL INSPECTION

The final inspection shall be arranged through the SOM, Lift Station Section. Pump stations shall only be considered as acceptable for operation and/or maintenance by the City upon written confirmation by the SOM, Lift Station Section.

WARRANTY

In addition to the equipment manufacturer's general warranties, the contractor shall warranty the pump station and related appurtenances to be free from defects in materials and workmanship for a period of not less than one year from the date of the City of Tulsa's final written acceptance of said pump station.

FINAL ACCEPTANCE

The following documentation must be submitted to the Sewer Utility Department, Engineering Division before a final inspection will be scheduled:

Four (4) sets of as-built wiring and piping schematics of the pump station site and any station access areas.

Four (4) sets of operation and maintenance manuals.

Warranty documents.

The City will not issue a written letter of acceptance or maintenance responsibility until such time that all of the above documentation has been received, final inspection has been performed, and all outstanding issues have been corrected to the satisfaction of the City of Tulsa SOM Lift Station Section. The City shall withhold final payment until all issues have been corrected.

Structural

GENERAL

The pump station structures shall consist of at minimum wet well, valve vault, inflow structure, and control building. All sanitary lift stations shall have an influent cutoff structure with an inflow alarm float ball.

FASTENERS

All bolts, anchors, fittings, and hardware installed in the wet well, inflow structure, or on the outside of the wet well, valve vault, control building, or inflow structure, must be 316 stainless steel or better.

All threads of 316 stainless steel must be liberally coated with anti-seize compound made for this purpose.

All concrete fasteners used for installation of braces, brackets, or boxes shall be 316 stainless steel drop in Anchors and shall be drilled to the manufacturer's recommended depth. Pump base anchor studs shall be sized as per pump manufacturer's recommendation.

CONCRETE SPECIFICATIONS

All requirements on cast-in-place concrete shall be in accordance with the most up to date City of Tulsa Street and Storm Drainage Specifications and Standards, Section 250 Concrete Structures.

CONTROL BUILDING

The control building should be a minimum of 8'X8' I.D. or larger as required by the equipment to be installed.

The exterior shall be split-face block, wheat in color. Smooth face blocks of the same color may be used in areas directly behind the A/C unit and electrical equipment.

The interior shall be painted bright white prior to the installation of any electrical equipment.

The entry door must be equipped with striker cover, entry lock, dead bolt lock, weather stripping threshold, closer, and hold open hardware. The door must be painted to match vinyl siding.

Security "on-off" switch is to be supplied by the City, as well as wiring diagram and switch mounting position.

Lift station door(s) shall be a minimum 3-0 X 7-0 fiberglass insulated and must have lever type handles on the interior. Doors must swing outward.

Building roofs shall be standing seam metal (Brown in color). Gable ends, soffit, etc. shall match steel trim or siding.

Locks shall be Corbin Russwin #60 key way.

WET WELL

INSPECTION

Following placement of the pumps and prior to allowing water in to enter the wet well, the wet well floor will be inspected by the City. The floor must be clean and dry for this inspection. The contractor/developer shall be responsible for arranging this inspection with the City.

GENERAL

The interior surfaces of the wet well shall be coated with 80 mills Raven 405 swimming pool blue in color.

The floor sloped to minimum 3ft x 3ft x 6ft sump under inflow line.

The wash down pads must be 3' wider and 3' longer than the debris basket. Wash down pad will be sloped to the drain in the corner of pad.

SLIDE RAILS

All pump lifting slide rails shall be made of 316 stainless steel pipe. Slide rails shall be installed and sized per manufacturer's instructions. The slide rails shall be firmly braced to the wet well wall with stainless steel support brackets placed at a maximum spacing of 8 feet.

VALVE VAULT

Valve vaults will have exhaust fans (Fantech model) with pickup duck within 6" of valve vault floor and capable of 10 air exchanges per hour.

Valve vault fans shall be controlled by the vault lights switch.

The interior surfaces of the valve vault shall be coated with 80 mills Raven 405 swimming pool blue in color.

Air relief valve installation shall be as shown in the photos below and drawings

Valve vault should be minimum of 7 feet from floor to ceiling.

INFLOW STRUCTURE

Hydrogate model to be used in all influent vaults. Stem of hydrogate must be reachable from ladder. Influent vaults shall have an entry hatch & 316 stainless steel ladder with 316 mounting hardware.

The interior surfaces of the inflow structure shall be coated with 80 mills Raven 405 swimming pool blue in color.

ACCESS HATCHES

All wet wells, valve vaults, and inflow structures shall be provided with aluminum access hatches as follows:

The access hatches shall be of aluminum construction rated for a 300 lbs. per square foot loading.

Door size shall be as indicated on the drawings.

The access frame and cover shall be flush with the top of the concrete with hinged and flush-locking mechanism.

Frame shall be securely placed, mounted above the pumps.

Hatches shall be equipped with form skirts, sized for the slab top thickness.

Doors shall be provided with padlock lock pockets recessed minimum 4"X4".

Hatches shall be provided with fall protection grating rated for a 300 lbs per square foot loading.

Grating shall be aluminum construction with a hold open device that locks the grate in the fully open 90 degree position.

Hatches shall be Bilco, Halliday, Flygt or approved equal.

All access hatch construction materials and appurtenances shall be manufactured from 316 stainless steel or aluminum.

MECHANICAL

CONTROL BUILDING

The City requires a heat/air/heat pump unit for the control building, Bard. Model size (Example: T48H1-C09BPXX3R) to be determined by the equipment installed in the control building. A 316 stainless steel security guard must be installed around the outside of this unit.

AIR SCRUBBER

Air scrubber systems, when used, must be installed outside of the control buildings. Install fan forced air filters on wet wells Plastec Jet series. Valve vaults must have exhaust fan, Fantech model with pickup duct within 6" of valve vault floor and a minimum 10 air exchanges per hour. Vault fans must be controlled by the vault light switch.

WET WELL

Install fan forced air filters on wet wells Plastec series.

VENT

The wet well structure shall be vented with a carbon filter and fan constructed from PVC pipe (refer to detail drawings). The vents shall be covered with a stainless steel or aluminum screen to reduce nuisance insects and debris from entering the wet well.

DISCHARGE RISERS

When ductile iron pipe is utilized for the pump discharge riser and the riser exceeds 8 feet in length, adjustable stainless steel support braces must be installed between the riser and wet well wall. The braces shall be placed at a maximum spacing of 8 feet.

PUMPS

3 identical make and model pumps shall be provided. Each shall be capable of handling flows in excess of the estimated daily peak flow (GPM). Each shall be designed to fit 2 pumps in tandem maximum flow conditions and must be of such capacity that with any one unit out of service the remaining units will have capacity to handle maximum sewage flows.

Storm water stations shall utilize a jockey pump design (small H.P. pump for low rain/runoff flows).

SUBMERSIBLE GRINDER

Grinders must be either JWC or Vogelsang rated for the station being built.

ACCEPTABLE MANUFACTURERS

Submersible non-clog solids handling pumps shall be Flygt Co. or approved equal.

Submersible grinder pumps shall be manufactured by the Flygt Co. or approved equal.

Hardened "N" type impellers, inverter duty rated, volutes must have wear rings. Pump motors must be reconnect able for 208/240/460 volts.

Sewage pumping stations will be submersible.

Only submersible-type pumps will be permitted.

Submersible-type grinder pumps will only be acceptable for pump stations utilizing 10-horse power pumps or smaller.

Pumps must be 3-phase.

Pumps less than 2-horse power are not acceptable.

All pumps above 5 H.P. shall be required to use V.F.D. drives

Pumps running on VFD's must be capable of running from full speed to minimum output speed without overheating.

Pumps handling raw wastewater shall be capable of passing solid spheres of at least three 3" in diameter. Pump suction and discharge piping shall be at least four inches 4" in diameter.

Exceptions to this requirement may be granted on a case-by-case basis when the design includes piping with a diameter at least one inch 1" greater than the solid sphere passed and equivalent protection from clogging is provided (grinder pumps, etc.)

PUMP PERFORMANCE CURVES

Pump performance curves for each pump shall be provided by manufacturer.

HOIST

A Miller DuraHoist hoist/winch retrieval system for confined space entry shall be installed at each lift station. The chain shall be sized to accommodate the installed pump weight. Pump lifting chain, clevises and shackles shall be made of 316 stainless steel.

Provide a minimum of one (1) hoist/winch system and portable base (model Dlt-4).

PIPING DESIGN

After discharge piping and valves have been installed in the valve vault, adjustable pipe cradle jacks shall be placed under the valves and tee, so that they have a 20-inch clearance between the floor and valve flanges.

Piping headers shall have a 2" ball valve lockable in the open and closed position on the bottom common header.

PIPE AND CONDUIT ENTRIES

"A"-lock" or "Z-lock" gaskets embedded in the concrete castings is the preferred method of entry. Other methods may be allowed provided that:

Entry methods do not affect structural integrity.

All entries must be a minimum of one foot from section joints.

Areas around pipe shall be grouted as to be leak-proof.

No couplings shall be allowed in the wall penetrations.

DISCHARGE PIPING

The pump discharge piping diameter and material shall be uniform from the pump discharge base to the common header tee.

Not all base elbows can be done without reducers.

VALVE VAULT

Back-flow preventers, in the wet well, must be Oatey.

COMBINATION AIR VALVES AND AIR RELEASE VALVES

A combination air valve shall be installed on any high points or "knees" of the force main, as deemed necessary by the City Engineer. The combination air valves shall be specifically manufactured for wastewater applications.

The body and cover of the valve shall be constructed of stainless steel or plastic that has a pressure rating greater than or equal to the force main pipe material. Bolts, pipe, nipples, and plugs shall be Type 316 stainless steel. Street elbows shall be stainless steel.

Isolation and flush valves shall be threaded ball valves with 316 stainless bodies, stainless steel ball and operating lever, and nylon seats.

Combination air valves shall be attached to the force main by means of a 316 stainless steel pipe nipple and ball valve threaded to a cast-iron mechanical joint (m.j.) x m.j. x tap tee. (Combination air valves on force mains smaller than 6 inches will require additional support.)

Combination air valves shall be placed in a vault as per the Standard Details. Acceptable combination air valve manufacturers are A.R.I., or approved equal.

CHECK VALVES

Approved shut-off and check valves shall be placed on the discharge line of each pump. The check valves shall be located between the shut-off valve and the pump. Approved shut-off valves shall be placed on the force main as necessary.

The shut-off and check valves shall be installed horizontally and located in accordance with the Standard Details. All valves shall be rated so as to withstand normal working pressure plus allowances for water hammer.

Shut-off valves shall be located so that each pump may be isolated from the common discharge header. Check valves shall be of the swing check type.

Swing check valves shall be flanged type and in full compliance with AWWA C508.

Valves will be supplied with dual external lever with weight or spring.

The pressure rating shall be 250psi.

Check valves will be American AVK Series 41 or equal. Valve shall be certified to ANSI/NSF 61.

VALVE BODIES

Valve bodies shall be of ASTM A536 Ductile Iron.

Class 125 Flanges shall be in compliance with ANSI B16.10.

Bronze seats, when required, shall be constructed of bronze complying with ASTM B62 and be mechanically retained in the valve body.

Laying lengths shall comply with ANSI/ASME B16.10.

VALVE DISC

Disc shall be a carbon steel core completely encapsulated with EPDM.

Bronze seated valves shall have a mechanically secured seat constructed from bronze complying with ASTM B62.

VALVE HINGE AND HINGE PIN

The hinge and hinge pin shall be constructed of AISI 316 stainless steel or fusion bonded epoxy coated ductile iron.

A minimum of two O-rings shall be used to seal the hinge pin.

Protective Coatings

All exposed ferrous surfaces except stainless steel shall be coated with a fusion bonded epoxy that shall comply with AWWA C550.

END CONNECTIONS

Flanged ends shall comply with ANSI/ASME B16.1, class 125 flanges.

MAINTENANCE

The check valve shall be designed such that the disc, hinge, and bonnet can be removed as one assembly.

The check valve shall be drilled and tapped to accept limit switch.

LIMIT SWITCH

The check valves will be fitted with limit switches, Allen Bradley 802T-A and lever 802T-W2D.

Switches shall be connected to the multi-smart controller and wiring cannot be ran with any AC or DC above 50volts in the same conduit.

FORCE MAIN REQUIREMENTS

Force Main Header/Manifold shall have an air release valve (A.R.I. S-025 with one way out only attachment) installed between the pump #3 pipe and the force main shut-off valve.

Thrust Blocks - The force main shall be fitted with permanent thrust blocks at all bends, tees, plugs, fittings or other significant changes in direction. Thrust blocks shall be constructed as per the Standard Details. Thrust block locations shall be given on both plan and profile views on the construction plans.

Isolation Valves – A force main shall have valves spaced at no more than one thousand five hundred feet intervals to facilitate initial testing and subsequent maintenance and repairs.

All lift stations shall have a force main shutoff valve. All pump discharge lines shall have a ½" ball valve test port in the valve vault located before the check valve.

PLUMBING

GENERAL

All pump stations shall be equipped with a by-pass pump arrangement as per the Standard Details.

Water meter shall be outside the station fence.

CONTROL BUILDING

Back flow preventers may be installed inside the rest room with easily accessible test ports.

All restrooms in lift stations shall have a 2 gallon cord and plug 120-volt hot water heater and shall be mounted 18" above finished floor with all fittings accessible to work on.

Fresh water supply to be installed as shown in the attached Hot Box photos. Back flow preventers may be installed inside the restroom. With a frost proof removable key thru the wall hydrant.

Water pressure shall be regulated with a water pressure regulator

WET WELL

The wet well shall have a 6" valve and blind flange for pump around and a force main shutoff valve.

VALVE VAULT

A drain pipe shall be installed from the valve vault to the pump vault. A flapper-style back-water check valve shall be installed on the valve vault drain line as per Standard Details.

A Moen Model # M8086 backflow preventer shall be installed inside the floor drain.

FORCE MAIN REQUIREMENTS

Install a 316 stainless steel nipple and ball valve between pipe and air release valve to isolate for maintenance.

Termination - Force mains shall discharge to a gravity sewer in a manner that smoothly directs the force main flow into the gravity sewer flow and minimizes turbulence.

Corrosion protection for the upstream manhole and two downstream manholes shall be provided. Force mains shall be connected to a gravity sewer as per the Standard Details.

Clean-outs - The need for clean-outs on the force main shall be determined during plan review by the City of Tulsa.

Force Main Pressure Test - Contractor shall fill and pressure test the force main. The minimum required test pressure shall be the maximum force main operating pressure plus 50 psi. (City representative shall be present during this test).

ELECTRICAL

All electrical equipment must be Square D or Cutler Hammer and must be NEMA rated. No I.E.C. rated equipment of any type will be accepted. All circuits shall be numbered and a label shall show the equipment served.

A flash hazard and shock hazard analysis, a breaker coordination study, and a one line diagram must be done for all installed equipment from the station main disconnect downstream to the outlet and lightning panel board. All code required labels and equipment name plates must be installed. Equipment name plates must be attached with 316 stainless steel pan head screws.

SERVICE ENTRANCE

All service entrances shall be sized to allow for a 50% increase in pump H.P. IE: Load. Service entrance voltages shall be 480/277 volt, 3 phase 4 wire, or 240/120, 3 phase 4 wire by permission only.

Both systems shall have a neutral equal to the service entrance conductor size, No single-phase service entrances, or phase converters will be accepted.

Each service shall be metered separately. No sharing of services with a business outside of City control.

All overhead services must be installed to allow personnel to safely remove equipment from the site with an overhead crane.

Station cannot be built under an existing power line. All overhead areas above station must be clear.

ELECTRICAL EQUIPMENT

All electrical equipment must be installed on 1-5/8" uni-strut long slot pattern, on the interior and exterior of the control building.

Uni-strut shall be hot dipped galvanized for building interior and 316 stainless steel for exterior.

Depending on the size of the station at least 4-20 amp GFCI, 120-volt receptacles on a 20-amp circuit breaker inside the control building and one outside the control building mounted on the Strut Rack Frame.

Electric utility enclosures and conduits may be of standard NEMA 3R material.

All panels and other electrical enclosures shall be mounted 6'6" from finished grade to the top of the enclosure (inside of or attached to the outside of the control building). One exception is the electric meter, which must be, mounted 5'6" from finished grade to center of meter. All other

exterior boxes, not mounted to the control building, must be 30" to the bottom of the enclosure from the finished grade.

All junction enclosures and switches exterior of the building must be a pad lock lockable. The uni-strut rack must consist of 1-5/8" 316 stainless steel long slot pattern back-to-back uni-strut for the post. These posts must be set in concrete 36" deep.

Junction enclosure, switches, outlets, etc. shall be attached to the strut rack by a stainless steel bolt in each of the 4 comers of each enclosure, utilizing the factory supplied mounting holes (do not drill holes in these enclosure for mounting bolts).

All switches, disconnects and breakers shall be pad lock lockable for lockout/tagout purposes.

Junction box enclosures shall be of 316 stainless steel.

The top of the concrete must be 6" above the finished grade and be sloped away from the post on all sides. The horizontal strut must be a minimum of 1 5/8" 316 stainless steel long slot pattern.

Any and all switches and/or receptacles must be mounted on 1/8" aluminum plate. Then the aluminum plate shall be mounted on the uni-strut frame.

FASTENERS

All bolts, nuts and washers must be 316 stainless or better.

The lower horizontal struts must also be a minimum 1-5/8". 316 stainless steel strut, the first strut to be installed 12" below the junction enclosure, the second strut to be 6" above final grade all conduit attached to strut shall use 316 stainless steel conduit clamps.

All hangers, anchor bolts, bolts, fasteners and uni-strut shall be 316 stainless steel unless noted otherwise.

SUBMERSIBLE GRINDER

MOTOR CONTROLLER(S)

The controller shall provide independent control of the grinder

Controller shall be JWC PC2220 serial number 112361 or equivalent

The controller shall be rated for 5 hp (3.75 kW), 460 volts, 3 phase, 60Hz

The controller shall incorporate a phase monitor (Timemark C2644) with fused disconnect switch integral to the control panel. Provide a normally open contact from the phase monitor in parallel with the E-Stop button. Provide a dry contact from the HAND/OFF/AUTO switch (open in OFF position, closed in AUTO or HAND position). The HAND/OFF/AUTO switch shall function as follows:

OFF - In this position the applicable pump will not run under any circumstance.

HAND - In this position the applicable pump shall run without regard for the level sensing commands and will stop when level reaches the off duty position. To further run the pump in hand, the switch must be held on to run.

AUTO - In this position both pumps shall be controlled by float switches. These switches will sense the appropriate level in the wet well and initiate start and stop commands to the pumps. All floats shall be interposed with intrinsically safe UL. Listed relays installed per NEC Article 504, ANSI/ISA-RP12.6 and all other applicable codes.

Provide 30 mm LED pilot lights for POWER, RUN, and FAIL.

Flash indicator-Grinder jammed, solid light- overload tripped, Long on Short off- over temp. PLC shall be Allen-Bradley Micrologics 1000. General purpose relay shall be IDEC RHUBL series.

OPERATION

The controller shall be equipped with a GRINDER ON-OFF/RESET-REMOTE three (3) position selector switch.

In the ON position the grinder will run.

In the OFF/RESET position grinder shall not run.

In the REMOTE position the grinder shall start and stop as controlled by a remotely-located dry contact.

The grinder shall only be reset by switching the GRINDER ON-OFF/RESET-REMOTE switch to the OFF/RESET position.

The controller shall also be equipped with a push button allowing for momentary reverse of the cutter stacks. Reverse operation shall only initiate while button is depressed and shall cease when button is released. The controller shall not allow for constant reverse operation.

Hand/OFF/AUTO switch must be "OFF" to operate the reverse jog.

COMPONENTS

Enclosures shall be NEMA 4X, fabricated of fiberglass-reinforced polyester resins, and shall be suitable for wall mounting. Doors shall have corrosion-resistant hinges and latches.

Enclosure shall house the control devices, relays, terminal blocks, and reversing motor starters.

Pilot devices shall be mounted on the enclosure front panel door.

The controller shall have 30 mm LRD indicator lights for POWER ON, RUN, and FAIL.

Indicator lights shall be 30 mm LED type pilot lights. Lights and selector switches shall be heavy duty NEMA 4X type.

Control transformer shall be protected by two primary fuses and one secondary fuse. The 120 volt secondary shall have one leg grounded.

Relay contacts shall be included for GRINDER RUN and FAIL signal outputs. The contacts shall be rated 2 ampere, 240 VAC, resistive load.

MOTOR STARTER

Starter shall be a full-voltage, NEMA Rated SQ.D reversing type (minimum size 1) with 120 volt operating coils.

Forward and reverse contactors on the starters shall have both mechanical and electrical interlocks.

Overload relays (OL) shall be adjusted so that the range selected includes the full load amperes (FLA) rating and service factor.

All motor starters, indicator lights, HOA switches, reset buttons, and overload units shall be Square-D.

SAFETY FEATURES

When the grinder jam condition occurs in the grinder ON or REMOTE mode the controller shall stop the grinder, then reverse the grinder rotation to clear the obstruction. If the jam is cleared, the controller shall return the grinder to normal operation.

Up to two(2) additional reversing cycles (3 times total) may occur within 30 seconds before the controller de-energizes the grinder motor and activates the grinder fail indicator and relay.

If a power failure occurs while a grinder is running, operation will resume when power is restored.

If a power failure occurs while the grinder is in a fail condition, the fail indicator shall reactivate when power is restored.

The controller shall provide overload protection for the motor through an overload relay mounted directly on the grinder starter with isolated N.O. contact that close then overload trips. All overload units shall be resettable from the panel front.

Provide short-circuit protection in the panel with a properly-sized Square-D circuit breaker and a throttle door operator.

Controller reset shall be from the local panel controls only.

INSTALLATION

Grinder(s) and motor controller(s) shall be installed in accordance with the supplier's installation instructions, and in compliance with all OSHA, local, state, and federal codes and regulations.

MANUFACTURER'S SERVICE

The contractor shall require the manufacturer to furnish the services of a qualified field engineer to perform the following functions in the designed periods of time. These services are to be performed at the jobsite. A minimum of one (1) visit to the jobsite totaling a minimum of four (4) hours shall be required or necessary visits to inspect and certify installed equipment.

Check-out of installation, start-up of equipment, and initial operator instruction. This service shall take place after all mechanical equipment and the control system is installed and mechanically operable.

After equipment is fully operational, and before Owner will assume responsibility for the operation of the equipment, the equipment manufacturer's representative shall instruct the Owner's operating personnel in the care, maintenance, and proper operation of the equipment.

VARIABLE FREQUENCY DRIVE

All pumps above 5 H.P. shall be required to use V.F.D. drives

V.F.D. shall be Square D, Cutler Hammer or ABB. Equipment supplied must include software and cabling for programming if different than our existing equipment software or cabling.

All V.F.D.s will require NEMA rated bypass input and output isolation contactor for each unit. All drives must have an output isolation contactor for automatic megger testing.

Additional cooling shall be required where V.F.D.s are mounted in group enclosures.

All cooling fans must be thermostatically controlled or on when the pump runs but cannot run continuously.

All air intakes shall have removable filters (See photo 3570 3571). V.F.D. drives may be required on pumps smaller than 5 H.P. where the design of the station dictates. I.E.: wet well size, number of starts per hour, output flow requirements, etc.

LEVEL CONTROL

Level control systems-shall be FLYGT multismart with:

A level sensing probe (probe length to be as close as standard size will allow for the top sensor to be at the bottom of the inflow line and the bottom sensor to be at the center line of the pump volute).

A transducer 0-5psi, 11.55ft, H2O pressure range (submersible weighted, sewage rated 316 stainless steel) with lifting eye and 316 stainless steel chain (Cable must reach from bottom of wet well to the controller without splice. 4-20 MA 2 wire).

Advanced motor protection.

Flow data and any and all of the latest advancements at the time of design of the lift station.

Acromag or Adams I/O expansion cards may be used when needed for additional I/O.

No analog or time delay function can be connected to the expansion cards. Level control systems must have a backup level control system that is automatically put into operation if the primary system fails.

This system must operate the largest pump in the station or if pumps are equal in size all pumps in a staggered time delay operation with a maximum of 2 pumps running at any one time.

Our standard system incorporates a Conery wide angle float ball model 2900B2S4C1K2 plus length of a cord required, time delay relays, intrinsic relay, auxiliary contactor contacts, and VFD running contacts. All panels and switches shall be U.L. 508A listed.

TRANSFORMERS

All transformers to serve station outlet and lighting shall be minimum 25 KVA for 1 phase 240/120 volt and 30 KVA for 208/120 volt 3 phase. Outlet and lighting panels shall have a minimum 100-amp main. Transformers shall be mounted at least 6'-6" above the finished floor grade. Transformers shall be mounted to walls with 1-5/8" X 1-5/8" strut.

Use a Cutler Hammer or Square D power point transformer /panel combination.

The outlet and lighting circuit breaker panel must be a minimum of 24 usable circuits having at least a 100-amp main, and have at least 4 spare breaker spaces.

All breakers must be equipped to accept a padlock so as to be padlocked in the off position for lockout/tagout purposes.

All control transformers shall be fused on the primary and secondary.

PUMP CONTROL PANEL

The intent of this specification is to provide a complete, integrated Pump Control System as described herein. It shall be factory assembled, wired and tested. The panel manufacturer shall supply 4 sets of AutoCAD As-Wired drawings upon completion of construction. Two copies of these drawings shall be provided inside the pump control panel and the other 2 sets given to the City's representative.

An equipment data tag shall be permanently affixed on the inside of the exterior door with the station designation, power source, pump horsepower, and pump full load amps. In addition to the label requirements of UL 508A, an engraved legend plate shall be permanently affixed on the

inside of the exterior door with the name, address and telephone number of the service representative for the pumps and control panel.

QUALITY ASSURANCE

The pump control panel shall be supplied by the pump manufacturer and fabricated by a current UL 508A Listed industrial control panel manufacturer. The panel manufacturer shall show its UL follow-up service procedure file number on submittals. All devices within the panel shall be UL listed and/or recognized where applicable and shall be mounted and wired in accordance with the most current edition of UL508 and NFPA. The panel manufacturer shall have a minimum of 5 years of experience manufacturing systems specifically for wastewater applications.

The pump control system(s) shall be fully tested by the factory prior to shipment. It shall include testing of both power and control devices as well as all control functions. A final inspection shall be performed prior to shipment and a copy of this form shall be provided with the panel.

The panel shall be designed with the following features to operate the specified pumps. The pump itself, the pump control panel, and related accessories shall be supplied by the pump supplier to insure compatibility and assure matching controls to pumps.

BASIC OPERATION

The pumps shall be operated automatically or manually as a pump down, lead/lag, common off system. Each pump shall be controlled primarily through a "Hand-Off-Auto" 3-position selector switch on the Multi-Smart. Control function requirements are further defined in the control section of these specifications.

Position Commands Located on Multismart:

OFF - In this position the applicable pump will not run under any circumstance.

HAND - In this position the applicable pump shall run without regard for the level sensing commands and will stop when level reaches the off duty position. To further run the pump in hand, the switch must be held on to run.

AUTO - In this position both pumps shall be controlled by float switches. These switches will sense the appropriate level in the wet well and initiate start and stop commands to the pumps. All floats shall be interposed with intrinsically safe UL. Listed relays installed per NEC Article 504, ANSI/ISA-RP12.6 and all other applicable codes.

PUMP SEQUENCE

A Flygt probe level sensors shall be provided with sufficient length cord to run between the probe and the junction box unspliced. The 4 levels shall act as:

LEVEL 4 - High Level Alarm.

LEVEL 3 - Start Lag Pump; 2 pumps running.

LEVEL 2 - Start Lead Pump; shall alternate on each call

LEVEL 1 - Off; all pumps stop

UTILITY POWER

Utility power to the panel shall be 480/277 volts, 3 phase, 4 wire, 60hz. It is the responsibility of the contractor to bring the necessary utility power to the pump station site.

WET WELL

The following electrical requirements shall be followed for wiring installed in the wet well interior:

All pump power, control leads and level control float leads shall be hung with 316 stainless steel Kellems grips from the bracket supplied by the pump manufacturer. The bracket shall be bolted to the inside of the wet well hatch frame or firmly bolted to the concrete immediately below the hatch frame, immediately below the hatch cover. The bracket shall be located so as not to interfere with the wet well entrance ladder. All wires shall be neatly passed from the bracket to the raceway.

Passage of the pump and float wires from the wet well to the junction box shall be made through a length of conduit installed between the junction box and wet well. No conduit shall be attached to the wet well top or ceiling.

The power lead for each pump shall be placed in separate conduit. All of the float, probe, and transducer leads shall be placed in individual conduit.

There shall be no electrical connections made in the pump chamber. All wiring shall run unbroken from the pump chamber to the junction box through the conduit and terminated on terminal blocks inside of the junction box.

Permanently installed dividers shall be installed in pump interface junctions between high voltage pump leads and low voltage sensor lead connections.

All pump and control conduits entering or exiting the pump control panel shall have explosion proof conduit seals suitable for Class I, Division 1 or 2, Group D environments. These seals shall be provided and installed by the installing contractor.

VALVE VAULT

Valve vault shall have minimum (TWO) Crouse Hinds Ceiling or wall mount LED Luminaries: These models are compatible with existing equipment and parts.

Crouse Hinds EVLEDCX2C701 Ceiling Mount.

Crouse Hinds EVLEDBX2C701

HIGH VOLTAGE

MAIN LUG ONLY

A power distribution block sized for the incoming power conductors shall be provided for the main power connection. A separate fused double throw transfer/disconnect service entrance switch shall be provided and installed by the contractor. The manual transfer switch shall have padlock provisions in "ON" utility (UP), "OFF" (CENTER), and "AUX GEN" (DOWN).

Individual Branch Disconnect and Short Circuit Protection

Each pump motor shall be provided with a combination circuit breaker motor starter. Circuit breakers shall be thermal magnetic, "E" frame or better and rated for 14,000 AIC at 480 VAC. Starters shall be NEMA rated. Starters smaller than Size 1 and half sizes will not be allowed.

Coils and contacts shall be replaceable without removing the motor starter from the enclosure. Overloads shall be ambient compensated, quick trip (Class10) type. Overload reset operators shall be provided to reset the overloads without opening the enclosure door.

POWER DISTRIBUTION SYSTEM

Associated with this installation will require the individual branch disconnect and short circuit protection to have a UL interrupting rating of 14 kA at 460 VAC.

CONTROL POWER

The 120 VAC, single-phase power shall be derived from a properly sized transformer.

Control power shall have an over current protection device suitable interrupting requirements of the system. Fused disconnect shall be provided in accordance with NEC and the system requirements.

LIGHTNING ARRESTOR

The system shall be protected by a lightning arrester for the electrical service and shall be capable of handling up to 600vac. It shall be single MOV design and provide protection for Category C Transient Surges as defined in ANS/IEEE C62.41 without degradation of components. The arrester shall provide protection between each phase line and the ground line. The arrester shall be UL listed as a secondary surge arrester, UL category OWHX.

The enclosure shall be molded UV resistant polycarbonate or equal material. All electrical connectors shall be sealed in a UL component recognized epoxy to exclude moisture, dirt and corrosion. A 1/2-inch conduit nipple and lock nut shall be provided. Leads shall be color-coded and a minimum of 18 inches long. It shall be provided loose for mounting on the exterior of the utility service entrance disconnect by the installing contractor.

Lightning arresters to be installed on the outside and bottom of the main disconnect on the load side of the main disconnect. Lightning arresters shall be Maclean Power Systems, indicating

type. Surge suppression equipment shall be Rayvoss, sized for service entrance with fused disconnect.

GROUND LUGS

Ground lugs shall be provided for both incoming service and for each motor. All grounding electrode systems shall be tested and shall be no more than 5 ohms resistance.

A grounding system test report shall be required in all new or rehab projects. All grounding rods must have approved ground rod wells for inspection and testing of the ground electrode system. Documentation shall be part of the final closeout.

THREE-PHASE POWER MONITOR

A UL recognized 3-phase power monitor shall interrupt the control power in the event of phase loss, phase reversal, low voltage and phase unbalance. It shall have primary fuse protection. Contacts shall be rated for 15A resistive at 120 VAC. The 3-phase power monitor shall automatically reset when proper power is re-applied

Phase monitor shall be Time Mark model 2644. The phase power monitor must to have 3-30 amp rated single mounted Mersen touch safe disconnect fuse holders with indicating lights between the incoming power supply and the phase monitor.

The 3 fuse holders (Part # USCC1I) shall be filled with 2 amp KTK fuses, and must be mounted as close to the sensing source as possible, having adequate room to operate them in an energized state.

All control systems shall incorporate a phase monitor to stop or keep pumps from starting under phase loss, low voltage or reversal and must use the same phase monitor for power fail alarm.

Special purpose relays shall be Time Mark, Diversified or Idec and be of the "plug-in" type.

All general-purpose relays shall be Idec and be of the "plug-in" type. 1 RH2BUL must be lighted when energized type.

COMPONENTS

Operator control devices shall be 30mm, NEMA and UL listed for Types 1, 12, 3R, 4 and 4X. Contact blocks shall be self-wiping and color-coded bridge type rated at 10A and must have a rated insulation of 600V.

Terminal connections shall be suitable for two 14 AWG control wires. All control and time delay relays shall be DPDT rated 10A @ 120 VAC, 8-pin socket mount type. Sockets shall have pressure plate terminals that accept two 14 AWG wires and shall be rated a minimum of 300V.

All terminal blocks supplied shall be box lug type rated at the proper voltage/ampereage and shall accept two 14 AWG wires.

CONDUIT SPECIFICATION

All conduits installed between the wet well and junction box shall be 50% larger than the cross section of the cord required. For a pump 50% larger than installed pump. A 1" conduit for each pump shall be installed for pump sensor cable and plugged in the junction if not used.

A separate conduit shall be provided for the power leads of each pump. One conduit for each float, probe, or transducer shall be provided.

All exterior conduit installed shall be 316 stainless steel conduit if entering the wet well or inflow structure.

All exterior conduits must be ¾" or larger if required by code and must be rigid galvanized steel throughout if not connected to the wet well.

All conduit encased in concrete or earthen material must be minimum ¾" rigid galvanized.

All conduits, coming out of the wet well, that contain flexible cords, must have a C.G.B. type cord connectors.

All conduits entering the wet well from structure must be 316 stainless steel, flexible cords, must also use 316 stainless steel chase nipples on the open end in the wet well.

Pump and Grinder cable conduits shall be sized no smaller than 53% fill for one cable of a pump or grinder while also allowing future upgrades of 50% cable size in the future.

These cords are to be supported by 316 stainless steel Kellems bail type cord grips.

The cord grips must be hung on 316 stainless steel hooks out of the way of pump removal.

All conduits leaving the interface junction boxes, routed to the control building, must have a vapor seal installed immediately above or below the interface junction boxes.

These seals should not be poured until final acceptance of entire project by the City of Tulsa.

Any and all excess cable from the pumps must be coiled and stored next to the pump access hatch.

Do not cut pump, grinder, float ball, probe, transducer, or pump sensor cable leave factory length.

Cables cannot be hung on the pump guide rails.

Interior building wiring shall be E.M.T. ran exposed on walls and ceilings Use steel fittings with insulated throat and steel couplings.

WIRING

Wiring schematics must be provided.

Schematic must include a physical wiring diagram with a legend for component identification.

A site plan showing all conduit runs (size, type, routing and location), this is to include a one line site plan from PSO feed pole to all equipment installed.

Digital photos in J-peg format of all underground installations, i.e. conduit runs, gas lines, waterlines, sewer lines, force main, gravity line, AEP/PSO conduit, etc.

A minimum 8" X 8" wire way shall be used below all panels, switches, A.T.S., transformers etc. Enclosure shall be hinged lid with the hinge on the bottom and be a minimum of 12" above finished floor. This enclosure shall contain all wiring 120 volts A.C. and above.

A minimum 4" X 4" wire way shall be used above all panels, switches, A.T.S., transformers, etc. Enclosure shall hinged lid with the hinge on the bottom. This enclosure shall contain wiring below 120 volt A.C. or D.C.

12 GAUAGE OR SMALLER

All wiring, shall be standard, solid color and the color is not to be duplicated until' all available colors have been used red, black, blue, light blue, yellow, orange, brown, tan, pink, gray and purple.

White is to be used as a neutral only.

Gray is to be used for 277 volt neutral.

Green is to be used as a ground only.

All wiring is to be identified by a permanent numbering system, such as Thomas and Betts heat shrink sleeves, white with black numbers, self-adhesive wrap around numbers will not be accepted.

The wiring shall carry the same number from the field terminal wiring strip to all other field devices (same numbers throughout).

This must include all wiring in the station and is not only for the control system (lights, receptacles, fans, etc.).

City of Tulsa requires 20% spare wiring in all underground conduits or wiring that passes through a vapor seal, with a minimum of 2 spare wires per conduit.

These wires are to be marked spare and give the location of the opposite end (12 gauge and smaller). All wire shall be copper of the stranded type.

All electrical systems shall be color coded to the City of Tulsa electrical code for system voltage identification and phase rotation.

All wire shall be megger tested after installation. Wire shall pass 500 volt 100.0 megohm or better. A megger test report shall be required as part of the final closeout documentation.

All 120 volt control wiring shall be in separate conduits from pump power wiring and pump sensor cables. All low voltage control wiring (50 volts or less per cord) shall be in separate conduits and wire ways, all pump power cables must be in their own, separate conduits.

FIELD WIRING

Control panel wiring shall be as follows:

All wiring installed on the line and load side of the electric meter shall be THHN stranded copper wire.

Electric service to the station shall be sized to provide the maximum total station amperage with all installed pumps running under a fully loaded condition and allow for a 50% expansion of pump horse power.

All pump station control panels shall be provided with a minimum 100-amp service.

CONTROL SECTION

All control wiring shall be minimum 16 AWG, MTW and shall be color-coded in accordance with all applicable codes and laws. Spiral wrap, tie wrap, fasteners and wire duct shall be provided as required for aesthetics and safety.

All components mounted on the door shall be wired with insulated connectors where "finger proof" terminals are not provided to prevent accidental shock hazards.

All components on the back panel shall be mounted on DIN rail or fastened via drilled and tapped screws to facilitate easy component replacement.

Pop rivets shall not be allowed. Ammeter loops shall be provided between the combination starter and terminal blocks.

Nylon white heat shrink sleeves wire markers shall be supplied at both ends of every wire.

All components on the back panel shall be identified by a Brady BMX-C + System metallized polyester printed adhesive label.

Dymo labels are not acceptable. These labels shall include all pertinent data applicable to ratings and sizes. Components on the door of the enclosure shall be identified with custom engraved plastic legend plates.

Voltage identification labels and comprehensive warning labels shall also be provided.

CONTROL PANEL ACCESSORIES

Indicator lamps-shall be red for all alarm (failure) lights, amber for pump ready lights, and green for pump running lights.

The amber pump ready lights must extinguish when the local "OFF" switch is in the off position, when the pump IS running and if the pump is in failure for any reason. Amber indication must be on when control is in the "VFD BYPASS" mode.

All alarms are manual reset except for power failure, control fail, high wet well, and inflow backup.

Panel indicator lights shall be 30MM 120-volt transformer type L.E.D. lamps.

Hold open arms on all control panels that have door-mounted equipment.

All door mounted equipment shall be finger touch safe.

RUN TIME METERS

Run time meters must be Crammer 365 E&S 6 digit 120 volt measuring in 10th's to closest 1/10 of an hour. Hour meters must total run times if running on VFD's, across the line contractors, normal level controls, or on back up level control and must not total any run time if failed.

THREE PHASE MOTORS

All pumps shall utilize be 3-phase motors. Single phase motors shall not be acceptable. Pump stations shall be served by utility supplied 3-phase power. The use of single phase power and a phase converter will not be considered.

All wiring ahead of the 3-phase panel shall be protected by 3 phase breakers sized to meet the total amperage and inductive in rush load of across the line starting 3 phase motors. Conductors shall be sized based on 3 phase amperage plus a 50% increase in pump horse power.

INTERIOR LIGHTING

The control building interior lighting shall be LED "Light Emitting Diodes" for all rooms of the following: These models are compatible with existing equipment and parts.

H.E. Williams Inc. Cat. # 12-4-L84/840-S-AF12125-DRV-UNV 2' x 4' LED ceiling surface mount- solid sides.

Lithonia ELM2SD Emergency Light Wall Mount "ONE Minimum per room".

Lithonia LHQMLED Exit-Emergency Light "ONE at exit-entry door".

EXTERIOR LIGHTING

Exterior area flood lighting luminaires shall be of the LED "Light Emitting Diodes" type with LED lamps color temperature of 5000K and have minimum lumens of 30,000.

Mounting luminaire with a knuckle slip fitter arm on a steel bullhorn having two tenons at 180 degree angle for luminaires.

A single pole switch shall be mounted indoors at entry door of the station building to turn on exterior pole mount area lights.

General Electric (EFH1) Ordering Number Logic: EFH1010EE77750NAK2DKBZ
Evolve luminaire (2 Luminaires per pole). Or equivalent

The light pole must be constructed to meet N.E.C. 2017 code, 410-30B 1 thru 6.

The light fixture must be installed level and plumb and meet the manufactures installation instructions. Trucks must be able to get within 10' of the pole for relamping or repairs.

Pole shall be Hinged Steel pole from Valmont Structures "20 feet" with Winch.
DSF10400F20P7FPGVBKFBCAB2180A (2 poles minimum per station).

Outdoor wall mount area light luminaires shall be of the LED "Light Emitting Diodes" type with LED lamps color temperature of 5000K and have minimum lumens of 13,000.

A single pole circuit breaker shall turn on power to motion sensor of wall light units.

General Electric (EWNA) Ordering Number Logic: EWNB0F37501NDKBZH Evolve
Wall Luminaire (minimum of 1 per side of control building).

Luminaires shall be installed as high as possible on each gable end of the control building, the luminaires all shall be controlled by a motion sensor.

VALVE VAULT LIGHTING

The valve vault shall have 2 Crouse Hinds Ceiling or wall mount LED Luminaires at minimum: These models are compatible with existing equipment and parts.

Crouse Hinds EVLEDCX2C707 Ceiling mount or

Crouse Hinds EVLEDBX2C707 Wall mount.

BACK-UP GENERATOR

Pump stations with pumps equal to or greater than 20 hp shall be equipped with a complete and operable emergency/standby generating system. The equipment shall be new, factory tested, and delivered ready for installation.

The stand-by generator will be diesel fuel.

Generator brand shall be M.T.U. or Blue Star.

Enclosure is level 3 for the lowest DBA level.

Have remote annunciator.

Sub base fuel tank 24-hour supply at full load.

Low fuel warning at 25% fuel level.

Engine shut down at 10% fuel level.

Fuel level to be displayed on controller.

Engines must meet current Emissions standards at time of installation.

Pump stations equipped backup generators shall be provided with an automatic transfer switch to switch from utility power to generator power.

The switch shall be properly sized for the load served as dictated by NEC and the manufacturer. Plus a 50% increase in pump horse power.

The switch shall be certified to meet the latest adopted transfer switch standards as defined by UL Acceptable manufacturers are Generac GTS, ASCO 300G or approved equal.

A generator receptacle shall be mounted on the side of the control building. It shall have male contacts and include the required poles to properly interface with the generator system voltage requirements.

The generator receptacle shall be suitable for connections in an outdoor environment. The generator receptacle shall be in accordance with Lift Station Standards as manufactured by Crouse-Hinds or Appleton.

We can also accept an emergency generator receptacle if the flow rates will allow it per ODEQ. This receptacle must work with our existing equipment we will supply you with the part numbers depending on the voltage configuration of the system being installed.

This receptacle must be installed in a mating angle box on the outside of the control building, as well as automatic start receptacle where it is easily accessed from the drive gate, less than 50' from receptacle to accessible parking spot for trailer mounted generator inside the fenced area.

Generator controller must be a Basler DGC 2020.

Generators must use a 12 lead wye reconnect able marathon

Required battery charger shall be 10 amp ENER Genius. 120vac cord and plug as shown.

Required block heater shall be hot start sized per engine, manufacturer requirements 120vac cord and plug and be of the horizontal type.

Automatic transfer switch must have a 7 -day programmable exercise clock for the generator applications.

The generator shall be sized so that all the pumps and appurtenances contained in the pump station can run simultaneously and allow for a 50% increase in horse power.

Must be sized to start pumps across the line in a staggered start time delay call.

SCADA

SCADA equipment must be supplied and match our existing equipment at time of construction.

Motorola ACE3600 CPU3680 with PLUG-IN ETHERNET 10/100 M PORT

3 I/O SLOTS FRAME

32 DI FAST 24V with optional 24V floating power supply

16 DI 4 DO EE 4 AI, $\pm 20\text{mA}$

APX6500 digital installation kit, APC 650 UPS BE65OG1

3rd party protocol license

AC power supply- 100-240V with battery charger

40-wire cable braid with TB holder 3 m

Enclosure shall be 30" in height 24" width 12" depth with pad lockable handle (Hoffman Model # CSD302412).

Analog Inputs shall fused 250Ma and isolated loop circuit protected

Digital inputs shall be wired as follows:

DI-1: Power Fail	DI-17: Pump #1 Running
DI-2: Control Fail	DI-18: Pump #2 Running
DI-3: Spare	DI-19: Pump #3 Running
DI-4: Security	DI-20: Pump #4 Running
DI-5: High wet well	DI-21: Pump #5 Running
DI-6: Spare	DI-22:
DI-7: Pump #1 Fail	DI-23:
DI-8: Pump #2 Fail	DI-24:
DI-9: Pump #3 Fail	DI-25:
DI-10: Pump #4 Fail	DI-26:
DI-11: Pump #5 Fail	DI-27:
DI-12: Grinder Fail	DI-28:
DI-13: Spare	DI-29:
DI-14: Generator Fail	DI-30:
DI-15: Generator Running	DI-31:
DI-16: Generator Exercise	DI-32:

RTU programming shall match current City of Tulsa Sewer Operations & Maintenance configuration and application. Consult with City of Tulsa Radio Services on acceptable antenna, specifications for radio and radio programming.

Security alarm wiring diagram will be supplied by City of Tulsa Lift Station section. Door mounted magnetic switch shall be mounted so that station door cannot open more than 4inches without activating SCADA security alarm input.

GROUND

The entire area inside the fence must be asphalt or concrete and is to be installed prior to installing the fence. This surface must slope to drain away from the control building and extend 1 foot outside the fence.

Any pump station located farther than 7 feet from the center of the pump chamber to the edge of a public street or road shall have a 12-foot wide paved access road provided to the station.

The access road shall be constructed as per the Standard Details and in accordance with the applicable sections of the City of Tulsa Street, Storm Drain and Sanitary Sewer Specifications. The access road shall be designed to limit the access road grade to a 12% maximum.

The access road will be required to have a turnaround area as shown on the Standard Details.

GRADING AND SEEDING

All ground surrounding the pump station must be graded with no slope greater than 15% and seeded as per the Sanitary Sewer Specifications and Standards for the City of Tulsa, Oklahoma. Final acceptance of the pump station will not be given until this an effective erosion control has been demonstrated.

FENCING

GENERAL

A galvanized chain-link fence surrounding the pump station site shall be provided as specified herein and as shown on the standard details. The fence shall be 7 feet high (minimum) with a 15-foot wide single cantilever sliding gate and a 48" pedestrian gate. Fencing shall be located so that:

There is a minimum space of 8ft between all pump station equipment (wet well, valve vault, emergency storage, standby generator, etc.) and the fence perimeter.

The gate shall be located so that service vehicles have a direct and unobstructed path to the valve vault, wet well, and standby generator. Access gate shall not be placed over a manhole.

FASTENERS

The chain-link fabric shall be securely fastened to all terminal posts by a 1/4" x 3/4" tension bars with heavy 11-gauge pressed steel bands at 14-inch maximum spacing, to line posts with 9-gauge wire clips at 14-inch maximum spacing, to the top rail with 9-gauge tie wires at 24-inch maximum spacing and to the bottom tension wire using 11-gauge galvanized hog rings at a 24-

inch maximum spacing. Install nuts for tension bands and hardware bolts on inside face of the fence and peen ends of bolts or score threads to prevent removal of nuts.

MATERIAL SPECIFICATION

CHAIN LINK

Chain-link fabric shall be a 2-inch mesh woven from No. 9 gauge aluminum-coated steel or aluminum-zinc alloy-coated steel conforming to ASTM A491 or F1345. The fabric shall have a height of 72 inches, 20-1/2 diamond count, with the bottom selvage twisted and the top selvage knuckled. Aluminum-coated steel fabric shall be given a clear organic coating after fabrication. Aluminum-zinc alloy coating on the steel fabric shall be not less than 0.6 ounce per square foot of uncoated wire surface.

FENCE FRAMEWORK

Galvanized steel, ASTM F1083 or ASTM A123.

FITTINGS AND ACCESSORIES

Unless otherwise noted, all fence fittings and accessories shall be galvanized according to ASTM A153.

POSTS

Gate Posts - 4.000 inches O.D. at 9.12 pounds per foot.

End, Corner, Angle or Pull Post - 2.375 inches O.D. at 3.65 pounds per foot.

Line Post and Gate Frame - 1.9 inches O.D. at 2.72 pounds per foot.

Top Rail - 1.66 inches O.D. at 2.27 pounds per foot.

BRACES

HORIZONTAL BRACE - 1.66 inches O.D. at 2.27 pounds per foot.

DIAGONAL BRACE - 3/8-inch diameter rod equipped with adjustable tightener.

BARBED WIRE AND SUPPORTING ARMS

Barbed wire shall consist of 3 strands of 2-wire aluminum-coated steel conforming to ASTM A585-81, Type I (with barbs spaced on 5-inch centers).

One supporting arm shall be placed on each line and pull post.

Single arm at 45 degrees with vertical, sloping to outside of fence.

Integral with post top and designed as a weather-tight closure cap.

Constructed for attaching 3 rows of barbed wire to each arm.

Designed for 200 pound minimum pull-down load.

Malleable iron or pressed steel.

BOTTOM TENSION WIRE

The bottom tension wire shall be a No. 7 gauge aluminum-coated steel conforming to ASTM A824, Type I. The tension wire shall be placed at the bottom of the chain-link fabric and stretched tight with galvanized turnbuckles.

POST TOPS

The post tops shall be designed as a weather-tight closure cap for the tubular posts. With the capability of supporting 3-strand barbed wire.

GATE FRAME

Gate frame to be fabricated by welding, vertical and horizontal members located no greater than 8 ft. apart.

The length of back frame support section shall be a minimum of 40% of the opening.

Welded joints are to be protected by applying zinc-rich paint in accordance with ASTM A780.

Gates should be designed to open or close by applying an initial pull force no greater 40 lbs.

INSTALLATION

FENCE

Follow general contour of ground and properly align.

POSTS

Set in concrete bases as indicated on Standard Details.

Temporarily brace until concrete base has set.

Install plumb and in straight alignment.

Install pull posts every 300 feet if no corner posts are encountered in that distance.

Install pull posts at changes in direction of 10 degrees to 30 degrees.

Install corner posts at changes in direction of 30 degrees or more.

Install pull posts at all abrupt changes in grade.

POST BRACING

Install braces for each end, pull and gate post and each side of each corner post.

Install after concrete has set.

Install so posts are plumb and in straight alignment when diagonal brace is under tension.

TENSION WIRE

Shall be tied to each post with a minimum 9-gauge galvanized wire.

STRECHER BARS

Install at each pull, end and gate post and on each side of corner posts.

BARBED WIRE

Attach 3 rows to each barbed wire supporting arm.

Pull wire taut and fasten securely to each arm.

Install 4 rows on extended gate end members of swing gates

GATES

Install plumb and level.

Install all hardware, framing, supports, and appurtenances as required for gate.

Hold open hardware to keep gates open in a strong wind.

Install keepers, ground-set items, and flush plate in concrete for anchorage as shown on Standard Details.

Adjust and lubricate as necessary for smooth operation.

LIFT STATION SIGNAGE

Each pump station shall be provided signage in accordance with the Standard Details. The sign(s) shall be securely fastened to the chain-link fence at a location clearly visible from the pump station access road and approved by the City with the Station Name, Sewer Operations and Maintenance Dispatch Phone Number, Physical Address of Station and No Trespassing.

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials and equipment required and install complete and make operational, electrical system as shown on the Drawings and as specified herein.
- B. The work shall include the following:
 - 1. Coordinate the electrical service requirements with the power company and provide the electrical service(s) from the Power Company at the locations indicated.
 - 2. Provide conduit, wire and field connections for all motors, motor controllers, control devices, control panels and electrical equipment furnished under other Divisions.
 - 3. Provide conduit, wiring and terminations for variable frequency drives, reactors, harmonic filters, transformers and power factor correction capacitors furnished and mounted under other related Divisions.
- C. Each bidder or their authorized representatives shall, before preparing their proposal, visit all areas of the existing buildings and structures in which work under this sub-bid is to be performed and inspect carefully the present installation. The submission of the proposal by this bidder shall be considered evidence that their representative has visited the buildings and structures and noted the locations and conditions under which the work will be performed and that he/she takes full responsibility for a complete knowledge of all factors governing his/her work.

1.02 SUBMITTALS

- A. As a minimum all equipment specified in each Section of Division 16 shall be submitted at one time. As an example all lighting fixtures shall be submitted together, all motor control centers shall be submitted together, etc. Submittals that do not comply will be returned disapproved.
- B. Mark submittals to clearly identify proposed equipment including accessories, options, and features and to exclude parts not applicable to the project. When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submittal piece of literature and each submittal drawing shall clearly reference the Project Specification and/or Contract Drawing that the submittal is to cover. General catalogs will not be accepted as cut sheets to fulfill submittal requirements.
- C. Check shop drawings for accuracy prior to submittal. Shop drawings shall be stamped with the date checked and a statement indicating that the shop drawings conform to this Section and the Drawings. This statement shall also list all exceptions to this Section and the Drawings. Mark submittals to identify proposed equipment including accessories, options and features being proposed for approval and exclude parts not to be used. Shop drawings not so checked and noted shall be returned marked NOT APPROVED.

- D. The Engineer's check shall be for conformance with the design concept of the project and compliance with this Section and the Drawings. Errors and omissions on approved shop drawings shall not relieve the Contractor from the responsibility of providing materials and workmanship required by this Section and the Drawings.
- E. All dimensions shall be field verified at the job site and coordinated with the work of all other trades.
- F. Material shall not be ordered or shipped until the shop drawings have been approved. No material shall be ordered or shop work started if shop drawings are marked "APPROVED AS NOTED - CONFIRM," "APPROVED AS NOTED - RESUBMIT" or "NOT APPROVED."
- G. Operation and Maintenance Data
 - 1. Submit operations and maintenance data for equipment furnished under this Division, in accordance with Section 01730. The manuals shall be prepared specifically for this installation and shall include catalog data sheets, drawings, equipment lists, descriptions, parts lists including replacement part numbers, to instruct operating and maintenance personnel unfamiliar with such equipment.
 - 2. Manuals shall include the following as a minimum:
 - a. A complete "As-Built" set of approved shop drawings.
 - b. A complete list of the equipment supplied, including serial numbers, ranges and pertinent data, model number, size, and quantity.
 - c. Detailed service, maintenance and operation instructions for each item supplied.
 - d. JPEG photos of equipment data tags.
 - e. JPEG photos of underground installations.
- H. Exceptions for Submittals
 - 1. Exceptions to the Specifications or Drawings shall be clearly defined by the Electrical Subcontractor in a separate section of each submittal package. The submittal shall contain the reason for the exception, the exact nature of the exception and the proposed substitution so that a proper evaluation may be made by the Engineer. The acceptability of any device or methodology submitted as an "or equal" or "exception" to the Specifications shall be at the sole discretion of the Engineer.
 - a. By noting the term "compliance", it shall be understood that the manufacturer is in full compliance with the item specified and will provide exactly the same with no deviations.
 - b. By noting the term "deviation", it shall be understood that the manufacturer prefers to provide a different component in lieu of the one specified and in so doing, takes full responsibility for making the equipment work as specified and will provide any and all

ancillary components to make the equipment work at no extra cost to the Owner.

- c. By noting the term "alternate", it shall be understood that the manufacturer proposes to provide the same operating function but prefers to do it in a different manner and in so doing, takes full responsibility for making the equipment work as specified and will provide any and all ancillary components to make the equipment work at no extra cost to the Owner. The alternate method shall be fully described with schematic diagrams and one-line diagrams as applicable.

1.03 REFERENCE STANDARDS

- A. Electric equipment, materials and installation shall comply with the National Electrical Code (NEC).
- B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.04 PRIORITY OF THE CONTRACT DOCUMENTS

- A. If, during the performance of the work, the Contractor finds a conflict, error or discrepancy between or among one or more of the Sections or between or among one or more Sections and the Drawings, furnish the higher performance requirements. The higher performance requirement shall be considered the equipment, material, device or installation method which represents the most stringent option, the highest quality or the largest quantity.
- B. In all cases, figured dimensions shall govern over scaled dimensions, but work not dimensioned shall be as directed by the Engineer and work not particularly shown, identified, sized, or located shall be the same as similar work that is shown or specified.
- C. Detailed Drawings shall govern over general drawings, larger scale Drawings take precedence over smaller scale Drawings, Change Order Drawings shall govern over Contract Drawings and Contract Drawings shall govern over Shop Drawings.
- D. If the issue of priority is due to a conflict or discrepancy between the provisions of the Contract Documents and any referenced standard, or code of any technical society, organization or association, the provisions of the Contract Documents will take precedence if they are more stringent or presumptively cause a higher level of performance. If there is any conflict or discrepancy between standard specifications, or codes of any technical society, organization or association, or between Laws and Regulations, the higher performance requirement shall be binding on the Contractor, unless otherwise directed by the Engineer.
- E. In accordance with the intent of the Contract Documents, the Contractor accepts the fact that compliance with the priority order specified shall not justify an increase in Contract Price or an extension in Contract Time nor limit in any way, the Contractor's responsibility to comply with all Laws and Regulations at all times

1.05 ENCLOSURE TYPES

- A. Unless otherwise required, electrical enclosures shall be NEMA Types as follows:

1. NEMA 4 in outdoor locations, rooms below grade including basements and buried vaults and "WET" locations shown on the Drawings.
2. NEMA 4X in "CORROSIVE" locations shown on the Drawings.

1.06 SERVICE AND METERING

- B. The Contractor shall be responsible for the following work:
1. Obtain an estimate from the power company for the work described above and include the cost of the power company work in the Bid Price.
 2. Make all arrangements with the power company for obtaining electrical service, pay all power company charges.

1.07 CODES, INSPECTION AND FEES

- A. Equipment, materials and installation shall comply with the requirements of the local authority having jurisdiction.
- B. Obtain all necessary permits and pay all fees required for permits and inspections.

1.08 INTERPRETATION OF DRAWINGS

- A. Unless specifically stated to the contrary, the Drawings do not show exact locations of conduit runs. Coordinate the conduit installation with other trades and the actual supplied equipment.
- B. Install each 3 phase circuit in a separate conduit unless otherwise shown on the Drawings.
- C. Conduit shown exposed shall be installed exposed; conduit shown concealed shall be installed concealed. Unless otherwise indicated install branch circuit conduits exposed in process/ industrial type spaces and concealed in finished spaces.
- D. Where circuits are shown as "home-runs" all necessary fittings and boxes shall be provided for a complete raceway installation. Where home-runs indicate conduit is to be installed concealed or exposed the entire branch circuit shall be installed in the same manner.
- E. Verify the exact locations and mounting heights of lighting fixtures, switches and receptacles prior to installation.
- F. Except where dimensions are shown, the locations of equipment, fixtures, outlets and similar devices shown on the Drawings are approximate only. Exact locations shall be determined by the Contractor and approved by the Engineer during construction. Obtain information relevant to the placing of electrical work and in case of any interference with other work, proceed as directed by the Engineer and furnish all labor and materials necessary to complete the work in an approved manner.

- G. Circuit layouts are not intended to show the number of fittings, or other installation details. Furnish all labor and materials to install and place in satisfactory operation all power, lighting and other electrical systems shown.
- H. Redesign of electrical or mechanical work, which is required due to the Contractor's use of an alternate item, arrangement of equipment and/or layout other than specified herein, shall be done by the Contractor at his/her own expense. Redesign and detailed plans shall be submitted to the Engineer for approval. No additional compensation will be provided for changes in the work, either his/her own or others, caused by such redesign.
- I. Raceways and conductors for low voltage (120 Volts) thermostats controlling HVAC unit heaters, exhaust fans and similar equipment are not shown on the Drawings. Provide raceways and conductors between the thermostats, the HVAC equipment and the motor starters for a complete and operating system. Raceways shall be installed concealed in all finished space and may be installed exposed in process spaces. Refer to the HVAC drawings for the locations of the thermostats.

1.09 SIZE OF EQUIPMENT

- A. Investigate each space in the structure through which electrical equipment furnished under Division 16 must pass to reach its final location. Coordinate shipping splits with the manufacturer to permit safe handling and passage through restricted areas in the structure.
- B. The equipment shall be kept upright at all times during storage and handling. When equipment must be tilted for passage through restricted areas, brace the equipment to ensure that the tilting does not impair the functional integrity of the equipment.

1.10 RECORD DRAWINGS

- A. As the work progresses, legibly record all field changes on a set of Project Contract Drawings, hereinafter called the "As Bulits". Include digital photographs in JPEG format of all underground installations.

1.11 MATERIALS AND EQUIPMENT

- A. Materials and equipment furnished under this contract shall be new.
- B. Material and equipment of the same type shall be the product of one manufacturer and shall be UL listed.

1.12 EQUIPMENT IDENTIFICATION

- A. Identify equipment, disconnect switches, separately mounted motor starters, control stations, etc. furnished under Division 16 with the name of the equipment it serves. Motor control centers, control panels, panelboards, switchboards, switchgear, junction or terminal boxes, transfer switches, etc, shall have nameplate designations as shown on the Drawings.

- B. Nameplates shall be engraved, laminated plastic, not less than 1/16-in thick by 3/4-in by 2-1/2-in with 3/16-in high white letters on a black background.
- C. Nameplates shall be screw mounted to NEMA 1 enclosures. Nameplates shall be bonded to all other enclosure types using an epoxy or similar permanent waterproof adhesive. Two sided foam adhesive tape is not acceptable. Where the equipment size does not have space for mounting a nameplate the nameplate shall be permanently fastened to the adjacent mounting surface.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 SLEEVES AND FORMS FOR OPENINGS

- A. Provide and place all sleeves for conduits penetrating floors, walls, partitions, etc. Locate all slots for electrical work and form before concrete is poured.
- B. Exact locations are required for stubbing-up and terminating concealed conduit. Obtain shop drawings and templates from equipment vendors or other subcontractors and locate the concealed conduit before the floor slab is poured.
- C. Where setting drawings are not available in time to avoid delay in scheduled floor slab pours, the Engineer may allow the installations of such conduit to be exposed. Requests for this deviation must be submitted in writing. No additional compensation for such change will be allowed.

3.02 CUTTING AND PATCHING

- A. Cutting and patching shall be done in a thoroughly workmanlike manner and be in compliance with modifications and repair to concrete as specified. Saw cut concrete and masonry prior to breaking out sections.

3.03 INSTALLATION

- A. Work not installed according to the Drawings and Specification shall be subject to change as directed by the Engineer at Contractor's expense.
- B. Electrical equipment shall be protected against mechanical and water damage. Store all electrical equipment in dry permanent shelters. Do not install electrical equipment in place until structures are weather-tight.
- C. Damaged equipment shall be replaced or repaired by the equipment manufacturer, at the Engineer's discretion and at the Contractor's expense.

- D. Repaint any damage to factory applied paint finish using touch-up paint furnished by the equipment manufacturer.

3.04 WORK SUPERVISION

- A. The Contractor shall designate in writing the qualified electrical supervisor who shall provide supervision to all electrical work on this project. The minimum qualifications for the electrical supervisor shall be a unlimited journeyman electrician as defined by Oklahoma Construction Industries Board. The supervisor or his appointed alternate possessing at least a journeyman electrician license shall be on site whenever electrical work is being performed. The qualifications of the electrical supervisor shall be subject to approval of the Owner and the Engineer.

END OF SECTION

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish and install complete raceway systems as shown on the Drawings and as specified herein.
- B. Home runs indicated are to assist the contractor in identifying raceways to be installed concealed or exposed. Raceways identified to be installed exposed on the Drawings shall be run near the ceilings or along the walls of the areas through which they pass and shall be routed to avoid conflicts with HVAC ducts, cranes and hoists, lighting fixtures, doors and hatches. Raceways indicated to be run concealed shall be run in the center of concrete floor slabs, in partitions, or above hung ceilings, as required.

PART 2 PRODUCTS

2.01 RACEWAYS AND FITTINGS

A. Steel Conduit and Fittings

1. Rigid metal conduit (GRS), couplings, factory elbows and fittings shall be heavy wall steel tubing with a hot-dipped galvanized finish inside and out after threading and shall comply with ANSI C 80.1 and UL/6.
2. Acceptable manufacturers:
 - a. Allied Tube & Conduit Corp.
 - b. LTV Steel Tubular Products Corp.
 - c. Triangular PWC Inc.
 - d. Or equal.
3. Rigid metal and intermediate metal conduit fittings shall be of the threaded type, and shall be steel or malleable iron, with a hot-dipped galvanized finish. Threadless fittings and split couplings are not allowed except in specific applications as approved by the Engineer.
4. Acceptable manufacturers:
 - a. Appleton Electric Co.
 - b. O-Z Gedney Co.
 - c. RACO Inc.
 - d. Gould/Efcor
 - e. Steel City
 - f. Or equal

B. 316 Stainless Steel Conduit and Fittings

1. Stainless Steel Conduit shall be manufactured in type 316 stainless steel.
2. Acceptable manufacturers:
 - a. Calbrite
 - b. Thomas & Betts
 - c. Or equal

2.02 BOXES AND FITTINGS

A. Dry and Damp Location Boxes and Fittings

1. Outlet boxes shall be zinc-galvanized, extra depth, pressed steel with knockouts and of size and type suitable for the intended application.
2. Boxes that are less than 100 cubic inches in size used for junction or pull boxes shall be zinc galvanized pressed steel not less than 14 USS gauge with appropriate blank covers, minimum size 4-11/16-in square by 2-1/8-in deep.
3. Boxes that are 100 cubic inches and larger shall be constructed of hot dip galvanized sheet steel without knockouts. Covers shall be secured with round head brass machine screws. All joints shall be welded and ground smooth.
4. Terminal cabinets shall be NEMA 12 sheet steel unless otherwise shown on the Drawings. Boxes shall be painted and have continuously welded seams. Welds shall be ground smooth and galvanized. Box bodies shall be flanged and shall not have holes or knockouts. Box bodies shall not be less than 14 gauge metal and covers shall not be less than 12 gauge metal. Terminal boxes shall be furnished with latching hinged doors, terminal mounting straps and brackets. Terminal blocks shall be rated not less than 20A, 600V.
5. Acceptable Manufacturers:
 - a. Appleton
 - b. Raco
 - c. Steel City
 - d. Hoffman
 - e. Electromate Division of Robroy Ind.
 - f. Wiegmann

B. Wet Location Boxes and Fittings

1. NEMA 4 terminal boxes, junction boxes, pull boxes, etc, shall be sheet Type 316 stainless steel unless otherwise shown on the Drawings. Boxes shall have continuously welded seams and mounting feet. Welds shall be ground smooth. Boxes shall be flanged and shall not have holes or knockouts. Box bodies shall not be less than 14 gauge metal and covers shall not be less than 12 gauge metal. Covers shall be gasketed and fastened with stainless steel quick latches (interface enclosures shall be pad lockable). Terminal boxes shall be furnished with hinged doors, terminal mounting straps and brackets. Terminal blocks shall be NEMA type, not less than 20 Amps, 600 Volt.
2. Cast or malleable iron device boxes shall be Type FD. Boxes and fittings shall have cadmium-zinc finish with cast covers and stainless steel screws.
3. Cast aluminum device boxes shall be Type FD. Boxes and fittings shall be copper free aluminum with cast aluminum covers and stainless steel screws
4. Acceptable Manufacturers:
 - a. Appleton
 - b. Crouse-Hinds
 - c. Steel City
 - d. Hoffman
 - e. Electromate - Division of Robroy Ind.
 - f. Or equal

2.03 HARDWARE

A. Conduit Mounting Equipment

1. In dry indoor areas, hangers, rods, backplates, beam clamps, channel, etc shall be galvanized iron or steel.
2. Stainless steel 316 S.S. channel with stainless steel hardware shall be used in areas designated "WET" or "CORROSIVE" on the Drawings and in outdoor locations.
3. Furnish any and all necessary supports, brackets, conduit sleeves, racks and bracing as required. All boxes and hardware shall be galvanized zinc plated steel except that stainless steel 316 S.S. shall be used in areas designated as "WET" or "CORROSIVE" on the Drawings.

PART 3 EXECUTION

3.01 RACEWAY APPLICATIONS

- A. Refer to Table 16110-1 for specific raceway application requirements.
- B. All conduit of a given type shall be the product of one manufacturer.

3.02 BOX APPLICATIONS

- A. Terminal boxes, junction boxes and pull boxes shall have NEMA ratings suitable for the location in which they are installed.
- B. All conduit bodies and pulling outlets shall comply with NEC wire bending space requirements. Mogul type fittings shall be used for sizes 2-1/2-in and larger.

<p style="text-align: center;">TABLE 16110-1 Raceway Application Guidelines</p>	
<i>Location/Circuit Type</i>	<i>Raceway Type</i>
Clean, dry non-finished areas - electrical rooms, generator rooms, mechanical rooms, pump rooms, shops, dry storage, etc.	▪ 316 stainless steel rigid conduit
Corrosive areas - chemical storage and handling areas, underground vaults, within tanks, wetwells, or clearwells, filter pipe galleries and locations where designated corrosive on the Drawings.	▪ 316 stainless steel rigid conduit
Hazardous areas - all locations - Class 1, Division 1 and 2.	▪ 316 stainless steel rigid conduit
Outdoor areas - all locations.	▪ 316 stainless steel rigid conduit

3.3 FITTINGS APPLICATIONS

- A. Combination expansion-deflection fittings shall be used where exposed conduits cross structure expansion joints or in straight runs where expansion is anticipated. Combination expansion-deflection fittings shall be installed where embedded conduits cross structural expansion joints. Refer to Structural Drawings for expansion joint locations. Provide bonding jumpers around fittings.
- B. All underground conduit penetrations at walls or other structures shall be sealed watertight. Conduit wall seals and sleeves shall be used in accordance with the manufacturer's installation instructions and the details shown on the Drawings.
- C. Conduit sealing bushings shall be used to seal conduit ends exposed to the weather and at other locations shown on the Drawings.
- D. Gas Containment Area Sealing
 1. Internally and externally seal each conduit entering or leaving any area containing noxious gases to prevent contamination into clean areas via the conduit system. Areas requiring this protection are rooms where chlorine, ammonia and ozone are stored, generated or handled. Caulking material for conduit internal use shall be synthetic elastomer type, 3M, Series CP25 or equal. External sealing shall be in accordance with the typical details shown on the Drawings.
- E. Insulated throat grounding bushings shall be used where specified herein and where conduits stub up into electrical equipment such as MCC's, switchgear, etc.

3.04 INSTALLATION

- A. No conduit smaller than 3/4-in electrical trade size shall be used, nor shall any have more than the equivalent of three 90 degree bends in any one run. Pull boxes shall be provided as required by the NEC after every 270 degrees of bends and for straight run not to exceed 200 feet or as directed.
- B. All conduit which may under any circumstance contain liquids such as water, condensation, liquid chemicals, etc, shall be arranged to drain away from the equipment served. If conduit drainage is not possible, conduit seals shall be used to plug the conduits. The ends of all conduits shall be temporarily plugged to exclude dust, moisture and debris from entering during construction.
- C. Conduit ends exposed to the weather shall be sealed with conduit sealing bushings.
- D. Conduits noted as spare shall be capped or plugged at both ends with easily removable fittings.
- E. Conduit terminating in NEMA 3R, 4, 4X enclosures shall be terminated with Myers type conduit hubs.
- F. Conduit terminating in pressed steel boxes shall have double locknuts and insulated bushings.
- G. Conduits containing equipment grounding conductors and terminating in sheet steel boxes shall have insulated throat grounding bushings.
- H. Conduits shall be installed using threaded fittings except for EMT.
- I. The use of running threads is prohibited. Where such threads are necessary, a 3-piece union shall be used.
- J. All conduits entering or leaving a motor control center, switchboard or other multiple compartment enclosure shall be stubbed up into the bottom horizontal wireway or other manufacturer's designated area, directly below the vertical section in which the conductors are to be terminated. The 3-in extension of conduit above the floor slab or concrete equipment pad may be reduced to a dimension that suits the equipment manufacturer's installation requirements if the 3-in stub-up interferes with the equipment being provided.
- K. Rigid galvanized steel conduits buried in earth shall be completely painted with bitumastic.
- L. Rigid galvanized steel conduits which have been field cut and threaded shall be painted with cold galvanizing compounds.
- M. PVC coated rigid galvanized steel conduit shall be used for elbows at risers at the utility pole for electrical and telephone service conduits. Rigid galvanized steel conduit shall be used at utility pole for electrical and telephone service and fire alarm conduits to a height of 10-ft above finished grade. Furnish and install weather heads at service pole riser if required by utility company.
- N. Liquid-tight flexible metal conduit shall be used for all motor terminations, the primary and secondary of transformers, generator terminations and other equipment where vibration is present or may require removal.

- O. Flexible couplings shall be used in hazardous locations for all motor terminations and other equipment where vibration is present.
- P. PVC coated rigid steel conduit shall be used as a transition section where concrete embedded conduit stubs out of floor slabs or through below grade walls or where conduit installed under building slabs on grade stub out of floors. The PVC coated rigid steel conduit shall extend a minimum of 3-in into and out of the floor slab, concrete pad, or wall to allow for proper threading of the conduit.
- R. Conduit supports, other than for underground raceways, shall be spaced at intervals not exceeding the distance required by the NEC to obtain rigid construction.
- S. Single conduits shall be supported by means of one-hole pipe clamps in combination with one-screw back plates, to raise conduits from the surface. Multiple runs of conduits shall be supported on fabricated channel trapeze type racks with steel horizontal members and threaded hanger rods. The rods shall be not less than 3/8-in diameter. Surface mounted panel boxes, junction boxes, conduit, etc, shall be supported by spacers to provide a minimum of 1/2-in clearance between wall and equipment.
- T. Conduit Supports (Other than Underground Raceways)
 - 1. Flush Mounted Supports
 - a. Support shall be spaced 10-ft or less, as required to obtain rigid conduit construction.
 - b. Attachment to concrete shall be with cast-in-place inserts, cast-in place welded plates with welded studs or stainless adhesive anchors.
 - 2. Conduit Racks
 - a. Support shall be spaced 10-ft or less, as required to obtain rigid conduit construction.
 - b. Horizontal seismic restraints shall be spaced at 30-ft or less.
 - c. Attachment to concrete shall be with cast-in-place inserts, cast-in place welded plate with welded studs or stainless adhesive anchors.
 - 4. Conduit Hangers
 - a. Conduit hangers shall be vertical supported 10-ft or less, as required to obtain rigid conduit construction.
 - b. Lateral seismic restraints (Sway Bracing) shall be spaced 20-ft or less.
 - c. Horizontal seismic restraints shall be spaced at 30-ft or less. There shall be at least one horizontal restraint per horizontal run.
 - d. Attachment to structural steel shall be by beam clamps or welded beam attachment. C-clamps will not be allowed for vertical hangers. Side beam clamps with beam hooks shall be used for seismic restraint only.

- e. Attachment to concrete shall be cast-in-place inserts, cast-in place welded plates with welded studs or stainless steel adhesive anchors.
- 5. All reinforcing bars shall be located by the Electrical Subcontractor with the use of a rebar locator prior to installing adhesive capsule type anchors. Mark the location of all reinforcing bars in an area bounded by a line drawn at least 18-in from the edge of the support bearing/weld plates on all four sides of the bearing/weld plates prior to fabricating and installing bearing/weld plates.
- 6. Where interference occurs, adjust anchor locations to clear reinforcing bars and alter support configuration at no additional cost to the Authority.
- U. Miscellaneous steel for the support of fixtures, boxes, transformers, starters, contactors, panels and conduit shall be furnished and installed. Channel supports shall be ground smooth and fitted with plastic end caps.
- V. Steel hot dipped galvanized channels shall be furnished and installed for the support of all electrical equipment and devices, where required, including all anchors, inserts, bolts, nuts, washers, etc, for a rigid installation. Channel supports shall be ground smooth and fitted with plastic end caps.
- W. 3/16-in polypropylene pull lines shall be installed in all new conduits noted as spares or designated for future equipment. Conduit noted as spare shall be capped or plugged at both ends with easily removable fittings
- X. Where no type or size is indicated for junction boxes, pull boxes or terminal cabinets, they shall be sized in accordance with the requirements of NEC Article 314. Enclosure type and material shall be as specified herein.
- Y. Pull or junction boxes shall be furnished and installed where shown on the Drawings, in every 200 feet of straight conduit runs or in runs where more than the equivalent of four 90 degree bends occur or at any point necessary for wire pulling and splicing. Splices shall not be made in pulling elbows.

END OF SECTION

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish, install and test all wire, cable and appurtenances as shown on the Drawings and as specified herein.

1.02 DELIVERY, STORAGE AND HANDLING

- A. Carefully handle all conductors to avoid kinks and damage to insulation.

PART 2 PRODUCTS

2.01 GENERAL

- A. Wires and cables shall be of annealed, 98 percent conductivity, soft drawn copper.
- B. All conductors shall be stranded, except that lighting and receptacle wiring may be solid.
- C. Except for control, signal and instrumentation circuits, wire smaller than No. 12 AWG shall not be used.
- D. Wire shall have 600 Volt insulation except where indicated otherwise.

2.02 BUILDING WIRE

- A. Wire for lighting, receptacles and other circuits not exceeding 150 Volts to ground shall be NEC type THHN/THWN as manufactured by General Cable.; American Insulated Wire Corp.; Southwire Co.; or equal.
- B. Wire for circuits over 150 Volts to ground within buildings and structures shall be NEC type THHN/THWN as manufactured by General Cable.; American Insulated Wire Corp.; Southwire Co.; or equal.
- C. Wire for circuits over 150 Volts to ground used underground or for service entrance shall be NEC type RHH-RHW-2/USE-2, flame retardant and CT rated as manufactured by The Okonite Co.; General Cable.; American Insulated Wire Corp.; or equal.
- D. Bare copper ground wire shall be stranded, annealed copper wire ASTM-B3 alloy coated soft copper electrical wire ASTM B189.
- E. Equipment grounding conductors shall be NEC Type THW green and sized in accordance with NEC Table 250-122. Ground grid conductors shall be insulated unless shown otherwise on the Drawings.

2.5 SPLICES (POWER CONDUCTORS)

- A. Unless otherwise indicated on the Drawings, splices shall not be made in the cables without prior written approval of the Engineer. Where splicing is approved by the Engineer, splicing materials for all 600 Volt splices shall be made with long barrel, tin plated copper compression (hydraulically pressed) connectors and insulated with heavy wall heat shrinkable tubing. The conductivity of all completed connections shall be not less than that of the uncut conductor. The insulation resistance of all completed connections of insulated conductors shall be not less than that of the uncut conductor.
- B. Wire lugs shall be tin plated copper, long barrel compression type (hydraulically pressed) for wire sizes No. 8 AWG and larger. Lugs for No. 10 AWG and smaller wire shall be locking spade type with insulated sleeve. Lugs shall be as manufactured by the Thomas and Betts Co.; Burndy; Amp; or equal.
- C. Compression type connectors shall be insulated with a heat shrink boot or outer covering and epoxy filling. Splice kits shall be as manufactured by Raychem (Tyco); Ideal Industries; 3M Co. or equal.
- D. Solderless pressure connectors shall be self-contained, waterproof and corrosion-proof units incorporating prefilled silicone grease to block out moisture and air. Connectors shall be sized according to manufacturer's recommendations. The connectors shall be UL listed and CSA approved, as manufactured by King Innovation; Ideal Industries, Inc., or equal.

2.06 MOTOR CONNECTIONS

- A. Motor connections shall be ring type mechanical compression terminations installed on the branch circuit wires and the motor leads and secured with bolt, nut and springwasher. Connections shall be insulated with a Raychem Type RVC, roll-on stub insulator; Thomas & Betts, Shrink-Kon MSCV20; or equal. For wire sizes N0. 8 and larger, long barrel, tin plated copper compression (hydraulically pressed) type connections Burndy Co., or equal) shall be installed on the branch circuit wires and the motor leads. Connections shall be insulated with heavy duty heat shrinkable material (Raychem Corp., or equal).

2.09 WIRE AND CABLE MARKERS

- A. All wire and cable markers shall be heat shrink white with black numbers.
- B. Wire and cable markers shall be "Omni-Grip" as manufactured by the W.H. Brady Co.; Thomas & Betts Co., SMS; 3M Co., STD-TAG; or equal.
- C. Wire and cables with diameters exceeding the capacity of the "Omni-Grip" shall be marked with pre-printed, self-adhesive vinyl tapes as manufactured by the W.H. Brady Co.; Panduit Corp.; 3M Co.; or equal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Uniquely identify all wires, cables and each conductor of multi-conductor cables (except lighting and receptacle wiring) at each end and in all manholes, hand holes and pull boxes with wire and cable markers.
- B. Use lubrications to facilitate wire pulling. Lubricants shall be UL approved for use with the insulation specified.
- C. Provide multi-conductor control and signal cables within the underground system. Cables shall be installed continuous from building to building without splices. Individual control conductors and twisted shielded pairs signal cables will not be allowed in underground systems.
- D. The crimping tools used in securing the conductor in the compression type connectors or terminal lugs shall be those made for that purpose and for the conductor sizes involved. The crimping tool shall be the ratchet type which prevents the tool from opening until the crimp action is completed. Such tools shall be a product of the connector manufacturer.
- E. Install an equipment grounding conductor in all raceways.
- F. Seal openings in slabs and walls through which wires and cables pass.
- G. Pull cables from the direction that requires the least tension. Use a feed-in tube and sheave designed for cable installation. Use sheaves with radii that exceed the cable manufacturer's recommended minimum bending radius. Use a dynamometer and constant velocity power puller. Velocity should not be less than 15-ft./min. or more than 50-ft./min. Do not exceed the cable manufacturer's maximum recommended tension.
- H. If cable can not be terminated immediately after installation, install heat shrinkable end caps.

3.02 WIRE COLOR CODE

- A. All wire shall be color coded or coded using electrical tape in sizes where colored insulation is not available. Where tape is used as the identification system, it shall be applied in all junction boxes, manholes and other accessible intermediate locations as well as at each termination.
- B. The following coding shall be used:

<u>System</u>	<u>Wire</u>	<u>Color</u>
240/120 Volts Single-Phase, 3 Wire	Neutral	White
	Line 1	Black
	Line 2	Red
208Y/120, Volts 3 Phase, 4 Wire	Neutral	White
	Phase A	Black
	Phase B	Red
	Phase C	Blue
240/120 Volts 3 Phase, 4 Wire delta, center tap	Neutral	White
	Phase A	Black
	Phase B (High)	Orange

ground on phase coil A-C	Phase C	Blue
480Y/277 Volts	Neutral	White
3 Phase, 4 Wire	Phase A	Brown
	Phase B	Orange
	Phase C	Yellow

- C. Neutral or ground wires that terminate in a Panelboard and require color tape shall have the color tape extend at least 6-in from the termination point.

3.03 TERMINATIONS AND SPLICES

- A. Power conductors: Unless otherwise indicated on the Drawings, no splices may be made in the cables without prior written approval of the Engineer. Where splicing is approved, terminations shall be die type or set screw type pressure connectors as specified. Splices (where allowed) shall be die type compression connector and waterproof with heat shrink boot or epoxy filling for copper conductors # 4 AWG and larger. Splices shall be solderless pressure connectors with insulating covers for copper conductors # 6 AWG and smaller. Aluminum conductors (where specified) shall employ terminations and splices specifically designed for aluminum conductors.
- B. Control Conductors: Termination on saddle-type terminals shall be wired directly with a maximum of two conductors. Termination on screw type terminals shall be made with a maximum of two spade connectors. Splices (where allowed) shall be made with insulated compression type connectors.
- C. Instrumentation Signal Conductors (including graphic panel, alarm, low and high level signals): terminations same as for control conductors. Splices allowed at instrumentation terminal boxes only.
- D. Except where permitted by the Engineer no splices will be allowed in manholes, handholes or other below grade located boxes.
- E. Splices shall not be made in push button control stations, control devices (i.e., pressure switches, flow switches, etc), conduit bodies, etc.

3.05 FIELD TESTING

- A. Test all 600 Volt wire insulation with a megohm meter after installation and prior to termination. Make tests at not less than 1000 Volts DC. Test duration shall be one minute. Submit a written test report of the results to the Engineer. Notify the Engineer in writing 48 hours prior to testing.
- B. Field testing and commissioning shall be done in accordance with the latest revision of the "Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems" published by the International Electrical Testing Association (NETA Standard ATS-1999) unless otherwise modified by this Section. Minimum wire insulation resistance shall not be less than 250 Megohms.

END OF SECTION

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish and install all miscellaneous equipment as shown on the Drawings and as specified herein.

1.02 EQUIPMENT LIST

- A. This Section provides the requirements for miscellaneous equipment typically employed in a facility, however, not all components specified in this Section are necessarily utilized on this project.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Disconnect Switches
 - 1. Disconnect switches shall be heavy-duty, quick-make, quick-break, visible blades, 600 Volt, 3 Pole with full cover interlock, interlock defeat and flange mounted operating handle. All current carrying parts shall be copper
 - 2. NEMA 4 enclosures shall be 316 stainless steel.
 - 3. NEMA 4X enclosures shall be 316 stainless steel.
 - 4. Switches shall be as manufactured by the Square D Co. or Cutler-Hammer without exception.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Mounting Stands
 - 1. Field mounted disconnects, pushbutton control stations, alarm panels, enclosed starters and circuit breakers, transformers, automatic transfer switches, wireways, contactors, terminal boxes, junction and pull boxes shall be mounted on galvanized or stainless steel stands as specified. Where clearance requirements for stands may not be maintained, the Engineer may direct electric control equipment to be wall-mounted adjacent to the driven equipment, but in no case shall the distance from the drive motor to the control station exceed 3-ft, all at no additional cost to the Owner.
 - 2. Channel supports shall be ground smooth and fitted with plastic end caps.

- B. All panelboards located in pedestal cabinets or outdoors and panelboards that have branch circuits feeding exterior to the building shall be equipped with lightning arresters and surge capacitors.

3.02 FIELD TESTING

- A. Before supplying power to the alarm panels, the following tests shall be done: Verify that all wiring connection interfaces that are required are present. Check for secure connections. Using a continuity device, verify that all discrete inputs and output to and from the control panel are wired in correct polarity and are operating in the correct state of operation (normally open or closed state). Check for any direct short circuits across all voltage supply sources. As each of the above tests are performed, the Electrical Contractor shall highlight and initial each circuit that is tested. This set of prints shall be signed and left inside the enclosure.
- B. Check mechanical interlocks for intended operation. Make any adjustments required.
- C. In the event of an equipment fault in the panel, notify the Engineer immediately. After the cause of the fault has been identified and corrected, a joint inspection of the equipment shall be conducted by the Contractor and Engineer. Repair or replace the equipment as directed by the Engineer prior to placing the equipment back into service at no additional cost to the Owner.

END OF SECTION

