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PROJECT SPECIFICATIONS AND CONTRACT DOCUMENTS

PROJECT NO. 111216

SWEETWATER LIFT STATION

DECEMBER 2013

GLENDALE

Registered Professional Engineer (Civil)
CERTIFICATE NO.
48993
TRACY H.
MORACA
12/10/13
Date Signed
ARIZONA, U.S.A.
Expires 12/31/14

CITY OF GLENDALE

ENGINEERING DEPARTMENT
5850 W. Glendale Avenue, Glendale, Arizona 85301 (623) 930-3630

GLENDALE

Engineering Department

Memorandum

DATE:	January 16, 2014
TO:	All Plan and Specification Holders
FROM:	Engineering
SUBJECT:	PROJECT NO. 111216 – SWEETWATER LIFT STATION

ADDENDUM NO. 1

In accordance with the contract documents "Information for Bidders," Page 4, Paragraph 12 CHANGES TO PLANS AND DOCUMENTS, the following revisions to the plans and specifications shall become a part of the contract documents and the bidder shall acknowledge receipt thereof as directed in Paragraph 13 of the Information for Bidders.

PLEASE SEE ATTACHED

Registered Professional Engineer (Civil)
CERTIFICATE NO.
48993
TRACY H.
MORACA
Date Signed 1/15/14
ARIZONA, U.S.A.
Expires 12/31/14

THIS ADDENDUM CONSISTS OF THE 54 PAGES INCLUDING THE COVER PAGE

Registered Professional Engineer (Civil)
CERTIFICATE NO.
48993
TRACY H.
MORACA
Date Signed 1/16/14
ARIZONA, U.S.A.
Expires 12/31/14

City of Glendale

January 16, 2014

Project Number 111216
Sweetwater Lift Station

ADDENDUM NO. 1

1. NOTICE TO CONTRACTORS

A. Page 1: **DELETE** the first sentence of the second paragraph in its entirety and **REPLACE** with, "Bids must be received by the Engineering Department of the City of Glendale no later 2:00 p.m., January 22, 2014".

B. Page 1: **DELETE** the last sentence of the second paragraph in its entirety and **REPLACE** with, "At that time, bids will be publically opened and read aloud in the Engineering Conference Room 3A, 5850 West Glendale Avenue, Glendale, Arizona."

2. TECHNICAL SPECIFICATIONS

A. Section 01010 – SUMMARY OF WORK
1. Page 01010-1: **ADD** the following Paragraph 1.04,

"1.04 SITE ACCESS

All construction access to the lift station site will be from the SRP Arizona Canal access road. No construction traffic or access shall be allowed from Dahlia Drive or via the mangate on Dahlia Drive. Personal vehicles are not allowed on the SRP Arizona Canal access road and use of personal vehicles will be subject to penalties. Company owned vehicles are allowed on the SRP Arizona Canal access road."

B. Section 01046 – DEMOLITION AND SALVAGE

1. Page 01046-1, Paragraph 1.01-A: **DELETE** the last sentence of the first paragraph in its entirely.

C. Section 01060 – SAFETY AND HEALTH

1. Page 01060-1: **ADD** the following Paragraph F, "F. It is the Contractor's responsibility to abide by the OSHA clearances, the Arizona Overhead

Powerline Safety Law (ARS 40-360-41) and the Arizona Underground Utility Law (ARS 40-360.28) as well as requirements of the Arizona Blue Stake Law when working around existing utilities."

D. Section 01605 – SHIPMENT, PROTECTION AND STORAGE

1. Page 01605-1 Paragraph 1.03-B: **DELETE** the second paragraph of this section in its entirety.

E. Section 02145 – SEWER BYPASSING AND DEWATERING

1. Page 02145-2, Paragraph 1.01 A.13: **DELETE** in the last sentence, "...at 57th Drive and Eugie Drive" and **REPLACE** with "...at 57th Drive and Eugie Avenue".
2. Page 02145-3, **ADD** the following to 1.01 A., "18. All components of the bypass pumping system, including, but not limited to, the redundant piping and pumps, shall adhere to the requirements of this Section."

F. Section 02760 – SEWER CLEANING

1. Page 02760-1, Paragraph 1.01 A: **ADD** the following to the end of the first paragraph, "The existing ductile iron pipe is known to have heavy tuberculation throughout that will require heavy cleaning."

G. Section 08305 – ACCESS HATCHES

1. Page 08305-1 Paragraph 1.02: **DELETE** the table in its entirety and **REPLACE** with the table below.

Description	Number	Minimum Clear Opening	Arrangement
Wet Well Access	1	30" x 48"	Single leaf

H. Section 09900 – COATING SYSTEMS

1. **DELETE** the section in its entirety and **REPLACE** with the attached with changes shown.

I. Section 09901 – CONCRETE STRUCTURE COATING SYSTEMS

1. Page 09901-8, Paragraph 2.01 A: **ADD** the following to the end of the first sentence, "or Raven 405, as manufactured by Raven Lining Systems, Tulsa, Oklahoma."

J. Section 10440 – IDENTIFICATION SIGNS

1. Page 10440-1, Paragraph 2.02 B: **ADD** the following sentence, "The sign shall be sized to allow the above information to be shown and provide a 0.375" border."

K. Section 15050 – PIPING SYSTEMS

1. Page 15050-12 Paragraph 3.06 System 12 – Exposed Pipe 4" – 8": **ADD** the sentence "with ceramic epoxy lining" to Ductile Iron requirements.
2. Page 15050-12 Paragraph 3.06 System 12 – Buried Pipe 4" – 12": **ADD** the sentence "with ceramic epoxy lining" to Ductile Iron requirements.

L. Section 16231 – OUTDOOR STANDBY DIESEL-ENGINE GENERATOR

1. Page 16231-14 Paragraph 2.06. **DELETE** the first sentence and **REPLACE** with "Provide 12 hour rated belly fuel tank, fuel level indication, and diesel fuel flowmeter indicating flow rate and flow total."

M. Section 17200 – INSTRUMENT INDEX

1. Page 17200-3 Paragraph 3.03 A.7: **DELETE** instrument W_55SLSAE/AIT-1708 from index

3. TECHNICAL DRAWINGS

A. Drawing C100

1. **DELETE** the sheet in its entirely and **REPLACE** with the attached reflecting changes to grades and pad elevations.

B. Drawing C101

1. **ADD** the following to Keynote 1, "The portion of the drywell left abandoned in place shall be filled with slurry backfill per Drawing S1, FOUNDATIONS, 2.01 – CONTROLLED LOW STRENGTH MATERIAL (CLSM)".

C. Drawing E101

1. **RELOCATE** the Terminal Boxes called out by Keynote 12 to the south corner of wetwell concrete slab. Boxes may face southwest or southeast.

SECTION 09900

COATING SYSTEMS

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This Section 09900 specifies coating systems, surface preparations, and application requirements for coating systems.

B. DEFINITIONS:

Specific coating terminology used in this Section 09900 is in accordance with definitions contained in ASTM D16, ASTM D3960, and the following definitions:

1. Abrasive: Material used for blast cleaning, such as sand, grit or shot.

2. Abrasive Blast Cleaning: Cleaning/surface preparation by abrasive propelled at high speed.

3. Anchor Pattern: Profile or texture of prepared surface(s).

4. ANSI: American National Standards Institute.

5. Bug Holes: Small cavities, usually not exceeding 15 mm in diameter, resulting from entrapment of air bubbles in the surface of formed concrete during placement and compaction.

6. Coating/Paint/Lining Thickness: The total thickness of primer, intermediate and/or finish coats.

7. Coating System Applicator (CSA): A generic reference to the specialty subcontractor or subcontractors retained by the Contractor to install the coating systems specified in this Section 09900.

8. Coating System Manufacturer (CSM): Refers to the acceptable coating system manufacturer, abbreviated as the CSM.

9. Coating System Manufacturer's Technical Representative(s) (CTR): Refers to the technical representative(s) of the acceptable Coating System Manufacturer and is abbreviated as CTR.

10. Dew point: Temperature of a given air/water vapor mixture at which condensation starts.

11. Dry Film Thickness (DFT): Depth of cured film, usually expressed in mils (0.001 inch). Use this definition as opposed to existing definition.

12. Drying Time: Time interval between application and curing of material.

13. Dry to Recoat: Time interval between application of material and ability to receive next coat.

14. Dry to Touch: Time interval between application of material and ability to touch lightly without damage.

15. Feather Edging: Reducing the thickness of the edge of paint.

16. Feathering: Operation of tapering off the edge of a point with a comparatively dry brush.

17. Field Coat: The application or the completion of application of the coating system after installation of the surface at the site of the work.

18. Hold Point: A defined point, specified in this Section 09900, at which work shall be halted for inspection.

19. Holiday: a discontinuity, skip, or void in coating or coating system film that exposes the substrate.

20. Honeycomb: Segregated condition of hardened concrete due to non-consolidation.

21. ICRI: International Concrete Repair Institute.

22. Incompatibility: Inability of a coating to perform well over another coating because of bleeding, poor bonding, or lifting of old coating; inability of a coating to perform well on a substrate.

23. Laitance: A layer of weak, non-durable concrete containing cement fines that is brought to the surface through bleed water because of concrete finishing and/or over-finishing.

24. Mil: 0.001 inch.

25. NACE: National Association of Corrosion Engineers.

26. Overspray: Dry spray, particularly such paint that failed to strike the intended surface.

27. Pinhole: A small diameter discontinuity in a coating or coating system film that is typically created by outgassing of air from a void in a concrete substrate resulting in exposure of the substrate or a void between coats.

28. Pot Life: Time interval after mixing of components during which the coating can be satisfactorily applied.

29. Resurfacer/Resurfacing Material: A layer of cementitious and/or resin-base material used to fill or otherwise restore surface continuity to worn or damaged concrete surfaces.

30. Shelf Life: Maximum storage time for which a material may be stored without losing its usefulness.

31. Shop Coat: One or more coats applied in a shop or plant prior to shipment to the site of the work, where the field or finishing coat is applied.

32. Spreading Rate: Area covered by a unit volume of paint at a specific thickness.

33. SSPC: The Society for Protective Coatings.

34. Stripe Coat: A separate coat of paint applied to all weld seems, pits, nuts/bolts/washers and edges by brush. This coat shall not be applied until any previous coat(s) have cured and, once applied, shall be allowed to cure prior to the application of the subsequent coat(s).

35. Surface Saturated Dry (SSD): Refers to concrete surface condition where the surface is saturated (damp) without the presence of standing water.

36. Tie Coat: An intermediate coat used to bond different types of paint coats. Coatings used to improve the adhesion of a succeeding coat.

37. Touch-Up Painting: The application of paint on areas of painted surfaces to repair marks, scratches, and areas where the coating has deteriorated to restore the coating film to an unbroken condition.

38. TPC: Technical Practice Committee.

39. Volatile Organic Compound (VOC) Content: The portion of the coating that is a compound of carbon, is photochemically reactive, and evaporates

during drying or curing, expressed in grams per liter (g/l) or pounds per gallon (lb/gal).

40. Immersion: Refers to a service condition in which the substrate is below the waterline or submerged in water or wastewater at least intermittently if not constantly.

41. Weld Splatter: Beads of metal scattered near seam during welding.

42. Wet Film Thickness (WFT): The primer or coating film's thickness immediately following application. Wet film thickness is measured in mils or thousandths of an inch (0.001 inch) and is abbreviated WFT.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued, or replaced.

Reference	Title
ANSI/ASC 29.4 Exhaust Systems	Abrasive Blasting Operations – Ventilation and Safe Practice
ANSI/NSF 61	Drinking Water System Components Health Effects
ANSI B74.18	Grading of Certain Abrasive Grain on Coated Abrasive Material
ASTM D16	Standard Terminology for Paint, Related Coatings, Materials, and Applications
ASTM D2200 (SSPC-VIS1)	Pictorial Surface Preparation Standards for Painting Steel Surfaces

Reference	Title
ASTM D3960	Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings
ASTM D4262	Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces
ASTM D4263	Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
ASTM D4414	Standard Practice for Measurement of Wet Film Thickness by Notch Gages
ASTM D4417	Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel
ASTM D4541	Standard Test Methods for Pull-Off Strength of Coatings On Metal Substrates Using Portable Adhesion Testers
ASTM D4787	Standard Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates
ASTM D5162	Standard Practice for Discontinuity (Holiday) Testing of Nonconductive Protective Coating on Metallic Substrates
ASTM D7234	Standard Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Adhesion Testers.
ASTM E337	Standard Test Method for Measuring Humidity With a Psychrometer
ASTM F1869	Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
FS 595b	Federal Standard Colors
ICRI 03732	Guideline for Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays
NACE Publication 6D-163	A Manual for Painter Safety
NACE Publication 6F-163	Surface Preparation of Steel or Concrete Tank/Interiors
NACE Publication 6G-164 A	Surface Preparation Abrasives for Industrial Maintenance Painting
NACE Standards	January 1988 Edition of the National Association of Corrosion Engineers, TPC.
NACE Standard RP0188	Standard Recommended Practice – Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates
NACE Standard RP0288	Standard Recommended Practice, Inspection of Linings on Steel and Concrete

Reference	Title
NACE Standard RP0892	Standard Recommended Practice, Linings Over Concrete in Immersion Service
NACE Publication TPC2	Coatings and Linings for Immersion Service
NAPF 500-03	Surface Preparation Standard for Ductile Iron Pipe and Fittings in Exposed Locations Receiving Special External Coatings and/or Special Internal Linings
NAPF 500-03-04	Abrasive Blast Cleaning for Ductile Iron Pipe
NAPF 500-03-05	Abrasive Blast Cleaning for Cast Ductile Iron Fittings
OSHA 1910.144	Safety Color Code for Marking Physical Hazards
OSHA 1915.35	Standards – 29CFR - Painting
SSPC	Paint Application Specification No. 1.
SSPC-AB 1	Mineral and Slag Abrasives
SSPC-PA 1	Shop, Field, and Maintenance Painting of Steel
SSPC-PA 2	Measurement of Dry Coating Thickness with Magnetic Gages
SSPC-PA 9	Measurement of Dry Coating Thickness on Cementitious Substrates Using Ultrasonic Gages
SSPC-PA Guide 1	Guide for Illumination of Industrial Painting Project
SSPC-PA Guide 3	A Guide to Safety in Paint Application
SSPC-PA Guide 6	Guide for Containing Debris Generated During Paint Removal Operations
SSPC-PA Guide 11	Guide for Coating Concrete
SSPC SP1	Solvent Cleaning
SSPC SP2	Hand Tool Cleaning
SSPC SP3	Power Tool Cleaning
SSPC SP5	White Metal Blast Cleaning
SSPC SP6	Commercial Blast Cleaning
SSPC SP7	Brush-Off Blast Cleaning
SSPC SP10	Near-White Blast Cleaning
SSPC SP11	Power Tool Cleaning to Bare Metal
SSPC SP12	Surface Preparation and Cleaning of Steel and Other Hard Materials by High and Ultra-High Pressure Water Jetting Prior to Recoating
SSPC SP13	Surface Preparation of Concrete

Reference	Title
SSPC-TR2	Wet Abrasive Blast Cleaning
SSPC-TU-3	Overcoating
SSPC-TU-4	Field Methods for Retrieval and Analysis of Soluble Salts on Substrates.
SSPC V2	Systems and Specifications: Steel Structures Painting Manual, Volume 2
SSPC-VIS 1	Visual Standard for Abrasive Blast Cleaned Steel
SSPC-VIS 3	Visual Standard for Power and Hand – Tool Cleaned Steel
SSPC-VIS 4	Visual Standards (Waterjetting)
SSPC-VIS 5	Visual Standards (Wet Abrasive Blast Cleaning)
WPCF Manual of Practice No. 17	Paints and Protective Coatings for Wastewater Treatment Facilities. Guide and Paint Application Specifications.

B. STANDARDIZATION:

Materials and supplies provided shall be the standard products of CSMs. Materials in each coating system shall be the products of a single CSM.

The standard products of CSMs other than those specified may be acceptable when it is demonstrated to the Construction Manager that they are equal in composition, durability, usefulness, and convenience for the purpose intended. Requests for consideration of CSMs other than those specified in this Section 09900 will be considered, provided the following minimum conditions are met. Such requests are not a substitution for submittals after the alternative CSMs have been considered and accepted.

1. The proposed coating system shall use an equal or greater number of separate coats to achieve the required total dry film thickness.

2. The proposed coating system shall use coatings of the same generic type as that specified including curing agent type.

3. Requests for consideration of products from CSMs other than those specified in this Section 09900 shall include information listed in paragraph 09900-1.04, Items 1, 2, and 3, demonstrating that the proposed CSM's product is equal to the specified coating system.

4. The CSA~~Contractor~~ and the proposed alternative CSM shall provide a list of references for the proposed product where the coating of the same generic type has been applied. The reference list shall include the project name, city, state, owner, phone number of owner; coating system

reference and number from this Section 09900; type of facility in which it was used, generic type, and year coating was applied.

C. QUALITY CONTROL REQUIREMENTS:

1. The Contractor is responsible for the workmanship and quality of the coating system installation. Inspections by the Construction Manager or the CTR will not relieve or limit the Contractor's responsibilities.

2. The CSA~~Contractor~~'s methods shall conform to requirements of this specification and the standards referenced in this Section 09900. Changes in the coating system installation requirements will be allowed only with the written acceptance of the Construction Manager before work commences.

3. Only personnel who are trained by the CTR specifically for this contract or who are approved by the CSM specifically for this contract shall be allowed to perform the coating system installation specified in this Section 09900.

4. Contaminated, outdated, diluted materials, and/or materials from previously opened containers shall not be used.

5. For repairs, the CSA~~Contractor~~ shall provide the same products, or products recommended by the CSM, as used for the original coating.

6. The CSA~~Contractor~~ shall identify the points of access for inspection by the Owner or the Construction Manager. The CSA~~Contractor~~ shall provide ventilation, ingress and egress, and other means necessary for the Construction Manager's personnel to access safely the work areas.

7. The CSA~~Contractor~~ shall conduct the work so that the coating system is installed as specified and shall inspect the work continually to ensure that the coating system is installed as specified. Coating system work that does not conform to the specifications or is otherwise not acceptable shall be corrected as specified.

8. The CSA~~Contractor~~ shall complete the Coating System Inspection Checklist, Form 09900-A, included in Section 01999, for coating system installations. Follow the sequential steps required for proper coating system installation as specified and as listed in the Coating System Inspection Checklist. For each portion of the work, install the coating system and complete sign-offs as specified prior to proceeding with the next step. After completing each step as indicated on the Coating System

Inspection Checklist, the CSA~~Contractor~~ shall sign the checklist indicating that the work has been installed and inspected as specified.

9. The CSA~~Contractor~~ shall provide written daily reports that present, in summary form, test data, work progress, surfaces covered, ambient conditions, quality control inspection test findings, and other information pertinent to the coating system installation.

D. INSPECTION AT HOLD POINTS

The CSA~~Contractor~~ shall conduct inspections at Hold Points during the coating system installation and record the results from those inspections on Form 09900-A. The Contractor or CSA shall coordinate such Hold Points with the Construction Manager such that the Construction Manager may observe CSA~~Contractor~~'s inspections on a scheduled basis. The Contractor shall provide the Construction Manager a minimum of two (2) days~~hours~~ of notice prior to conducting Hold Point Inspections. The Hold Points shall be as follows:

1. Environment and Site Conditions. Prior to commencing an activity associated with coating system installation, the CSA~~Contractor~~ shall measure, record, and confirm acceptability of ambient air temperature and humidity as well as other conditions such as proper protective measures for surfaces not to be coated and safety requirements for personnel. The acceptability of the weather and/or environmental conditions within the structure shall be determined by the requirements specified by the CSM of the coating system being used.

2. Conditions Prior to Surface Preparation. Prior to commencing surface preparation, the CSA~~Contractor~~ shall observe, record, and confirm that oil, grease, and/or soluble salts have been eliminated from the surface.

3. Monitoring of Surface Preparation. Spot checking of degree of cleanliness, surface profile, and surface pH testing, where applicable. In addition, the compressed air used for surface preparation or blow down cleaning shall be checked to confirm it is free from oil and moisture.

4. Post Surface Preparation. Upon completion of the surface preparation, the CSA~~Contractor~~ shall measure and inspect for proper degree of cleanliness and surface profile as specified in this Section 09900 and in the CSM's written instructions.

5. Monitoring of Coatings Application. The CSA~~Contractor~~ shall inspect, measure, and record the wet film thickness and general film quality (visual inspection) for lack of runs, sags, pinholes, holidays, etc. as the application work proceeds.

6. Post Application Inspection. The CSA~~Contractor~~ shall identify defects in application work including pinholes, holidays, excessive runs or sags, inadequate or excessive film thickness and other problems as may be observed.

7. Post Cure Evaluation. The CSA~~Contractor~~ shall measure and inspect the overall dry film thickness. The CSA~~Contractor~~ shall conduct a DFT survey, as well as perform adhesion testing, holiday detection, or cure testing as required based on the type of project and the specific requirements in this Section 09900 and/or in the CSM's written instructions.

8. Follow-up to Corrective Actions and Final Inspection. The CSA~~Contractor~~ shall measure and reinspect corrective coating work performed to repair defects identified at prior Hold Points. This activity also includes final visual inspection along with follow-up tests such as holiday detection, adhesion tests, and DFT surveys.

1.03 DELIVERY AND STORAGE

Materials shall be delivered to the job site in their original, unopened containers. Each container shall be properly labeled. Materials shall be handled and stored to prevent damage to or loss of label.

Labels on material containers shall show the following information:

1. Name or title of product.
2. CSM's batch number.
3. CSM's name.
4. Generic type of material.
5. Application and mixing instructions.
6. Hazardous material identification label.
7. Shelf life expiration date.

Materials shall be stored in enclosed structures and shall be protected from weather and excessive heat or cold in accordance with the CSM's recommendations. Flammable materials shall be stored in accordance with state and local requirements.

Containers shall be clearly marked indicating personnel safety hazards associated with the use of or exposure to the materials.

Material Safety Data Sheets (MSDS) for each material shall be provided to the Construction Manager.

The CSA~~Contractor~~ shall store and dispose of hazardous waste according to federal, state and local requirements. This requirement specifically addresses waste solvents and coatings.

1.04 SUBMITTALS:

Provide in accordance with Section 01300:

1. A copy of this specification section, with addendum updates included, and referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate specification compliance or marked to indicate requested deviations from specification requirements or those parts which are to be provided by the CSA~~Contractor~~ or others. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the CSA~~Contractor~~, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined shall signify compliance on the part of the CSA~~Contractor~~ with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for requested deviations to the specification requirements shall be cause for rejection of the entire submittal and no further submittal material will be reviewed.

2. CSM's current printed recommendations and product data sheets for coating systems including:

   a. Volatile organic compound (VOC) data

   b. Surface preparation recommendations.

   c. Primer type, where required.

   d. Maximum dry and wet-mil thickness per coat.

   e. Minimum and maximum curing time between coats, including atmospheric conditions for each.

   f. Curing time before submergence in liquid.

   g. Thinner to be used with each coating.

   h. Ventilation requirements.

i. Minimum atmospheric conditions during which the paint shall be applied.

j. Allowable application methods.

k. Maximum allowable moisture content.

l. Maximum shelf life.

3. Affidavits signed and sealed by an officer of the CSM's corporation, attesting to full compliance of each coating system component with current and promulgated federal, state, and local air pollution control regulations and requirements.

4. Material Safety Data Sheets (MSDS) for materials to be delivered to the job site, including coating system materials, solvents, and abrasive blast media.

5. List of cleaning and thinner solutions allowed by the CSMs.

6. Storage requirements including temperature, humidity, and ventilation for Coating System Materials as recommended by the CSMs.

7. CSM's detailed, written instructions for coating system treatment and graphic details for coating system terminations in the structures to be coated including pipe penetrations, metal embedments, gate frames, and other terminations to be determined from the contract drawings. This information shall also include detail treatment for coating system at joints in concrete.

8. The ~~Contractor and~~ CSA shall provide a minimum of five project references each including contact name, address, and telephone number where similar coating work has been performed by their companies in the past five years.

1.05 RESPONSIBILITIES OF THE CTR

The ~~Contractor~~ CSA shall retain or obtain the services of the CTR to be on site to perform the ~~Contractor and/or~~ CSA's application training and to routinely inspect and verify in writing that the application personnel have successfully performed surface preparation, filler/surface application, coating system application, and Quality Control Inspection in accordance with this Section 09900 and to warrantable level of quality. The CTR shall be onsite a minimum of two individual site visits and when any submerged locations are being coated. This must include checking the required degree of cleanliness, surface pH for concrete substrates, surface profile of substrates, proper mixing of coating materials, application (including checking the wet and dry film thickness of the coating systems), proper cure of the

coating systems, and proper treatment of coating systems at terminations, transitions, and joints and cracks in substrates. Refer to Paragraph 1.05 B. for further details on these CTR requirements. This inspection is in addition to the inspection performed by the CSA~~Contractor~~ in accordance with this Section 09900.

A. COATING SYSTEM INSTALLATION TRAINING

1. Provide a minimum of 8 hours of classroom and off site training for CSA's applicatcrs~~ion~~ and supervisory personnel ~~(both the Contractor's and CSA's)~~. Provide training to a minimum of two supervisory personnel from the CSA ~~and one supervisor from the Contractor~~. Alternatively, the CTR shall provide a written letter from the CSM stating that the application personnel (listed by name) who shall perform coating work are approved by the CSM without further or additional training.

2. One CTR can provide training for up to fourteen application personnel and three supervisory personnel at one time. The training shall include the following as a minimum:

   a. A detailed explanation of mixing, application, curing, and termination details.

   b. Hands-on demonstration of how to mix and apply the coating systems.

   c. A detailed explanation of the ambient condition requirements (temperature and humidity) and surface preparation requirements for application of the coating system as well as a detailed explanation of re-coat times, cure times, and related ambient condition requirements.

   d. When training is performed, the CTR shall provide a written letter stating that training was satisfactorily completed by the personnel listed by name in the letter.

B. COATING SYSTEM INSPECTION

While on site to routinely inspect and verify, the CTR shall perform the following activities to confirm acceptability and conformance with the specifications:

1. Inspect ambient conditions during various coating system installation at hold points for conformance with the specified requirements.

2 Inspect the surface preparation of the substrates where the coating system will terminate or will be applied for conformance to the specified application criteria.

3. Inspect preparation and application of coating detail treatment (for example, terminations at joints, metal embedments in concrete, etc.).

4. Inspect application of the filler/surface materials for concrete and masonry substrates.

5. Inspect application of the primers and finish coats including wet and dry film thickness of the coatings.

6. Inspect coating systems for cure.

7. Review adhesion testing of the cured coating systems for conformance to specified criteria.

8. Review coating system continuity testing for conformance to specified criteria.

9. Inspect and record representative localized repairs made to discontinuities identified via continuity testing.

10. Conduct a final review of completed coating system installation for conformance to the specifications.

11. Prepare and submit a site visit report following each site visit that documents the acceptability of the coating work in accordance with the CSM's recommendations.

C. FINAL REPORT

Upon completion of coating work for the project, the CTR shall prepare a final report. That report shall summarize daily test data, observations, drawings, and photographs in a report to be submitted in accordance with paragraph 09900-2.02. Include substrate conditions, ambient conditions, and application procedures, observed during the CTR's site visits. Include a statement that the completed work was performed in accordance with the requirements of this Section 09900 and the CSM's recommendations.

PART 2--PRODUCTS

2.01 MATERIALS

Notwithstanding the listing of product names in this Section 09900, the Contractor and/or CSA shall provide affidavits, signed and sealed by an officer of the CSM's corporation, attesting to full compliance of each coating system component with current and promulgated federal, state, and local air pollution control regulations and requirements. No coatings shall be applied to a surface until the specified affidavits have been submitted and have been reviewed and accepted. Failure to comply with this requirement shall be cause for rejection and removal of such materials from the site.

The following list specifies the material requirements for coating systems. Coating systems are categorized by generic name followed by an identifying abbreviation. If an abbreviation has a suffix number, it is for identifying subgroups within the coating system. Coating Systems E-5 and E-6 shall be NSF 61 certified.

Coating System	CSM	First Coat(s)	Finish Coat(s)
Epoxy Coatings			
E-2	PPG PMC	Amerlock 2/400 Series	Amerlock 2/400 Series
	Carboline	Carboguard 890	Carboguard 890
	International Paint/ICI	Bar-Rust 236	Bar-Rust 236
	Sherwin Williams	Sea Guard 6000 Epoxy N11-400	Sea Guard 6000 Epoxy N11-400
	Tnemec	Series V27 or V69	Series V69
Specialty Epoxy Linings			
EA-1	Carboline	Plasite 4500S	Plasite 4500S
	Sauereisen	Sewergard 210S	Sewergard 210S
	Tnemec	Series 435	Series 435

Coating System	CSM	First Coat(s)		Finish Coat(s)
Epoxy Polyurethane				
		Primer Coat(s)	Intermediate Coat(s)	
EU-1	PPG PMC	Amercoat	Amercoat 385	Amercoat 450H
	Carboline	Carbozinc 859	Carboguard 890	Carbothane 134 VOC
	International Paint/ICI	Cathacoat 313	Devran 233 or 224HS	Devthane 379
	Sherwin Williams	Zinc Clad IV	Macropoxy 646	Hi Solids Polyurethane
	Tnemec	Series 90-97	Series V69	Series 1075
Latex Acrylic				
L-1	PPG PMC	Amercoat 148		Amercoat 220
	Carboline	Carbocrylic 120		Carbocrylic 3359
	International Paint/ICI	UH Gripper 3210		Dulux Pro 1406
	Sherwin Williams	Loxon Acrylic Primer		Sher Cryl HPA
	Tnemec	Series 1028 or 1029		Series 1028 or 1029
Miscellaneous				
M-1	Carboline	Carbowrap Priming Paste		Tape A, B, or C (temp. dependent)
	Denso	Denso Paste		Densyl Tape
	Trenton	Waxtape Primer		#1 Wax Tape
M-2	Carboline	Carbomastic 15		Carbomastic 15
	International Paint/ICI	Bar-Rust 231 (231K 9100)		Bar-Rust 231 (231K 9100)
	Sherwin Williams	Epoxy Mastic Aluminum II		Epoxy Mastic Aluminum II
	Tnemec	Series 135 (1243)		Series 135 (1243)

***See CSM's Product Data Sheets for acceptable thinners for VOC compliance or do not thin.**

2.02 PRODUCT DATA

1. Prior to application of coatings, submit letter(s) from the CTR(s) identifying the application personnel who have satisfactorily completed training as specified in paragraph 09900-1.05 or a letter from the CSM stating that personnel who shall perform the work are approved by the CSM without need for further or additional training.

2. Submit reports specified in paragraph 09900-1.02 C.10 and 09900-1.05 B.12 when the work is underway.

3. Submit the Coating System Inspection Checklists, using Form 09900-A, included in Section 01999, for the coating work.

4. CTR final report in accordance with paragraph 09900-1.05 C.

PART 3--EXECUTION

3.01 COATINGS

A. GENERAL:

Coating products shall not be used until the Construction Manager has accepted the affidavits specified in paragraph 09900-1.04 and 2.01, the Construction Manager has inspected the materials, and the CTR has trained the ~~Contractor and~~ CSA in the surface preparation, mixing and application of each coating system.

B. SHOP AND FIELD COATS:

1. SHOP APPLIED PRIME COAT: Except as otherwise specified, prime coats may be shop-applied or field-applied. Shop-applied primer shall be compatible with the specified coating system and shall be applied at the minimum dry film thickness recommended by the CSM. Data sheets identifying the shop primer used shall be provided to the on-site coating application personnel. Adhesion tests shall be performed on the shop primer as specified in paragraph 09900-3.01B.3. Damaged, deteriorated and poorly applied shop coatings that do not meet the requirements of this Section 09900 shall be removed and the surfaces recoated. If the shop primer coat meets the requirements of this Section 09900, the field coating may consist of touching up the shop prime coat and then applying the finish coats to achieve the specified film thickness and continuity.

2. FIELD COATS: Field coats shall consist of one or more prime coats and one or more finish coats to build up the coating to the specified dry film thickness. Unless otherwise specified, finish coats shall not be applied until other work in the area is complete and until previous coats have been inspected.

3. ADHESION CONFIRMATION: The CSA~~Contractor~~ shall perform an adhesion test after proper cure in accordance with ASTM D3359 to demonstrate that (1) the shop applied prime coat adheres to the substrate, and (2) the specified field coatings adhere to the shop coat. Test results showing an adhesion rating of 5A on immersed surfaces and 4A or better on other surfaces shall be considered acceptable for coatings 5 mils or more in thickness (Method A). Test results showing an adhesion rating of 5B on immersed surfaces and 4B or better on other surfaces shall be considered acceptable for coating thicknesses less than 5 mils.

C. APPLICATION LOCATION REQUIREMENTS:

1. EQUIPMENT, NONIMMERSED: Items of equipment, or parts of equipment that are not immersed in service, shall be shop primed and then finish coated in the field after installation with the specified or acceptable color. If the shop primer requires topcoating within a specified period, the equipment shall be finish coated in the shop and then touch-up painted after installation. If equipment removal and reinstallation is required for the project, touch-up coating work shall be performed in the field following installation.

2. EQUIPMENT, IMMERSED: Items of equipment, or parts and surfaces of equipment that are immersed when in service, with the exception of pumps and valves, shall have surface preparation and coating work performed in the field. Coating systems applied to immersed equipment shall be pinhole free.

D. Erect and maintain protective enclosures as stipulated per SSPC-Guide 6 Guide for Containing Debris Generated During Paint Removal Operations.

3.02 PREPARATION

A. GENERAL:

Surface preparations for each type of surface shall be in accordance with the specific requirements of each coating specification sheet (COATSPEC) and the following. In the event of a conflict, the COATSPEC sheets shall take precedence.

Surfaces to be coated shall be clean and dry. Before applying coating or surface treatments, oil, grease, dirt, rust, loose mill scale, old weathered coatings, and other foreign substances shall be removed. Oil and grease shall be removed before mechanical cleaning is started. Where mechanical cleaning is accomplished by blast cleaning, the abrasive used shall be washed, graded and free from contaminants that might interfere with the adhesion of the coatings. The air used for blast cleaning shall be sufficiently free of oil and moisture so as not to cause detrimental contamination of the surfaces to be coated.

Where deemed necessary by the Owner's representative, a NACE International certified coatings inspector, provided by the Owner, will inspect and approve surfaces to be coated before application of a coating. Surface defects identified by the inspector shall be corrected by the CSA~~Contractor~~ at no additional cost to the Owner.

Cleaning and painting shall be scheduled so that dust and spray from the cleaning process shall not fall on wet, newly coated surfaces. Hardware, hardware accessories, nameplates, data tags, machined surfaces, sprinkler heads, electrical fixtures, and similar uncoated items which are in contact with coated surfaces shall be removed or masked prior to surface preparation and painting operations. Following completion of coating, removed items shall be reinstalled. Equipment adjacent to walls shall be disconnected and moved to permit cleaning and painting of equipment and walls and, following painting, shall be replaced and reconnected.

B. BLAST CLEANING:

When abrasive blast cleaning is required to achieve the specified surface preparation the following requirements for blast cleaning materials and equipment shall be met:

1. Used or spent blast abrasive shall not be reused on this project.

2. The compressed air used for blast cleaning shall be filtered and shall contain no condensed water and no oil. Moisture traps shall be cleaned at least once every four hours or more frequently as required to prevent moisture from entering the supply air to the abrasive blasting equipment.

3. Oil separators shall be installed just downstream of compressor discharge valves and at the discharge of the blast pot discharges. These shall be checked on the same frequency as the moisture traps as defined in item 2 above.

4. Regulators, gauges, filters, and separators shall be in use on compressor air lines to blasting nozzles times during this work.

5. An air dryer or desiccant filter drying unit shall be installed which dries the compressed air prior to blast pot connections. This dryer shall be used and maintained for the duration of surface preparation work.

6. The abrasive blast nozzles used shall be of the venturi or other high velocity type supplied with a minimum of 100 psig air pressure and sufficient volume to obtain the blast cleaning production rates and cleanliness/specified.

7. The CSA~~Contractor~~ shall provide ventilation for airborne particulate evacuation (meeting pertinent safety standards) to optimize visibility for both blast cleaning and inspection of the substrate during surface preparation work.

8. If, between final surface preparation work and coating system application, contamination of prepared and cleaned metallic substrates occurs, or if the prepared substrates' appearance darkens or changes color, recleaning by water blasting, reblasting and abrasive blast cleaning shall be required until the specified degree of cleanliness is reclaimed.

9. The CSA~~Contractor~~ is responsible for dust control and for protection of mechanical, electrical, and other equipment adjacent to and surrounding the work area.

C. SOLVENT CLEANING:

Any solvent wash, solvent wipe, or cleaner used, including but not limited to those used for surface preparation in accordance with SSPC SP-1 Solvent Cleaning and shall be of the emulsifying type which emits no more than 340 g/l VOCs for AIM regions, 250 g/l for CARB regions and 100 g/l for SCAQMD regions, contains no phosphates, is biodegradable, removes no zinc, and is compatible with the specified primer.

Clean white cloths and clean fluids shall be used in solvent cleaning.

D. METALLIC SURFACES:

Metallic surfaces shall be prepared in accordance with applicable portions of surface preparation specifications of the Society for Protective Coatings (SSPC) specified for each coating system. See Coat Spec for each coating system in this Section 09900. The profile depth of the surface to be coated shall be in accordance with the COATSPEC requirements in this Section measured by Method C of ASTM D4417. Blast particle size shall be selected by the CSA~~Contractor~~ to produce the specified surface profile. The solvent in solvent cleaning operations shall be as recommended by the CSM.

Preparation of metallic surfaces shall be based upon comparison with SSPC-VIS1-89 (ASTM D2200), and as described in the Coat Spec for each coating system. If dry abrasive blast cleaning is selected and to facilitate inspection, the CSA~~Contractor~~ shall, on the first day of cleaning operations, abrasive blast metal panels to the standards specified. Plates shall measure a minimum of 8-1/2 inches by 11 inches. Panels meeting the requirements of the specifications shall be initialed by the Contractor and the Construction Manager and coated with a clear non-yellowing finish. One of these panels shall be prepared for each type of abrasive blasting and shall be used as the comparison standard throughout the project.

Blast cleaning requirements for steel, ductile iron and stainless steel substrates are as follows:

1. Steel piping shall be prepared in accordance with SSPC SP-6 (Commercial Blast Cleaning) and primed before installation. Ductile iron piping surfaces including fittings shall be prepared in accordance with NAPF 500-03, NAPF 500-03-04, and NAPF 500-03-05.

2. Stainless steel surfaces shall be abrasive blast cleaned to leave a clean uniform appearance with a minimum surface profile of 1.5 to 2.5 mils that is uniform.

3. Remove traces of grit, dust, dirt, rust scale, friable material, loose corrosion products or embedded abrasive from substrate by vacuum cleaning prior to coating application.

4. Care must be taken to prevent contamination of the surface after blasting from worker's fingerprints, deleterious substances on workers' clothing, or from atmospheric conditions.

5. Ambient environmental conditions in the enclosure must be constantly monitored and maintained to ensure the degree of cleanliness is held and no "rust back" occurs prior to coating material application.

E. CONCRETE SURFACES:

1. Inspection of concrete surfaces prior to surface preparation and surface preparation of concrete surfaces shall be performed in accordance with SSPC-SP13 (also called NACE 6).

2. Prepare substrate cracks, areas requiring resurfacing and perform detail treatment including but not limited to, terminating edges, per CSM recommendations. This shall precede surface preparation for degree of cleanliness and profile.

3. The surface profile for prepared concrete surfaces to be coated shall be evaluated by comparing the profile of the prepared concrete with the profile of graded abrasive paper, as described in ANSI B74.18 or by comparing the profile with the ICRI 03732 (surface profile replicas). Surface profile requirements shall be in accordance with the Coat Spec requirements and the CSM's recommendations.

4. Surface cleanliness of prepared concrete substrates shall be inspected after cleaning, preparation, and/or drying, but prior to making repairs or applying a coat in the coating system. If concrete surfaces are repaired, they shall be reinspected for surface cleanliness prior to application of the coating system.

5. Surface preparation of concrete substrates shall be accomplished using methods such as dry abrasive blast cleaning, high, or ultra high-pressure water blast cleaning in accordance with SSPC-SP-13. The selected cleaning method shall produce the requirements set forth below.

   a. A clean substrate that is free of calcium sulfate, loose coarse or fine aggregate, laitance, loose hydrated cement paste, and otherwise deleterious substances shall be achieved. Blast cleaning and other means necessary shall be used to open up air voids or bugholes to expose their complete perimeter. Leaving shelled over, hidden air voids beneath the exposed concrete surface is not acceptable. Concrete substrate must be dry prior to the application of filler/surface or coating system materials.

Acceptable surface preparation must produce a concrete surface with a minimum pH of 8.0 to be confirmed by surface pH testing. If after surface preparation, the surface pH remains below 8.0, perform additional water blasting, cleaning, or abrasive blast cleaning until additional pH testing indicates an acceptable pH level.

b. Following inspection by the CSA~~Contractor~~ of the concrete surface preparation, thoroughly vacuum clean concrete surfaces to be coated to remove loose dirt, and spent abrasive (if dry blast cleaning is used) leaving a dust free, sound concrete substrate. Debris produced by blast cleaning shall be removed from the structures to be coated and disposed of legally off site by the CSA~~Contractor~~.

6. Should abrasive blast cleaning or high or ultrahigh pressure water blasting not remove degraded concrete, chipping or other abrading tools shall be used to remove the deteriorated concrete until a sound, clean substrate is achieved which is free of calcium sulfate, loose coarse or fine aggregate, laitance, loose hydrated cement paste, and otherwise deleterious substances. Concrete substrates must be dry prior to the application of filler/surfacers or coating system materials.

7. Surface cleanliness of prepared concrete substrates shall be inspected after cleaning, preparation, and/or drying, but prior to application of coating materials. If concrete surfaces are repaired, they shall be reinspected for surface cleanliness and required surface profile prior to application of the coating system.

8. Moisture content of concrete to be coated shall be tested in accordance with ASTM D4263, Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method and ASTM F 1869, Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride. The ASTM D4263 plastic sheet test shall be conducted at least once for every 500 sq. ft. of surface area to be coated. The presence of any moisture on plastic sheet following test period constitutes a non-acceptable test. For concrete surfaces to be coated which are on the negative or back side of concrete walls or structures exposed to soils (back filled) or immersed and waterproofed in accordance with Section 07100, perform calcium chloride tests in accordance with ASTM F-1869 once for each 500 sq. ft. of surface area to be coated. Comply with CSM's written recommendations regarding acceptance/non-acceptance of moisture vapor emissions.

F. MASONRY SURFACES:

1. Prepare masonry surfaces such as Concrete Masonry Units (CMU) to remove chalk, loose dirt, dried mortar splatter, dust, peeling, or loose existing coatings, or otherwise deleterious substances to leave a clean, sound substrate.

2. Be certain masonry surfaces are dry prior to coating application. If pressure washing or low-pressure water blast cleaning is used for preparation, allow the masonry to dry for at least 5 days under dry weather conditions or when the minimum ambient temperature is 70 degrees F prior to coating application work.

3.03 APPLICATION

A. WORKMANSHIP:

1. Coated surfaces shall be free from runs, drips, ridges, waves, laps, and brush marks. Coats shall be applied to produce an even film of uniform thickness completely coating corners and crevices.

2. The CSA~~Contractor~~'s equipment shall be designed for application of the materials specified. Compressors shall have suitable traps and filters to remove water and oils from the air. A paper blotter test shall be performed by the CSA~~Contractor~~ when requested by the Construction Manager to determine if the air is sufficiently free of oil and moisture so as not to produce deteriorating effects on the coating system. The amount of oil and moisture in spray air shall be less than the amount recommended by the CSM. Spray equipment shall be equipped with mechanical agitators, pressure gages, and pressure regulators, and spray nozzles of the proper sizes.

3. Each coat of coating material shall be applied evenly and sharply cut to line. Care shall be exercised to avoid overspraying or spattering paint on surfaces not to be coated. Glass, hardware, floors, roofs, and other adjacent areas and installations shall be protected by taping, drop cloths, or other suitable measures.

4. Coating applications method shall be conventional or airless spray, brush or roller, or trowel as recommended by CSM.

5. Allow each coat to cure or dry thoroughly, according to CSM's printed instructions, prior to recoating.

6. Vary color for each successive coat for coating systems when possible.

7. When coating complex steel shapes, prior to overall coating system application, stripe coat welds, edges of structural steel shapes, metal cut-outs, pits in steel surfaces, or rough surfaces with the primer coat. This involves applying a separate coat using brushes or rollers to ensure proper coverage. Stripe coat via spray application is not permitted.

B. COATING PROPERTIES, MIXING AND THINNING:

Coatings, when applied, shall provide a satisfactory film and smooth even surface. Glossy undercoats shall be lightly sanded to provide a surface suitable for the proper application and adhesion of subsequent coats. Coating materials shall be thoroughly stirred, strained, and kept at a uniform consistency during application. Coatings consisting of two or more components shall be mixed in accordance with the CSM's instructions. Where necessary to suit the conditions of the surface, temperature, weather and method of application, the coating may be thinned as recommended by the CSM immediately prior to use. The volatile organic content (VOC) of the coating as applied shall comply with prevailing air pollution control regulations. Unless otherwise specified, coatings shall not be reduced more than necessary to obtain the proper application characteristics. Thinner shall be as recommended by the CSM.

C. ATMOSPHERIC CONDITIONS:

Coatings shall be applied only to surfaces that are dry, and only under conditions of evaporation rather than condensation. Coatings systems shall not be applied during rainy, misty weather, or to surfaces upon which there is frost or moisture condensation. During damp weather, when the temperature of the surface to be coated is within 10 degrees F of the dew point, forced dehumidification equipment may be used to maintain a temperature of minimum 40 degrees F and 10 degrees F above the dew point for the surfaces to be coated, the coated surface, and the atmosphere in contact with the surface. These conditions shall be maintained for a period of at least 8 hours or as recommended by the CSM. Where conditions causing condensation are severe, dehumidification equipment, fans, and/or heaters shall be used inside enclosed areas to maintain the required atmospheric and surface temperature requirements for proper coating application and cure.

D. CONCRETE SUBSTRATE TEMPERATURES AND DETAIL TREATMENT:

1. When the surface temperatures of the concrete substrates to be coated are rising or when these substrates are in direct sunlight, outgassing of air from the concrete may result in bubbling, pinhole formations, and/or blistering in the coating system. The application of the filler/surface and the coating system will only be allowed during periods of falling temperature. This will require that application of the filler/surface and coating system shall only occur during the cooler evening hours. CSA~~Contractor~~ shall include any cost for working outside of normal hours in the bid.

Should bubbles, pinholes, or discontinuities form in the applied coating system material, they shall be repaired as recommended by the CSM. Should pinholes develop in the filler/surfacer material or in the first coat of the coating material, the pinholes shall be repaired in accordance with the CSM's recommendations prior to application of the next coat of material. Whenever pinholes occur, the air void behind or beneath the pinhole shall be opened up completely and then completely filled with the specified filler/surfacer material. Next, the coated area around the pinhole repair shall be abraded and the coating reapplied over that area.

2. Perform application detail work per CSM's current written recommendations and/or drawings.

E. PROTECTION OF COATED SURFACES:

Items that have been coated shall not be handled, worked on, or otherwise disturbed, until the coating is completely dry and hard. After delivery at the site, and upon permanent erection or installation, shop-coated metalwork shall be recoated or retouched with specified coating when it is necessary to maintain the integrity of the film.

F. METHOD OF COATING APPLICATION:

1. Where two or more coats are required, alternate coats shall contain sufficient compatible color additive to act as indicator of coverage, or the alternate coats shall be of contrasting colors. Color additives shall not contain lead, or lead compounds, which may be destroyed or affected by hydrogen sulfide or other corrosive gas, and/or chromium.

2. Mechanical equipment, on which the equipment manufacturer's coating is acceptable, shall be touch-up primed and coated with two coats of the specified coating system to match the color scheduled. Electrical and instrumentation equipment specified in Divisions 16 and 17 shall be coated as specified in paragraph 09900-3.03 I.

3. Coatings shall not be applied to a surface until it has been prepared as specified. The primer or first coat shall be applied by brush to ferrous surfaces that are not blast-cleaned. Coats for blast-cleaned ferrous surfaces and subsequent coats for nonblast-cleaned ferrous surfaces may be either brush or spray applied. After the prime coat is dry, pinholes and holidays shall be marked, repaired in accordance with CSM's recommendations and retested before succeeding coats are applied. Unless otherwise specified, coats for concrete and masonry shall be brushed, rolled, or troweled.

G. FILM THICKNESS AND CONTINUITY:

1. WFT of the first coat of the coating system and subsequent coats shall be verified by the CSA~~Contractor~~, following application of each coat.

2. The surface area covered per gallon of coating for various types of surfaces shall not exceed those recommended by the CSM. The first coat, referred to as the prime coat, on metal surfaces refers to the first full paint coat and not to solvent wash, grease emulsifiers or other pretreatment applications. Coatings shall be applied to the thickness specified, and in accordance with these specifications. Unless otherwise specified, the average total thickness (dry) of a completed protective coating system on exposed metal surfaces shall be not less than 1.25 mils per coat. The minimum thickness at any point shall not deviate more than 25 percent from the required average. Unless otherwise specified, no less than two coats shall be applied.

3. In testing for continuity of coating about welds, projections (such as bolts and nuts), and crevices, the Construction Manager shall determine the minimum conductivity for smooth areas of like coating where the dry-mil thickness has been accepted. This conductivity shall be the minimum required for these rough or irregular areas. Pinholes and holidays shall be recoated to the required coverage.

4. The ability to obtain specified film thickness is generally compromised when brush or roller application methods are used and, therefore, more coats may need to be applied to achieve the specified dry film thickness.

5. For concrete substrates, the CSA~~Contractor~~ shall apply a complete skim coat of the specified filler/surfacer material over the entire substrate prior to application of the coating system. This material shall be applied such that all open air voids and bugholes in the concrete substrate are completely filled prior to coating application.

H. SPECIAL REQUIREMENTS:

Before erection, the CSA~~Contractor~~ shall apply all but the final finish coat to interior surfaces of roof plates, roof rafters and supports, pipe hangers, piping in contact with hangers, and contact surfaces that are inaccessible after assembly. The final coat shall be applied after erection. Structural friction connections and high tensile bolts and nuts shall be coated after erection. Areas damaged during erection shall be hand-cleaned or power-tool cleaned and recoated with primer coat prior to the application of subsequent coats. Touch-up of surfaces shall be performed after installation. Surfaces to be coated shall be clean and dry at the time of application. Except for those to be filled with grout, the underside of equipment bases and supports that have not been galvanized shall be coated with at least two coats of primer specified

for system E-2 prior to setting the equipment in place. Provide coating system terminations at leading edges and transitions to other substrates in accordance with the CSM's recommendations or detail drawings.

I. ELECTRICAL AND INSTRUMENTATION EQUIPMENT AND MATERIALS:

Electrical and instrumentation equipment and materials shall be coated by the equipment manufacturer as specified below.

1. FINISH: Electrical equipment shall be treated with zinc phosphate, bonderized or otherwise given a rust-preventive treatment. Equipment shall be primed, coated with enamel, and baked. Minimum dry film thickness shall be 3 mils.

Unless otherwise specified, instrumentation panels shall be coated with system E-1 for indoor mounting and system EU-1 for outdoor mounting.

Before final acceptance, the CSA~~Contractor~~ shall touch up scratches on equipment with identical color coating. Finish shall be smooth, free of runs, and match existing finish. Prior to touching up scratches, CSA~~Contractor~~ shall fill them with an appropriate filler material approved by the CSM.

2. COLOR: Exterior color of electrical equipment shall be FS 26463 (ANSI/NSF 61) light gray. Interior shall be painted FS 27880 white. Nonmetallic electrical enclosures and equipment shall be the equipment manufacturer's standard grey color.

Exterior color of instrumentation panels and cabinets mounted indoors shall be FS 26463 light gray; unless otherwise specified, exterior color for cabinets mounted outdoors shall be FS 27722, white. Cabinet interiors shall be FS 27880, white.

3.04 CLEANUP

Upon completion of coating, the CSA~~Contractor~~ shall remove surplus materials, protective coverings, and accumulated rubbish, and thoroughly clean surfaces and repair overspray or other coating-related damage.

3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating systems for different types of surfaces and general service conditions for which these systems are normally applied are specified on the following COATSPEC sheets. Surfaces shall be coated in accordance with the COATSPEC to the system thickness specified. Coating systems shall be as specified in paragraph 09900-3.06, Coating System Schedule. In case of conflict between the schedule and the COATSPECS, the requirements of the schedule shall prevail.

Coating Specification Sheets included in Table 09900A are included this paragraph 09900-3.05.

Table 09900A Coating Specification Sheets

Coating System ID	Coating Material	Surface	Service Condition
E-2	Epoxy	Metal	Immersed, nonpotable; non-immersed, moderately corrosive environment, color required.
EA-1	Blended Amine Cured Epoxy	Metal	Immersed, nonpotable; non-immersed, corrosive environment, color not required especially for headspace environments that are corrosive due to biogenic sulfide corrosion.
L-1	Latex	Concrete, masonry, plaster, gypsum board	Interior and Exterior including existing exterior coated concrete.
M-1	Petrolatum based mastic or wax based wrapping tapes	Metal	Below grade (buried) or where little to no surface preparation can be performed on piping or structural steel.
M-2	Epoxy mastic or equal	Ferrous Metal	Interior, corrosive environment, confined enclosures, where minimal surface preparation is possible.
EU-1	Zinc-epoxy-polyurethane system	Ferrous Metal	Exterior, exposed to direct sunlight, moderately corrosive non-immersed.

3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification:	E-2
Coating Material:	Epoxy
Surface:	Metal
Service Condition:	Immersed, nonpotable; non-immersed, moderately corrosive environment, color required.
Surface Preparation:	
Ferrous Metal:	Ferrous metal surfaces shall be prepared in accordance with SSPC SP-5 (White Metal Blast Cleaning) to achieve a uniform surface profile of 2.0 to 2.5 mils. Damaged shop coating shall be cleaned in accordance with SSPC SP-5 (White Metal Blast Cleaning) and vacuum cleaning and spot primed with the primer specified. Shop epoxy primed surfaces shall require light abrasive blasting or abrading prior to receiving finish coats if the maximum recoat time for the primer has been exceeded. This cleaning must produce a uniform 1.0- to 1.5-mil profile in the intact shop primer. For ductile iron surfaces, refer to the requirements in paragraph 09900-3.02 D.
Nonferrous and Galvanized Metal:	Nonferrous and galvanized metal shall be prepared in accordance with SSPC SP-7 (Brush-off Blast Cleaning) to achieve a uniform surface profile of 1.0 to 1.5 mils. Galvanized steel with this E-2 coating system shall not be used in immersion service in wastewater.
Application:	Field
General:	Prime coat may be thinned and applied as recommended by the CSM, provided the coating as applied complies with prevailing air pollution control regulations.
Ferrous Metal:	Prime coat shall be an epoxy primer compatible with the specified finish coats.

3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification:	E-2 (continued)
Nonferrous and Galvanized Metal:	Nonferrous and galvanized metal, non-immersed, shall be coated prior to the application of the prime coat with a grease emulsifying agent in accordance with the CSM's written instructions. Nonferrous metal to be immersed shall not be painted. Galvanized metal shall not be immersed even if it is painted.
System Thickness:	16 mils dry film.
Coatings:	
Primer:	One coat at CSM's recommended dry film thickness.
Finish:	Two or more coats at CSM's recommended dry film thickness per coat to the specified system thickness.

3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification:	EA-1
Coating Material:	Blended Amine Cured Epoxy
Surface:	Metal
Service Condition:	Immersed, nonpotable; non-immersed, corrosive environment, color not required especially for headspace environments that are corrosive due to biogenic sulfide corrosion.

Surface Preparation:

Ferrous Metal:

Ferrous metal surfaces shall be prepared in accordance with SSPC SP-5 (White Metal Blast Cleaning) to achieve a uniform surface profile of 3.0 to 3.5 mils. Blast Cleaning shall produce a minimum surface profile of 3.0 mils.

Shop primed surfaces which are to be incorporated in the work shall be prepared in the field by cleaning surfaces in accordance with SSPC SP-11 (Power Tool Cleaning to Bare Metal). Damaged shop coated areas shall be cleaned in accordance with SSPC SP-5 (White Metal Blast Cleaning) and spot primed with the primer specified. Shop epoxy primed surfaces shall require light abrasive blasting and blow down cleaning prior to receiving finish coats. Cast or ductile iron surfaces to be coated shall be abrasive blast cleaned to a clean, gray uniform metal appearance free of variations in color and loose materials. Ductile iron surfaces shall be prepared in accordance with paragraph 09900-3.02 D.

Nonferrous and Galvanized Metal:

Nonferrous and galvanized metal shall be prepared in accordance with SSPC SP-7 (Brush-off Blast Cleaning) to achieve a uniform surface profile of 2.0 to 2.5 mils. Galvanized metal should generally not be used in these environments.

3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification:	EA-1 (continued)
Application:	Field
General:	Prime coat may be thinned and applied as recommended by the CSM, provided the coating as applied complies with prevailing air pollution control regulations. Drying time between coats shall be as specified by the CSM for the site conditions. If the maximum recoat time is exceeded, surface preparation shall require solvent washing, light abrasive blasting, or other procedures per CSM's instructions.
Ferrous Metal:	If shop priming is required or field priming is necessary, the prime coat shall be an epoxy primer compatible with the specified coating system. Generally, the EA-1 coating system is self-priming and does not require a primer unless there is a special reason to prime the steel to hold the blast cleaning from rusting back.
System Thickness:	30 to 40 mils dry film.
Coatings:	
Primer:	One coat at CSM's recommended dry film thickness only if required by special circumstances.
Finish:	One or more coats at CSM's recommended dry film thickness per coat to the specified system thickness.
Testing:	Holiday detection shall be performed over 100% of the coated surface area to identify any holidays or pinholes that must be repaired.
Pinhole and Holiday Repair Procedure:	Pinholes and holidays identified by Holiday Detection shall be repaired as follows: • Using a pencil grinder, remove a 1/2-inch diameter area of the coating system material back to the ferrous metal substrate. The metal must be shiny.

- Aggressively sand or abrade the intact coating system surface 2 inches around the complete periphery of the 1/2-inch diameter removal area to produce a uniform 6 to 8 mils profile.

- Vacuum clean the prepared area to remove all dust and dirt to achieve a clean, sound surface. Tape the peripheral area to prevent coating application onto unprepared surfaces.

- Brush apply one coat of the finish coating material. Following proper recoat cure time, apply additional coats of the finish coating system to achieve 60 mils DFT at the coating removal area and feather the coating onto the roughened coated surfaces to form a neat repair outline.

3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification:	EU-1
Coating Material:	Zinc-Epoxy-Polyurethane System
Surface:	Ferrous Metal
Service Condition:	Exterior, exposed to direct sunlight, moderately corrosive, non-immersed.
Surface Preparation:	
General:	Shop primed surfaces which are to be incorporated in the work shall be prepared in the field by cleaning surfaces in accordance with SSPC SP-2 (Hand Tool Cleaning). Damaged shop coated areas shall be cleaned in accordance with SSPC SP-3 (Power Tool Cleaning) and recoated with the primer specified.
Ferrous Metal:	Bare ferrous metal surfaces shall be prepared in accordance with SSPC SP-6 (Commercial Blast Cleaning) 2.5 – 3.0. Ductile iron surfaces to be coated shall be abrasive blast cleaned in accordance with paragraph 09900-3.02 D. Ferrous metal with rust bleeding shall be cleaned in accordance with SSPC-SP-11 (Power Tool Cleaning to Bare Metal). Areas of rust penetration shall be spot blasted to SSPC SP-10 (Near White Blast) and spot primed with the specified primer.
Galvanized Metal:	Damaged galvanized steel areas with exposed ferrous metal and/or rusted shall be cleaned in accordance with SSPC SP-5 (White Metal Blast Cleaning) or Power Tool Cleaned to Bare Metal in accordance with SSPC-SP-11 to achieve a uniform 1.0- to 1.5-mil profile and spot primed with the primer specified. Nonferrous and galvanized metal shall be prepared in accordance with SSPC SP-7 (Brush-off Blast Cleaning) to impart a 1.0- to 2.0-mil profile to the galvanized steel surfaces. Where this cannot be performed, prepare by abrading in accordance with SSPC-SP-3, Power Tool Cleaning to impart a 1.0- to 1.5-mil profile uniformly to the galvanized steel surfaces.

3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification:	EU-1 (continued)
	For EU-1 over galvanized steel, delete the zinc rich primer.
Application:	Field
General:	Prime coat may be thinned and applied as recommended by the CSM, provided the coating as applied complies with prevailing air pollution control regulations.
Ferrous Metal:	Prime coats shall be a zinc rich epoxy or polyurethane primer compatible for use with urethane finish coats and applied in accordance with written instructions of the CSM or in the case of CARB or SCAQMD applications, prime with specified primer that is not zinc rich. In these cases, only a two-coat system is applied.
System Thickness:	3 to 4 mils of zinc rich primer, one intermediate or primer epoxy coat at 5 to 6 mils and one finish coat of polyurethane at 2 to 3 mils DFT.
Coatings:	
Primer:	One coat at CSM's recommended dry film thickness.
Intermediate:	One coat at CSM's recommended dry film thickness.
Finish:	One coat at CSM's recommended dry film thickness per coat to meet the specified system thickness.

3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification:	L-1
Coating Material:	Latex
Surfaces:	Concrete, masonry, plaster, gypsum board.
Service Condition:	Interior and exterior including existing exterior coated concrete.
Surface Preparation:	
Concrete:	Concrete surfaces shall be allowed to age for at least 28 days and allowed to dry to the moisture content recommended by the CSM. Moisture content may be tested by the Construction Manager with a Delmhorst Instrument Company moisture detector, or equal. Loose concrete and laitance shall be removed from surfaces, and voids and cracks shall be repaired as specified in Section 03300.
Existing Coated Concrete:	Remove all loose coating down to a sound substrate or intact, well-adhered existing coating by scraping or other means. Then, abrade all surfaces to achieve a 0.5- to 1.5-mil uniform profile and vacuum clean to remove all loose dirt, paint chips, and dirt.
Masonry:	Masonry surfaces shall be allowed to age for at least 28 days. Holes or other joint defects shall be filled with mortar and repointed. Loose or splattered mortar shall be removed by scraping and chipping. Masonry surfaces shall be cleaned with clear water by washing and scrubbing to remove foreign and deleterious substances. Muriatic acid shall not be used. After cleaning, masonry surfaces shall be filled with block filler compatible with the specified primer.
Plaster:	Plaster surfaces shall be dry, clean, and free from grit, loose plaster, and surface irregularities. Cracks and holes shall be repaired with acceptable patching materials, keyed to existing surfaces, and sandpapered smooth. Surfaces shall be cleaned with clear water by washing and scrubbing to remove foreign and deleterious substances. After cleaning, surfaces shall be sealed with a compatible sealer.

3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification:	L-1 (continued)
Gypsum Wallboard:	Tape joints and spackled nail heads shall be sanded smooth and dusted. Seal with PVA sealer for interior uses only.
Application:	Field
	Sealer or filler shall dry a minimum of 48 hours prior to primer application.
	Drying time between coats shall be as recommended by CSM.
System Thickness:	4 mils dry film.
Coatings:	
Primer:	One coat at CSM's recommended dry film thickness.
Finish:	Two or more coats at CSM's recommended dry film thickness per coat to the specified system thickness.

3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification:	M-1
Coating Material:	Petrolatum based mastic or wax based wrapping tapes.
Surfaces:	Metal
Service Condition:	Below grade (buried) or where little to no surface preparation can be performed on piping or structural steel.
Surface Preparation:	Remove loose scale, rust, dirt, excessive moisture, or frost from the surface in accordance with SSPC SP-2 (Hand Tool Cleaning).
Application:	All surfaces shall be hand rubbed or brushed with a priming paste recommended by the CSM. Sharp projections such as threads, irregular contours, or badly pitted areas shall receive a liberal amount of priming paste to ensure maximum protection of metal throughout.

On irregular shaped surfaces, i.e., nuts, bolts, flanges, valves, etc., the CSA~~Contractor~~ shall use either of the following systems recommended by the CSM.

A. Apply recommended mastic by hand in sufficient quantity to build an even contour over entire surface. The CSA ~~Contractor~~ shall pay particular attention to ensure that folds and air pockets within the mastic layer are thoroughly pressed out prior to subsequent application of tape.

OR:

B. An extra layer of tape shall be cut and carefully molded around sharp projections, nuts, bolts, etc., before final application of tape, in order to meet specified system thickness.

3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification:	M-1 (Continued)
	Tape shall be spirally wrapped with a 55 percent overlap and sufficient tension and pressure to provide continuous adhesion without stretching the tape. Edges of tape must be continuously smoothed and sealed by hand during wrapping. On vertical application, CSA ~~contractor~~ shall begin at bottom and proceed upward creating a weatherboard overlap.
System Thickness:	Smooth contours shall have a minimum thickness of 50 mils while nuts, bolts, and sharp projections shall be 100 mils.
Tape:	Number and types of tape wraps shall be in accordance with the CSM's written instructions.

3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification:	M-2
Coating Material:	Epoxy mastic or equal
Surface:	Ferrous Metal
Service Condition:	Interior, corrosive environment, confined enclosures, where minimal surface preparation is possible.
Surface Preparation:	
Ferrous Metal:	All uncoated ferrous metal surfaces shall be prepared in accordance with SSPC SP-3 (Power Tool Cleaning), or SSPC-SP-11 (Power to Cleaning to Bare Metal) prior to assembly. Surface preparation to achieve a uniform surface profile of 2.0 to 2.5 mils. Shop primed ferrous metal surfaces and fabricated assemblies shall be clean and dry prior to the application of field coats. Following assembly, the CSA~~Contractor~~ shall smooth welds and prominences using power tools prior to the application of the field applied coatings.
Application:	Field
General:	Prior to the application of field applied coatings, welds, back-to-back angles, sharp or rough edges and weld splatter shall be brushed with the specified prime coat and allowed to cure overnight.
System Thickness:	15 mils dry film.
Coatings:	
Prime:	One coat of the CSM's recommended dry film thickness.
Finish:	One or more coats of CSM's recommended dry film thickness per coat to the specified system thickness.

3.06 COATING SYSTEMS SCHEDULE (FINISH SCHEDULE)

Specific coating systems, colors, and finishes for rooms, galleries, piping, equipment, and other items that are coated or have other architectural finishes are specified in the following coating system schedule. Unless otherwise specified in the coating system schedule, the word "interior" shall mean the inside of a building or structure, and the word "exterior" shall mean outside exposure to weather elements.

Location Description	Surface	Coating System Identification	Standard Color
A. General. All surfaces not specified by area or structure	1. Structural Steel, Metal Decking, and Galvanized Acoustical Decking	Uncoated or E-2	
	2. Equipment and Metal Appurtenances		
	a. Equipment, non immersed, unless otherwise specified		
	1) Outdoors	EU-1	PER CLIENT
	b. Equipment, immersed, unless otherwise specified	E-2	Beige
	c. Existing equipment		
	1) Not damaged nor modified by work in this contract	Uncoated	--
	2) Damaged, exposed, or modified by work in this contract		
	a) Outdoors	EU-1 without primer (see paragraph 09900-3.02)	Match existing color
	d. Electrical switchgear panels, unit substations, motor control centers, power transformers, distribution centers, and relay panels; indoors and outdoors	See paragraph 09900-3.03 I	ANSI 61 Grey (outside) FS 27880 White (inside)
	e. Instrumentation panels, graphic indicating panels, indicating and transmitting field panels, unless otherwise specified		
	1) Outdoors	See paragraph 09900-3.03 I	FS 27722 White (outside) FS 27880 White (inside)
	f. Existing electrical and instrumentation panels		
	1) Not damaged by work in this contract	Uncoated	--
	2) Damaged or exposed to outside surfaces by work in this contract		

Location Description	Surface	Coating System Identification	Standard Color
	a) Outdoors	EU-1 without primer (see paragraph 09900-3.02 F)	FS 26306 Grey (Electrical) FS 27722 White (Instrumentation)
	3. Conduit, Piping and Ductwork		
	a. Ferrous, non-ferrous and galvanized piping, and appurtenant hangers and supports, non-immersed, unless otherwise specified.		
	1) Outdoors – noncorrosive	EU-1	FS 20040 Brown
	b. Ferrous piping, appurtenant and supports, immersed	E-2	To be determined
	c. Conduit, outlet and junction boxes, lighting transformers, lighting, communication and small power panels, control stations, piping, lagged ductwork, appurtenant hangers, clamps, and supports on coated surfaces, unless otherwise specified.		
	1) Outdoors	EU-1	Match background color
	d. Conduit, outlets and junction boxes, lighting transformers, lighting, communication and small power panels, control stations, piping, lagged ductwork, appurtenant hangers, clamps and supports on uncoated surfaces, unless otherwise specified		
	1) Outdoors	EU-1	FS 20040 Brown
	e. Existing conduit, outlet and junction boxes, lighting transformers, lighting communication and small power panels, control stations, piping, lagged ductwork, appurtenant hangers, clamps, and supports		
	1) Not damaged nor modified by work in this contract	Uncoated	--
	2) Damaged, exposed, or modified by work in this contract		
	a) Outdoors	EU-1 without primer (see paragraph 09900-3.02 F)	Match existing color
	f. Racked conduits and cable trays	Uncoated	--
	g. Insulated pipe jacketing	Uncoated	--
	4. Concrete, Grout, Masonry and Plaster		
	a. Walls and ceilings		
	1) Precast concrete or colored masonry	Uncoated	--
	2) Outdoors, unless otherwise specified	Uncoated	--

Location Description	Surface	Coating System Identification	Standard Color
	b. Existing coated surfaces, including exterior site wall	L-1	Match existing color.
	5. Precast Concrete Metalwork Fasteners, anchors, supports, etc	EU-1	Match wall
	6. Other g. Buried, sleeve-type and flanged pipe, couplings, valves, mechanical and electrical penetrations	M-1 or M-2	Manufacturer's color
G. Wet well	1. Piping and appurtenant hangers and supports above max. water level elevation 1188.47	EA-1	--
	2. Piping and appurtenance hangars and supports below max. water level elevation 1188.47	E-2	--

Notes:

1. Owner will select color from coating manufacturer's list of EPA approved colors for potable water.

3.07 INSPECTION AND TESTING BY OWNER

A. Inspection by the Owner or others does not limit the Contractor's or CSA's responsibilities for quality workmanship or quality control as specified or as required by the CSM's instructions. Inspection by the Owner is in addition to any inspection required to be performed by the Contractor.

B. The Owner may perform, or contract with an inspection agency to perform, quality control inspection and testing of the coating work covered by this Section 09900. These inspections may include the following:

1. Inspect materials upon receipt to ensure that are supplied by the CSM.

2. Inspect to verify that specified storage conditions for the coating system materials, solvents and abrasives are provided.

3. Inspect and record findings for the degree of cleanliness of substrates.

4. Inspect and record the pH of concrete and metal substrates.

5. Inspect and record substrate profile (anchor pattern).

6. Measure and record ambient air and substrate temperature.

7. Measure and record relative humidity.

8. Check for the presence of substrate moisture in the concrete.

9. Inspect to verify that correct mixing of coating system materials is performed in accordance with CSM's instructions.

10. Inspect, confirm, and record that the "pot life" of coating system materials is not exceeded during installation. Inspect to verify that recoat limitations for coating materials are not exceeded.

11. Perform adhesion testing.

12. Measure and record the thickness of the coating system.

13. Inspect to verify proper curing of the coating system in accordance with the CSM's instructions.

14. Perform holiday or continuity testing for coatings that will be immersed or coatings that will be exposed to aggressively corrosive conditions.

3.08 FINAL INSPECTION

A. Contractor shall conduct a final inspection to determine whether coating system work meets the requirements of the specifications.

B. The Construction Manager will subsequently conduct a final inspection with the Contractor and CSA to determine the work is in conformance with requirements of the contract documents.

C. Any rework required shall be marked. Such areas shall be recleaned and repaired as specified at no additional cost to the Owner.

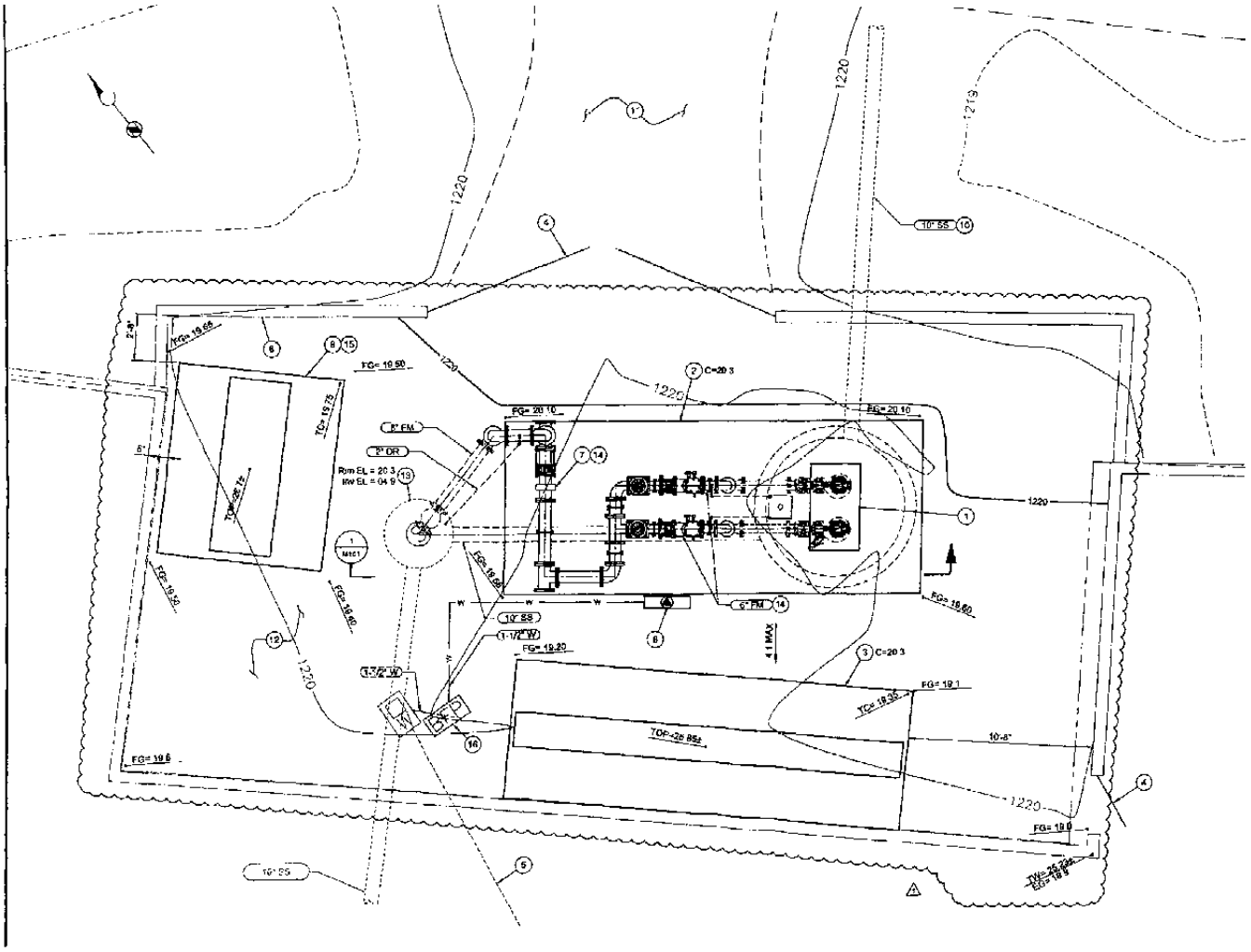
[illegible]			
Project Name:			
Owner		Coating System Manufacturer(CSM)	
General Contractor (GC)		Coating System Applicator(CSA)	
Area or Structure		Location within Structure	
Coating System (e.g. E-1)		Coating Type (e.g. Epoxy, etc.)	

[illegible]					
1	Completion of cleaning and substrate decontamination prior to abrasive blast cleaning.	GC QC			
		CSM QC			
		CSA QC			
2	Installation of protective enclosure of structure or area and protection of adjacent surfaces or structures that are not to be coated.	GC QC			
		CSM QC			
		CSA QC			
3	Completion of ambient condition control in structure or building area and acceptance of ventilation methods in structure or Area.	GC QC			
		CSM QC			
		CSA QC			
4	Completion of Surface Preparation for Substrates to Be Coated.	GC QC			
		CSM QC			
		CSA QC			
5	Completion of Primer Application.	GC QC			
		CSM QC			
		CSA QC			

6	Completion of Concrete Repairs If Required and Related Surface Preparation Rework Prior to Coating System Application.	GC QC			
		CSM QC			
		CSA QC			
7	Completion of Concrete Filler/ Surface Application to Concrete.	GC QC			
		CSM QC			
		CSA QC			
8	Completion of First Finish Coat Application and of Detail Treatment at Transitions or Terminations.	GC QC			
		CSM QC			
		CSA QC			
9	Completion of Second Finish Coat Application and of Detail Treatment at Transitions and Terminations.	GC QC			
		CSM QC			
		CSA QC			
10	Completion of Full and Proper Cure of Coating System.	GC QC			
		CSM QC			
		CSA QC			
11	Completion of Testing of Cured Coating System including Adhesion, Holiday (Continuity) Testing and Dry Film Thickness.	GC QC			
		CSM QC			
		CSA QC			
12	Completion of Localized Repairs to Coating System Following Testing.	GC QC			
		CSM QC			
		CSA QC			

Step	Description		Name	Signature	Date
13	Final Acceptance of Coating System Installation Including Final Clean-Up Complying with Specification Requirements and the CSM's Quality Requirements.	GC QC			
		CSM QC			
		CSA QC			

***END OF SECTION ***



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2. NEW CONCRETE EQUIPM STRUCTURAL DRAWINGS
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4. NEW GATES, SEE STRUCT
5. EXISTING WATER SERVICE
6. EXISTING 6 FOOT MASON
7. FLOW METER
8. TYPE C POST MOUNTED U DRAWING M2 FOR DETAIL
9. NEW GENERATOR PAD, SE DRAWINGS. INSTALL SALV GENERATOR
10. SEE DRAWING C200 FOR F REHABILITATION
11. EXISTING AGGREGATE DR EXISTING CONDITION
12. EXISTING SITE AGGREGAT EXISTING CONDITION
13. FORCEMAIN DISCHARGE M DETAIL A/C102
14. SEE DRAWING M100
15. INSTALL SALVAGED GENER
16. REDUCED PRESSURE BAC ASSEMBLY PER CDG STAN

ILENDALE-BORDER, 143447-P12-103, 143447-LS-501, 143447-LS-M01

PROJECT SPECIFICATIONS AND CONTRACT DOCUMENTS

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COUNCIL MEMBERS
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Samuel U. Chavira
Ian Hugh
Yvonne J. Knaack
Manuel D. Martinez
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ACTING CITY ENGINEER
Craig A. Johnson

GLENDALE

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TECHNICAL SPECIFICATIONS

NOTICE TO CONTRACTORS

Sealed bids shall be either mailed to the City of Glendale Engineering Department, 5850 West Glendale Avenue, Glendale, Arizona, 85301, or hand-delivered to the Engineering Department office, third floor, 5850 West Glendale Avenue, Glendale, Arizona, for furnishing all plant, material, equipment and labor, and to complete construction of: **PROJECT NO. 111216 SWEETWATER LIFT STATION.** Project includes modification of an existing wetwell-drywell lift station to a wetwell only lift station, including upgrades to associated piping and electrical systems. The upstream gravity sewer and associated manholes will be rehabilitated. Bypass pumping will be required to maintain sewer service. The sewer lift station is adjacent to the Arizona Canal within the Estates at Marshall Ranch, 55th Avenue north of Cactus Road.

Bids must be received by the Engineering Department of the City of Glendale no later than 2:00p.m., January 21, 2014. Any bid received after that time will not be considered and will be returned to the bidder. At that time, the bids will be publicly opened and read aloud in the Engineering Department Conference Room, 5850 West Glendale Avenue, Glendale, Arizona.

A pre-bid conference will be held on January 8, 2014, at 10:00a.m., in the Engineering Department Conference Room, 5850 West Glendale Avenue, Glendale, Arizona. Bidders, contractors, and other interested parties are invited to attend this conference which will be conducted by the Owner and Engineer to answer any questions.

Plans, specifications and contract documents may be examined, and copies may be obtained at City of Glendale Engineering Department, 5850 West Glendale Avenue, Glendale, Arizona. A non-refundable charge of $40.00 shall be paid for each set of plans and specifications issued from this office.

Each bid shall be in accordance with the plans, specifications and contract documents, and shall be set forth and submitted on the BID DOCUMENTS included with the project specifications book. The BID DOCUMENTS may be removed from the project specifications book and submitted independently of such book. Each bid shall be accompanied by a proposal guarantee, in the form of a certified or cashier's check or bid bond for ten percent (10%) of the amount of bid, made payable to the order of the City of Glendale, Arizona, to insure that the successful bidder will enter into the contract if awarded to him and submit the required Certificate of Insurance, Payment Bond and Performance Bond. All proposal guarantees, except those of the three lowest qualified bidders, will be returned immediately following the opening and checking of proposals. The proposal guarantees of the three lowest qualified bidders will be returned immediately after the contract documents have been executed by the successful bidder. The proposal guarantee shall be declared forfeited as liquidated damages if the successful bidder refuses to enter into said contract or submit the Certificate of Insurance, Payment Bond and Performance Bond after being requested to do so by the City of Glendale, Arizona.

The City of Glendale reserves the right to reject any or all bids or waive any informality or irregularity in a bid. No bidder may withdraw his bid for a period of fifty (50) days after opening and reading of the bids.

The City of Glendale is an equal opportunity employer and minority business enterprises and women's business enterprises are encouraged to submit bids.

CITY OF GLENDALE, ARIZONA

Published: December 12 & 19, 2013
The Glendale Star

INFORMATION FOR BIDDERS

1. ELIGIBILITY OF CONTRACTORS: When calling for bids for contracts for public work to be performed on behalf of the State or any political subdivision thereof, which will be paid for from public funds, no bid shall be considered for performance of a contract, including construction work which is not submitted by a bidder duly licensed as a contractor in this State. No bid shall be awarded to any contractor or entity not authorized to do business in the State of Arizona by the Arizona Corporation Commission, as required by statute.

2. PROPOSAL: Bids to receive consideration shall be made in accordance with the following instructions:

(a) Before submitting a bid, bidders shall carefully examine the plans and specifications and contract documents, visit the site of the work, fully inform themselves as to all existing conditions and limitations.

(b) Bids shall be submitted on the "PROPOSAL" forms provided and delivered to the City of Glendale Engineering Department on or before the day and hour set in the "NOTICE TO CONTRACTORS," as published. Bids shall be enclosed in a sealed envelope marked on the outside lower right-hand corner indicating:

1. The bidder's name and address.
2. The project number.
3. The title of the project.
4. The time and date the bids are to be received.

(c) It is the sole responsibility of the bidder to see that his bid is received in proper time. Any bids received after the scheduled closing time for receipt of bids will be returned to the bidder unopened.

(d) The signatures of all persons shall be in longhand. Any interlineations, alterations, or erasures must be initialed by the signer of the bid.

(e) Bids shall not contain any recapitulations of the work to be done. No oral, telegraphic, telephonic, or modified proposals will be considered.

3. BID SECURITY: Each proposal shall be accompanied by a proposal guarantee in the form of a certified or cashier's check or bid bond, with a properly executed Power of Attorney attached, in an amount equal at least to ten percent (10%) of the proposal payable without condition to the City. If a bid bond is submitted with the bid it shall be issued by a company licensed with the Arizona Department of Insurance and authorized to issue such bonds in this state. **NO BONDS ISSUED BY INDIVIDUAL SURETIES WILL BE ACCEPTED. The company issuing the bid bond shall have a rating of not less than A- in the BEST rating available at the time this project was let to bid**. The proposal guarantee shall guarantee that the bidder, if awarded the contract, will, within ten (10) working days after the award, execute such contract in accordance with the proposal and in manner and form required by the contract documents, and will furnish good and sufficient bond for the faithful performance of the same, a payment bond and a certificate of insurance. The bid securities of the three (3) lowest bidders will be retained until the contract is awarded, or other disposition made thereof. The bid securities of all bidders, except the three (3) lowest, will be returned promptly after the canvass of bids. In the event the Contractor fails, within ten (10)

working days after the award, to execute said Contract and deliver the Performance and Labor and Material Payment Bonds and the Certificate of Insurance, the Bid Security shall become the property of the City.

4. WITHDRAWAL OF BID: Any bidder may withdraw his bid, either personally, by telegram or by written request, at any time prior to the scheduled closing time for receipt of bids. No bid may be withdrawn by telephone. Any bid withdrawn will not be opened and will be returned to the bidder. After opening and reading of the bids, no bidder may withdraw his bid for a period of fifty (50) days from the date of opening and reading.

5. LATE BIDS: Bids received after the scheduled closing time for receipt of bids, as contained in the "Notice to Contractors," will not be considered and will be returned to the bidder.

6. AWARD OR REJECTION OF BIDS: The contract will be awarded to the lowest and best qualified responsive bidder complying with these instructions and with the "NOTICE TO CONTRACTORS." The City of Glendale, Arizona, however, reserves the right to accept or reject any or all bids or to waive any or all informalities or irregularities in the bid. Alternates may be accepted depending upon the availability of City funds. Accepted alternates will be considered in determining the lowest responsive and responsible bidder.

7. BIDDERS INTERESTED IN MORE THAN ONE BID: No person, firm or corporation shall be allowed to make, file, or be interested in more than one (1) bid for the same work unless alternate bids are called for in the specifications or any addenda. A person, firm, or corporation who has submitted a sub-proposal to a bidder, or who has quoted prices on materials to a bidder is not thereby disqualified from submitting a sub-proposal or quoting prices to other bidders.

8. CONTRACT AND BONDS: The form of contract, which the successful bidder as Contractor will be required to execute and the forms of bonds which he shall be required to furnish are included in the contract documents and should be carefully examined by the bidder. The successful bidder shall use the forms provided or such other forms as are acceptable by the City. The Contract and Performance and Labor and Material Payment Bonds will be executed in three (3) original counterparts. All bonds shall be issued by companies licensed with the Arizona Department of Insurance and authorized to issue such bonds in this state. **NO BONDS ISSUED BY INDIVIDUAL SURETIES WILL BE ACCEPTED. The company issuing any bond shall have a rating of not less than A- in the BEST rating available at the time this project was let to bid.**

9. INSURANCE REQUIREMENTS: Contractor, and each Sub-contractor performing work or providing materials related to this Agreement must procure and maintain the insurance coverages described (collectively, "Contractor's Policies"), until each Parties' obligations under this Agreement are completed. Contractor must at all times relevant hereto carry a commercial general liability policy with a combined single limit of at least $1,000,000 per occurrence and $2,000,000 annual aggregate. **Contracts in excess of $250,000 shall require $2,000,000 single occurrence/$5,000,000 annual aggregate.**

Sub-contractors must at all times relevant hereto carry a general commercial liability policy with a combined single limit of at least $1,000,000 per occurrence.

This commercial general liability insurance must include independent contractors' liability, contractual liability, broad form property coverage, products and completed operations, XCU

hazards if requested by the City, and a separation of insurance provision.

These limits may be met through a combination of primary and excess liability coverage.

Auto. A business auto policy providing a liability limit of at least $1,000,000 per accident for Contractor and $1,000,000 per accident for Sub-contractors and covering owned, non-owned and hired automobiles.

Workers' Compensation and Employer's Liability. A workers' compensation and employer's liability policy providing at least the minimum benefits required by Arizona law.

Equipment Insurance. Contractor must secure, pay for, and maintain all-risk insurance as necessary to protect the City against loss of owned, non-owned, rented or leased capital equipment and tools, equipment and scaffolding, staging, towers and forms owned or rented by Contractor or its Sub-contractors.

10. SUBCONTRACTORS LISTING AND CERTIFICATION OF CONTRACT COMPLIANCE: The contractor will be required to furnish the form of subcontractors listing and certification of contract compliance with the executed contract documents. This information is requested for tracking and insurance purposes only.

11. INTERPRETATION OF PLANS AND DOCUMENTS: If any person contemplating a bid for proposed contract is in doubt as to the true meaning of any part of the plans, specifications, or other proposed contract documents, or finds discrepancies in or omissions from the plans and specifications, he may submit to the Engineering Department, a written request for an interpretation or correction thereof. The person submitting the request will be responsible for its prompt delivery. Questions received less than ninety-six (96) hours before the bid opening time may not be answered. Any interpretation or correction of the documents will be made only by Addendum, duly issued and a copy of such Addendum will be mailed or delivered to each person receiving a set of such documents. The City of Glendale will not be responsible for any other explanations or interpretations of the proposed documents.

12. CHANGES TO PLANS AND DOCUMENTS: Any changes to the plans and documents shall be made only by Addendum. No verbal or other changes to the plans and documents will be valid. A copy of each Addendum will be mailed or delivered as provided in Section 13 below.

13. ADDENDUM: Any addenda will be faxed, mailed or delivered to all who are known by the City to have received a complete set of bid documents, and to offices where bid documents have been filed for review purposes. It is the responsibility of each bidder to ascertain that he has received all addenda issued by telephoning the office identified in the NOTICE TO CONTRACTORS as the location where bid documents are available prior to submitting his bid.

Bidders shall acknowledge all addenda in the appropriate location on the "PROPOSAL" form. Failure to acknowledge receipt of Addenda shall render the bid proposal non-responsive and it will be rejected.

14. ASSIGNMENT OF CONTRACT: No assignment by the Contractor of any contract to be entered into hereunder, or any part thereof, or of funds to be received thereunder by the Contractor, will be recognized by the Owner by the Owner unless such assignment has had prior approval of the Owner, and the Surety has been given due notice of such assignment in writing and has consented

thereto in writing.

15. PLANS AND SPECIFICATIONS TO SUCCESSFUL BIDDER: The successful bidder may obtain five (5) sets of plans and specifications for this project from the City.

16. TIME OF COMPLETION: The Contractor shall commence work under this project on or before the tenth day following receipt of the Notice to Proceed for that project from the City of Glendale and shall fully complete all work under the project within two hundred ten (210) consecutive calendar days from and including the date of receipt of such Notice to Proceed. Time is of the essence in the completion of all work required under this contract. The Contractor shall, at all times, during the continuance of the contract, prosecute the work with such force and equipment as is sufficient to complete all work within the time specified.

17. CITY OF GLENDALE TRANSACTION PRIVILEGE TAX: The City of Glendale transaction privilege tax shall **NOT** be waived under the provisions of this contract. The current privilege tax rate can be obtained from the City of Glendale Sales Tax and Licenses Department. The Contractor shall be responsible for reporting and payment of all city, county, state or federal taxes.

18. PRE-BID CONFERENCE: A pre-bid conference will be held on January 8, 2014, at 10:00a.m., in the Engineering Department Conference Room, 5850 West Glendale Avenue, Glendale, Arizona. Bidders, contractors, and other interested parties are invited to attend this conference which will be conducted by the Owner and Engineer to answer any questions.

19. ALTERNATES: Alternate proposals will not be considered unless called for in the documents or any addenda thereto. When alternates are requested, all requested alternates or alternate bid items, unless otherwise stated, shall be bid. If no change in the base bid will occur with the alternate, enter "No Change."

20. APPROVAL OF SUBSTITUTIONS: The materials, products and equipment described in the Documents and Addenda establish a standard or required function, dimension, appearance and quality to be met by any proposed substitution. No substitute will be considered, before bid opening, unless written request for approval has been received by the City Engineer at least ten (10) working days prior to the scheduled closing time for receipt of bids. Each such request shall include the name of the material or equipment for which it is to be substituted and a complete description of the proposed substitute including any drawings, cuts, performance and test data and any other information necessary for evaluation of the substitute. Bidder shall not be entitled to approval of a substitute.

If a substitute is approved, the approval shall be set forth in an Addendum. Bidders shall not rely upon approvals made in any other manner.

21. USE OF "EQUALS": When the specifications for materials, articles, products and equipment state "or equal," contractor may bid upon, and use materials, articles, products and equipment which will perform equally the duties imposed by the general design. The City Engineering Department will have the final approval of all materials, articles, products and equipment proposed to be used as an "equal." It shall not be purchased or installed without the prior written approval from the City Engineering Department.

Approvals for "equals," before bid opening, may be requested in writing to the City Engineering

Department for approval. Requests must be received at least ten (10) days prior to the date set for opening the Bid Proposals. The request shall state the name of the material, article, product or equipment for which the item is sought to be considered an equal and a complete description of the proposed equal including any drawings, cuts, performance and test data and any other information necessary for approval of the equal. All approvals will be issued in the form of an addendum.

22. EXAMINATION OF CONTRACT DOCUMENTS AND VISIT SITE: Before submitting a Bid Proposal, bidders should carefully examine the Contract Documents, visit the site of the work, fully inform themselves as to all existing conditions and limitations. No consideration will be granted for any alleged misunderstanding of the material, articles or piece of equipment to be furnished or work to be done. It is understood that the tender of the Bid Proposal carries with it the agreement to all items and conditions referred to herein or indicated in the Contract Documents.

23. BIDDERS IN DEFAULT: No bid will be awarded to any person, firm or corporation that is not authorized by the Arizona Corporation Commission to do business in the State of Arizona, in arrears or is in default to the City of Glendale upon any debt or contract, or that is a defaulter as surety or otherwise upon any obligation to the City of Glendale, or has failed to faithfully perform any previous contract with the City of Glendale.

24. QUALIFICATION SUBMITTAL REQUIREMENTS: To ensure a safe, efficient, high-quality project, the City shall require the Prime Contractor and their Subcontractors to meet minimum qualifications for performing wastewater pumping station, cured-in-place pipe (CIPP) lining, bypassing pumping, and manhole coating work. Information required in this Section must be submitted in detail on the forms provided with the contract proposal. **If a bidder fails to provide the information required herein, their bid shall be rejected.**

Qualifications for Wastewater Pumping Station Work

The Prime Contractor shall submit the Wastewater Pumping Station Qualification form verifying experience required herein. All reference experience shall be for projects successfully completed by the Prime Contractor within the United States within the last 5 years. The minimum qualifying Contractor experience shall meet the following criteria:

1. Three (3) sewage wastewater pumping projects utilizing submersible wastewater pumps with discharge nozzles 3 inches in diameter or larger and motors 5 horsepower or larger.

The Prime Contractor shall also submit the Superintendent Qualification Form providing the name(s) and qualifications for each scheduled superintendent for the project. It is required that the superintendents named are the superintendents assigned to the project. The Contractor is required to have at least one qualified superintendent on the job at all times during construction activities. All referenced experience shall be for projects successfully completed by the Superintendent within the United States within the last 5 years. The minimum qualifying Superintendent experience shall meet the following criteria:

1. Three (3) sewage wastewater pumping project utilizing submersible wastewater pumps with discharge nozzles 3 inches in diameter or larger and motors 5 horsepower or larger.

Qualifications for CIPP Lining Work

The Prime Contractor or Subcontractor shall submit the CIPP Qualification form verifying CIPP lining experience required herein. All reference experience shall be for projects successfully completed by the Prime Contractor or Subcontractor within the United States within the last 5 years. Additionally, all referenced projects shall have used the same CIPP liner and resin combination proposed for this project, and shall have been installed using the inversion method. The minimum qualifying Prime Contractor or Subcontractor experience shall meet the following criteria:

1. Three (3) projects with a total of at least 10,000 total linear feet of CIPP lining in sewers 8 to 24 inches in diameter.

The Prime Contractor or Subcontractor shall also submit the Superintendent Qualification Form providing the name(s) and qualifications for each scheduled superintendent for the project. It is required that the superintendents named are the superintendents assigned to the project. The Contractor is required to have at least one qualified superintendent on the job at all times during construction activities. All referenced experience shall be for projects successfully completed by the Superintendent within the United States within the last 5 years. Additionally, all referenced projects shall have used the same CIPP liner and resin combination proposed for this project, and shall have been installed using the inversion method. The minimum qualifying Superintendent experience shall meet the following criteria:

1. Three (3) projects totaling 10,000 linear feet of CIPP lining in sewers 8 to 24 inches in diameter.

Qualifications for Bypass Pumping Work

The Prime Contractor or Subcontractor shall submit the Bypass Pumping Qualification form verifying bypass pumping experience required herein. Prime Contractor or Subcontractor shall have bypass pumping experience for sewer flows equal to or greater than 1 mgd and shall have been maintained and in operation for a minimum of 2 months. Prime Contractor or Subcontractor shall submit on the attached bypass pumping Qualification form, three (3) successfully completed bypass pumping projects that have been completed within the last 5 years. All bypass work experience shall be without spills or mishaps.

Qualifications for Manhole Coating Work

The Prime Contractor or Subcontractor shall submit the Manhole Coating Qualification Form verifying manhole coating experience required herein. Prime Contractor or Subcontractor shall have coating experience from three successfully completed projects within the past 5 years using the same coating system specified for this project.

Prime Contractor or Subcontractor shall also submit Manufacturer's Certification attesting that Applicant is qualified and approved to install coating system specified for this project.

END OF INFORMATION FOR BIDDERS

PROPOSAL

Place Gilbert Arizona

Date January 21, 2014

Proposal of Hunter Contracting Co, a Corporation organized and existing under the laws of the State of Arizona. a partnership consisting of Not applicable; or an individual trading as Not applicable.

TO THE HONORABLE MAYOR AND COUNCIL
CITY OF GLENDALE
GLENDALE, ARIZONA

Gentlemen:

The undersigned hereby proposes and agrees to furnish any and all required labor, materials, construction equipment, transportation and services for the construction of: **PROJECT 111216 - SWEETWATER LIFT STATION**, in strict conformity with the plans and specifications for the following unit prices:

(Extension of these unit prices on the basis of estimated quantities and the totaling of these extensions are for the purpose of comparing bids only. The mathematics of such extensions and totaling will be checked and corrected by the Engineering Department, before evaluating the bids, and the lowest of such corrected and checked totals will determine the lowest bids.)

City of Glendale
Sweetwater Lift Station
Project No. 111216

BID SCHEDULE

Bid Item	Description	Quantity	Unit	Unit Cost	Total Cost
1	Bypass Pumping	1	LS	$ 244,200.00	$ 244,200.00
2	Abandon, Demolish, and/or Remove Existing Lift Station Facilities	1	LS	$ 24,300.00	$ 24,300.00
3	Furnish and Install New Lift Station Facilities	1	LS	$623,000.00	$ 623,000.00
4	Furnish and Install 10-inch CIPP Liner	908	LF	$ 106.00	$ 96,248.00
5	Rehabilitate Existing Manhole	5	EA	$ 11,600.00	$ 58,000.00
6	Rehabilitate Existing Wet Well	1	EA	$ 37,600.00	$ 37,600.00
7	Mobilization/Demobilization	1	LS	$ 4,100.00	$ 4,100.00
8	Construction Survey & Layout	1	LS	$ 7,000.00	$ 7,000.00
9	Traffic Control	1	LS	$ 16,500.00	$ 16,500.00
10	Allowance for Construction Material Sampling & Testing	1	LS	$7,500	$ 7,500
11	Allowance for Upgrade of Electrical Service	1	LS	$20,000	$ 20,000
12	Owner's Allowance for Construction Contingency	1	LS	$160,000	$160,000
				TOTAL BASE BID	$ 1,298,448.00

The undersigned hereby declares that he has visited the site(s) and has carefully examined the contract documents relating to the work covered by the above bid or bids.

Upon receipt of notice of the acceptance of this bid, we will execute the formal contract attached within ten (10) days, and will deliver a one hundred percent (100%) Performance Bond for the faithful performance of this Contract, together with a one hundred percent (100%) Payment Bond and Certificate of Insurance.

The bid security attached, with endorsement, in the sum of ten percent (10%) of the total bid, is to become the property of the City of Glendale, Arizona, in the event the Contract and Bonds are not executed within the time set forth, as liquidated damages for the delay and additional work caused thereby.

The undersigned has checked carefully all the above figures and understands that the City of Glendale, Arizona, will not be responsible for any errors or omissions on the part of the undersigned in making up this bid.

The undersigned understands that the Mayor and Council of the City of Glendale, Arizona, reserves the right to reject any or all bids or to waive any informalities or irregularities in the bid.

Respectfully submitted,

Arizona Contractor's Classification and License No.

AZROC070961A

Hunter Contracting Co.
Contractor

By _____
Robert S. Carlson, Vice President

701 N. Cooper Rd.
Gilbert AZ 85233
(Complete business address)

Telephone Number: 480-892-0521 602-359-1323 (Cell)
Fax Number 480-892-4932

Bidder shall signify receipt of all Addenda here (if any):

Addendum 1 dated Jan. 16, 2014

Failure to acknowledge receipt of all Addenda shall render the bid proposal non-responsive and will be rejected.

Acknowledged by _____
Robert S Carlson, Vice President

WASTEWATER PUMPING CONTRACTOR QUALIFICATION FORM

City of Glendale, Sweetwater Lift Station
Project No. 111216

Provide the Prime Contractor's project experience below. Project experience shall meet the minimum requirements described herein

CONTRACTOR'S NAME Hunter Contracting Co.

1. PROJECT: Casa Grande Influent Pump Station DATE COMPLETED 11 / 2009
NAME & ADDRESS OF CITY: City of Casa Grande
510 East Florence Boulevard, Casa Grande, Arizona 85122
CONTACT PERSON Terrence McKeon, PE PHONE NUMBER 520-421-8625 x 3341
TYPE OF PUMP INSTALLED: Submersible PUMP MANUFACTURER Flight
PUMP DISCHARGE NOZZLE SIZE: 14" MOTOR HORSEPOWER 45

2 PROJECT: Casa Grande RAS Pump Station DATE COMPLETED 05/2011
NAME & ADDRESS OF CITY City of Casa Grande
510 E Florence Blvd Casa Grande AZ 85122
CONTACT PERSON: Terrence McKeon, PE PHONE NUMBER 520-421-8625 x 3341
TYPE OF PUMP INSTALLED: Submersible PUMP MANUFACTURER Flight
PUMP DISCHARGE NOZZLE SIZE: 8" MOTOR HORSEPOWER 45

3. PROJECT: Casa Grande WAS Pump Station DATE COMPLETED 01/2011
NAME & ADDRESS OF CITY: City of Casa Grande
510 E Florence Blvd Casa Grande AZ 85122
CONTACT PERSON: Terrence McKeon, PE PHONE NUMBER 520-421-8625 x 3341
TYPE OF PUMP INSTALLED: Submersible PUMP MANUFACTURER Flight
PUMP DISCHARGE NOZZLE SIZE: 6" MOTOR HORSEPOWER 20

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WASTEWATER PUMPING SUPERINTENDENT QUALIFICATION FORM

City of Glendale, Sweetwater Lift Station
Project No. 111216

Provide the name of the construction superintendent/superintendents to be assigned to the above stated project Each qualified superintendent shall meet the minimum requirements described herein.

SUPERINTENDENT'S NAME: Chad Rowe / Gary Hornberger

1 PROJECT: Casa Grande Pump Stations DATE COMPLETED 2013
NAME & ADDRESS OF CITY. City of Casa Grande
510 E Florence Blvd Casa Grande AZ 85122
CONTACT PERSON: Terrence McKeon, PE PHONE NUMBER 520-421-8625 x 3341
TYPE OF PUMP INSTALLED. Submersible PUMP MANUFACTURER Flight
PUMP DISCHARGE NOZZLE SIZE: 6" - 14" MOTOR HORSEPOWER 20 - 45
TOTAL TIME ACTING AS SUPERINTENDENT. Twenty four MONTHS.

2 PROJECT: City of Mesa DATE COMPLETED on-going
NAME & ADDRESS OF CITY: City of Mesa
20 E Main St Mesa AZ 85201
CONTACT PERSON: Joel Watson, PE PHONE NUMBER 480-644-5574
TYPE OF PUMP INSTALLED: Submersible PUMP MANUFACTURER Flight
PUMP DISCHARGE NOZZLE SIZE: 4" - 8" MOTOR HORSEPOWER 5 - 10
TOTAL TIME ACTING AS SUPERINTENDENT: Eight MONTHS.

3. PROJECT: Gila River Indian Community DATE COMPLETED on-going
NAME & ADDRESS OF CITY: Gila River Indian Community
315 W Casa Blanca Rd Sacaton AZ 85147
CONTACT PERSON Dewane Badonie PHONE NUMBER 520-562-3343
TYPE OF PUMP INSTALLED. Submersible PUMP MANUFACTURER Flight
PUMP DISCHARGE NOZZLE SIZE: 4" MOTOR HORSEPOWER 5 - 10
TOTAL TIME ACTING AS SUPERINTENDENT: Four MONTHS.

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CIPP CONTRACTOR QUALIFICATION FORM

City of Glendale, Sweetwater Lift Station
Project No. 111216

Provide the Prime Contractor's or Subcontractor's project experience below Project experience shall meet the minimum requirements described herein.

CONTRACTOR'S NAME: SAK Construction

1. PROJECT: Broadway Rehab DATE COMPLETED 6/2013
NAME & ADDRESS OF CITY: Pima County, 3355 Dodge Rd Tucson, AZ 85716
TIME OF YEAR INSTALLED: Summer MAXIMUM SITE TEMPERATURE: 100° F
CONTACT PERSON: Jason DeCarlo PHONE NUMBER 602-376-0264
DIAMETER OF CIPP INSTALLED: 8" - 10" LINER MANUFACTURER SAK
LENGTH OF CIPP INSTALLED: 5,100 LF RESIN TYPE AOC L713-LTA

2. PROJECT: Roger Rd Rehab DATE COMPLETED 6/2013
NAME & ADDRESS OF CITY: Pima County, 3355 Dodge Rd Tucson, AZ 85716
TIME OF YEAR INSTALLED: Summer MAXIMUM SITE TEMPERATURE: 100° F
CONTACT PERSON: Jason Decarlo PHONE NUMBER 602-376-0264
DIAMETER OF CIPP INSTALLED: 8" LINER MANUFACTURER SAK
LENGTH OF CIPP INSTALLED: 1,300 LF RESIN TYPE AOC L713-LTA

3. PROJECT: JDA 34 Sewer Rehab DATE COMPLETED 7/2013
NAME & ADDRESS OF CITY: City of Phoenix, 200 W Washington St. Phoenix, AZ 85003
TIME OF YEAR INSTALLED: Spring/Summer MAXIMUM SITE TEMPERATURE: 110° F
CONTACT PERSON: Steve Fernandez PHONE NUMBER 602-743-7626
DIAMETER OF CIPP INSTALLED: 8" - 12" LINER MANUFACTURER SAK
LENGTH OF CIPP INSTALLED: 16,500 LF RESIN TYPE AOC L713-LTA

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CIPP SUPERINTENDENT QUALIFICATION FORM

City of Glendale, Sweetwater Lift Station
Project No. 111216

Provide the name of the construction superintendent/superintendents to be assigned to the above stated project. Each qualified superintendent shall meet the minimum requirements described herein.

SUPERINTENDENT'S NAME: Hauss Hancock

1. PROJECT: Broadway Rehab DATE COMPLETED 6/2013
NAME & ADDRESS OF CITY: Pima County, 3355 Dodge Rd Tucson, AZ 85716
TIME OF YEAR INSTALLED: Summer MAXIMUM SITE TEMPERATURE: 100°F
CONTACT PERSON: Jason Decarlo PHONE NUMBER 602-376-0264
DIAMETER OF CIPP INSTALLED: 8" - 10" LINER MANUFACTURER SAK
LENGTH OF CIPP INSTALLED: 5,100 LF RESIN TYPE AOC L713-LTA
INSTALLATION METHOD (Inversion or pull/winch): Inversion
TOTAL TIME ACTING AS SUPERINTENDENT: 1 MONTHS.

2. PROJECT: Roger Rd Rehab DATE COMPLETED 6/2013
NAME & ADDRESS OF CITY: Pima County, 3355 Dodge Rd Tucson, AZ 85716
TIME OF YEAR INSTALLED: Summer MAXIMUM SITE TEMPERATURE: 100°F
CONTACT PERSON: Jason Decarlo PHONE NUMBER 602-376-0264
DIAMETER OF CIPP INSTALLED: 8" LINER MANUFACTURER SAK
LENGTH OF CIPP INSTALLED: 1,300 LF RESIN TYPE AOC L713-LTA
INSTALLATION METHOD (Inversion or pull/winch): Inversion
TOTAL TIME ACTING AS SUPERINTENDENT: 1 MONTHS.

3. PROJECT: JOA 34 Sewer Rehab DATE COMPLETED 7/2013
NAME & ADDRESS OF CITY: City of Phoenix, 200 W Washington Phoenix, AZ 85003
TIME OF YEAR INSTALLED: Spring/Summer MAXIMUM SITE TEMPERATURE: 110°F
CONTACT PERSON: Steve Fernandez PHONE NUMBER 602-743-7626
DIAMETER OF CIPP INSTALLED: 8" - 12" LINER MANUFACTURER SAK
LENGTH OF CIPP INSTALLED: 16,500 LF RESIN TYPE AOC L713-LTA
INSTALLATION METHOD (Inversion or pull/winch): Inversion
TOTAL TIME ACTING AS SUPERINTENDENT: 2 MONTHS.

BYPASS PUMPING QUALIFICATION FORM

City of Glendale, Sweetwater Lift Station
Project No 111216

Provide the Prime Contractor's or Subcontractor's bypass pumping experience below. Bypass pumping experience shall meet the minimum requirements described herein

1 PROJECT: Lift Station #9 Bypass DATE COMPLETED 24 AUG 2013
NAME & ADDRESS OF CITY Town of Gilbert
525 N. Lindsay Rd
CONTACT PERSON: Hardo Todd PHONE NUMBER 480 503 6430
CAPACITY OF BYPASS PUMPING (mgd) 2 MGD LENGTH OF DIVERSION (feet) 100'
TOTAL TIME MAINTAINED AND IN OPERATION (months) 1-week

2 PROJECT: County Sewer Replacement # DATE COMPLETED 22 AUG 2013
NAME & ADDRESS OF CITY: UpSize - Scottsdale Rd. Curry to Gilbert
City of Tempe P.O. Box 5002 Tempe AZ 85281
CONTACT PERSON: Josh Rutherford PHONE NUMBER 480 250 5107
CAPACITY OF BYPASS PUMPING (mgd): 1.5 MGD LENGTH OF DIVERSION (feet): 400'
TOTAL TIME MAINTAINED AND IN OPERATION (months) 2.5 Months
* BC - A.C.I. Albuquerque, NM Mike Rocco 505-242-4849

3 PROJECT: Red Road Lift Station Box DATE COMPLETED 7 Nov 2013
NAME & ADDRESS OF CITY: Screen Improvements
Fehr Construction / Sun City, AZ 11140 N. 136 Ave Surprise, AZ
CONTACT PERSON: Ryan Moritz PHONE NUMBER 480-464-0011
CAPACITY OF BYPASS PUMPING (mgd): 7 MGD LENGTH OF DIVERSION (feet): 100'
TOTAL TIME MAINTAINED AND IN OPERATION (months) 1.25 Months

City of Tempe
Josh Rutherford
480 250-5107
Joshua_Rutherford@Tempe.Gov

Rain For Rent

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MANHOLE COATING QUALIFICATION FORM

City of Glendale, Sweetwater Lift Station
Project No 111216

Provide the Prime Contractor's or Subcontractor's manhole coating experience below. Project experience shall meet the minimum requirements described herein

1 PROJECT: Town of Gilbert Manhole Rehabilitation JOC DATE COMPLETED 1st Year 6/30/2013, 2nd Year 6/30/2014
NAME & ADDRESS OF CITY: Town of Gilbert, Public Works 900 E Juniper Ave, Gilbert AZ

CONTACT PERSON: Hondo Judd PHONE NUMBER 480-503-6430
COATING SYSTEM Sewer Shield 150 NUMBER OF STRUCTURES COATED 15

2. PROJECT: Goodyear Weststar Manhole Rehabilitation DATE COMPLETED 9/24/2013
NAME & ADDRESS OF CITY: City of Goodyear, Wastewater Collections
4980 South 157th Ave, Goodyear, AZ 85338

CONTACT PERSON: Pilar R Avila III PHONE NUMBER 623-606-4759
COATING SYSTEM Sewer Shield 150 NUMBER OF STRUCTURES COATED 9

3. PROJECT: Avondale Broadway Manhole Rehabilitation DATE COMPLETED 10/19/2012
NAME & ADDRESS OF CITY: City of Avondale, Public Works
3999 E Lower Buckeye Road, Avondale, AZ 85323

CONTACT PERSON: Mike Yracheta PHONE NUMBER 623-764-2513
COATING SYSTEM Sewer Shield 150 NUMBER OF STRUCTURES COATED 10

Joseph Painting Co.
4702 E Virginia St.
Mesa AZ 85215

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ENVIRONMENTAL COATINGS
4702 E. Virginia Street • Mesa, Arizona 85215-9101
AZ phone (480) 984-7608 • FAX (480) 380-4461

Date: **January 21, 2014**

Re: **Glendale Sweetwater Lift Station & Manhole Rehabilitation**

Contractor: **JPCI Services**

Project #: **111216**

To whom it may concern:

Joseph Painting Company, Inc dba JPCI Services has completed all training for the application of all Sewer Shield Products and is hereby certified to apply Sewer Shield 100, Sewer Shield 150, Flex-Guard 250, and C-120 Acid Resistant Cement Underlayment, and Sewer Shield Cote 120 (also known as Enviro-Cote 120).

Joseph Painting Company, Inc. dba JPCI Services has applied Environmental Coatings Sewer Shield System successfully for more than 20 years. They are qualified applicators for all of our products.

If you have any questions please feel free to call.

Sincerely,

Sharon L Fitzpatrick

Sharon L. Fitzpatrick.
Sales Representative

ATTENTION BIDDERS

PLEASE AFFIX
MANHOLE COATINGS MANUFACTURER'S CERTIFICATE
TO THIS PAGE

CITY OF GLENDALE

Subcontractor Listing and Certification of Contract Compliance

PROJECT 111216 - SWEETWATER LIFT STATION

The undersigned contractor hereby submits the following list of firms to be employed as subcontractors on the above referenced project:

SUBCONTRACTOR	WORK ELEMENTS	CONTRACT VALUE	DBE(Y/N)*	AGENCY**
Alliance	Electrician	216,500	Y	
SAK	CIPP Lining	45,400-	N	
Rain for Rent	By Pass Pump.	99,000-	N	
Joseph Painting	Coatings	67,400-	Y	
Pro Pipe	Pipe Cleaning	16,000-	N	
Case Foundation	Drilling	27,600-	N	
~~Painting~~	~~A+O~~	~~15,500~~		
Biddle & Brown	Gates	6500	N	
A+O	Painting	15,500	N	

The undersigned hereby certifies that all subcontracts shall be in writing and shall provide that all work to be performed shall be in accordance with the terms of the Contract. All subcontracts shall be subject to approval by the City. Certified copies of all subcontracts shall be furnished to the Engineer; however, prices may be omitted. Subcontracts shall conform to the regulations governing employment of labor.

Hunter Contracting Co.
Name of Firm

DBE?(Y/N)*: N Agency**:

Robert S. Carlson
Signature

Robert S Carlson, Vice President
Title

*Firms certified as Disadvantaged Business Enterprises. **Indicate certifying agency, e.g., ADOT, MCHD, COP, etc. This information is requested for tracking purposes only. The City of Glendale is an equal opportunity employer and minority business enterprises and women's business enterprises are encouraged to submit bids.

Project 111216

C-8814
02/25/2014

CONSTRUCTION AGREEMENT

This Construction Agreement ("Agreement") is entered into and effective between the CITY OF GLENDALE, an Arizona municipal corporation ("City"), and Hunter Contracting, Co , an Arizona corporation, ("Contractor") as of the 25 day of February, 2014

RECITALS

A City intends to undertake a project for the benefit of the public and with public funds that is more fully set forth in the **Notice to Contractors** and the attached **Exhibit A** ("Project");

B City desires to retain the services of Contractor to perform those specific duties and produce the specific work as set forth in the Project, the plans and specifications, the **Information for Bidders,** and the **Maricopa Association of Governments** ("MAG") **General and Supplemental Conditions and Provisions,**

C City and Contractor desire to memorialize their agreement with this document

AGREEMENT

In consideration of the Recitals, which are confirmed as true and correct and incorporated by this reference, the mutual promises and covenants contained in this Agreement, and other good and valuable consideration, City and Contractor agree as follows·

1. Project.

1.1 Scope. Contractor will provide all services and material necessary to assure the Project is completed timely and efficiently consistent with Project requirements, including, but not limited to, working in close interaction and interfacing with City and its designated employees, and working closely with others, including other contractors, providers or consultants retained by City

1.2 Documents. The following documents are, by this reference, entirely incorporated into this Agreement and attached Exhibits as though fully set forth herein

(A) Notice to Contractors;
(B) Information for Bidders,
(C) MAG General Conditions, Supplemental General Conditions, Special and Technical Provisions;
(D) Proposal,
(E) Bid Bond,
(F) Payment Bond,
(G) Performance Bond,
(H) Certificate of Insurance,
(I) Appendix; and
(J) Plans and Addenda thereto.

Should a conflict exist between this Agreement (and its attachments), and any of the incorporated documents as listed above, the provisions of this Agreement shall govern

1.3 Project Team.

(A) Project Manager. Contractor will designate an employee as Project Manager with sufficient training, knowledge, and experience to, in the City's opinion, to complete the project and handle all aspects of the Project such that the work produced by Contractor is consistent with applicable standards as detailed in this Agreement

(B) Project Team

(1) The Project manager and all other employees assigned to the project by Contractor will comprise the "Project Team."

(2) Project Manager will have responsibility for and will supervise all other employees assigned to the project by Contractor.

(C) Sub-contractors

(1) Contractor may engage specific technical contractor (each a "Sub-contractor") to furnish certain service functions

(2) Contractor will remain fully responsible for Sub-contractor's services

(3) Sub-contractors must be approved by the City, unless the Sub-contractor was previously mentioned in the response to the solicitation

(4) Contractor shall certify by letter that contracts with Sub-contractors have been executed incorporating requirements and standards as set forth in this Agreement

2. **Schedule.** The Project will be undertaken in a manner that ensures it is completed in a timely and efficient manner If not otherwise stated in **Exhibit A**, the Project shall be completed by no later than within two hundred ten (210) consecutive calendar days from and including the date of receipt of the Notice to Proceed

3. **Contractor's Work.**

3.1 **Standard.** Contractor must perform services in accordance with the standards of due diligence, care, and quality prevailing among contractors having substantial experience with the successful furnishing of services and materials for projects that are equivalent in size, scope, quality, and other criteria under the Project and identified in this Agreement

3.2 **Licensing.** Contractor warrants that

(A) Contractor and Sub-contractors will hold all appropriate and required licenses, registrations and other approvals necessary for the lawful furnishing of services ("Approvals"), and

(B) Neither Contractor nor any Sub-contractor has been debarred or otherwise legally excluded from contracting with any federal, state, or local governmental entity ("Debarment")

(1) City is under no obligation to ascertain or confirm the existence or issuance of any Approvals or Debarments or to examine Contractor's contracting ability

(2) Contractor must notify City immediately if any Approvals or Debarment changes during the Agreement's duration and the failure of the Contractor to notify City as required will constitute a material default of this Agreement

3.3 **Compliance.** Services and materials will be furnished in compliance with applicable federal, state, county and local statutes, rules, regulations, ordinances, building codes, life safety codes, or other standards and criteria designated by City.

3.4 **Coordination; Interaction.**

(A) If the City determines that the Project requires the coordination of professional services or other providers, Contractor will work in close consultation with City to proactively interact with any other contractors retained by City on the Project ("Coordinating Entities")

(B) Subject to any limitations expressly stated in the budget, Contractor will meet to review the Project, schedules, budget, and in-progress work with Coordinating Entities and the City as often and for durations as City reasonably considers necessary in order to ensure the timely work delivery and Project completion

(C) If the Project does not involve Coordinating Entities, Contractor will proactively interact with any other contractors when directed by City to obtain or disseminate timely information for the proper execution of the Project

3.5 **Hazardous Substances.** Contractor is responsible for the appropriate handling, disposal of, and if necessary, any remediation and all losses and damages to the City, associated with the use or release of hazardous substances by Contractor in connection with completion of the Project.

3.6 **Warranties.** At any time within two years after completion of the Project, Contractor must, at Contractor's sole expense and within 20 days of written notice from the City, uncover, correct and remedy all defects in Contractor's work. City will accept a manufacturer's warranty on approved equipment as satisfaction of the Contractor's warranty under this subsection

3.7. **Bonds.** Upon execution of this Agreement, and if applicable, Contractor must furnish Payment and Performance bonds as required under A R S § 34-608

4. **Compensation for the Project.**

4.1 **Compensation.** Contractor's compensation for the Project, including those furnished by its Sub-contractors will not exceed $1,298,448 00, as specifically detailed in the Contractor's bid and set forth in **Exhibit B** ("Compensation").

4.2 **Change in Scope of Project.** The Compensation may be equitably adjusted if the originally contemplated scope of services as outlined in the Project is significantly modified by the City

(A) Adjustments to the Scope or Compensation require a written amendment to this Agreement and may require City Council approval

(B) Additional services which are outside the scope of the Project and not contained in this Agreement may not be performed by the Contractor without prior written authorization from the City

5. **Billings and Payment.**

5.1 **Applications.**

(A) The Contractor will submit monthly invoices (each, a "Payment Application") to City's Project Manager and City will remit payments based upon the Payment Application as stated below

(B) The period covered by each Payment Application will be one calendar month ending on the last day of the month.

5.2 **Payment.**

(A) After a full and complete Payment Application is received, City will process and remit payment within 30 days

(B) Payment may be subject to or conditioned upon City's receipt of.

(1) Completed work generated by Contractor and its Sub-contractors, and

(2) Unconditional waivers and releases on final payment from Sub-contractors as City may reasonably request to assure the Project will be free of claims arising from required performances under this Agreement

5.3 **Review and Withholding.** City's Project Manager will timely review and certify Payment Applications.

(A) If the Payment Application is rejected, the Project Manager will issue a written listing of the items not approved for payment

(B) City may withhold an amount sufficient to pay expenses that City reasonably expects to incur in correcting the deficiency or deficiencies rejected for payment

(C) Contractor will provide, by separate cover, and concurrent with the execution of this Agreement, all required financial information to the City, including City of Glendale Transaction Privilege License and Federal Taxpayer identification numbers

(D) City will temporarily withhold Compensation amounts as required by A R S 34-221(C)

6. **Termination.**

6.1 **For Convenience.** City may terminate this Agreement for convenience, without cause, by delivering a written termination notice stating the effective termination date, which may not be less than 15 days following the date of delivery.

(A) Contractor will be equitably compensated any services and materials furnished prior to receipt of the termination notice and for reasonable costs incurred.

(B) Contractor will also be similarly compensated for any approved effort expended and approved costs incurred that are directly associated with Project closeout and delivery of the required items to the City.

6.2 **For Cause.** City may terminate this Agreement for cause if Contractor fails to cure any breach of this Agreement within seven days after receipt of written notice specifying the breach.

(A) Contractor will not be entitled to further payment until after City has determined its damages If City's damages resulting from the breach, as determined by City, are less than the equitable amount due but not paid Contractor for Service and Repair furnished, City will pay the amount due to Contractor, less City's damages

(B) If City's direct damages exceed amounts otherwise due to Contractor, Contractor must pay the difference to City immediately upon demand, however, Contractor will not be subject to consequential damages more than $1,000,000 or the amount of this Agreement, whichever is greater

7. **Insurance.**

7.1 **Requirements.** Contractor must obtain and maintain the following insurance ("Required Insurance").

(A) Contractor and Sub-contractors Contractor, and each Sub-contractor performing work or providing materials related to this Agreement must procure and maintain the insurance coverages described below (collectively, "Contractor's Policies"), until each Parties' obligations under this Agreement are completed

(B) General Liability

(1) Contractor must at all times relevant hereto carry a commercial general liability policy with a combined single limit of at least $2,000,000 per occurrence and $5,000,000 annual aggregate.

(2) Sub-contractors must at all times relevant hereto carry a general commercial liability policy with a combined single limit of at least $1,000,000 per occurrence

(3) This commercial general liability insurance must include independent contractors' liability, contractual liability, broad form property coverage, products and completed operations, XCU hazards if requested by the City, and a separation of insurance provision.

(4) These limits may be met through a combination of primary and excess liability coverage

(C) Auto. A business auto policy providing a liability limit of at least $1,000,000 per accident for Contractor and 1,000,000 per accident for Sub-contractors and covering owned, non-owned and hired automobiles

(D) Workers' Compensation and Employer's Liability A workers' compensation and employer's liability policy providing at least the minimum benefits required by Arizona law

(E) Equipment Insurance Contractor must secure, pay for, and maintain all-risk insurance as necessary to protect the City against loss of owned, non-owned, rented or leased capital equipment and tools, equipment and scaffolding, staging, towers and forms owned or rented by Contractor or its Sub-contractors

(F) Notice of Changes Contractor's Policies must provide for not less than 30 days' advance written notice to City Representative of

(1) Cancellation or termination of Contractor or Sub-contractor's Policies,

(2) Reduction of the coverage limits of any of Contractor or and Sub-contractor's Policies, and

(3) Any other material modification of Contractor or Sub-contractor's Policies related to this Agreement

(G) Certificates of Insurance

(1) Within 10 business days after the execution of the Agreement, Contractor must deliver to City Representative certificates of insurance for each of Contractor and Sub-contractor's Policies, which will confirm the existence or issuance of Contractor and Sub-contractor's Policies in accordance with the provisions of this section, and copies of the endorsements of Contractor and Sub-contractor's Policies in accordance with the provisions of this section

(2) City is and will be under no obligation either to ascertain or confirm the existence or issuance of Contractor and Sub-contractor's Policies, or to examine Contractor and Sub-contractor's Policies, or to inform Contractor or Sub-contractor in the event that any coverage does not comply with the requirements of this section

(3) Contractor's failure to secure and maintain Contractor Policies and to assure Sub-contractor policies as required will constitute a material default under this Agreement

(H) Other Contractors or Vendors

(1) Other contractors or vendors that may be contracted by Contractor with in connection with the Project must procure and maintain insurance coverage as is appropriate to their particular agreement

(2) This insurance coverage must comply with the requirements set forth above for Contractor's Policies (e g , the requirements pertaining to endorsements to name the parties as additional insured parties and certificates of insurance)

(I) Policies Except with respect to workers' compensation and employer's liability coverages, the City must be named and properly endorsed as additional insureds on all liability policies required by this section.

(1) The coverage extended to additional insureds must be primary and must not contribute with any insurance or self insurance policies or programs maintained by the additional insureds

(2) All insurance policies obtained pursuant to this section must be with companies legally authorized to do business in the State of Arizona and acceptable to all parties

7.2 Sub-contractors.

(A) Contractor must also cause its Sub-contractors to obtain and maintain the Required Insurance

(B) City may consider waiving these insurance requirements for a specific Sub-contractor if City is satisfied the amounts required are not commercially available to the Sub-contractor and the insurance the Sub-contractor does have is appropriate for the Sub-contractor's work under this Agreement

(C) Contractor and Sub-contractors must provide to the City proof of Required Insurance whenever requested

7.3 Indemnification.

(A) To the fullest extent permitted by law, Contractor must defend, indemnify, and hold harmless City and its elected officials, officers, employees and agents (each, an "Indemnified Party," collectively, the

"Indemnified Parties"), for, from, and against any and all claims, demands, actions, damages, judgments, settlements, personal injury (including sickness, disease, death, and bodily harm), property damage (including loss of use), infringement, governmental action and all other losses and expenses, including attorneys' fees and litigation expenses (each, a "Demand or Expense"; collectively, "Demands or Expenses") asserted by a third-party (i e. a person or entity other than City or Contractor) and that arises out of or results from the breach of this Agreement by the Contractor or the Contractor's negligent actions, errors or omissions (including any Sub-contractor or other person or firm employed by Contractor), whether sustained before or after completion of the Project

(B) This indemnity and hold harmless policy applies even if a Demand or Expense is in part due to the Indemnified Party's negligence or breach of a responsibility under this Agreement, but in that event, Contractor shall be liable only to the extent the Demand or Expense results from the negligence or breach of a responsibility of Contractor or of any person or entity for whom Contractor is responsible

(C) Contractor is not required to indemnify any Indemnified Parties for, from, or against any Demand or Expense resulting from the Indemnified Party's sole negligence or other fault solely attributable to the Indemnified Party

7.4 **Waiver of Subrogation.** Contractor waives, and will require any Subcontractor to waive, all rights of subrogation against the City to the extent of all losses or damages covered by any policy of insurance

8. **Immigration Law Compliance.**

8.1 Contractor, and on behalf any subcontractor, warrants, to the extent applicable under A R.S. § 41-4401, compliance with all federal immigration laws and regulations that relate to their employees as well as compliance with A R S § 23-214(A) which requires registration and participation with the E-Verify Program

8 2 Any breach of warranty under subsection 8 1 above is considered a material breach of this Agreement and is subject to penalties up to and including termination of this Agreement.

8 3 City retains the legal right to inspect the papers of any Contractor or subcontractor employee who performs work under this Agreement to ensure that the Contractor or any subcontractor is compliant with the warranty under subsection 8 1 above.

8.4 City may conduct random inspections, and upon request of City, Contractor shall provide copies of papers and records of Contractor demonstrating continued compliance with the warranty under subsection 8.1 above Contractor agrees to keep papers and records available for inspection by the City during normal business hours and will cooperate with City in exercise of its statutory duties and not deny access to its business premises or applicable papers or records for the purposes of enforcement of this section 8

8 5 Contractor agrees to incorporate into any subcontracts under this Agreement the same obligations imposed upon Contractor and expressly accrue those obligations directly to the benefit of the City Contractor also agrees to require any subcontractor to incorporate into each of its own subcontracts under this Agreement the same obligations above and expressly accrue those obligations to the benefit of the City.

8 6 Contractor's warranty and obligations under this section to the City is continuing throughout the term of this Agreement or until such time as the City determines, in its sole discretion, that Arizona law has been modified in that compliance with this section is no longer a requirement

8 7 The "E-Verify Program" above means the employment verification program administered by the United States Department of Homeland Security, the Social Security Administration, or any successor program

9. **Conflict.** Contractor acknowledges this Agreement is subject to A R S § 38-511, which allows for cancellation of this Agreement in the event any person who is significantly involved in initiating, negotiating, securing, drafting, or creating the Agreement on City's behalf is also an employee, agent, or consultant of any other party to this Agreement

10. **Non-Discrimination Policies.** Contractor must not discriminate against any employee or applicant for employment on the basis of race, religion, color sex or national origin Contractor must develop, implement and maintain non-discrimination policies and post the policies in conspicuous places visible to employees and applicants for employment Contractor will require any Sub-contractor to be bound to the same requirements as stated within this section.

11. Notices.

11.1 A notice, request or other communication that is required or permitted under this Agreement (each a "Notice") will be effective only if

(A) The Notice is in writing, and

(B) Delivered in person or by private express overnight delivery service (delivery charges prepaid), certified or registered mail (return receipt requested)

(C) Notice will be deemed to have been delivered to the person to whom it is addressed as of the date of receipt, if:

(1) Received on a business day, or before 5 00 p m , at the address for Notices identified for the Party in this Agreement by U S. Mail, hand delivery, or overnight courier on or before 5.00 p.m , or

(2) As of the next business day after receipt, if received after 5 00 p m

(D) The burden of proof of the place and time of delivery is upon the Party giving the Notice

(E) Digitalized signatures and copies of signatures will have the same effect as original signatures

11 2 **Representatives.**

(A) Contractor. Contractor's representative ("Contractor's Representative") authorized to act on Contractor's behalf with respect to the Project, and his or her address for Notice delivery is

Hunter Contracting Co
Attn: Robert Carlson
720 North Cooper Road
Gilbert, Arizona 85233

(B) City. City's representative ("City's Representative") authorized to act on City's behalf, and his or her address for Notice delivery is

City of Glendale
Attn. Jim McMains
5850 West Glendale Avenue
Glendale, Arizona 85301

With required copies to:

City of Glendale
City Manager
5850 West Glendale Avenue
Glendale, Arizona 85301

City of Glendale
City Attorney
5850 West Glendale Avenue
Glendale, Arizona 85301

(C) Concurrent Notices.

(1) All notices to City's representative must be given concurrently to City Manager and City Attorney.

(2) A notice will not be considered to have been received by City's representative until the time that it has also been received by City Manager and City Attorney

(3) City may appoint one or more designees for the purpose of receiving notice by delivery of a written notice to Contractor identifying the designee(s) and their respective addresses for notices

(D) **Changes.** Contractor or City may change its representative or information on Notice, by giving Notice of the change in accordance with this section at least ten days prior to the change

12. **Financing Assignment.** City may assign this Agreement to any City-affiliated entity, including a non-profit corporation or other entity whose primary purpose is to own or manage the Project

13. **Entire Agreement; Survival; Counterparts; Signatures.**

13.1 **Integration.** This Agreement contains, except as stated below, the entire agreement between City and Contractor and supersedes all prior conversations and negotiations between the parties regarding the Project or this Agreement

(A) Neither Party has made any representations, warranties or agreements as to any matters concerning the Agreement's subject matter

(B) Representations, statements, conditions, or warranties not contained in this Agreement will not be binding on the parties

(C) Any solicitation, addendums and responses submitted by the Contractor are incorporated fully into this Agreement as Exhibit A Any inconsistency between Exhibit A and this Agreement will be resolved by the terms and conditions stated in this Agreement

13.2 **Interpretation.**

(A) The parties fairly negotiated the Agreement's provisions to the extent they believed necessary and with the legal representation they deemed appropriate

(B) The parties are of equal bargaining position and this Agreement must be construed equally between the parties without consideration of which of the parties may have drafted this Agreement

(C) The Agreement will be interpreted in accordance with the laws of the State of Arizona.

13.3 **Survival.** Except as specifically provided otherwise in this Agreement each warranty, representation, indemnification and hold harmless provision, insurance requirement, and every other right, remedy and responsibility of a Party, will survive completion of the Project, or the earlier termination of this Agreement

13.4 **Amendment.** No amendment to this Agreement will be binding unless in writing and executed by the parties Any amendment may be subject to City Council approval

13.5 **Remedies.** All rights and remedies provided in this Agreement are cumulative and the exercise of any one or more right or remedy will not affect any other rights or remedies under this Agreement or applicable law

13.6 **Severability.** If any provision of this Agreement is voided or found unenforceable, that determination will not affect the validity of the other provisions, and the voided or unenforceable provision will be reformed to conform to applicable law

13.7 **Counterparts.** This Agreement may be executed in counterparts, and all counterparts will together comprise one instrument

14. **Dispute Resolution.** Each claim, controversy and dispute ("Dispute") between Contractor and City will be resolved in accordance with Exhibit C. The final determination will be made by the City

15. **Exhibits.** The following exhibits, with reference to the term in which they are first referenced, are incorporated by this reference

Exhibit A	Project
Exhibit B	Compensation
Exhibit C	Dispute Resolution

Project 111216

The parties enter into this Agreement as of the date shown above.

City of Glendale,
an Arizona municipal corporation

By Brenda S Fischer
Its City Manager

ATTEST:

City Clerk (SEAL)

APPROVED AS TO FORM.

City Attorney

Hunter Contracting Co.
an Arizona corporation

By. ~~Steven Padrila~~ Rob Padilla
Its: ~~President~~ Vice President

WOMEN-OWNED/MINORITY BUSINESS [ ] YES [X] NO
CITY OF GLENDALE TRANSACTION PRIVILEGE TAX NO. 100012648
FEDERAL TAXPAYER IDENTIFICATION NO 86-0172434

Project 111216

EXHIBIT A
CONSTRUCTION AGREEMENT

PROJECT

Project includes modification of an existing wetwell-drywell lift station to a wetwell only lift station, including upgrades to associated piping and electrical systems The upstream gravity sewer and associated manholes will be rehabilitated Bypass pumping will be required to maintain sewer service

Project 111216

EXHIBIT B
CONSTRUCTION AGREEMENT

COMPENSATION

METHOD AND AMOUNT OF COMPENSATION

By bid, including all services, materials and costs

NOT-TO-EXCEED AMOUNT

The total amount of compensation paid to Contractor for full completion of all work required by the Project during the entire term of the Project must not exceed $1,298,448 00

DETAILED PROJECT COMPENSATION

As shown on Page 9 of the Bid Schedule.

EXHIBIT C
CONSTRUCTION AGREEMENT

DISPUTE RESOLUTION

1. Disputes.

1.1 Commitment. The parties commit to resolving all disputes promptly, equitably, and in a good-faith, cost-effective manner.

1.2 Application. The provisions of this Exhibit will be used by the parties to resolve all controversies, claims, or disputes ("Dispute") arising out of or related to this Agreement-including Disputes regarding any alleged breaches of this Agreement

1 3 Initiation A party may initiate a Dispute by delivery of written notice of the Dispute, including the specifics of the Dispute, to the Representative of the other party as required in this Agreement

1 4 Informal Resolution When a Dispute notice is given, the parties will designate a member of their senior management who will be authorized to expeditiously resolve the Dispute

(A) The parties will provide each other with reasonable access during normal business hours to any and all non-privileged records, information and data pertaining to any Dispute in order to assist in resolving the Dispute as expeditiously and cost effectively as possible,

(B) The parties' senior managers will meet within 10 business days to discuss and attempt to resolve the Dispute promptly, equitably, and in a good faith manner, and

(C) The Senior Managers will agree to subsequent meetings if both parties agree that further meetings are necessary to reach a resolution of the Dispute

2. Arbitration.

2 1 Rules. If the parties are unable to resolve the Dispute by negotiation within 30 days from the Dispute notice, and unless otherwise informal discussions are extended by the mutual agreement, the Dispute will be decided by binding arbitration in accordance with Construction Industry Rules of the AAA, as amended herein Although the arbitration will be conducted in accordance with AAA Rules, it will not be administered by the AAA, but will be heard independently

(A) The parties will exercise best efforts to select an arbitrator within 5 business days after agreement for arbitration If the parties have not agreed upon an arbitrator within this period, the parties will submit the selection of the arbitrator to one of the principals of the mediation firm of Scott & Skelly, LLC, who will then select the arbitrator The parties will equally share the fees and costs incurred in the selection of the arbitrator

(B) The arbitrator selected must be an attorney with at least 15 years experience with commercial construction legal matters in Maricopa County, Arizona, be independent, impartial, and not have engaged in any business for or adverse to either Party for at least 10 years.

2.2 Discovery. The extent and the time set for discovery will be as determined by the arbitrator. Each Party must, however, within ten (10) days of selection of an arbitrator deliver to the other Party copies of all documents in the delivering party's possession that are relevant to the dispute

2.3 Hearing The arbitration hearing will be held within 90 days of the appointment of the arbitrator The arbitration hearing, all proceedings, and all discovery will be conducted in Glendale, Arizona unless otherwise agreed by the parties or required as a result of witness location Telephonic hearings and other reasonable arrangements may be used to minimize costs.

2 4 Award At the arbitration hearing, each Party will submit its position to the arbitrator, evidence to support that position, and the exact award sought in this matter with specificity. The arbitrator must select the award sought

by one of the parties as the final judgment and may not independently alter or modify the awards sought by the parties, fashion any remedy, or make any equitable order The arbitrator has no authority to consider or award punitive damages.

2 5 Final Decision The Arbitrator's decision should be rendered within 15 days after the arbitration hearing is concluded This decision will be final and binding on the Parties

2.6 Costs The prevailing party may enter the arbitration in any court having jurisdiction in order to convert it to a judgment. The non-prevailing party shall pay all of the prevailing party's arbitration costs and expenses, including reasonable attorney's fees and costs

3. **Services to Continue Pending Dispute.** Unless otherwise agreed to in writing, Contractor must continue to perform and maintain progress of required services during any Dispute resolution or arbitration proceedings, and City will continue to make payment to Contractor in accordance with this Agreement

4. **Exceptions.**

4 1 Third Party Claims City and Contractor are not required to arbitrate any third-party claim, cross-claim, counter claim, or other claim or defense of a third-party who is not obligated by contract to arbitrate disputes with City and Contractor

4.2 Liens City or Contractor may commence and prosecute a civil action to contest a lien or stop notice, or enforce any lien or stop notice, but only to the extent the lien or stop notice the Party seeks to enforce is enforceable under Arizona Law, including, without limitation, an action under A R S § 33-420, without the necessity of initiating or exhausting the procedures of this Exhibit.

4 3 Governmental Actions This Exhibit does not apply to, and must not be construed to require arbitration of, any claims, actions or other process filed or issued by City of Glendale Building Safety Department or any other agency of City acting in its governmental permitting or other regulatory capacity

Project 111216

BOND #106 054 862
ISSUED IN TRIPLICATE
2 of 3 originals

C-_____

INDIVIDUAL SURETIES WILL NOT BE ACCEPTED

STATUTORY PERFORMANCE BOND PURSUANT TO TITLE 34, CHAPTER 2, ARTICLE 2, OF THE ARIZONA REVISED STATUTES

(Penalty of this bond must be 100% of the Contract Amount)

KNOW ALL MEN BY THESE PRESENTS:

That HUNTER CONTRACTING CO. (hereinafter called the Principal), as Principal, and *, a corporation organized and existing under the laws of the State of CONNECTICUT with its principal office in the City of HARTFORD, (hereinafter called the Surety), as Surety, are held and firmly bound unto the City of Glendale, a municipal corporation, (hereinafter called the Obligee), in the amount of ONE MILLION, TWO HUNDRED NINETY-EIGHT THOUSAND, FOUR HUNDRED ~~FORTY-EIGHT~~ & NO/100 Dollars ($1,298,448.00), for the payment whereof, the said Principal and Surety bind themselves, and their heirs, administrators, successors and assigns, jointly and severally, firmly by these presents.

*TRAVELERS CASUALTY AND SURETY COMPANY OF AMERICA

WHEREAS, The Principal has entered into a certain written contract with the Obligee, dated the ____ day of , 20___, to construct **PROJECT 111216 - SWEETWATER LIFT STATION**, which contract is hereby referred to and made a part hereof as fully and to the same extent as if copied at length herein.

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION IS SUCH, that if the said Principal shall faithfully perform and fulfill all undertakings, covenants, terms, conditions and agreements of said contract during the original term of said contract any extension thereof, with or without notice to the Surety, and during the life of any guaranty required under the contract and shall also perform and fulfill all the undertakings, covenants, terms, conditions, and agreements of any and all duly authorized modifications of said contract that may hereafter be made, notice of which modifications to the Surety being hereby waived; then the above obligation shall be void, otherwise to remain in full force and effect.

PROVIDED, HOWEVER, that this bond is executed pursuant to the provisions of Title 34, Chapter 2, Article 2, of the Arizona Revised Statutes, and all liabilities on this bond shall be determined in accordance with the provisions of said Title, Chapter, and Article, to the extent as if it were copied at length herein.

The prevailing party or any party which recovers judgment on this bond shall be entitled to such reasonable attorney's fees as may be fixed by the court or a judge thereof.

Witness our hands this 5TH day of MARCH, 2014.

HUNTER CONTRACTING CO.
Principal Seal

By _____
Rob Padilla, Vice President

TRAVELERS CASUALTY AND SURETY COMPANY OF AMERICA
Surety Seal
By: _____
WILLIAM J. PASSEY, ATTORNEY-IN-FACT

Agency of Record
PASSEY-BOND CO., INC.
P.O. BOX 819
MESA, AZ 85211
Agency Address

Telephone Number: 480-969-2291

INDIVIDUAL SURETIES WILL NOT BE ACCEPTED
STATUTORY PAYMENT BOND PURSUANT TO TITLE 34,
CHAPTER 2, ARTICLE 2, OF THE ARIZONA REVISED STATUTES
(Penalty of this bond must be 100% of the Contract Amount)

KNOW ALL MEN BY THESE PRESENTS:

That, HUNTER CONTRACTING CO. (hereinafter called the Principal), as Principal, and *, a corporation organized and existing under the laws of the State of CONNECTICUT with its principal office in the City of HARTFORD, (hereinafter called the Surety), as Surety, are held and firmly bound unto the City of Glendale, a municipal corporation, (hereinafter called the Obligee), in the amount of ** Dollars ($1,298,448.00), for the payment whereof; the said Principal and Surety bind themselves, and their heirs, administrators, successors and assigns, jointly and severally, firmly by these presents.

*TRAVELERS CASUALTY AND SURETY COMPANY OF AMERICA

WHEREAS, The Principal has entered into a certain written contract with the Obligee, dated the day of _____, 20____, to construct **PROJECT 111216 - SWEETWATER LIFT STATION** which contract is hereby referred to and made a part hereof as fully and to the same extent as if copied at length herein.

**ONE MILLION, TWO HUNDRED NINETY-EIGHT THOUSAND, FOUR HUNDRED FORTY-EIGHT & NO/100

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION IS SUCH, that if the said Principal shall promptly pay all monies due to all persons supplying labor or materials to him or his subcontractors in the prosecution of the work provided for in said Contract, then this obligation shall be void, otherwise to remain in full force and effect.

PROVIDED, HOWEVER, that this bond having been required of the said Principal in order to comply with the provisions of Title 34, Chapter 2, Article 2, of the Arizona Revised Statutes, all rights and remedies on this bond shall inure solely to such persons and shall be determined in accordance with the provisions, conditions, and limitations of said Title, Chapter and Article, to the same extent as if they were copied at length herein.

The prevailing party or any party which recovers judgment on this bond shall be entitled to such reasonable attorney's fees as may be fixed by the court or a judge thereof.

Witness our hands this 5th day of MARCH, 20 14.

HUNTER CONTRACTING CO.
Principal Seal

By _____
Rob Padilla, Vice President

TRAVELERS CASUALTY AND SURETY COMPANY OF AMERICA
Surety Seal
By: _____
WILLIAM J. PASSEY, ATTORNEY-IN-FACT

Agency of Record
PASSEY-BOND CO., INC.
P.O. BOX 819, MESA, AZ 85211
Agency Address

Telephone 480-969-2291

TRAVELERS

POWER OF ATTORNEY

Farmington Casualty Company
Fidelity and Guaranty Insurance Company
Fidelity and Guaranty Insurance Underwriters, Inc.
St Paul Fire and Marine Insurance Company
St. Paul Guardian Insurance Company

St. Paul Mercury Insurance Company
Travelers Casualty and Surety Company
Travelers Casualty and Surety Company of America
United States Fidelity and Guaranty Company

Attorney-In Fact No 227705

Certificate No. 005816126

KNOW ALL MEN BY THESE PRESENTS That Farmington Casualty Company, St Paul Fire and Marine Insurance Company, St Paul Guardian Insurance Company, St Paul Mercury Insurance Company, Travelers Casualty and Surety Company, Travelers Casualty and Surety Company of America, and United States Fidelity and Guaranty Company are corporations duly organized under the laws of the State of Connecticut, that Fidelity and Guaranty Insurance Company is a corporation duly organized under the laws of the State of Iowa, and that Fidelity and Guaranty Insurance Underwriters, Inc , is a corporation duly organized under the laws of the State of Wisconsin (herein collectively called the "Companies"), and that the Companies do hereby make, constitute and appoint

William J Passey, Debbie Lavo, Christina Shriner, and Michael W Hubay

of the City of Mesa, State of Arizona, their true and lawful Attorney(s)-in-Fact, each in their separate capacity if more than one is named above, to sign, execute, seal and acknowledge any and all bonds, recognizances, conditional undertakings and other writings obligatory in the nature thereof on behalf of the Companies in their business of guaranteeing the fidelity of persons, guaranteeing the performance of contracts and executing or guaranteeing bonds and undertakings required or permitted in any actions or proceedings allowed by law

IN WITNESS WHEREOF, the Companies have caused this instrument to be signed and their corporate seals to be hereto affixed, this 28th day of February, 2014

Farmington Casualty Company
Fidelity and Guaranty Insurance Company
Fidelity and Guaranty Insurance Underwriters, Inc
St. Paul Fire and Marine Insurance Company
St. Paul Guardian Insurance Company

St. Paul Mercury Insurance Company
Travelers Casualty and Surety Company
Travelers Casualty and Surety Company of America
United States Fidelity and Guaranty Company

State of Connecticut
City of Hartford ss

By
Robert L Raney, Senior Vice President

On this the 28th day of February, 2014, before me personally appeared Robert L Raney, who acknowledged himself to be the Senior Vice President of Farmington Casualty Company, Fidelity and Guaranty Insurance Company, Fidelity and Guaranty Insurance Underwriters, Inc , St Paul Fire and Marine Insurance Company, St Paul Guardian Insurance Company, St Paul Mercury Insurance Company, Travelers Casualty and Surety Company, Travelers Casualty and Surety Company of America, and United States Fidelity and Guaranty Company, and that he, as such, being authorized so to do, executed the foregoing instrument for the purposes therein contained by signing on behalf of the corporations by himself as a duly authorized officer

In Witness Whereof, I hereunto set my hand and official seal
My Commission expires the 30th day of June, 2016

Marie C. Tetreault
Marie C Tetreault, Notary Public

58440-8-12 Printed in U S A

This Power of Attorney is granted under and by the authority of the following resolutions adopted by the Boards of Directors of Farmington Casualty Company, Fidelity and Guaranty Insurance Company, Fidelity and Guaranty Insurance Underwriters, Inc , St Paul Fire and Marine Insurance Company, St Paul Guardian Insurance Company, St Paul Mercury Insurance Company, Travelers Casualty and Surety Company, Travelers Casualty and Surety Company of America, and United States Fidelity and Guaranty Company, which resolutions are now in full force and effect, reading as follows

RESOLVED, that the Chairman, the President, any Vice Chairman, any Executive Vice President, any Senior Vice President, any Vice President, any Second Vice President, the Treasurer, any Assistant Treasurer, the Corporate Secretary or any Assistant Secretary may appoint Attorneys-in-Fact and Agents to act for and on behalf of the Company and may give such appointee such authority as his or her certificate of authority may prescribe to sign with the Company's name and seal with the Company's seal bonds, recognizances, contracts of indemnity, and other writings obligatory in the nature of a bond, recognizance, or conditional undertaking, and any of said officers or the Board of Directors at any time may remove any such appointee and revoke the power given him or her, and it is

FURTHER RESOLVED, that the Chairman, the President, any Vice Chairman, any Executive Vice President, any Senior Vice President or any Vice President may delegate all or any part of the foregoing authority to one or more officers or employees of this Company, provided that each such delegation is in writing and a copy thereof is filed in the office of the Secretary, and it is

FURTHER RESOLVED, that any bond, recognizance, contract of indemnity, or writing obligatory in the nature of a bond, recognizance, or conditional undertaking shall be valid and binding upon the Company when (a) signed by the President, any Vice Chairman, any Executive Vice President, any Senior Vice President or any Vice President, any Second Vice President, the Treasurer, any Assistant Treasurer, the Corporate Secretary or any Assistant Secretary and duly attested and sealed with the Company's seal by a Secretary or Assistant Secretary, or (b) duly executed (under seal, if required) by one or more Attorneys-in-Fact and Agents pursuant to the power prescribed in his or her certificate or their certificates of authority or by one or more Company officers pursuant to a written delegation of authority, and it is

FURTHER RESOLVED, that the signature of each of the following officers President, any Executive Vice President, any Senior Vice President, any Vice President, any Assistant Vice President, any Secretary, any Assistant Secretary, and the seal of the Company may be affixed by facsimile to any Power of Attorney or to any certificate relating thereto appointing Resident Vice Presidents, Resident Assistant Secretaries or Attorneys-in-Fact for purposes only of executing and attesting bonds and undertakings and other writings obligatory in the nature thereof, and any such Power of Attorney or certificate bearing such facsimile signature or facsimile seal shall be valid and binding upon the Company and any such power so executed and certified by such facsimile signature and facsimile seal shall be valid and binding on the Company in the future with respect to any bond or understanding to which it is attached

I, Kevin E Hughes, the undersigned, Assistant Secretary, of Farmington Casualty Company, Fidelity and Guaranty Insurance Company, Fidelity and Guaranty Insurance Underwriters, Inc , St Paul Fire and Marine Insurance Company, St Paul Guardian Insurance Company, St Paul Mercury Insurance Company, Travelers Casualty and Surety Company, Travelers Casualty and Surety Company of America, and United States Fidelity and Guaranty Company do hereby certify that the above and foregoing is a true and correct copy of the Power of Attorney executed by said Companies, which is in full force and effect and has not been revoked

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed the seals of said Companies this 5th day of March, 20 14

Kevin E. Hughes

Kevin E Hughes, Assistant Secretary

To verify the authenticity of this Power of Attorney, call 1-800-421-3880 or contact us at www travelersbond com Please refer to the Attorney-In-Fact number, the above-named individuals and the details of the bond to which the power is attached

STATE OF ARIZONA

DEPARTMENT OF INSURANCE

CERTIFICATE OF AUTHORITY

I, **JOHN A. GREENE,** Director of Insurance of the State of Arizona, do hereby certify that

TRAVELERS CASUALTY AND SURETY COMPANY OF AMERICA
Domiciled in Connecticut
NAIC NO. 31194

is hereby authorized, subject to the provisions thereof and the Charter Powers of said Company, to transact the business of:

CASUALTY WITH WORKERS' COMPENSATION
DISABILITY
MARINE AND TRANSPORTATION
PROPERTY
SURETY
VEHICLE

insurance within the State of Arizona until terminated at the request of the insurer or suspended or revoked by the Director of Insurance.

Arizona Revised Statute § 20-217 (C) states:

> *A **Certificate of Authority** remains the property of the State of Arizona. Upon termination at the request of the insurer or revocation by the Director of Insurance, the insurer shall immediately deliver the Certificate of Authority to the Director of Insurance.*

In TESTIMONY WHEREOF, I have hereunto set my hand and affixed the official seal of the Director of Insurance at the City of Phoenix. The effective date of this Certificate is July 1, 1997.

John A. Greene

John A. Greene
Director of Insurance

E146 (01/97)

292944

000843

STATE OF ARIZONA

DEPARTMENT OF INSURANCE

THIS IS TO CERTIFY, THAT THIS INSTRUMENT IS A FULL, TRUE AND CORRECT COPY OF THE ORIGINAL ELECTRONICALLY FILED WITH THE NATIONAL ASSOCIATION OF INSURANCE COMMISSIONERS AND CONSISTS OF 1 PAGE(S)

HEREUNTO SET MY HAND AND THE OFFICIAL SEAL OF THIS DEPARTMENT

FOR THE DIRECTOR OF INSURANCE THIS 14 JANUARY 2013.

AUTHORIZED REPRESENTATIVE

DIRECTOR OF INSURANCE STATE OF ARIZONA

282944

CERTIFICATE NO.:

CERTIFICATE OF LIABILITY INSURANCE

DATE (MM/DD/YYYY): 3/6/2014

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AFFIRMATIVELY OR NEGATIVELY AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW THIS CERTIFICATE OF INSURANCE DOES NOT CONSTITUTE A CONTRACT BETWEEN THE ISSUING INSURER(S), AUTHORIZED REPRESENTATIVE OR PRODUCER, AND THE CERTIFICATE HOLDER

IMPORTANT If the certificate holder is an ADDITIONAL INSURED, the policy(ies) must be endorsed If SUBROGATION IS WAIVED, subject to the terms and conditions of the policy, certain policies may require an endorsement A statement on this certificate does not confer rights to the certificate holder in lieu of such endorsement(s)

PRODUCER
Passey-Bond Co., Inc.
28 North Center Street
P. O. Box 819
Mesa AZ 85211-0819

CONTACT NAME: Kori L. Moseley, CISR, CPIW
PHONE (A/C, No, Ext): (480)969-2291 FAX (A/C, No): (480)833-4833
E-MAIL ADDRESS: korim@passeybond.com

INSURER(S) AFFORDING COVERAGE	NAIC #
INSURER A Cincinnati Insurance Co.	10677
INSURER B Great American Insurance Group	16691
INSURER C SCF American Insurance Co.	
INSURER D	
INSURER E	
INSURER F	

INSURED
Hunter Contracting Co.

701 N. Cooper Road
Gilbert AZ 85233

COVERAGES CERTIFICATE NUMBER. REVISION NUMBER:

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS

INSR LTR	TYPE OF INSURANCE	ADDL INSR	SUBR WVD	POLICY NUMBER	POLICY EFF (MM/DD/YYYY)	POLICY EXP (MM/DD/YYYY)	LIMITS	
A	GENERAL LIABILITY X COMMERCIAL GENERAL LIABILITY CLAIMS-MADE X OCCUR X GA233AZ/GA4316AZ/GA101 X GA4094/CG2404/GA4088 GEN'L AGGREGATE LIMIT APPLIES PER POLICY X PRO-JECT LOC	X	Y	CPP1061979	5/1/2013	5/1/2014	EACH OCCURRENCE DAMAGE TO RENTED PREMISES (Ea occurrence) MED EXP (Any one person) PERSONAL & ADV INJURY GENERAL AGGREGATE PRODUCTS - COMP/OP AGG	$ 1,000,000 $ 500,000 $ 10,000 $ 1,000,000 $ 2,000,000 $ 2,000,000 $
A	AUTOMOBILE LIABILITY X ANY AUTO ALL OWNED AUTOS / SCHEDULED AUTOS X HIRED AUTOS / X NON-OWNED AUTOS X AA4171 AA4172 / X AA4174			CPA1061979	5/1/2013	5/1/2014	COMBINED SINGLE LIMIT (Ea accident) BODILY INJURY (Per person) BODILY INJURY (Per accident) PROPERTY DAMAGE (Per accident)	$ 1,000,000 $ $ $ $
B	X UMBRELLA LIAB / X OCCUR EXCESS LIAB / CLAIMS-MADE DED X RETENTION $ 10,000			TUU405724707	5/1/2013	5/1/2014	EACH OCCURRENCE AGGREGATE	$ 10,000,000 $ 10,000,000 $
C	WORKERS COMPENSATION AND EMPLOYERS' LIABILITY ANY PROPRIETOR/PARTNER/EXECUTIVE OFFICER/MEMBER EXCLUDED? (Mandatory in NH) Y/N N If yes, describe under DESCRIPTION OF OPERATIONS below	N/A	Y	WC000313 A60219	5/1/2013	5/1/2014	X WC STATU-TORY LIMITS / OTH-ER E.L. EACH ACCIDENT E.L. DISEASE - EA EMPLOYEE E.L. DISEASE - POLICY LIMIT	 $ 500,000 $ 500,000 $ 500,000
A	Course of Construction			CPP1061979	5/1/2013	5/1/2014	Limit/Deductible	$10mil/10,000

DESCRIPTION OF OPERATIONS / LOCATIONS / VEHICLES (Attach ACORD 101, Additional Remarks Schedule, if more space is required)
Job #111216/HCC 14404-1 Sweetwater Lift Station Glendale, Arizona.

CERTIFICATE HOLDER

City of Glendale
Attn: Engineering Dept
5850 W. Glendale Avenue
Glendale, AZ 85301

CANCELLATION

SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, NOTICE WILL BE DELIVERED IN ACCORDANCE WITH THE POLICY PROVISIONS

AUTHORIZED REPRESENTATIVE

Bill Passey/KORI

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THIS ENDORSEMENT CHANGES THE POLICY. PLEASE READ IT CAREFULLY.

ARIZONA AUTOMATIC ADDITIONAL INSURED - WHEN REQUIRED IN CONTRACT OR AGREEMENT WITH YOU - COMPLETED OPERATIONS

This endorsement modifies insurance provided under the following:

COMMERCIAL GENERAL LIABILITY COVERAGE PART

A. **SECTION II - WHO IS AN INSURED, 2.** is amended to include:

e. Any person or organization, hereinafter referred to as **Additional Insured:**

(1) Who or which is not specifically named as an additional insured under any other provision of, or endorsement added to, this Coverage Part; and

(2) For whom you are required to add as an additional insured, except any architect, engineer or surveyor, on a completed operations basis on this Coverage Part

under a written contract or written agreement:

(1) But only with respect to liability caused, in whole or in part, by "your work" performed for that additional insured by you or on your behalf; and

(2) If the written contract or written agreement specifies coverage for the additional insured in the "products-completed operation hazard".

With respect to the person(s) or organization(s) referenced in Paragraph **A.2.e.** above, their status as an additional insured under this endorsement will not apply beyond the period of time required in that written construction contract or agreement referred to in Paragraph **A.2.e.** above. If that written construction contract or agreement does not specify a period of time, this coverage will not apply beyond 1 year from the completion of "your work" where the work that caused the "bodily injury" or "property damage" occurred. "Your work" will be deemed completed as specified in Paragraph a.(2) of **SECTION V - DEFINITIONS, 19.** "Products-completed operations hazard".

B. With respect to the additional insureds referenced in Paragraph **A.2.e.** above, the following exclusion is added to Paragraph **2. Exclusions** of **SECTION I - COVERAGES, COVERAGE A. BODILY INJURY AND PROPERTY DAMAGE LIABILITY**, this insurance does not apply to "bodily injury" or "property damage" arising out of:

1. The rendering of or failure to render any professional services by you or on your behalf, but only with respect to either or both of the following operations:

a. Providing engineering, architectural or surveying services to others; and

b. Providing or hiring independent professionals to provide engineering, architectural or surveying services in connection with the construction work you perform.

Subject to the final paragraph of this exclusion below, professional services include:

a. Preparing, approving or failing to prepare or approve, maps, shop drawings, opinions, reports, surveys, field orders, change orders, or drawings and specifications; and

b. Supervisory or inspection activities performed as a part of any architectural or engineering activities.

Professional services do not include services within construction means, methods, techniques, sequences and procedures employed by you in connection with construction work you perform.

2. "Your work" for which a consolidated (wrap-up) insurance program has been provided by the prime contractor / project manager or owner of the construction project in which you are involved.

3. "Bodily injury" or "property damage" arising out of "residential construction".

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C. **SECTION III - LIMITS OF INSURANCE** is amended to include:

The limits of insurance available to the additional insured(s) will not exceed:

1. Those limits specified in the written construction contract or agreement referred to in Paragraph **A.2.e.** above; or

2. The Limits of Insurance specified in the Declarations of this Coverage Part;

whichever are less. If no limits are specified in that written construction contract or agreement, the limits available to the additional insured(s) will not exceed the Limits of Insurance specified in the Declarations of this Coverage Part. The limits of insurance available to the additional insured(s) are inclusive of and not in addition to the Limits of Insurance shown in the Declarations.

D. **SECTION IV - COMMERCIAL GENERAL LIABILITY CONDITIONS** is amended to include the following.

AUTOMATIC ADDITIONAL INSURED PROVISION

The written construction contract or agreement referred to in Paragraph **A.2.e.** above must:

1. Be currently in effect or become effective during the term of this Coverage Part; and

2. Have been executed prior to the "bodily injury" or "property damage" to which this endorsement pertains.

E. **SECTION IV - COMMERCIAL GENERAL LIABILITY CONDITIONS, 5. Other Insurance, b. Excess Insurance** is amended to include the following:

1. Where required by the written construction contract or agreement referred to in Paragraph **A.2.e.** above, this insurance is primary and / or noncontributory as respects any other insurance policy issued to the additional insured, and such other insurance policy shall be excess and / or noncontributing, whichever applies, with this insurance.

2. Any insurance provided by this endorsement shall be primary to other insurance available to the additional insured except:

   a. As otherwise provided in **SECTION IV - COMMERCIAL GENERAL LIABILITY CONDITIONS, 5. Other Insurance, b. Excess Insurance**; or

   b. When other valid and collectible insurance is available to the additional insured:

      (1) As an additional insured by attachment of an endorsement to another insurance policy; and

      (2) On an excess basis.

      In such case the coverage provided under this endorsement shall also be excess.

F. **SECTION V - DEFINITIONS** is amended to include:

1. "Residential construction" means:

   a. A structure where any of the structure's square foot area is used, or is intended, for the purpose of human habitation and includes, but is not limited to, single-family housing, multi-family housing, apartments, condominiums, townhouses, and similar structures intended for human habitation; and

   b. Common areas and appurtenant structures of those structures listed in Paragraph **1.a.** above.

   "Residential construction" does not include:

   a. Hospitals or prisons; and

   b. Military housing, dormitories, long-term care facilities, hotels or motels, provided there is no individual ownership of units.

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THIS ENDORSEMENT CHANGES THE POLICY. PLEASE READ IT CAREFULLY.

WAIVER OF TRANSFER OF RIGHTS OF RECOVERY AGAINST OTHERS TO US

This endorsement modifies insurance provided under the following:

COMMERCIAL GENERAL LIABILITY COVERAGE PART.

SCHEDULE

Name of Person or Organization:

ANY PERSON OR ORGANIZATION FOR WHOM YOU ARE REQUIRED TO NAME UNDER THIS ENDORSEMENT IN A WRITTEN CONTRACT OR AGREEMENT.

(If no entry appears above, information required to complete this endorsement will be shown in the Declarations as applicable to this endorsement.)

The TRANSFER OF RIGHTS OF RECOVERY AGAINST OTHERS TO US Condition (Section IV -- COMMERCIAL GENERAL LIABILITY CONDITIONS) is amended by the addition of the following:

We waive any right of recovery we may have against the person or organization shown in the Schedule above because of payments we make for injury or damage arising out of your ongoing operations or "your work" done under a contract with that person or organization and included in the "products-completed operations hazard". This waiver applies only to the person or organization shown in the Schedule above.

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THIS ENDORSEMENT CHANGES THE POLICY. PLEASE READ IT CAREFULLY.

CONTRACTORS' COMMERCIAL GENERAL LIABILITY BROADENED ENDORSEMENT

This endorsement modifies insurance provided under the following:

COMMERCIAL GENERAL LIABILITY COVERAGE PART

A. Endorsement - Table of Contents:

Coverage:	Begins on Page:
1. Employee Benefit Liability Coverage	2
2. Unintentional Failure to Disclose Hazards	7
3. Damage to Premises Rented to You	8
4. Supplementary Payments	9
5. Medical Payments	9
6. Voluntary Property Damage (Coverage **a.**) and Care, Custody or Control Liability Coverage (Coverage **b.**)	9
7. 180 Day Coverage for Newly Formed or Acquired Organizations	10
8. Waiver of Subrogation	10
9. Automatic Additional Insured - Specified Relationships: Managers or Lessors of Premises; Lessor of Leased Equipment; Vendors; State or Political Subdivisions - Permits Relating to Premises; State or Political Subdivisions - Permits; and Contractors' Operations	10
10. Broadened Contractual Liability - Work Within 50' of Railroad Property	13
11. Property Damage to Borrowed Equipment	13
12. Employees as Insureds - Specified Health Care Services: Nurses; Emergency Medical Technicians, and Paramedics	14
13. Broadened Notice of Occurrence	14

B. Limits of Insurance:

The Commercial General Liability Limits of Insurance apply to the insurance provided by this endorsement, except as provided below:

1. Employee Benefit Liability Coverage

Each Employee Limit:	$ 1,000,000
Aggregate Limit:	$ 3,000,000
Deductible:	$ 1,000

3. Damage to Premises Rented to You

The lesser of:

a. The Each Occurrence Limit shown in the Declarations; or

b. $500,000 unless otherwise stated $ _____

4. Supplementary Payments

a. Bail bonds: $ 1,000

b. Loss of earnings: $ 350

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5. **Medical Payments**

Medical Expense Limit. $ 10,000

6. **Voluntary Property Damage** (Coverage **a.**) **and Care, Custody or Control Liability Coverage** (Coverage **b.**)

Limits of Insurance (Each Occurrence)
Coverage **a.** $1,000
Coverage **b.** $5,000 unless otherwise stated $ _____

Deductibles (Each Occurrence)
Coverage **a.** $250
Coverage **b.** $250 unless otherwise stated $ _____

COVERAGE	PREMIUM BASIS (a) Area (b) Payroll (c) Gross Sales (d) Units (e) Other	RATE (For Limits in Excess of $5,000)	ADVANCE PREMIUM (For Limits in Excess of $5,000)
b. Care, Custody or Control			$
		TOTAL ANNUAL PREMIUM	$

11. **Property Damage to Borrowed Equipment**

Each Occurrence Limit: $ 10,000
Deductible: $ 250

C. Coverages:

1. **Employee Benefit Liability Coverage**

a. The following is added to **SECTION I - COVERAGES: Employee Benefit Liability Coverage.**

(1) **Insuring Agreement**

(a) We will pay those sums that the insured becomes legally obligated to pay as damages caused by any act, error or omission of the insured, or of any other person for whose acts the insured is legally liable, to which this insurance applies. We will have the right and duty to defend the insured against any "suit" seeking those damages. However, we will have no duty to defend against any "suit" seeking damages to which this insurance does not apply. We may, at our discretion, investigate any report of an act, error or omission and settle any claim or "suit" that may result. But:

1) The amount we will pay for damages is limited as described in **SECTION III - LIMITS OF INSURANCE**; and

2) Our right and duty to defend ends when we have used up the applicable limit of insurance in the payment of judgments or settlements.

No other obligation or liability to pay sums or perform acts or services is covered unless explicitly provided for under Supplementary Payments.

(b) This insurance applies to damages only if the act, error or omission, is negligently committed in the "administration" of your "employee benefit program"; and

1) Occurs during the policy period; or

2) Occurred prior to the effective date of this endorsement provided:

a) You did not have knowledge of a claim or "suit" on or before the effective date of this endorsement.

You will be deemed to have

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knowledge of a claim or "suit" when any "authorized representative";

i) Reports all, or any part, of the act, error or omission to us or any other insurer;

ii) Receives a written or verbal demand or claim for damages because of the act, error or omission; and

b) There is no other applicable insurance.

(2) Exclusions

This insurance does not apply to:

(a) Bodily Injury, Property Damage or Personal and Advertising Injury

"Bodily injury", "property damage" or "personal and advertising injury".

(b) Dishonest, Fraudulent, Criminal or Malicious Act

Damages arising out of any intentional, dishonest, fraudulent, criminal or malicious act, error or omission, committed by any insured, including the willful or reckless violation of any statute.

(c) Failure to Perform a Contract

Damages arising out of failure of performance of contract by any insurer.

(d) Insufficiency of Funds

Damages arising out of an insufficiency of funds to meet any obligations under any plan included in the "employee benefit program".

(e) Inadequacy of Performance of Investment / Advice Given With Respect to Participation

Any claim based upon:

1) Failure of any investment to perform;

2) Errors in providing information on past performance of investment vehicles; or

3) Advice given to any person with respect to that person's decision to participate or not to participate in any plan included in the "employee benefit program".

(f) Workers' Compensation and Similar Laws

Any claim arising out of your failure to comply with the mandatory provisions of any workers' compensation, unemployment compensation insurance, social security or disability benefits law or any similar law.

(g) ERISA

Damages for which any insured is liable because of liability imposed on a fiduciary by the Employee Retirement Income Security Act of 1974, as now or hereafter amended, or by any similar federal, state or local laws.

(h) Available Benefits

Any claim for benefits to the extent that such benefits are available, with reasonable effort and cooperation of the insured, from the applicable funds accrued or other collectible insurance.

(i) Taxes, Fines or Penalties

Taxes, fines or penalties, including those imposed under the Internal Revenue Code or any similar state or local law.

(j) Employment-Related Practices

Any liability arising out of any:

(1) Refusal to employ;

(2) Termination of employment;

(3) Coercion, demotion, evaluation, reassign-

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ment, discipline, defamation, harassment, humiliation, discrimination or other employment-related practices, acts or omissions; or

(4) Consequential liability as a result of (1), (2) or (3) above.

This exclusion applies whether the insured may be held liable as an employer or in any other capacity and to any obligation to share damages with or repay someone else who must pay damages because of the injury.

(3) **Supplementary Payments**

SECTION I - COVERAGES, SUPPLEMENTARY PAYMENTS - COVERAGES A AND B also apply to this Coverage.

b. Who is an Insured

As respects Employee Benefit Liability Coverage, **SECTION II - WHO IS AN INSURED** is deleted in its entirety and replaced by the following:

(1) If you are designated in the Declarations as:

(a) An individual, you and your spouse are insureds, but only with respect to the conduct of a business of which you are the sole owner.

(b) A partnership or joint venture, you are an insured. Your members, your partners, and their spouses are also insureds but only with respect to the conduct of your business.

(c) A limited liability company, you are an insured. Your members are also insureds, but only with respect to the conduct of your business. Your managers are insureds, but only with respect to their duties as your managers.

(d) An organization other than a partnership, joint venture or limited liability company, you are an insured. Your "executive officers" and directors are insureds, but only with respect to their duties as your officers or directors. Your stockholders are also insureds, but only with respect to their liability as stockholders.

(e) A trust, you are an insured. Your trustees are also insureds, but only with respect to their duties as trustees.

(2) Each of the following is also an insured:

(a) Each of your "employees" who is or was authorized to administer your "employee benefit program".

(b) Any persons, organizations or "employees" having proper temporary authorization to administer your "employee benefit program" if you die, but only until your legal representative is appointed.

(c) Your legal representative if you die, but only with respect to duties as such. That representative will have all your rights and duties under this Coverage Part.

(3) Any organization you newly acquire or form, other than a partnership, joint venture or limited liability company, and over which you maintain ownership or majority interest, will qualify as a Named Insured if no other similar insurance applies to that organization. However, coverage under this provision:

(a) Is afforded only until the 180th day after you acquire or form the organization or the end of the policy period, whichever is earlier; and

(b) Does not apply to any act, error or omission that was committed before you acquired or formed the organization.

c. Limits of Insurance

As respects Employee Benefit Liability Coverage, **SECTION III - LIMITS OF INSURANCE** is deleted in its entirety and replaced by the following:

(1) The Limits of Insurance shown in Section **B. Limits of Insurance, 1. Employee Benefit Liability Coverage** and the rules

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below fix the most we will pay regardless of the number of:

(a) Insureds;

(b) Claims made or "suits" brought;

(c) Persons or organizations making claims or bringing "suits";

(d) Acts, errors or omissions; or

(e) Benefits included in your "employee benefit program".

(2) The Aggregate Limit shown in Section **B. Limits of Insurance, 1. Employee Benefit Liability Coverage** of this endorsement is the most we will pay for all damages because of acts, errors or omissions negligently committed in the "administration" of your "employee benefit program".

(3) Subject to the limit described in **(2)** above, the Each Employee Limit shown in Section **B. Limits of Insurance, 1. Employee Benefit Liability Coverage** of this endorsement is the most we will pay for all damages sustained by any one "employee", including damages sustained by such "employee's" dependents and beneficiaries, as a result of:

(a) An act, error or omission; or

(b) A series of related acts, errors or omissions, regardless of the amount of time that lapses between such acts, errors or omissions,

negligently committed in the "administration" of your "employee benefit program".

However, the amount paid under this endorsement shall not exceed, and will be subject to the limits and restrictions that apply to the payment of benefits in any plan included in the "employee benefit program".

(4) **Deductible Amount**

(a) Our obligation to pay damages on behalf of the insured applies only to the amount of damages in excess of the deductible amount stated in the Declarations as applicable to Each Employee. The limits of insurance shall not be reduced by the amount of this deductible.

(b) The deductible amount stated in the Declarations applies to all damages sustained by any one "employee", including such "employee's" dependents and beneficiaries, because of all acts, errors or omissions to which this insurance applies.

(c) The terms of this insurance, including those with respect to:

1) Our right and duty to defend the insured against any "suits" seeking those damages; and

2) Your duties, and the duties of any other involved insured, in the event of an act, error or omission, or claim,

apply irrespective of the application of the deductible amount.

(d) We may pay any part or all of the deductible amount to effect settlement of any claim or "suit" and, upon notification of the action taken, you shall promptly reimburse us for such part of the deductible amount as we have paid.

d. **Additional Conditions**

As respects **Employee Benefit Liability Coverage, SECTION IV - COMMERCIAL GENERAL LIABILITY CONDITIONS** is amended as follows:

(1) Item **2. Duties in the Event of Occurrence, Offense, Claim or Suit** is deleted in its entirety and replaced by the following:

2. **Duties in the Event of an Act, Error or Omission, or Claim or Suit**

a. You must see to it that we are notified as soon as practicable of an act, error or omission which may result in a claim. To the extent possible, notice should include:

(1) What the act, error or omission was and when it occurred; and

(2) The names and addresses of anyone who may suffer dam-

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ages as a result of the act, error or omission.

b. If a claim is made or "suit" is brought against any insured, you must:

(1) Immediately record the specifics of the claim or "suit" and the date received; and

(2) Notify us as soon as practicable.

You must see to it that we receive written notice of the claim or "suit" as soon as practicable.

c. You and any other involved insured must:

(1) Immediately send us copies of any demands, notices, summonses or legal papers received in connection with the claim or "suit";

(2) Authorize us to obtain records and other information;

(3) Cooperate with us in the investigation or settlement of the claim or defense against the "suit"; and

(4) Assist us, upon our request, in the enforcement of any right against any person or organization which may be liable to the insured because of an act, error or omission to which this insurance may also apply.

d. No insured will, except at that insured's own cost, voluntarily make a payment, assume any obligation, or incur any expense without our consent.

(2) Item **5. Other Insurance** is deleted in its entirety and replaced by the following:

5. Other Insurance

If other valid and collectible insurance is available to the insured for a loss we cover under this Coverage Part, our obligations are limited as follows:

a. Primary Insurance

This insurance is primary except when **c.** below applies. If this insurance is primary, our obligations are not affected unless any of the other insurance is also primary. Then, we will share with all that other insurance by the method described in **b.** below

b. Method of Sharing

If all of the other insurance permits contribution by equal shares, we will follow this method also. Under this approach each insurer contributes equal amounts until it has paid its applicable limit of insurance or none of the loss remains, whichever comes first.

If any of the other insurance does not permit contribution by equal shares, we will contribute by limits. Under this method, each insurer's share is based on the ratio of its applicable limit of insurance to the total applicable limits of insurance of all insurers.

c. No Coverage

This insurance shall not cover any loss for which the insured is entitled to recovery under any other insurance in force previous to the effective date of this Coverage Part

e. *Additional Definitions*

As respects **Employee Benefit Liability Coverage, SECTION V - DEFINITIONS** is amended as follows:

(1) The following definitions are added:

1. "Administration" means:

a. Providing information to "employees", including their dependents and beneficiaries, with respect to eligibility for or scope of "employee benefit programs";

b. Interpreting the "employee benefit programs";

c. Handling records in connection with the "employee benefit programs"; or

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d. Effecting, continuing or terminating any "employee's" participation in any benefit included in the "employee benefit program".

However, "administration" does not include.

a. Handling payroll deductions; or

b. The failure to effect or maintain any insurance or adequate limits of coverage of insurance, including but not limited to unemployment insurance, social security benefits, workers' compensation and disability benefits.

2. "Cafeteria plans" means plan authorized by applicable law to allow "employees" to elect to pay for certain benefits with pre-tax dollars.

3. "Employee benefit programs" means a program providing some or all of the following benefits to "employees", whether provided through a "cafeteria plan" or otherwise:

a. Group life insurance, group accident or health insurance; dental, vision and hearing plans; and flexible spending accounts; provided that no one other than an "employee" may subscribe to such benefits and such benefits are made generally available to those "employees" who satisfy the plan's eligibility requirements;

b. Profit sharing plans, employee savings plans, employee stock ownership plans, pension plans and stock subscription plans, provided that no one other than an "employee" may subscribe to such benefits and such benefits are made generally available to all "employees" who are eligible under the plan for such benefits;

c. Unemployment insurance, social security benefits, workers' compensation and disability benefits; and

d. Vacation plans, including buy and sell programs; leave of absence programs, including military, maternity, family, and civil leave; tuition assistance plans; transportation and health club subsidies.

(2) The following definitions are deleted in their entirety and replaced by the following:

21. "Suit" means a civil proceeding in which money damages because of an act, error or omission to which this insurance applies are alleged. "Suit" includes:

a. An arbitration proceeding in which such damages are claimed and to which the insured must submit or does submit with our consent;

b. Any other alternative dispute resolution proceeding in which such damages are claimed and to which the insured submits with our consent; or

c. An appeal of a civil proceeding.

8. "Employee" means a person actively employed, formerly employed, on leave of absence or disabled, or retired. "Employee" includes a "leased worker". "Employee" does not include a "temporary worker".

2. **Unintentional Failure to Disclose Hazards**

SECTION IV - COMMERCIAL GENERAL LIABILITY CONDITIONS, 7. Representations is hereby amended by the addition of the following:

Based on our dependence upon your representations as to existing hazards, if unintentionally you should fail to disclose all such hazards at the inception date of your policy, we will not reject coverage under this Coverage Part based solely on such failure.

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3. **Damage to Premises Rented to You**

a. The last Subparagraph of Paragraph **2. SECTION I - COVERAGES, COVERAGE A. - BODILY INJURY AND PROPERTY DAMAGE, 2. LIABILITY Exclusions** is hereby deleted and replaced by the following:

Exclusions **c.** through **q.** do not apply to damage by fire, explosion, lightning, smoke or soot to premises while rented to you or temporarily occupied by you with permission of the owner.

b. The insurance provided under **SECTION I - COVERAGES, COVERAGE A. BODILY INJURY AND PROPERTY DAMAGE LIABILITY** applies to "property damage" arising out of water damage to premises that are both rented to and occupied by you.

(1) As respects Water Damage Legal Liability, as provided in Paragraph **3.b.** above:

The exclusions under **SECTION I - COVERAGES, COVERAGE A. BODILY INJURY AND PROPERTY DAMAGE LIABILITY, 2. Exclusions**, other than **i. War** and the **Nuclear Energy Liability Exclusion**, are deleted and the following are added:

This insurance does not apply to:

(a) "Property damage":

1) Assumed in any contract; or

2) Loss caused by or resulting from any of the following:

a) Wear and tear;

b) Rust, corrosion, fungus, decay, deterioration, hidden or latent defect or any quality in property that causes it to damage or destroy itself;

c) Smog;

d) Mechanical breakdown including rupture or bursting caused by centrifugal force;

e) Settling, cracking, shrinking or expansion; or

f) Nesting or infestation, or discharge or release of waste products or secretions, by insects, birds, rodents or other animals.

(b) Loss caused directly or indirectly by any of the following:

1) Earthquake, volcanic eruption, landslide or any other earth movement;

2) Water that backs up or overflows from a sewer, drain or sump;

3) Water under the ground surface pressing on, or flowing or seeping through:

a) Foundations, walls, floors or paved surfaces;

b) Basements, whether paved or not; or

c) Doors, windows or other openings.

(c) Loss caused by or resulting from water that leaks or flows from plumbing, heating, air conditioning, or fire protection systems caused by or resulting from freezing, unless:

1) You did your best to maintain heat in the building or structure; or

2) You drained the equipment and shut off the water supply if the heat was not maintained.

(d) Loss to or damage to:

1) Plumbing, heating, air conditioning, fire protection systems, or other equipment or appliances; or

2) The interior of any building or structure, or to personal property in the building or structure

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caused by or resulting from rain, snow, sleet or ice, whether driven by wind or not.

c. **Limit of Insurance**

The Damage to Premises Rented to You Limit as shown in the Declarations is amended as follows:

(2) Paragraph **6.** of **SECTION III - LIMITS OF INSURANCE** is hereby deleted and replaced by the following:

6. Subject to **5.** above, the Damage to Premises Rented to You Limit is the most we will pay under **COVERAGE A. BODILY INJURY AND PROPERTY DAMAGE LIABILITY**, for damages because of "property damage" to premises while rented to you or temporarily occupied by you with permission of the owner, arising out of any one "occurrence" to which this insurance applies.

(3) The amount we will pay is limited as described in Section **B. Limits of Insurance, 3. Damage to Premises Rented to You** of this endorsement

4. **Supplementary Payments**

Under **SECTION I - COVERAGE, SUPPLEMENTARY PAYMENTS - COVERAGES A AND B**:

a. Paragraph **2.** is replaced by the following:

Up to the limit shown in Section **B. Limits of Insurance, 4.a. Bail Bonds** of this endorsement for cost of bail bonds required because of accidents or traffic law violations arising out of the use of any vehicle to which the Bodily Injury Liability Coverage applies. We do not have to furnish these bonds.

b. Paragraph **4.** is replaced by the following:

All reasonable expenses incurred by the insured at our request to assist us in the investigation or defense of the claim or "suit", including actual loss of earnings up to the limit shown in Section **B. Limits of Insurance, 4.b. Loss of Earnings** of this endorsement per day because of time off from work.

5. **Medical Payments**

The Medical Expense Limit of Any One Person as stated in the Declarations is amended to the limit shown in Section **B. Limits of Insurance, 5. Medical Payments** of this endorsement.

6. **Voluntary Property Damage and Care, Custody or Control Liability Coverage**

a. **Voluntary Property Damage Coverage**

We will pay for "property damage" to property of others arising out of operations incidental to the insured's business when:

(1) Damage is caused by the insured; or

(2) Damage occurs while in the insured's possession.

With your consent, we will make these payments regardless of fault.

b. **Care, Custody or Control Liability Coverage**

SECTION I - COVERAGES, COVERAGE A. BODILY INJURY AND PROPERTY DAMAGE LIABILITY, 2. Exclusions, j. Damage to Property, Subparagraphs **(3)**, **(4)** and **(5)** do not apply to "property damage" to the property of others described therein.

With respect to the insurance provided by this section of the endorsement, the following additional provisions apply:

a. The Limits of Insurance shown in the Declarations are replaced by the limits designated in Section **B. Limits of Insurance, 6. Voluntary Property Damage and Care, Custody or Control Liability Coverage** of this endorsement with respect to coverage provided by this endorsement. These limits are inclusive of and not in addition to the limits being replaced. The Limits of Insurance shown in Section **B. Limits of Insurance, 6. Voluntary Property Damage and Care, Custody or Control Liability Coverage** of this endorsement fix the most we will pay in any one "occurrence" regardless of the number of:

(1) Insureds,

(2) Claims made or "suits" brought; or

(3) Persons or organizations making claims or bringing "suits".

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b. **Deductible Clause**

(1) Our obligation to pay damages on your behalf applies only to the amount of damages for each "occurrence" which are in excess of the deductible amount stated in Section **B. Limits of Insurance, 6. Voluntary Property Damage and Care, Custody or Control Liability Coverage** of this endorsement. The limits of insurance will not be reduced by the application of such deductible amount.

(2) Condition **2. Duties in the Event of Occurrence, Offense, Claim or Suit**, applies to each claim or "suit" irrespective of the amount.

(3) We may pay any part or all of the deductible amount to effect settlement of any claim or "suit" and, upon notification of the action taken, you shall promptly reimburse us for such part of the deductible amount as has been paid by us.

7. **180 Day Coverage for Newly Formed or Acquired Organizations**

SECTION II - WHO IS AN INSURED is amended as follows:

Subparagraph **a.** of Paragraph **4.** is hereby deleted and replaced by the following:

a. Insurance under this provision is afforded only until the 180th day after you acquire or form the organization or the end of the policy period, whichever is earlier;

8. **Waiver of Subrogation**

SECTION IV - COMMERCIAL GENERAL LIABILITY CONDITIONS, 9. Transfer of Rights of Recovery Against Others to Us is hereby amended by the addition of the following:

We waive any right of recovery we may have because of payments we make for injury or damage arising out of your ongoing operations or "your work" done under a written contract requiring such waiver with that person or organization and included in the "products-completed operations hazard". However, our rights may only be waived prior to the "occurrence" giving rise to the injury or damage for which we make payment under this Coverage Part. The insured must do nothing after a loss to impair our rights. At our request, the insured will bring "suit" or transfer those rights to us and help us enforce those rights.

9. **Automatic Additional Insured - Specified Relationships**

a. The following is hereby added to **SECTION II - WHO IS AN INSURED**:

(1) Any person or organization described in Paragraph **9.a.(2)** below (hereinafter referred to as additional insured) whom you are required to add as an additional insured under this Coverage Part by reason of:

(a) A written contract or agreement; or

(b) An oral agreement or contract where a certificate of insurance showing that person or organization as an additional insured has been issued,

is an insured, provided:

(a) The written or oral contract or agreement is:

1) Currently in effect or becomes effective during the policy period; and

2) Executed prior to an "occurrence" or offense to which this insurance would apply; and

(b) They are not specifically named as an additional insured under any other provision of, or endorsement added to, this Coverage Part.

(2) Only the following persons or organizations are additional insureds under this endorsement, and insurance coverage provided to such additional insureds is limited as provided herein:

(a) The manager or lessor of a premises leased to you with whom you have agreed per Paragraph **9.a.(1)** above to provide insurance, but only with respect to liability arising out of the ownership, maintenance or use of that part of a premises leased to you, subject to the following additional exclusions:

This insurance does not apply to:

1) Any "occurrence" which takes place after

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you cease to be a tenant in that premises.

2) Structural alterations, new construction or demolition operations performed by or on behalf of such additional insured.

(b) Any person or organization from which you lease equipment with whom you have agreed per Paragraph **9.a.(1)** above to provide insurance. Such person(s) or organization(s) are insureds solely with respect to their liability arising out of the maintenance, operation or use by you of equipment leased to you by such person(s) or organization(s). However, this insurance does not apply to any "occurrence" which takes place after the equipment lease expires.

(c) Any person or organization (referred to below as vendor) with whom you have agreed per Paragraph **9.a.(1)** above to provide insurance, but only with respect to "bodily injury" or "property damage" arising out of "your products" which are distributed or sold in the regular course of the vendor's business, subject to the following additional exclusions:

1) The insurance afforded the vendor does not apply to:

a) "Bodily injury" or "property damage" for which the vendor is obligated to pay damages by reason of the assumption of liability in a contract or agreement. This exclusion does not apply to liability for damages that the vendor would have in the absence of the contract or agreement;

b) Any express warranty unauthorized by you;

c) Any physical or chemical change in the product made intentionally by the vendor;

d) Repackaging, unless unpacked solely for the purpose of inspection, demonstration, testing, or the substitution of parts under instructions from the manufacturer, and then repackaged in the original container,

e) Any failure to make such inspections, adjustments, tests or servicing as the vendor has agreed to make or normally undertakes to make in the usual course of business, in connection with the distribution or sale of the products;

f) Demonstration, installation, servicing or repair operations, except such operations performed at the vendor's premises in connection with the sale of the product;

g) Products which, after distribution or sale by you, have been labeled or relabeled or used as a container, part or ingredient of any other thing or substance by or for the vendor.

2) This insurance does not apply to any insured person or organization:

a) From whom you have acquired such products, or any ingredient, part or container, entering into, ac-

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companying or containing such products; or

b) When liability included within the "products-completed operations hazard" has been excluded under this Coverage Part with respect to such products.

(d) Any state or political subdivision with which you have agreed per Paragraph **9.a.(1)** above to provide insurance, subject to the following additional provision:

This insurance applies only with respect to the following hazards for which the state or political subdivision has issued a permit in connection with premises you own, rent or control and to which this insurance applies:

1) The existence, maintenance, repair, construction, erection, or removal of advertising signs, awnings, canopies, cellar entrances, coal holes, driveways, manholes, marquees, hoist away openings, sidewalk vaults, street banners, or decorations and similar exposures; or

2) The construction, erection, or removal of elevators; or

3) The ownership, maintenance, or use of any elevators covered by this insurance.

(e) Any state or political subdivision with which you have agreed per Paragraph **9.a.(1)** above to provide insurance, subject to the following provisions:

1) This insurance applies only with respect to operations performed by you or on your behalf for which the state or political subdivision has issued a permit.

2) This insurance does not apply to "bodily injury", "property damage" or "personal and advertising injury" arising out of operations performed for the state or political subdivision.

(f) Any person or organization with which you have agreed per Paragraph **9.a.(1)** above to provide insurance, but only with respect to liability caused, in whole or in part, by your ongoing operations performed for that additional insured by you or on your behalf. A person or organization's status as an insured under this provision of this endorsement ends when your operations for that insured are completed.

(3) Any insurance provided to an additional insured designated under Paragraph **9.a.(2)**:

(a) Subparagraphs **(e)** and **(f)** does not apply to "bodily injury" or "property damage" included within the "products-completed operations hazard";

(b) Subparagraphs **(a)**, **(b)**, **(d)** and **(e)** does not apply to "bodily injury", "property damage" or "personal and advertising injury" arising out of the sole negligence or willful misconduct of the additional insured or their agents, "employees" or any other representative of the additional insured; or

(c) Subparagraph **(f)** does not apply to "bodily injury", "property damage" or "personal and advertising injury" arising out of:

1) The rendering of or failure to render any professional services by you or on your behalf, but only with respect to either or both of the following operations:

a) Providing engineering, architectural or surveying services to others; and

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b) Providing or hiring independent professionals to provide engineering, architectural or surveying services in connection with the construction work you perform.

Subject to the final paragraph of this exclusion below, professional services include:

a) Preparing, approving or failing to prepare or approve, maps, shop drawings, opinions, reports, surveys, field orders, change orders or drawings and specifications; and

b) Supervisory or inspection activities performed as a part of any architectural or engineering activities.

Professional services do not include services within construction means, methods, techniques, sequences and procedures employed by you in connection with construction work you perform.

2) "Your work" for which a consolidated (wrap-up) insurance program has been provided by the prime contractor-project manager or owner of the construction project in which you are involved.

b. Only with regard to insurance provided to an additional insured designated under Paragraph **9.a.(2)** Subparagraph (f) above, **SECTION III - LIMITS OF INSURANCE** is amended to include:

The limits applicable to the additional insured are those specified in the written contract or agreement or in the Declarations of this Coverage Part, whichever are less. If no limits are specified in the written contract or agreement, or if there is no written contract or agreement, the limits applicable to the additional insured are those specified in the Declarations of this Coverage Part. The limits of insurance are inclusive of and not in addition to the limits of insurance shown in the Declarations.

c. **SECTION IV - COMMERCIAL GENERAL LIABILITY CONDITIONS, 5. Other Insurance** is hereby amended as follows:

Any insurance provided by this endorsement shall be primary to other insurance available to the additional insured except:

(1) As otherwise provided in **SECTION IV - COMMERCIAL GENERAL LIABILITY CONDITIONS, 5. Other Insurance, b. Excess Insurance**; or

(2) For any other valid and collectible insurance available to the additional insured as an additional insured by attachment of an endorsement to another insurance policy that is written on an excess basis. In such case, the coverage provided under this endorsement shall also be excess.

10. Broadened Contractual Liability - Work Within 50' of Railroad Property

It is hereby agreed that Paragraph **f.(1)** of Definition **12.** "Insured contract" (**SECTION V - DEFINITIONS**) is deleted.

11. Property Damage to Borrowed Equipment

a. The following is hereby added to Exclusion **j. Damage to Property** of Paragraph **2., Exclusions** of **SECTION I - COVERAGES, COVERAGE A. BODILY INJURY AND PROPERTY DAMAGE LIABILITY**:

Paragraphs **(3)** and **(4)** of this exclusion do not apply to tools or equipment loaned to you, provided they are not being used to perform operations at the time of loss.

b. With respect to the insurance provided by this section of the endorsement, the following additional provisions apply:

(1) The Limits of insurance shown in the Declarations are replaced by the limits designated in Section **B. Limits of Insurance, 11.** of this endorsement with respect to coverage provided by this endorsement. These limits are inclusive of and not in addition to the limits being replaced. The

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Limits of Insurance shown in Section **B. Limits of Insurance, 11.** of this endorsement fix the most we will pay in any one "occurrence" regardless of the number of:

(a) Insureds,

(b) Claims made or "suits" brought; or

(c) Persons or organizations making claims or bring "suits".

(2) Deductible Clause

(a) Our obligation to pay damages on your behalf applies only to the amount of damages for each "occurrence" which are in excess of the Deductible amount stated in Section **B. Limits of Insurance, 11.** of this endorsement. The limits of insurance will not be reduced by the application of such Deductible amount.

(b) Condition **2. Duties in the Event of Occurrence, Offense, Claim or Suit**, applies to each claim or "suit" irrespective of the amount.

(c) We may pay any part or all of the deductible amount to effect settlement of any claim or "suit" and, upon notification of the action taken, you shall promptly reimburse us for such part of the deductible amount as has been paid by us.

12. Employees as Insureds - Specified Health Care Services

It is hereby agreed that Paragraph **2.a.(1)(d)** of **SECTION II - WHO IS AN INSURED**, does not apply to your "employees" who provide professional health care services on your behalf as duly licensed:

a. Nurses;

b. Emergency Medical Technicians; or

c. Paramedics,

in the jurisdiction where an "occurrence" or offense to which this insurance applies takes place.

13. Broadened Notice of Occurrence

Paragraph **a.** of Condition **2. Duties in the Event of Occurrence, Offense, Claim or Suit (SECTION IV - COMMERCIAL GENERAL LIABILITY CONDITIONS)** is hereby deleted and replaced by the following:

a. You must see to it that we are notified as soon as practicable of an "occurrence" or an offense which may result in a claim. To the extent possible, notice should include:

(1) How, when and where the "occurrence" or offense took place,

(2) The names and addresses of any injured persons and witnesses; and

(3) The nature and location of any injury or damage arising out of the "occurrence" or offense.

This requirement applies only when the "occurrence" or offense is known to an "authorized representative".

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THIS ENDORSEMENT CHANGES THE POLICY. PLEASE READ IT CAREFULLY.

PRIMARY / NONCONTRIBUTORY AMENDMENT OF CONDITIONS FOR DESIGNATED ADDITIONAL INSUREDS

This endorsement modifies insurance provided under the following:

COMMERCIAL GENERAL LIABILITY COVERAGE PART

SCHEDULE

Name of Person or Organization (Additional Insured):

Any entity for which the insured is required in a written contract to cover on a primary and noncontributory basis

With respect to insurance provided the additional insured shown in the Schedule, **SECTION IV - COMMERCIAL GENERAL LIABILITY CONDITIONS, 5. Other Insurance** is deleted in its entirety and replaced by the following:

5. Other Insurance

If other valid and collectible insurance is available to the additional insured for a loss we cover under Coverages **A** or **B** of this Coverage Part, our obligations are limited as follows:

a. Primary Insurance

Where required by a written contract, this insurance is primary and noncontributory as respects any other insurance policy issued to the additional insured. Otherwise, **b.** below applies.

b. Excess Insurance

This insurance is excess over any of the other insurance available to the additional insured whether primary, excess, contingent or on any other basis.

When this insurance is excess, we will have no duty under Coverages **A** or **B** to defend any claim or "suit" that any other insurer has a duty to defend. If no other insurer defends, we will undertake to do so, but we will be entitled to the insured's rights against all those other insurers.

When this insurance is excess over any other insurance, we will pay only our share of the amount of the loss, if any, that exceeds the sum of:

(1) The total amount that all such other insurance would pay for the loss in the absence of this insurance; and

(2) The total of all deductible and self-insured amounts under all that other insurance.

We will share the remaining loss, if any, with any other insurance that was not bought specifically to apply in excess of the Limits of Insurance shown in the Declarations of this Coverage Part.

c. Method of Sharing

If all of the other insurance permits contribution by equal shares, we will follow this method also. Under this approach each insurer contributes equal amounts until it has paid its applicable limit of insurance or none of the loss remains, whichever comes first.

If any of the other insurance does not permit contribution by equal shares, we will contribute by limits. Under this method, each insurer's share is based on the ratio of its applicable limit of insurance to the total applicable limits of insurance of all insurers.

Hunter Contracting Co
CPP1061979

SCF Arizona™
and its subsidiary companies

CARRIER CODE SCF American - 28394

POLICY ENDORSEMENT

Please attach this endorsement to your policy

This endorsement changes the policy to which it is attached and is effective on the date issued unless otherwise stated

If you have any questions, please contact your local SCF Arizona office

EFFECTIVE 12 01 AM	MO	DAY	YEAR	AMENDING POLICY NUMBER	MO	DAY	YEAR	AUTHORIZED REPRESENTATIVE
05/01/2013				A60219	04/15/2013			

Counter signed at Phoenix, Arizona

Hunter Contracting Co
720 N Cooper Rd
Gilbert, AZ 85233

Waiver of Our Right to Recover From Others Endorsement

We have the right to recover our payments from anyone liable for an injury covered by this policy We will not enforce our right against the person or organization named in the Schedule (This agreement applies only to the extent that you perform work under a written contract that requires you to obtain this agreement from us)

This agreement shall not operate directly or indirectly to benefit anyone not named in the Schedule

☐ Schedule — Job Name & Contract Number

☒ Blanket — Any and all Arizona jobs This agreement applies only to the extent that you perform work under a written contract that requires you to obtain this agreement from us

This endorsement changes the policy to which it is attached and is effective on the date issued unless otherwise stated

Premium Charge $ 0 00

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CITY OF GLENDALE, ARIZONA
PUBLIC WORKS/ENGINEERING DEPARTMENT

CONTRACTOR'S AFFIDAVIT
REGARDING
SETTLEMENT OF CLAIMS

PROJECT 111216 - SWEETWATER LIFT STATION

To the City of Glendale, Arizona

Gentlemen:

This is to certify that all lawful claims for materials, rental of equipment and labor used in connection with the construction of the above project, whether by subcontractor or claimant in person, have been duly discharged.

The undersigned, for the consideration of $_____ , as set out in the final pay estimate, as full and complete payment under the terms of the contract, hereby waives and relinquishes any and all further claims or right of lien under, in connection with, or as a result of the above described project. The undersigned further agrees to indemnify and save harmless the City of Glendale against any and all liens, claims of liens, suits, actions, damages, charges, costs, litigation expenses, attorneys' fees and any other and expenses whatsoever, which said City may suffer arising out of the failure of the undersigned to pay for all labor performance and materials furnished for the performance of said installation.

Signed and dated at _____ , this _____ day of _____ , 20___.

_____
Contractor

By _____

STATE OF ARIZONA)
) ss.
COUNTY OF MARICOPA)

The foregoing instrument was subscribed and sworn to before me this ___ day of _____, 20
.

_____
Notary Public

My Commission Expires: _____

SUPPLEMENTAL GENERAL CONDITIONS

1. GENERAL: By Ordinance No. 1110 New Series, the City of Glendale adopted the "Uniform Standard Specifications for Public Works Construction," which are sponsored and distributed by the Maricopa Association of Governments. Copies of these documents, with revisions, are on file in the office of the City Engineer of the City of Glendale, and are hereby made a part of these Contract Documents.

Whenever in the Uniform Standard Specifications, the words "The Contracting Agency" are used, the meaning shall be the City of Glendale.

In all cases where ASTM, AASHTO, AWWA, USAG, Federal, City of Phoenix, MAG Specifications, Maricopa County, Arizona State Highway, City of Glendale or other standard specifications are referred to, unless otherwise stated, revisions, supplements or addenda issued on or before the date of this contract, shall prevail. In the event of any conflict between these project specifications and the requirements of the plans, detail drawings, MAG Standard Details and Specifications, these project specifications shall prevail.

2. DEFINITIONS: The following terms, as used in or pertaining to the Contract Documents, are defined as follows:

CITY: The word "City" refers to the City of Glendale, Arizona. The official representative of said City in these proceedings shall be the City Engineer.

CONTRACTOR: The word "Contractor" means the person, firm, or corporation with whom the Contract is made by the City.

MATERIALS: The term "Materials" includes, in addition to materials incorporated in the project, equipment and other material used and/or consumed in the performance of the work.

SUBCONTRACTOR: The word "Subcontractor" includes those having a direct contract with the Contractor and those who furnish material worked to a special design according to the plans and/or specifications for this work, but does not include those who merely furnish materials not so worked.

ENGINEER: The word "Engineer" means a person, firm or corporation duly authorized by the City, to act for the City in staking out the work, inspecting materials and construction, and interpreting plans and specifications.

CONTRACT DOCUMENTS: The words "Contract Documents" mean the Notice to Contractors, Information for Bidders, "Uniform Standard Specifications for Public Works Construction," MAG General Conditions, Supplemental General Conditions, Special Provisions, Supplemental Specifications, Proposal, Contract, Payment Bond, Performance Bond, Certificates of Insurance, Plans and Addenda thereto.

3. PROPOSAL QUANTITIES: It is expressly understood and agreed by the parties hereto that the quantities of the various classes of work to be done and material to be furnished under this Contract, which have been estimated as stated in the Proposal, are only approximate and are to be used SOLELY for the purpose of comparing, on a consistent basis, the proposals offered for the work under this Contract; and the Contractor further agrees that the City will not be held responsible if any of the quantities shall be found incorrect; and the Contractor will not make any claim for damages or for loss of profits because of a difference between the quantities of the various classes of work as estimated and the work actually done. If any error, omission, or mis-statement is found to occur in the estimated quantities, the same shall not invalidate this Contract or release the Contractor from the execution and completion of the whole or any part of the work in accordance with the specifications and the plans herein mentioned, or for the prices herein agreed upon and fixed therefore, or excuse him from any of the obligations or liabilities hereunder, or entitle him to any damages or compensation except as may be provided for in this Contract.

4. WITHDRAWAL OF PROPOSALS: No proposal shall be withdrawn following the opening and reading of the bids for a period of 50 days from the date of opening without the consent of the contracting agency through the body or agent duly authorized to accept or reject the proposal.

5. LOSSES AND DAMAGES: All loss or damage arising out of the nature of the work to be done or from the action of the elements, or from any unforeseen circumstances in the prosecution of the same, or from any unusual obstructions or difficulties which may be encountered in and/or during the prosecution of the work, or from any casualty whatsoever of every description, shall be sustained and borne by the Contractor at his own cost and expense except as otherwise provided by the contract documents or the laws of the State of Arizona.

6. DUST PREVENTION: The Contractor shall take whatever steps, procedures or means required to prevent abnormal dust conditions due to his construction operations in connection with this contract. The dust control measures shall be maintained at all times during construction of the project, to the satisfaction of the Engineer, in accordance with the requirements of the "Maricopa County Health Department Air Pollution Control Regulations" which have been adopted pursuant to A.R.S. § 36-779.

The Contractor shall be required to obtain the necessary permit from the Maricopa County Air Pollution Control Bureau, 1001 N. Central Ave., Phoenix, Arizona 85004 - telephone (602) 506-6727.

7. EXCESS MATERIAL: Excess material shall be removed from the work site and wasted at a location approved by the Engineer. Broken concrete and asphalt may be delivered to the Glendale Sanitary Landfill located at 115th Avenue and Glendale Avenue. The prevailing regulations and fee schedule will not be waived for work under this project. All materials, to be disposed of at the landfill, shall be weighed and disposed of at the prevailing rate.

8. STOCKPILE OF MATERIALS: The Contractor may place or stockpile materials in the public right-of-way, if approved by the Engineer, provided they do not prevent access to adjacent properties or prevent compliance with traffic regulations.

Traffic shall not be required to travel over stockpiled materials, and proper dust control shall be maintained.

9. REFUSE COLLECTION ACCESS: At any time the project construction shall require the closure or disruption of traffic in any roadway, alley, or refuse collection easement such that normal refuse collection will be interfered with, the Contractor shall, at least 48 hours prior to causing such closure or disruption, make arrangements with the Field Operations Department in order that refuse collection service can be maintained.

10. CLEAN-UP: After all work under this contract is completed, the Contractor shall remove all loose concrete, lumber, wire, reinforcing, debris, and other materials not incorporated in the work, from the site of the work. Clean-up shall include the removal of all excess pointing mortar materials within pipes and removal of over-size rocks and boulders left after finish grading. The contractor shall provide for the legal disposal of all waste products, debris, etc., and shall make necessary arrangements for such disposal.

11. SHOP DRAWINGS: The Contractor shall provide shop drawings as may be necessary for the prosecution of the work as required by the contract documents. The Engineer shall promptly review all shop drawings. The Engineer's approval of any shop drawing shall not release the Contractor from responsibility for deviations from the contract documents. The approval of any shop drawing which substantially deviates from the requirements of the contract documents shall be evidenced by a change order.

When submitted for the Engineer's review, shop drawings shall bear the contractor's certification that he has reviewed, checked, and approved the shop drawings and that they are in conformance with the requirements of the contract documents.

Portions of the work requiring a shop drawing or sample submission shall not begin until the shop drawing or sample submission has been approved by the Engineer. A copy of each approved shop drawing and each approved sample shall be kept in good order by the Contractor at the site and shall be available to the Engineer.

12. PROTECTION OF FINISHED OR PARTIALLY FINISHED WORK: The Contractor shall properly guard and protect all finished or partially finished work, and shall be responsible for the same until the entire contract is completed and accepted, in writing, by the City. The Contractor shall turn over the entire work in full accordance with the specifications before final settlement shall be made.

13. STATUS OF EMPLOYEES: Contractor shall be responsible for assuring the legal working status of its employees and its subcontractor's employees.

14. LAWS AND REGULATIONS: This Contract shall be governed by and constructed in accordance with the laws of the State of Arizona. The Contractor shall keep himself fully informed of all existing and future City and County Ordinances and Regulations and State and Federal Laws and Occupational Safety and Health Standards (OSHA) in any manner affecting the work herein specified. He shall at all times observe and comply with said Ordinances, Regulations, or Laws.

15. PERMITS: The City has obtained certain required permits which are included in the project specifications, but it will be the duty of the Contractor to determine that all the necessary permits have been obtained. The Contractor shall, at his own expense, obtain all required permits which have not been furnished by the City. A no-fee permit will be issued for work in the City of Glendale right-of-way and easement. (Also see Paragraph 7. Dust Prevention.)

16. ELECTRIC POWER AND WATER: The Contractor shall make his own arrangements for electric power and water. Subject to the convenience of the City, he may be permitted to connect to existing facilities where available, but he shall meter and bear the cost of such power or water. Fire hydrant meters may be obtained from the City of Glendale. Installation and removal of meters should be scheduled through the City's Water Services/Utilities Division at 930-2700. For details and current rates, please visit http://www.glendaleaz.com/CrossConnection/firehydrantmeterprogram.cfm.

17. SURVEY CONTROL POINTS AND MONUMENTS: Existing survey monuments indicated on the plans or found during construction shall be protected by the Contractor, and in the event removal is necessary, removal and replacement shall be performed by permission of the Engineer, under direct supervision of the Engineer or his authorized representative. Survey monuments shall be constructed to conform to the requirements of MAG Specifications, Section 405, and Standard Details.

18. EXISTING UTILITIES: The Contractor is hereby advised that the location of all utilities, as shown on the plans, may not be complete nor exact and the Contractor shall satisfy himself as to the exact location of the utilities by contacting Blue Stake or the utility companies before proceeding with the work. After the underground utilities are located by Blue Stake or the utility company, the contractor shall excavate in a careful and prudent manner to prevent unwillful damage to the underground utilities.

In the event the Contractor or its Subcontractor damages an existing, properly identified underground City of Glendale water or sewer line, the Contractor shall be responsible for the repairs at its expense.

The exact location of all existing underground service utilities, whether or not indicated on the plans, shall be determined by the Contractor at no expense to the City, and he shall conduct his work so as to prevent interruption of service or damage to them.

The Contractor shall protect existing utility services and be responsible for their replacement if damaged by him, or to make necessary adjustment in their location, if required, in order to complete the work for his Contract.

Utility companies and other interested parties have been provided with construction plans and the

construction schedule for this project. The Contractor shall comply with MAG Specifications 105.6 to cooperate with the utility companies.

19. MAINTENANCE OF IRRIGATION FACILITIES: Where irrigation facilities interfere with construction, the Contractor shall remove and replace the affected irrigation facilities to its original condition. Final acceptance of replaced facilities will depend upon final approval of the Engineer.

20. OVERHEAD UTILITY LINES AND POLES: Contractor is advised that when work around overhead lines and poles is required on a project the Contractor is required to coordinate with Utility Companies who own and operate overhead lines and poles. The coordination may include, but not be limited to the following activities: pole bracing, de-energizing of lines, and temporary relocations. Contractor is responsible to contact the applicable Utility Company representative and discuss his proposed construction methods; in order to determine what actions the Utility Company must take and the costs related to those actions. The Contractor shall include these costs in the applicable bid items for this project.

The primary and the backup representatives for this review and cost determinations are as follows:

Arizona Public Service:	Mr. Bobby Garza	602-371-7989
Qwest:	Mr. Ron Floyd	602-630-1932
Salt River Project:	Mr. Tim Rinn	602-236-8694
Salt River Project:	Ms. Mariann Ward	602-236-6389
Cox Communications:	Mr. Ron Pint	623-328-3529
Cox Communications:	Ms. Linda Facio	623-328-3500

21. SOUTHWEST GAS FACILITIES EXPOSED DURING CONSTRUCTION: The Contractor, upon exposing a gas line during construction, shall call SOUTHWEST GAS at 602-271-4277. The Southwest Gas patrolman will respond, usually within an hour, to inspect the line. Minor cuts or abrasions to the pipe coating will be rewrapped and tracer wire will be reconnected at no cost to the City.

22. UNDERGROUND UTILITIES' BEDDING: All water, sewer, storm drain, irrigation and other conduits installed within the City of Glendale shall be bedded from bottom of excavation to one foot above the pipe with granular bedding material meeting the requirements of Section 601.4.6 of MAG Uniform Standard Specifications. The initial bedding under the pipe shall follow City of Glendale Detail G-690.

23. SEWER SERVICE LINES: The Contractor shall be responsible for locating, and protecting from damage during construction, all sewer service lines within the project which are not owned by the City. Contractor will be permitted to review the "as-builts" to assist Contractor in locating the non-City owned sewer service lines. These "as-builts" were prepared, and supplied to the City, by private developers or contractors who installed the non-City owned sewer service lines. Therefore, the City does not guarantee or warranty the accuracy of such "as-builts" and the contractor, as a condition for being allowed to review such "as-builts", hereby agrees to hold the City harmless for any and all damages or other expenses contractor may incur as a result of any inaccuracies or incorrect information in these "as-builts".

24. RIGHTS-OF-WAY: The City will provide rights-of-way and easements for all work specified in this Contract, and the Contractor shall not enter or occupy with man, tools, equipment or materials any private ground outside the property of the City of Glendale, Maricopa County, Arizona, without the consent of the property owner.

25. SUBCONTRACTS: Subcontracts shall be in accordance with, and the Contractor shall be bound by, the following provisions:

All subcontracts shall be subject to the approval of the City.

All subcontracts shall be in writing and shall provide that all work to be performed thereunder shall be performed in accordance with the terms of the Contract.

Certified copies of any and all subcontracts shall be furnished to the City Engineering Department; however, prices may be omitted.

Subcontracts shall conform to the regulations governing employment of labor.

The subcontracting of any part of the work will in no way relieve the Contractor of his responsibility under the Contract.

26. PRE-CONSTRUCTION CONFERENCE: After completion of the Contract Documents, to include bonds, insurance and signatures, and prior to the commencement of any work on the project, the Engineer will schedule a Pre-Construction Conference. This will be held at the City of Glendale, 5850 West Glendale Avenue, Glendale, Arizona.

The purpose of this Conference is to establish a working relationship between the Contractor, Utility Companies, and the Engineer. The agenda will include critical elements of the construction schedule, procedures for handling shop drawings and other submittals, cost breakdown of major lump sum items, payment application and processing, coordination with the involved utility companies, emergency telephone numbers for all representatives involved in the course of construction, and establishment of the Notice to Proceed date.

Minimum attendance by the Contractor shall be a responsible official of the company/corporation, who is authorized to execute and sign documents on behalf of the company/corporation.

27. OVERTIME:

Regular Work Hours: The work required to be performed by the Plans and Specifications for the Project shall be performed only during regular working hours, unless the City has authorized overtime work in accordance with the procedures set forth below. Regular working hours shall be defined as one 8-1/2 hour shift per day, Monday through Friday, or, upon prior approval of the City, one 10-1/2 hour shift per day on a compressed four day work week during Monday through Friday. Regular working hours shall not include Saturdays, Sundays or City recognized legal holidays.

Authorization and Costs: If the Contractor desires to schedule work for times other than regular work hours (overtime), the Contractor shall make a written request to the City at least two business days prior to the scheduled overtime. The City reserves the right to deny the request to work overtime based on the best interest and needs of the City. If an overtime request is denied, the City may, at its sole discretion, extend the contract time at no additional costs to the City.

In the event the Contractor does perform work overtime, with or without the prior approval of the City, the Contractor shall be responsible to the City for all additional costs that may be incurred by the City as a result of the Contractor's overtime work, including costs for engineering, inspections, testing, surveying and construction administration, all in accordance with MAG Section 108.5. However, the Contractor shall not be responsible for City's costs incurred as a result of overtime work requested by the City or overtime work resulting from an emergency which is not the responsibility of the Contractor or its employees, subcontractors or suppliers. The City's cost will be billed directly to the Contractor or may, at the City's option, be deducted from monies due the Contractor.

28. CONTRACTOR'S CONSTRUCTION SCHEDULE: Concurrently, with the execution of the contract and prior to the pre construction conference, the Contractor shall submit a preliminary schedule for the Engineer's review and acceptance. The schedule shall be in sufficient detail to allow the Engineer to determine if the proposed schedule will conform to an acceptable program of construction operations, as determined by the contracting agency. Within ten calendar days after the preliminary schedule, described above, has been accepted by the Engineer, the Contractor shall submit a progress schedule, utilizing the critical path method scheduling technique, showing the order in which he proposes to carry out the work, the dates on which he will start each phase of the work, and the contemplated date for completion of each phase. The Contractor shall not be permitted to commence construction until the schedule complying with this paragraph has been submitted to the

City. The Contractor will not be granted any extension to the contract time or compensation for any damages as a result of the City's refusal to allow Contractor to commence construction until the critical path method progress schedule has been submitted and accepted by the Engineer.

The critical path method (CPM) scheduling technique requires a breakdown of the entire work into individual tasks and an analysis of the number of days required to perform each task. The schedule submitted to the City should highlight and identify the critical path for the project. After the work is in progress, the Contractor shall submit supplementary progress schedules, using the critical path method technique, of the progress to date and projection for completion. The supplementary progress schedules shall be submitted with each pay request in accordance with the paragraph, "Payments to Contractors," of these Supplemental General Conditions. The progress schedules shall be subject to the acceptance of the Engineer. In the event the Contractor fails to submit a supplementary progress schedule acceptable to the Engineer, the City may withhold further progress payments to the Contractor until the Contractor submits an acceptable supplementary progress schedule, which is accepted by the Engineer, to the City. Schedule changes requiring an increase in the City's engineering personnel on the project shall not be put into effect until the Engineer has approved such increase and made arrangements for the required additional personnel.

29. CHARACTER OF WORKMEN: None but skilled foremen and workmen shall be employed on work requiring special qualifications. When required by the Engineer, the Contractor shall discharge any person who is, in the opinion of the Engineer, disorderly, dangerous, insubordinate, incompetent, or otherwise objectionable. The Contractor shall keep the City harmless from damages or claims for compensation that may occur in the enforcement of this section of the specifications.

30. HINDRANCES AND DELAYS: Except as otherwise provided herein, no charge shall be made by the Contractor for hindrances or delays from any cause during the progress of the work embraced in this Contract; but such delays, if due to no fault or neglect of the Contractor, shall entitle the Contractor to an extension of time allowed for completing the work, sufficient to compensate for the delay, the amount of the delay to be determined by the Engineer, provided the Contractor shall give said Engineer immediate notice in writing of the cause of such delay.

30.1 Delay: In the event of a delay for which the City is solely responsible, which is unreasonable under the circumstances and which was not within the contemplation of City and Contractor at the time this Contract is executed, City and Contractor shall negotiate, in good faith, a payment by the City to Contractor for the expenses incurred by Contractor as a result of such delay, in accordance with the City of Glendale Engineering Department's POLICY STATEMENT FOR CALCULATING DELAYS AND DAMAGES. This provision shall not be construed to void any provision in the contract which requires notice of delay or provides for liquidated damages. However, if the delay is the result of any act or neglect of a third party, including the architect, engineer or other contractor employed by the City, or by labor disputes, fire, unusual delay in transportation, adverse weather conditions not reasonably foreseeable, unavoidable casualties, or any causes beyond the Contractor's control, the Contractor shall not be entitled to any payments or compensation for expenses incurred as a result of such delay, but the Contract Time shall be extended by Change Order for such reasonable time as the Engineer may determine. No extension or compensation will be granted for any delay which is the result, wholly or partially, of any act or neglect of Contractor or any Subcontractor hired by Contractor.

31. LIQUIDATED DAMAGES:

31.1 Should the contractor fail to substantially complete the work under this contract within the time for completion stated in the paragraph "Time of Completion," in the Information for Bidders, then the contractor shall pay the City of Glendale, Arizona, liquidated damages, pursuant to the provisions of Section 108.9, Standard Specifications for Public Works Construction, Maricopa Association of Governments, until the work is substantially complete.

31.2 Should the contractor fail to fully and finally complete the work under this contract within the time for completion set forth in the paragraph "Time of Completion," in the Information for Bidders, even though the contractor has achieved substantial completion of the work within such time, then the

contractor shall pay the City of Glendale, liquidated damages (pursuant to the provisions of Section 108.9, Standard Specifications for Public Works Construction, Maricopa Association of Governments), in an amount equal to 100% of the applicable liquidated damage rate set forth in MAG Section 108.9 for each and every calendar day of delay until the work is fully and finally complete and accepted.

31.3 The date of substantial completion shall be the date when the work is sufficiently complete, in accordance with the contract documents, so the owner can fully occupy and utilize the work or designated portion thereof for the use for which it is intended, with all the project's parts and systems operable as required by the contract documents and all the work is complete, accessible, operable, and usable by the owner for its intended purpose(s), and all parts, systems and sitework are 100% complete and cleaned for the owner's use. Only incidental corrective work and final cleaning (if required), beyond cleaning needed for the owner's full use, may remain for final completion.

31.4 Full and final completion shall be that date when all work under the project, including incidental corrective work under punch list and final cleaning, has been completed and the entire project is accepted by the owner.

32. PAYMENTS TO CONTRACTOR: The measurements of quantities and the payments to the Contractor shall be in accordance with MAG Uniform Standard Specifications for Public Works Construction, Part 100 - General Conditions, Section 109 - Measurements and Payments.

Payments will be made on the basis of itemized, monthly statements prepared by the City and signed by the Contractor. The Contractor shall submit an itemized, duly certified and approved estimate for work completed through the last day of the preceding month in accordance with MAG Specifications, as amended by these Supplemental General Conditions. Upon approval of the pay estimate, the City will mail the check directly to the Contractor.

The pay estimate shall be accompanied by an updated progress schedule as required by these Supplemental General Conditions and a cash flow report when required by the Special Provisions. Approval of progress payments shall be conditional upon submittal of progress schedules and cash flow reports, when required, which are acceptable to the Engineer.

Upon 100% completion and acceptance of the project, and with the request for final payment, the Contractor shall complete and submit the "Contractor's Affidavit Regarding Settlement of Claims" form which is included in these specifications. Before final payment and release of retention, Contractor must arrange for its Surety to provide the City with a fully executed AIA Consent of Surety form. To avoid delays in the final payment, the Surety may send the Consent of Surety directly to the City via fax at (623) 915-2861, and mail the original to the City of Glendale Engineering Department, 5850 West Glendale Avenue, Glendale, Arizona 85301. Should any ambiguity arise between the Contract and these Conditions, the provisions of the Contract shall prevail.

33. WARRANTY: This project shall have a 2 year warranty. The warranty period shall begin upon final acceptance of the work by the City of Glendale.

END OF SUPPLEMENTAL GENERAL CONDITIONS

SPECIAL PROVISIONS

1. SCOPE OF WORK: Project includes modification of an existing wetwell-drywell lift station to a wetwell only lift station, including upgrades to associated piping and electrical systems. The upstream gravity sewer and associated manholes will be rehabilitated. Bypass pumping will be required to maintain sewer service. The sewer lift station is adjacent to the Arizona Canal within the Estates at Marshall Ranch, 55th Avenue north of Cactus Road.

2. DEFINITIONS:

A. Section: Reference to a Section on the plans or in these Specifications shall mean a Section of the Uniform Standard Specifications for Public Works Construction, sponsored and distributed by Maricopa Association of Governments (MAG), latest revision. The provisions of MAG Uniform Standard Specifications and Details for Public Works Construction, which are not altered or modified by the drawings or by these Special Provisions or by any subsequently issued Addendum, shall apply to the contract even though the Contractor's attention is not specifically drawn to such provisions.

B. Standard Detail: Reference to a MAG Standard Detail (MAG S.D.) on the plans or in these specifications shall mean a standard detail drawing in the latest revision of the Uniform Standard Specifications for Public Works Construction, sponsored and distributed by Maricopa Association of Governments. City of Glendale Standard Detail (C.O.G. S.D.) shall mean a standard detail drawing in the City of Glendale's Engineering Design and Construction Standards, latest revision. City of Phoenix Standard Detail (C.O.P. S.D.) shall mean a standard detail drawing in the Phoenix Supplemental Standard Details for Public Works Construction, latest revision.

3. CONSTRUCTION SURVEYING AND LAYOUT: The work under this item shall consist of furnishing all materials, personnel, equipment, and traffic control necessary to perform all surveying, staking, and verification of the accuracy of all control points per the plans and as directed by the Engineer. Included in this work shall be all calculations required for the satisfactory completion of the project in conformance with the plans and these Special Provisions. The work shall be done under the direction of a registered professional engineer or a registered land surveyor employed by the Contractor. The crew chief shall be NICET Certified Level III or a registered land surveyor. The Contractor shall furnish all equipment, materials and other devices necessary for establishing, checking, marking and maintaining points, lines, grades and layouts.

Throughout the work, the Contractor shall set all stakes including, but not limited to; centerline stakes; offset stakes; reference point stakes; slope stakes; pavement lines, curb lines and grade stakes at intervals not greater than 25 feet; stakes for sewers, roadway drainage, pipe, under drains, clearing, paved gutter, fence, right of way markers, and survey monuments; blue tops of subgrade, subbase and base courses at intervals not greater than 50 feet; permanent as-built elevation marks; and all other horizontal or vertical controls necessary for complete and accurate layout and construction of the work. Stakes for horizontal and vertical curves shall be set at intervals appropriate for the length of curve. The coordinates of any new control points established by the Contractor during the course of the work shall be given to the Engineer within five working days of control point establishment.

Field notes shall be kept in standard field notebooks furnished by the Contractor. Field notes shall be kept in a clear, orderly and neat manner consistent with standard surveying practices. The standard field notebooks or copies of, shall be made available to the Engineer upon request at any time during the prosecution of the work.

When utility adjustments are a part of the contract, the Contractor shall perform all layout work and set all control points, stakes and references necessary for carrying out all such adjustments.

The Contractor shall cross-section all fill areas for monthly, quantity estimates and as directed by the Engineer. The Engineer may verify the accuracy of same. The Engineer shall check all measurements

that involve determination of final quantities.

Any errors, omissions or discrepancies in the project plans shall be immediately brought to the attention of the Engineer. The Contractor shall promptly notify the Engineer in writing, explaining the problem in detail. The Engineer will advise the Contractor within three working days of any corrective actions deemed necessary. No changes in the project plans will be allowed without the approval of the Engineer.

The Contractor shall be compensated for additional work associated with survey and layout when:

A. The project plans do not provide sufficient information and new calculations must be performed.

B. The Contractor performs survey work based on erroneous plan information, which results in the duplication of work.

C. Changes by the Engineer to the plan information for which the Contractor has already performed the work and results in the duplication of such work.

The Contractor shall not be due compensation for any survey work when:

A. Information provided on the plans is sufficiently complete to allow any additional information necessary for the complete layout of the work to be routinely calculated.

B. The Contractor fails to inform the Engineer of discovered plan errors before the performance of any extra survey work.

C. Work is included in any other pay item.

The Contractor shall inform the Engineer in a timely manner of any omissions, ambiguities, or errors which the Contractor feels may result in extra calculations or survey work, so as not to delay the project or create any unnecessary calculations.

All additional survey work shall be documented by the Contractor and verified by the Engineer before compensation may be granted. Documentation shall consist of a detailed diary specifically addressing the work involved in the alleged problem area. The Contractor may be required to provide calculations, charts, graphs, drawings, or any other physical evidence, which will verify additional work.

The Contractor shall be responsible for verifying curb and gutter grades before placement of concrete using a steel straightedge, string line or other method approved by the Engineer. The field verification shall be performed in the presence of the Engineer or designated representative.

The Engineer reserves the right to make inspections and random checks of the staking and layout. Inspection or acceptance of all or any part of the Contractor's staking and layout by the Engineer does not relieve the Contractor of full responsibility to secure the proper dimensions, grades and elevations of the work.

If, in the Engineer's opinion, the work is not being performed in a manner that will assure proper controls and accuracy, the Engineer will order any or all of the staking and layout work redone at no additional cost to the City. If any portion of the Contractor's staking and layout work is ordered redone and requires additional rechecking by the Engineer, the City shall be reimbursed for all costs

for such additional checking. The amount of such costs will be deducted from the Contractor's monthly estimate.

The Contractor shall provide final "as-constructed" field surveying, including both vertical and horizontal data based on the finished work. The Contractor shall also furnish final Record Drawings for all improvements. The Record Drawings shall be prepared by a Registered Land Surveyor and submitted to the Owner for approval prior to final acceptance of the project. The Record Drawings shall be prepared on a set of reproducible copies of the construction plans. The completed drawings shall be signed and sealed by the Registered Land Surveyor responsible for obtaining the As-built information and preparing the Record Drawings.

All survey field books and documentation shall be available for inspection by the Engineer.

Payment for this item will be made at the contract lump sum price fully complete for **M1058000 CONSTRUCTION SURVEYING AND LAYOUT**.

4. SUSPENSION OF WORK: The Engineer reserves the right to suspend the work wholly or in part if deemed necessary for the best interest of the City. This suspension will be without compensation to the Contractor, other than to adjust the contract time in accordance with MAG Section 108.

5. COMPLIANCE WITH MANUFACTURER'S INSTRUCTIONS: In all instances wherein the item and/or specifications require installation or construction in accordance with either manufacturer's or supplier's recommendations and/or instructions, said recommendations and/or instructions shall be submitted with the applicable portions clearly marked for approval prior to the commencement of work on that item or portion of the contract.

6. TRAFFIC REGULATIONS:

6.1 All traffic affected by this construction shall be regulated in accordance with the City of Phoenix "Traffic Barricade Manual," the "Manual of Uniform Traffic Control Devices" and these Special Provisions. The following traffic restrictions are minimum requirements throughout the construction period:

6.1.1 All references in the City of Phoenix "Traffic Barricade Manual" and the "Manual of Uniform Traffic Control Devices" to "arterial" and/or "collector" streets shall mean "arterial and/or major arterial" streets and are referred to as "major" streets in the following sections.

6.1.2 A minimum of two travel lanes (one for each direction) shall be maintained open to traffic at all times on all major streets. All work that enters or crosses a major street must be done at times other than 6:00 a.m. to 8:30 a.m., and 4:00 p.m. to 6:00 p.m. unless approved by the Transportation Director or Designee.

6.1.3 A travel lane shall be defined as ten (10) feet of roadway not obstructed by traffic control devices with a safe motor vehicle operating speed of twenty-five (25) miles per hour.

6.1.4 A travel lane will not be considered as open to traffic until it has been graded reasonably smooth and is paved with a minimum of two (2) inches of asphalt. This shall be considered temporary pavement and shall be removed completely before proceeding with final surfacing.

6.1.5 The Contractor shall provide and maintain all required and requested traffic control devices to protect and guide traffic for all work in the construction area.

6.1.6 Intersection area shall be defined as all of the area within the right-of-way of intersecting

streets, plus two-hundred fifty (250) feet beyond the center of the intersected streets on all legs of the intersection.

6.1.7 The Contractor shall maintain all existing traffic signs erect, clean and in full view of the intended traffic at all times. Street name signs at major street intersections shall be maintained erect at all times. If any signs interfere with construction, the Contractor shall notify the Transportation Department at least 48 hours in advance before covering or removing said signage. The Contractor shall be responsible for reinstalling all signs removed or covered and verifying they are correctly placed. The Transportation Department will inspect all signage prior to completion of the project.

6.1.8 Local access to all properties on the subject project shall be maintained at all possible times in the form of a safe and reasonable direct route to at least one of the above defined major streets. Whenever local access cannot be maintained, the Contractor shall notify the affected property owner or user and the Engineer at least Seventy-Two (72) hours in advance.

6.1.9 The Contractor shall be required to provide a uniformed off-duty City of Glendale police officer to assist with traffic control whenever traffic in any one direction is restricted to one lane at a signalized major intersection or at other locations if it should become necessary in the opinion of the Transportation Director or Designee. If the Contractor chooses to use a police officer at other locations during peak traffic hours or to assist with his other traffic control operations, the cost shall be included in the lump sum for "Traffic Control" and not paid out of the hours allowed for "Off Duty Glendale Police Officer." All requests for off-duty officers will be made through the Glendale Police Department, Off-Duty Work Administrator. The Contractor must provide evidence of workmen's compensation coverage before any officer will be permitted to work.

Measurement for payment of the uniformed off-duty Glendale police officer hours will be made by the actual number of man-hours used for traffic control at signalized major intersections or as approved by the Engineer. Because the quantity of hours is dependent on the Contractors schedule of activities, the unit price bid for this item will be administered as a contingency bid item and any adjustment in hours will not be subject to the 20 percent limitation.

Payment for the off-duty Glendale police officer will be made at the contract unit price bid per hour for OFF DUTY GLENDALE POLICE OFFICER and shall include the net hourly rate of $35.00 per police officer with a three (3) hour minimum. The net hourly rate shall be increased to include withholding for Federal, State, FICA, Medicare, Workmen's Compensation insurance and any payroll administrative costs.

6.1.10 The Contractor shall prepare a traffic control plan for the project and submit it to the City Transportation Director or Designee for review and approval at least fifteen (15) working days prior to the start of construction. The traffic control plan must be submitted through the City of Glendale on-Line Traffic Control Plan application process at www.glendaleaz.com/transportation/TrafficControlForm.cfm. The traffic control plan shall include message boards installed a minimum of seven (7) working days prior to restrictions when requested by the Transportation Director or Designee, additional public notification shall be required for major restrictions that impact adjacent stakeholders. Any changes to the traffic control plan during construction shall be submitted to the City Transportation Director or Designee for approval at least seventy-two (72) hours before implementation.

Payment for this item shall be made at the contract lump sum price for TRAFFIC CONTROL.

6.1.11 It is the City's desire to maintain one lane of traffic in each direction on minor streets whenever possible. Should it become imperative for the Contractor to close off a portion of any minor street or reduce the travel way to a single lane, he/she must obtain approval

from the City Transportation Director or Designee Seventy-Two (72) hours prior to implementing a traffic control change. He/she must provide all the necessary signs to detour traffic and/or flag person to control traffic for a single lane. The maximum amount of time that the street may be closed is from 9:00 a.m. until 4:00 p.m.

6.1.12 Flagger Requirements: All flaggers shall be properly trained and certified by a recognized source, such as the American Traffic Safety Services Association (ATSSA) or National Safety Council, and shall carry with them at all times proof that training and certification requirements have been completed within the last two years.

7. ENERGIZED AERIAL ELECTRICAL POWER LINES: The utility company maintains energized aerial electrical power lines in the immediate vicinity of this project. Do not consider these lines to be insulated. Construction personnel working in proximity to these lines are exposed to an extreme hazard from electrical shock. Contractors, their employees, and all other construction personnel working on this project must be warned of the danger and instructed to take adequate protective measures, including maintaining a minimum ten (10) feet clearance between the lines and all construction equipment and personnel. (See: OSHA Standard 1926.550(a)15.) As an additional safety precaution, Contractors should also be instructed to call the utility company to arrange, if possible, to have these lines de-energized or relocated when the work reaches their immediate vicinity. The cost of such temporary arrangements would be borne by the Contractor. The utility company can often respond to such requests if two days advance notice is given, but some situations may require up to sixty (60) days lead time for relocation or other arrangements.

8. CONCRETE GUTTER WATER TESTING: The MAG Uniform Standard Specifications, Section 340.3, CONSTRUCTION METHODS, shall be modified as follows: The 1/2 inch referenced in Paragraph 16 beginning, "When required by the Engineer, gutter having a slope of 0.8 foot...," shall be changed to 1/4 inch.

9. RECORD DRAWINGS: The Contractor shall maintain one set of contract drawings with all changes, deviations, additions and deletions clearly marked thereon. Upon completion of the work, this set of drawings, shall be marked "RECORD DRAWINGS," dated, and delivered to the Engineer prior to approval of the Contractor's final payment request.

10. SOILS REPORT: The boring logs and soils report for this project are available for review at the City Engineering Office upon request. The boring logs and soils report are provided only as a courtesy. The logs and soils reports are not incorporated into, or part of, the contract and the City of Glendale makes no warranties, express or implied, as to the accuracy of the information contained therein. The Contractor should not rely on the information contained therein and should perform its own investigation as to the subsurface conditions of the project. The logs and soils reports are not intended, nor should they be relied upon by the Contractor as, a representation of the true soil conditions of the project. If there is a conflict between this provision and any other provision of the contract documents, this provision will prevail. The Contractor will accomplish the project under whatever condition he finds at the contract price.

11. CONSTRUCTION MATERIALS SAMPLING AND TESTING: The contractor, at their expense, shall provide adequate personnel for construction materials sampling and testing functions as required by the City of Glendale. Proof of certifications of the following requirements shall be provided to the City of Glendale prior to commencement of construction:

A. LABORATORY TESTING SERVICES: Construction materials testing laboratories must meet the following requirements in order to perform laboratory testing on construction materials samples:

a. Possess and maintain current AASHTO accreditation (including R18) provided by the AASHTO Materials Reference Laboratory (AMRL), and Cement and Concrete Reference Laboratory (CCRL) in any test methods preformed and be currently participating in their respective proficiency programs.

b. Concrete strength testing must be performed by a technician currently certified by the American Concrete Institute (ACI) as a "Concrete Strength Testing Technician".

B. FIELD TESTING AND SAMPLING SERVICES: Field technicians shall be employed by the construction materials testing laboratory noted above and have current "*Field Technician Certification*" from the Arizona Technical Testing Institute (ATTI) and current "*Concrete Field Testing Technician – Grade 1*" certification from the American Concrete Institute.

C. TESTING FREQUENCIES: Laboratory and field testing and sampling shall adhere to the current City of Glendale minimum frequencies (see tables below) formal documentation, records etc. shall be provided to the City in a timely manner and as part of required project documentation for overall project acceptance. The City reserves the right to utilize independent / additional testing to confirm prior results.

Payment for this item will be made at the contract lump sum price fully complete for CONSTRUCTION MATERIALS SAMPLING AND TESTING.

CITY OF GLENDALE - CONSTRUCTION ENGINEERING

MATERIALS TESTING SECTION

ASPHALTIC CONCRETE MINIMUM SAMPLING AND TESTING FREQUENCY

TYPE OF SAMPLE	REQUIRED TEST(S)	TEST METHOD DESIGNATION	MINIMUM SAMPLE FREQUENCY	MINIMUM SIZE OF SAMPLE
COLD FEED AGGREGATE OR COMBINED HOT-BIN AGGREGATE SAMPLES	SIEVE ANALYSIS	A.S.T.M. C - 136	1 - EVERY 500 TONS	25Kg
	SAND EQUIVALENT	A.S.T.M. D - 2419	1 - PER DAY	10Kg
	SPECIFIC GRAVITY (COARSE & FINE)	A.S.T.M. C-127 / C-128	1 - PER DAY	10Kg
	SIEVE ANALYSIS	A.S.T.M. C - 136	1 - PER EACH ADDITIONAL 500 TONS PRODUCED	25Kg
UNCOMPACTED ASPHALTIC CONCRETE MIXTURE	IGNITION-GRADATION	ARIZ 427	1 - PER FIRST 500 TONS PER DAY	9 Kg
	GYRATORY COMPACTION	AASHTO TP4	1 - PER FIRST 500 TONS PER DAY	5 Kg
	MAX. THEORETICAL SPECIFIC GRAVITY	A.S.T.M. D - 2041	1 - PER FIRST 500 TONS PER DAY	7 Kg
	IGNITION-GRADATION	ARIZ 427	1 - PER EACH ADDITIONAL 500 TONS PRODUCED	4 Kg
	MARSHAL COMPACTION	ASTM D-6926 D6927	1 - PER FIRST 500 TONS PER DAY	9 Kg
COMPACTED ASPHALTIC CONCRETE MIXTURE	NUCLEAR DENSITY	A.S.T.M. D - 2950	1 - PER 750 LINEAR FT PER PASS OR RIBBON	N/A
	SPECIFIC GRAVITY BY CORE SAMPLE	A.S.T.M. D - 2726	1 - PER 750 LINEAR FT PER PASS OR RIBBON	N/A

revised OCT 2015

City of Glendale				
Minimum Construction Materials Field Testing Frequency				
Type of Material	Type of Structure	Minimum Test Frequency	Minimum Test Requirement	Test Method
Native In-Situ	Curb, Gutter & Sidewalk	1-per 500 lin ft	90% & +2 -4% of optimum moisture	ASTM D-698 / D-2922
Native In-Situ	Roadway Subgrade	1-per 500 lin ft	95% & +2 -4% of optimum moisture	ASTM D-698 / D-2922
Native In-Situ	Trench Backfill	1-per 500 lin ft per 1 ft. lift	95% & +2 -4% of optimum moisture	ASTM D-698 / D-2922
Native In-Situ	Structural Fill	1-per lift	95% & +2 -4% of optimum moisture	ASTM D-698 / D-2922
Native In-Situ	Driveways, Aprons, Valley Gutters	1-per structure	95% & +2 -4% of optimum moisture	ASTM D-698 / D-2922
Aggregate Base	Pipe Bedding	1-per 500 lin ft	95%	ASTM D-698 / D-2922
Aggregate Base	Curb, Gutter & Sidewalk	1-per 500 lin ft	95%	ASTM D-698 / D-2922
Aggregate Base	Roadway Base	1-per 500 lin ft	100%	ASTM D-698 / D-2922
Aggregate Base	Structural Fill	1-per lift	95%	ASTM D-698 / D-2922
Concrete	Curb, Gutter, Sidewalk, Driveways	1 set per 50 yards or 1/2 days pour	1 set of 4, 4x8 Cylinders	ASTM C-71 / C-172
Asphaltic Concrete	Roadway (Arterial)	1-per 750 lin ft per pass	92% - Nuclear Density	ASTM D-2950 / D-2041
Asphaltic Concrete	Roadway (Arterial)	1-per 750 lin ft per pass	92% - Core Density	ASTM D-2726
Asphaltic Concrete	Roadway (Residential)	1-per 750 lin ft per pass	95% - Marshall Density	ASTM D-6926/D6927
Asphaltic Concrete	Roadway (Residential)	1-per 750 lin ft per pass	95% - Core Density	ASTM D-2726
Asphaltic Concrete	Roadway	1 Sample per 500 tons	Uncompacted Field Sample	AC Laboratory Tests*

NOTE: This table is based on the approximate **minimum** number of tests to be performed and requirements may be increased depending on site conditions or other circumstances at the discretion of the City of Glendale.

* All Asphaltic Concrete Laboratory Tests are covered on another sheet provided upon request.

Revised [illegible]

12. CASH FLOW REPORT: The Contractor shall prepare a Cash Flow Report for projected monthly project cash flow on a City provided form and submit it for approval prior to issuance of the Notice to Proceed. The accumulation of monthly pay estimate costs shall be plotted versus time in accordance with the proposed construction schedule. After approval, the Contractor shall submit an updated Cash Flow Report prior to the receipt of each Progress Payment. Each updated Cash Flow Report shall reflect the Contractor's actual monthly payment versus the actual elapsed contract time.

At the City's request, if the projected quarterly project cash flow varies by more than ten percent of the total contract price, the Contractor shall prepare a revised Cash Flow Report. Each revised Cash Flow Report is subject to approval by the City prior to issuance of the progress payment.

Revisions to the report resulting from Contractor initiated delays or work schedule changes shall be at no cost to the City. Any revisions required by City initiated delays or changes to the work shall be paid as an integral part of the approved Change Order.

13. CONSTRUCTION SIGN: The project type to be indicated on the sign shall be 111216 - SWEETWATER LIFT STATION . See "Construction Sign Detail."

14. ALLOWANCE FOR CONSTRUCTION CONTINGENCIES: Bid schedule includes a lump sum contingency allowance. This allowance is at all times the property of the City and is for the sole purpose of reimbursing Contractor for any unforeseen work not apparent at the time of bidding or additional work requested by the CITY OF GLENDALE.

No work anticipated for reimbursement under this Bid Item shall be initiated by Contractor until Contractor, City of Glendale Representative and City of Glendale agree on the scope and cost to perform the additional work. The Contractor shall prepare and submit to City of Glendale Representative a cost itemization and summary for the additional work. City of Glendale Representative and City of Glendale shall review and approve prior to Contractor proceeding with any additional work. Any portion of the stated sum not expended remains the property of the City of Glendale.

Work under this section shall consist of any additional work identified by the owner and contractor due to construction activity. All work under this item shall be itemized as per MAG requirements and deducted from the set amount of $160,000. All work under this section shall include but is not limited to all necessary materials, tools, layout, survey and labor required to complete each task.

Measurement and payment for this item shall be made on an individual basis per task and as described above. Limit for this item is set at $160,000 on the bid form, under line item ALLOWANCE FOR CONSTRUCTION CONTINGENCY.

END OF SPECIAL PROVISIONS

City of Glendale

Sweetwater Lift Station Upgrade

Technical Specifications
Final Submittal

October 2013

Registered Professional Engineer (Civil)
CERTIFICATE NO.
48993
TRACY H.
MORACA
Date Signed 10/31/13
ARIZONA, U.S.A.
Expires 12/31/14

Prepared by

Brown AND Caldwell

201 East Washington Street, Suite 500
Phoenix, Arizona 85004

CITY OF GLENDALE
SWEETWATER LIFT STATION UPGRADE
FINAL TECHNICAL SPECIFICATIONS

Registered Professional Engineer (Civil)
CERTIFICATE NO. 48993
TRACY H. MORACA
Date Signed 10/3/13
ARIZONA, U.S.A.
Expires 12/31/14

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SECTION 01010

SUMMARY OF WORK

PART 1--GENERAL

1.01 DESCRIPTION

The work covered under this contract will be performed at the site of the Sweetwater Lift Station in Glendale, Arizona.

1.02 DESCRIPTION OF OWNER'S PROJECT

The overall project will consist of modification of a wetwell-drywell lift station to a wetwell only lift station, including upgrades to associated piping and electrical systems. The upstream gravity sewer and associated manholes will be rehabilitated. Bypass pumping will be required to maintain sewer service.

1.03 WORK OF THIS CONTRACT

The work to be performed under this contract includes furnishing and installing submersible wetwell pumps, controls, telemetry system, piping, valves, fittings, and appurtenances, entrance gates, and associated site work and electrical equipment. Additional work includes cured-in-place pipeline rehabilitation, manhole rehabilitation, and a bypass pumping system.

PART 2--NOT USED

PART 3--NOT USED

END OF SECTION

SECTION 01046

DEMOLITION AND SALVAGE

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE OF WORK:

This section includes materials and equipment to be salvaged and returned to the Owner; or demolished and removed from the site as trash by the Contractor. The sequence in which systems can be worked on shall be as specified in specification Section 01014, Work Sequence.

Furnish all labor, material, equipment, and incidentals required to demolish, modify, or alter, existing facilities as shown or specified and as required for the installation of new mechanical equipment, piping, architectural features and appurtenances. Existing piping and equipment shall be removed and dismantled as necessary for the performance of structural, architectural, and piping alterations in accordance with the requirements herein specified.

Contractor shall coordinate with the subcontractors and Owner for all materials required to be turned over to Owner. Concrete surface preparation and coating is specified in specification Sections 03300 and 09900.

B. PERFORMANCE REQUIREMENTS:

1. EXISTING CONDITIONS: Contractor shall visit the site and inspect the nature and condition of all facilities to be demolished, partially demolished, modified, or altered in any way prior to submittal of his Bid. No increase in cost or extension of Contract time will be considered for failure to know the conditions of the site and structures.

2. SALVAGE AND REUSE: Any items specifically indicated to be re-used or designated to be salvaged for Owner's own purposes shall be carefully removed, and be relocated to designated storage areas on the project site. Contractor shall protect salvaged equipment and materials from weather, staining, construction damage, theft, and vandalism. Arrange storage to facilitate inspection by Construction Manager.

The Contractor shall notify the Construction Manager fifteen (15) days prior to commencement of demolition work in an area. The Owner shall then tag equipment, piping, valves, control devices, electrical, etc. with a color code system to designate whether the items are to be salvaged or reused and store accordingly.

3. DEMOLITION AND DISPOSAL: Equipment to be demolished shall be per the Contract Drawings. All other materials removed under the demolition Work, including dismantled equipment and materials, piping, pumps, fittings, valves, machinery, gates, concrete

equipment pads, miscellaneous and structural metals, masonry, and other construction debris shall become the property of the Contractor and be removed from the site as trash. Trash and debris shall be disposed of legally, off the site, by Contractor. Upon removal from site, Contractor shall have the rights of salvage of materials.

1.02 QUALITY ASSURANCE

A. PROTECTION OF EXISTING FACILITIES:

The Contractor shall diligently protect existing structures and property of the Owner while proceeding with Work of this section and the entire Contract. All damage shall be repaired at once to the satisfaction of the Owner. All such repairs shall be at the expense of the Contractor and no claims for additional payment will be accepted.

When removing materials or portions of existing structures and when making openings in walls and partitions, the Contractor shall provide barriers, dust screens, and other protective devices so as not to damage the structures beyond the limits necessary for the new Work, nor to damage the structures or contents by falling or flying debris nor to transfer any heavy shocks and vibrations to structures to remain. Swinging weights shall not be used to demolish structures.

PART 2--MATERIALS AND METHODS

2.01 REPAIR AND RESTORATION

A. GENERAL:

The Contractor shall alter or rework existing structures as shown and specified. Generally, when items of equipment and piping are removed, the areas and surfaces from which items were removed shall be left with a neat appearance and finish compatible with surrounding areas, colors, and surfaces. The Contractor shall do all painting, sanding, grouting, sacking, resurfacing, and other Work as necessary to comply with the above requirements. Prior to structural modifications, all surfaces shall be subject to inspection by the Construction Manager. Colors shall match existing colors as closely as possible. For replacement, repair of restoration of Work removed, comply with the specifications for the type of Work to be done.

B. PENETRATIONS:

Where holes in existing masonry or concrete are required to be sealed, unless otherwise specified, they shall be sealed with cement mortar or concrete. The sides of the openings shall be provided with keyed joints and shall be suitably roughened to furnish a good bond and make a watertight joint. All loose or unsound material adjacent to the opening shall be removed and, if necessary, replaced with new material. The method of placing the mortar seal shall provide a suitable means of releasing entrapped air.

C. MODIFICATIONS OF EXISTING STRUCTURES:

Where only a portion of the existing structure is to be removed, the existing concrete shall be sawed to neat lines as shown on the plans or as established by the Construction Manager. Reinforcing steel shall be removed to a depth of two inches from the finished surface. Anchor bolts for equipment and structural steel removed shall be cut off 1-inch below the concrete surface. Surface shall be finished as specified in Division 3.

When connections are to be made to existing concrete structures, the existing reinforcing steel shall be exposed to a depth of 12 inches and all bars spliced to the new reinforcing steel.

D. PIPING MODIFICATIONS:

Where necessary or required for the purpose of making piping connections, cut existing pipelines and provide suitable plugs, bulkheads, or other means to hold back the flow of water or other liquids, all as required in the performance of the Work under this Contract. The remaining open ends of all piping, valves, fittings, and appurtenances that are removed shall be plugged with standard pipe plugs or closed with flanges so that there will be no leakage through the closure.

PART 3--EXECUTION

3.01 GENERAL

A. CONTROL OF HAZARD AND NUISANCE CONDITIONS:

All demolition, salvage, and renovation Work shall be conducted in a manner which will protect the environment, promote public health and safety, and preclude nuisance conditions, in strict conformance with the requirements of specification Sections 01060, Safety and Health; and 01560, Environmental Controls. In addition, Contractor shall enforce the following safety requirements:

1. No fires will be permitted on-site.

2. Post "No Smoking" signs in all interior spaces and in hazardous or confined spaces where dismantling operations are to be carried on. Strictly enforce "No Smoking" restrictions among all personnel employed on the Work.

B. DEMOLITION OF EXISTING STRUCTURES:

Structures that are in the way of new construction shall be removed completely, regardless if they are above or below existing or proposed ground or grade. This Work may be done in any manner selected by the Contractor, and reviewed by the Construction Manager, that does not endanger adjacent structures and property. The use of explosives will not be permitted for any purposes.

Structures not in the way of proposed construction, but designated to be demolished or removed shall be removed, to a point three feet below existing or proposed grade, whichever is lower. That portion that will remain below grade shall be cleaned of rubble and debris including exposed reinforcing steel, backfilled with Type C material in accordance with specification Section 02200, Earthwork and graded in accordance with the site grading plan.

Structural steel members shall be cut into sections of such weight and size as will permit convenient handling, hauling, and storage. Concrete to be demolished and removed shall be broken into pieces not greater than 24-inches in any dimension by methods reviewed by the Construction Manager.

C. GRADING AND BACKFILL:

All excavation made in connection with this item and all openings below permanent ground caused by the removal of a structure or buried piping shall be backfilled with suitable material and graded to match the proposed grading plan. That portion of the backfill which will support any portion of a roadbed, driveway, or structure shall be backfilled and compacted in accordance with specification Sections 02200, Earthwork, and 02500, Paving.

3.02 ITEMS TO BE SALVAGED AND RETURNED TO OWNER

Contractor shall request the Construction Manager to identify all items to be salvaged prior to the start of the Work. Salvaged items shall be properly disconnected to retain their full salvage value and cleaned before turning over to the Owner. Salvaged items shall include:

Item description	Equipment ID
Salvaged Items	
Standby Generator	No ID number
Remote Telemetry Unit/PLC enclosure	No ID number
Radio Pole and antenna	No ID number
Reused Items	
Interior component and panel of PLC unit	No ID number
Generator Sign	No ID number

END OF SECTION

SECTION 01050

SURVEY INFORMATION

The Owner has established reference benchmarks and baselines as shown on the Drawings. From the information provided, the Contractor shall develop and make such additional surveys as are needed for construction, such as control lines, slope stakes, batter boards, stakes for pipe locations and other working points, lines, and elevations. Survey work shall be performed under the supervision of a licensed land surveyor or registered civil engineer. Contractor shall reestablish reference benchmarks and survey control monuments destroyed by his operations at no cost to the Owner.

END OF SECTION

SECTION 01060

SAFETY AND HEALTH

1.0 GENERAL

A. SAFETY AND HEALTH REGULATIONS

The Contractor shall comply with Safety and Health Regulations for Construction, promulgated by the Secretary of Labor under Section 107 of the Contract Work Hours and Safety Standards Act, as set forth in Title 29, C.F.R. Copies of these regulations may be obtained from Labor Building, 14th and Constitution Avenue N.W., Washington, DC 20013.

B. The Contractor shall also comply with the provisions of the Federal Occupational Safety and Health Act, as amended.

C. Precaution shall be exercised by the Contractor at all times for the protection of persons (including employees) and property. The Contractor shall comply with the provisions of all applicable laws, pertaining to such protection including all Federal, State and Local occupational safety and health acts, standards and regulations promulgated thereunder.

D. The Contractor shall provide and maintain in a neat, sanitary condition such accommodations for the use of the employees as may be necessary to comply with the requirements and regulations of the Arizona State Department of Health.

E. The Contractor shall provide all safeguards, safety devices and protective equipment and take any other needed actions, on his own responsibility reasonably necessary to protect the life and the health of employees on the job, the safety of the public, and to protect property in connection with the performance of the work covered by this contract.

END OF SECTION

SECTION 01071

STANDARD REFERENCES

Wherever used in the project manual, the following abbreviations will have the meanings listed:

AA	Aluminum Association Incorporated P.O. Box 753 Waldorf, MD 20604
AABC	Associated Air Balance Council 1518 K Street N.W. Washington, DC 20005
AAMA	American Architectural Manufacturers Association 1540 East Dundee Road, Suite 310 Palatine, IL 60067
AASHTO	American Association of State Highway and Transportation Officials 444 North Capitol Street, N.W., Suite 249 Washington, DC 20001
ABMA	American Bearing Manufacturers Association 1200 19th Street N.W., Suite 300 Washington, DC 20036
ACI	American Concrete Institute 22400 West Seven Mile Road P.O. Box 19150, Redford Station Detroit, MI 48219
AEIC	Association of Edison Illuminating Companies 600 North 18th Street P.O. Box 2641 Birmingham, AL 35291
AGA	American Gas Association ATTN: Records 1515 Wilson Boulevard Arlington, VA 22209
AGMA	American Gear Manufacturer's Association, Inc. 1500 King Street, Suite 201 Alexandria, VA 22314
AHA	American Hardboard Association 1210 West Northwest Highway Palatine, IL 60067
AISC	American Institute of Steel Construction One East Wacker Drive, Suite 3100 Chicago, IL 60601

AISI	American Iron and Steel Institute 1101 Seventeenth Street, NW, Suite 1300 Washington, DC 20036
AITC	American Institute of Timber Construction 7012 South Revere Parkway, Suite 140 Englewood, CO 80112
ALSC	American Lumber Standard Committee P.O. Box 210 Germantown, MD 20875
AMCA	Air Movement and Control Association, Inc. 30 West University Drive Arlington Heights, IL 60004
ANSI	American National Standards Institute 11 West 42nd Street, 13th Floor New York, NY 10036
APA	American Plywood Association 7011 South 19th Street Tacoma, WA 98466
API	American Petroleum Institute 1220 "L" Street N.W. Washington, DC 20005
ARI	Air-Conditioning and Refrigeration Institute 4301 North Fairfax Drive, Suite 425 Arlington, VA 22203
ASCE	American Society of Civil Engineers United Engineering Center 345 East 47th Street New York, NY 10017
ASCII	American Standard Code for Information Interchange United States of America Standards Institute 10 East 40th Street New York, NY 10016
ASE Code	American Standard Safety Code for Elevators, Dumbwaiter and Escalators American National Standards Institute 1430 Broadway New York, NY 10018
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers, Inc. 1791 Tullie Circle, NE Atlanta, GA 30329
ASME	American Society of Mechanical Engineers 345 East 47th Street New York, NY 10017
ASTM	American Society for Testing and Materials 100 Barr Harbor Drive West Conshohocken, PA 19428

AWPA	American Wood-Preservers' Association 9549 Old Fredrick Road Ellicott City, MD 21042 or P.O. Box 286 Woodstock, MD 21163-0286
AWS	American Welding Society 550 NW LeJeune Road P.O. Box 351040 Miami, FL 33135
AWWA	American Water Works Association 6666 West Quincy Avenue Denver, CO 80235
BOCA	Building Officials and Code Administrators, International, Inc. 4051 West Flossmoor Road Country Club Hills, IL 60478
CALTEST	Materials Manual, State of California, Business and Transportation Agency Department of Public Works State of California, Department of Transportation 6002 Folsom Boulevard Sacramento, CA 95819
CALTRANS	Standard Specifications, State of California, Department of Transportation State of California, Business and Transportation Agency P.O. Box 1499 Sacramento, CA 95807
CBM	Certified Ballast Manufacturers 2120 Keith Building Cleveland, OH 44115
CMAA	Crane Manufacturers Association of America, Inc. (Formerly called: Overhead Electrical Crane Institute) (OECI) 8720 Red Oak Boulevard, Suite 201 Charlotte, NC 28217
CRSI	Concrete Reinforcing Steel Institute 933 N Plum Grove Road Schaumburg, IL 60173
CSA	Canadian Standards Association 178 Rexdale Boulevard Rexdale, Ontario, M9W IR3, Canada
DEMA	Diesel Engine Manufacturer's Association 30200 Detroit Road Cleveland, OH 44145
DHI	Door and Hardware Institute 14170 Newbrook Drive Chantilly, VA 22021

DIS	Division of Industrial Safety California Department of Industrial Relations 2422 Arden Way Sacramento, CA 95825
EEI	Edison Electric Institute 90 Park Avenue New York, NY 10016
EIA	Electronic Industries Association Order from: Global Engineering Documents 18201 McDurmott West Irvine, CA 92714
EJMA	Expansion Joint Manufacturers Association 25 North Broadway Tarrytown, NY 10591
ESO	Electrical Safety Orders California Administrative Code, Title 8, Chap. 4, Subarticle 5 Office of Procurement, Publications Section P.O. Box 20191 8141 Elder Creek Road Sacramento, CA 95820
FEDSPEC	Federal Specifications General Services Administration Specification and Consumer Information Distribution Branch Washington Navy Yard, Bldg. 197 Washington, DC 20407
FEDSTDS	Federal Standards (see FEDSPECS)
FM	Factory Mutual Engineering and Research Corporation 1151 Boston-Providence Turnpike P.O. Box 9102 Norwood, MA 02062
HEI	Heat Exchange Institute 1300 Sumner Avenue Cleveland, OH 44115
HI	Hydraulic Institute 9 Sylvan Way, Suite 180 Parsippany, NJ 07054
HPVA	Hardwood Plywood & Veneer Association 1825 Michael Faraday Drive P.O. Box 2789 Reston, VA 22090-2789
IAPMO	International Association of Plumbing and Mechanical Officials 20001 Walnut Drive S Walnut, CA 91789

ICBO	International Conference of Building Officials 5360 Workman Mill Road Whittier, CA 90601
ICEA	Insulated Cable Engineers Association P.O. Box 440 South Yarmouth, MA 02664
IEEE	Institute of Electrical and Electronics Engineers 445 Hoes Lane P.O. Box 1331 Piscataway, NJ 08855
IES	Illuminating Engineering Society of North America 120 Wall Street New York, NY 10017
ISA	Instrument Society of America 67 Alexander Drive P.O. Box 12277 Research Triangle Park, NC 27709
JIC	Joint Industrial Council 7901 West Park Drive McLean, VA 22101
MAG	Maricopa Association of Governments 302 North 1st Avenue, Suite 300 Phoenix, AZ 85003
MFMA	Metal Framing Manufacturers Association 401 N. Michigan Avenue Chicago, IL 60611
MILSPEC	Military Specifications Naval Publications and Forms Center 5801 Tabor Avenue Philadelphia, PA 19120
MSS	Manufacturers Standardization Society of the Valve & Fittings Industry, Inc. 127 Park Street, N.E. Vienna, VA 22180
NAAMM	National Association of Architectural Metal Manufacturers 11 South La Salle Street, Suite 1400 Chicago, IL 60603
NACE	National Association of Corrosion Engineers 1440 South Creek Drive Houston, TX 77084
NBC	National Building Code Published by BOCA
NEC	National Electric Code National Fire Protection Association One Batterymarch Park P.O. Box 9101 Quincy, MA 02269

NELMA	Northeastern Lumber Manufacturers Association, Inc. P.O. Box 87A Cumberland Center, ME 04021
NEMA	National Electrical Manufacturer's Association 2101 L Street, NW, Suite 300 Washington, DC 20037
NESC	National Electric Safety Code American National Standards Institute 1430 Broadway New York, NY 10018
NFOR	National Forest Products Association (Formerly National Lumber Manufacturer's Association) 1111 19 Street NW, Suite 700 Washington, DC 20036
NFPA	National Fire Protection Association One Batterymarch Park P.O. Box 9101 Quincy, MA 02269
NHLA	National Hardwood Lumber Association 6830 Raleigh LaGrange P.O. Box 34518 Memphis, TN 38184-0518
NSF	National Sanitation Foundation 3475 Plymouth Road P.O. Box 130140 Ann Arbor, MI 48113
OSHA	Occupational Safety and Health Act U.S. Department of Labor Occupational and Health Administration San Francisco Regional Office 450 Golden Gate Avenue, Box 36017 San Francisco, CA 94102
PCI	Precast/Prestressed Concrete Institute 175 West Jackson Blvd., Suite 1859 Chicago, IL 60604
PPIC	The Plumbing & Piping Industry Council, Inc. 510 Shatto Place, Suite 402 Los Angeles, CA 90020
RIS	Redwood Inspection Service California Redwood Association 405 Enfrente Dr., Suite 200 Novato, CA 94949
RMA	Rubber Manufacturers Association 1400 K Street NW, Suite 900 Washington, DC 20005

SAE	Society of Automotive Engineers, Inc. 400 Commonwealth Drive Warrendale, PA 15096
SAMA	Scientific Apparatus Makers Association One Thomas Circle Washington, DC 20005
SBC	Standard Building Code Published by SBCCI
SBCCI	Southern Building Code Congress International Inc. 900 Montclair Road Birmingham, AL 35213
SCMA	Southern Cypress Manufacturers Association 400 Penn Center Boulevard, Suite 530 Pittsburg, PA 15235
SDI	Steel Door Institute 30200 Detroit Road Cleveland, OH 44145
SMACNA	Sheet Metal and Air Conditioning Contractors National Association, Inc. P.O. Box 221230 Chantilly, VA 22021
SPI	Society of the Plastics Industry, Inc. 1275 K Street NW, Suite 400 Washington, DC 20005
SPIB	Southern Pine Inspection Bureau 4709 Scenic Highway Pensacola, FL 32504
SSPC	Society for Protective Coatings 40 24th Street, 6th Floor Pittsburgh, PA 15222
SSPWC	Standard Specifications for Public Works Construction Building News, Inc. 3055 Overland Avenue Los Angeles, CA 90034
TEMA	Tubular Exchanger Manufacturer's Association 25 North Broadway Tarrytown, NY 10591
TPI	Truss Plate Institute 583 D'Onofrio Drive, Suite 200 Madison, WI 53719
UBC	Uniform Building Code Published by ICBO
UL	Underwriters Laboratories Inc. 333 Pfingsten Road Northbrook, IL 60062
UMC	Uniform Mechanical Code Published by ICBO

UPC	Uniform Plumbing Code Published by IAPMO
USBR	Bureau of Reclamation U.S. Department of Interior Engineering and Research Center Denver Federal Center, Building 67 Denver, CO 80225
WCLIB	West Coast Lumber Inspection Bureau 6980 SW Varns St. P.O. Box 23145 Portland, OR 97223
WWPA	Western Wood Products Association (Formerly called: West Coast Lumbermen's Association (WCLA)) Yeon Building 522 SW 5th Avenue Portland, OR 97204

END OF SECTION

SECTION 01300

SUBMITTALS

PART 1--GENERAL

1.01 DESCRIPTION

Submittals covered by these requirements include manufacturers' information, shop drawings, test procedures, test results, samples, requests for substitutions, and miscellaneous work-related submittals. Submittals shall also include, but not be limited to, all mechanical, electrical and electronic equipment and systems, materials, reinforcing steel, fabricated items, and piping and conduit details. The Contractor shall furnish all drawings, specifications, descriptive data, certificates, samples, tests, methods, schedules, and manufacturer's installation and other instructions as specifically required in the contract documents to demonstrate fully that the materials and equipment to be furnished and the methods of work comply with the provisions and intent of the contract documents.

1.02 CONTRACTOR'S RESPONSIBILITIES

The Contractor shall be responsible for the accuracy and completeness of the information contained in each submittal and shall assure that the material, equipment or method of work shall be as described in the submittal. The Contractor shall verify that all features of all products conform to the specified requirements. Submittal documents shall be clearly edited to indicate only those items, models, or series of equipment, which are being submitted for review. All extraneous materials shall be crossed out or otherwise obliterated. The Contractor shall ensure that there is no conflict with other submittals and notify the Construction Manager in each case where his submittal may affect the work of another contractor or the Owner. The Contractor shall coordinate submittals among subcontractors and suppliers including those submittals complying with unit responsibility requirements specified in paragraph 11000-1.02 C and applicable technical sections.

The Contractor shall coordinate submittals with the work so that work will not be delayed. The Contractor shall coordinate and schedule different categories of submittals, so that one will not be delayed for lack of coordination with another. No extension of time will be allowed because of failure to properly schedule submittals. The Contractor shall not proceed with work related to a submittal until the submittal process is complete. This requires that submittals for review and comment shall be returned to the Contractor stamped "No Exceptions Taken" or "Make Corrections Noted."

The Contractor shall certify on each submittal document that the Contractor has reviewed the submittal, verified field conditions, and complied with the contract documents.

The Contractor may authorize in writing a material or equipment supplier to deal directly with the Construction Manager or with the Owner with regard to a submittal. These dealings shall be limited to contract interpretations to clarify and expedite the work.

1.03 CATEGORIES OF SUBMITTALS

A. GENERAL:

Submittals fall into two general categories; submittals for review and comment, and submittals which are primarily for information only. Submittals which are for information only are generally specified as PRODUCT DATA in Part 2 of applicable specification sections.

At the beginning of work, the Construction Manager will furnish the Contractor lists of those submittals specified in the project manual. Two separate lists will be provided: submittals for review and comment and product data (submittals) for information only.

B. SUBMITTALS FOR REVIEW AND COMMENT:

All submittals except where specified to be submitted as product data for information only shall be submitted by the Contractor to the Construction Manager for review and comment.

C. SUBMITTALS (PRODUCT DATA) FOR INFORMATION ONLY:

Where specified, the Contractor shall furnish submittals (product data) to the Construction Manager for Information only. Submittal requirements for operation and maintenance manuals, which are included in this category, are specified in Section 01730.

1.04 TRANSMITTAL PROCEDURE

A. GENERAL:

Unless otherwise specified, submittals regarding material and equipment shall be accompanied by Transmittal Form 01300-A specified in Section 01999. Submittals for operation and maintenance manuals, information and data shall be accompanied by Transmittal Form 01730-A specified in Section 01999. A separate form shall be used for each specific item, class of material, equipment, and items specified in separate, discrete sections, for which the submittal is required. Submittal documents common to more than one piece of equipment shall be identified with all the appropriate equipment numbers. Submittals for various items shall be made with a single form when the items taken together constitute a manufacturer's package or are so functionally related that expediency indicates checking or review of the group or package as a whole.

A unique number, sequentially assigned, shall be noted on the transmittal form accompanying each item submitted. Original submittal numbers shall have the following format: "XXX"; where "XXX" is the sequential number assigned by the Contractor. Resubmittals shall have the following format: "XXX-Y"; where "XXX" is the originally assigned submittal number and "Y" is a sequential letter assigned for resubmittals, i.e., A, B, or C being the 1st, 2nd, and 3rd resubmittals, respectively. Submittal 25B, for example, is the second resubmittal of submittal 25.

B. DEVIATION FROM CONTRACT:

If the Contractor proposes to provide material, equipment, or method of work which deviates from the project manual, deviations shall be indicated under "deviations" on the transmittal form accompanying the submittal copies.

C. SUBMITTAL COMPLETENESS:

Submittals which do not have all the information required to be submitted, including deviations, are not acceptable and will be returned without review.

1.05 REVIEW PROCEDURE

A. GENERAL:

Submittals are specified for those features and characteristics of materials, equipment, and methods of operation which can be selected based on the Contractor's judgment of their conformance to the specified requirements. Other features and characteristics are specified in a manner which enables the Contractor to determine acceptable options without submittals. The review procedure is based on the Contractor's guarantee that all features and characteristics not requiring submittals conform as specified. Review shall not extend to means, methods, techniques, sequences or procedures of construction, or to verifying quantities, dimensions, weights or gages, or fabrication processes (except where specifically indicated or required by the project manual) or to safety precautions or programs incident thereto. Review of a separate item, as such, will not indicate approval of the assembly in which the item functions.

When the contract documents require a submittal, the Contractor shall submit the specified information as follows:

1. Three hard copies of all submitted information plus one electronic copy in PDF format on compact disc (CD) of all information shall be transmitted with submittals for review and comment.

2. Unless otherwise specified, three hard copies of all submitted information plus one electronic copy in PDF format on CD shall be transmitted with submittals (Product Data) for information only.

B. SUBMITTALS FOR REVIEW AND COMMENT:

Unless otherwise specified, within 10 working days after receipt of a submittal for review and comment, the Construction Manager shall review the submittal and return one hard copy. The returned submittal shall indicate one of the following actions:

1. If the review indicates that the material, equipment or work method complies with the project manual, submittal copies will be marked "NO EXCEPTIONS TAKEN." In this event, the Contractor may begin to

implement the work method or incorporate the material or equipment covered by the submittal.

2. If the review indicates limited corrections are required, copies will be marked "MAKE CORRECTIONS NOTED." The Contractor may begin implementing the work method or incorporating the material and equipment covered by the submittal in accordance with the noted corrections. Where submittal information will be incorporated in O&M data, a corrected copy shall be provided.

3. If the review reveals that the submittal is insufficient or contains incorrect data, copies will be marked "AMEND AND RESUBMIT." The Contractor shall not undertake work covered by this submittal until it has been revised, resubmitted and returned marked either "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED."

4. If the review indicates that the material, equipment, or work method does not comply with the project manual, copies of the submittal will be marked "REJECTED - SEE REMARKS." Submittals with deviations which have not been identified clearly may be rejected. The Contractor shall not undertake the work covered by such submittals until a new submittal is made and returned marked either "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED."

C. SUBMITTALS (PRODUCT DATA) FOR INFORMATION ONLY:

Such information is not subject to submittal review procedures and shall be provided as part of the work under this contract and its acceptability determined under normal inspection procedures.

1.06 EFFECT OF REVIEW OF CONTRACTOR'S SUBMITTALS

Review of contract drawings, methods of work, or information regarding materials or equipment the Contractor proposes to provide, shall not relieve the Contractor of his responsibility for errors therein and shall not be regarded as an assumption of risks or liability by the Construction Manager or the Owner, or by any officer or employee thereof, and the Contractor shall have no claim under the contract on account of the failure, or partial failure, of the method of work, material, or equipment so reviewed. A mark of "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED" shall mean that the Owner has no objection to the Contractor, upon his own responsibility, using the plan or method of work proposed, or providing the materials or equipment proposed, and in the case of "MAKE CORRECTIONS NOTED" the Contractor will implement those corrections prior to any action.

PART 2--NOT USED

PART 3--NOT USED

END OF SECTION

SECTION 01380

PHOTOGRAPHS

PART 1--GENERAL

1.01 PRECONSTRUCTION PHOTOGRAPHS

The Contractor shall provide preconstruction photographs prior to commencement of work on the site. The photographs shall be minimum 35-mm film size or electronic jpeg files with an index print, and shall indicate on the front of each print the date, name of work, and the location where the photograph was taken. Before construction may start, 4-inch by 6-inch glossy prints of each exposure, together with the negative, or electronic jpeg files on a CD with an index print, clearly depicting preconstruction conditions must be delivered to the Construction Manager. Preconstruction photographs shall be taken at locations to be designated by the Construction Manager.

1.02 CONSTRUCTION PHOTOGRAPHS

The Contractor shall provide construction photographs showing the progress of the work. The photographs shall be taken of such subjects as may be directed, shall be minimum 35-mm film size or electronic jpeg files on a CD with an index print, and shall indicate on the front of each print the date, job title and brief description of the photograph including the location where the photograph was taken. Starting one week after the date of the preconstruction photographs and continuing as long as the work is in progress, a minimum of 28 weekly photographs shall be taken.

Upon acceptance of the work, a minimum of 24 color exposure photographs shall be made of the work where directed by the Construction Manager. 4-inch by 6-inch prints of each exposure, together with the negatives or electronic jpeg files on a CD with an index print, shall be delivered to the Construction Manager within 10 days following each set of exposures.

PART 2--NOT USED

PART 3--NOT USED

END OF SECTION

SECTION 01500

CONTRACTOR'S UTILITIES

PART 1--GENERAL

1.01 DESCRIPTION

This section describes the responsibilities of the Contractor with regard to temporary power, telephone service, water, sanitary facilities, barriers, fencing, protection of Work, water control, access roads, parking, progress cleaning, project signage, and buildings. This Section also describes the Contractor's responsibility for overall safety of project activities.

1.02 POWER

The Contractor shall provide power for construction at the site. He shall make arrangements with the electrical utility and with the Owner for power takeoff points, voltage and phasing requirements, transformers and metering and shall pay the costs and fees arising there from. The Contractor shall provide the special connections required for his work.

1.03 TELEPHONE

The Contractor shall provide telephone service at the construction site. Radio-telephone service is not acceptable as a substitute for telephone service. Cellular telephones are acceptable.

1.04 SANITARY FACILITIES

The Contractor shall provide toilet and wash-up facilities for his work force at the site of work. The facilities shall comply with applicable laws, ordinances, and regulations pertaining to the public health and sanitation of dwellings and camps, in conformance with OSHA CFR 1926.5.

1.05 WATER

The Contractor shall provide water for construction at the site. For conservation reasons, water flooding of trenches for backfilling using potable water is discouraged. The Contractor shall request water using form provided by City of Glendale. City of Glendale must approve form prior to water use.

1.06 SECURITY

The Contractor shall provide security and facilities to protect Work, and existing facilities, from unauthorized entry, vandalism, or theft. The Contractor is responsible for any losses that occur.

PART 2--NOT USED

PART 3--NOT USED

END OF SECTION

SECTION 01560

ENVIRONMENTAL CONTROLS

PART 1--GENERAL

1.01 SITE MAINTENANCE

The Contractor shall keep the work site clean and free from rubbish and debris. Materials and equipment shall be removed from the site when they are no longer necessary. Upon completion of the work and before final acceptance, the work site shall be cleared of equipment, unused materials, and rubbish to present a clean and neat appearance.

1.02 AIR POLLUTION CONTROL

The Contractor shall not discharge or cause to be discharged any smoke, dust, and other contaminants into the atmosphere that violate the regulations of any legally constituted authority. The Contractor shall also abate dust nuisance by cleaning, sweeping, and sprinkling with water, or other means as necessary. The use of water, in amounts which result in mud on public streets, is not acceptable as a substitute for sweeping or other methods.

1.03 NOISE CONTROL

Construction start and stop times shall be according to the City of Glendale Noise Ordinance. From April 15th to October 15th, concrete may be poured between the hours of 5:00 A.M. and 7:00 P.M. All other construction or repair work shall not begin prior to 6:00 A. M. and must stop by 7:00 P.M. From October 16th to April 14th, concrete may be poured between the hours of 6:00 A.M to 7:00 P.M. All other construction or repair work shall not begin prior to 7:00 A.M. and must stop by 7:00 P.M. Written authorization from the City Engineer will be required to work beyond the above stated time limits. Noise from Contractor's operations shall not exceed limits established by applicable laws or regulations and in no event shall exceed 86 dBA at a distance of 50feet from the noise source.

1.04 BARRIERS

The Contractor shall provide barriers to prevent unauthorized entry to construction areas. The Contractor shall take all necessary measures to protect existing facilities and adjacent properties from damage resulting from construction operations.

The Contractor shall take measures to protect plant life that has been designated to remain and shall be responsible for the replacement of such plant life if damaged during construction activities.

The Contractor shall take all reasonable measures to protect non-Contractor vehicles, materials stored onsite and structures from damage.

PART 2--NOT USED

PART 3--NOT USED

END OF SECTION

SECTION 01605

SHIPMENT, PROTECTION AND STORAGE

PART 1--GENERAL

1.01 GENERAL

Equipment, products and materials shall be shipped, handled, stored, and installed as specified by the manufacturer and to prevent damage to the items. Damaged items will not be permitted as part of the work except in cases of minor damage that have been satisfactorily repaired and are acceptable to the Construction Manager. The Contractor shall identify equipment, product and material staging and storage areas and confirm acceptance of these areas with the City at the pre-construction meeting.

1.02 PIPE

Pipe and appurtenances shall be handled, stored, and installed as recommended by the manufacturer. Pipes with paint, tape coatings, linings or the like shall be stored to protect the coating or lining from physical damage or other deterioration. Pipes shipped with interior bracing shall have the bracing removed only as recommended by the manufacturer.

1.03 EQUIPMENT

A. PACKAGE AND MARKING:

All equipment shall be protected against damage from moisture, dust, handling, or other cause during transport from manufacturer's premises to site. Each item or package shall be marked with the number unique to the specification reference covering the item.

Stiffeners shall be used where necessary to maintain shapes and to give rigidity. Parts of equipment shall be delivered in assembled or subassembled units where possible.

B. IDENTIFICATION:

Each item of equipment and valve shall have permanently affixed to it a label or tag with its equipment or valve number designated in this contract. Marker shall be of stainless steel. Location of label will be easily visible.

Shipping manifests for each item of equipment or valve from the manufacturer or supplier certifying that all materials and components are manufactured in the United States, and that the manufactured goods were assembled into the final product in the United States shall be kept on file by the Contractor such that demonstration of Buy American Standards may be verified.

C. SHIPPING:

Bearing housings, vents and other types of openings shall be wrapped or otherwise sealed to prevent contamination by grit and dirt.

Damage shall be corrected to conform to the requirements of the contract before the assembly is incorporated into the work. The Contractor shall bear the costs arising out of dismantling, inspection, repair and reassembly.

D. FACTORY APPLIED COATINGS:

Unless otherwise specified, each item of equipment shall be shipped to the site of the work with the manufacturer's shop applied epoxy prime coating as specified in Section 09900. The prime coating shall be applied over clean dry surfaces in accordance with the coating manufacturer's recommendations. The prime coating will serve as a base for field-applied finish coats. Electrical equipment and materials shall be painted by manufacturer as specified in paragraph 09900-3.03 H.

E. STORAGE:

During the interval between the delivery of equipment to the site and installation, all equipment, unless otherwise specified, shall be stored in an enclosed space affording protection from weather, dust and mechanical damage and providing favorable temperature, humidity and ventilation conditions to ensure against equipment deterioration. Manufacturer's recommendations shall be adhered to in addition to these requirements.

Equipment and materials to be located outdoors may be stored outdoors if protected against moisture condensation. Equipment shall be stored at least 6 inches above ground. Temporary power shall be provided to energize space heaters or other heat sources for control of moisture condensation. Space heaters or other heat sources shall be energized without disturbing the sealed enclosure.

F. PROTECTION OF EQUIPMENT AFTER INSTALLATION:

After installation, all equipment shall be protected from damage from, including but not limited to, dust, abrasive particles, debris and dirt generated by the placement, chipping, sandblasting, cutting, finishing and grinding of new or existing concrete, terrazzo and metal; and from the fumes, particulate matter, and splatter from welding, brazing and painting of new or existing piping and equipment. As a minimum, vacuum cleaning, blowers with filters, protective shieldings, and other dust suppression methods will be required at all times to adequately protect all equipment. During concreting, including finishing, all equipment that may be affected by cement dust must be completely covered. During painting operations, all grease fittings and similar openings shall be covered to prevent the entry of paint. Electrical switchgear, unit substation, and motor load centers shall not be installed until after all concrete work and sandblasting in those areas have been completed and accepted and the ventilation systems installed.

PART 2--NOT USED

PART 3--NOT USED

END OF SECTION

SECTION 01660

EQUIPMENT AND SYSTEM PERFORMANCE AND OPERATIONAL TESTING

PART 1--GENERAL

1.01 DESCRIPTION

This section contains requirements for the Contractor's performance in documenting testing work required under this contract. In addition, this section contains requirements the for the Contractor's performance during installed performance testing of all mechanical, electrical, instrumentation, and HVAC equipment and systems, including structures for watertight construction, provided under this contract. This section supplements but does not supersede specific testing requirements found elsewhere in this project manual.

1.02 QUALITY ASSURANCE

A. QUALITY ASSURANCE:

The Contractor is responsible for Quality Assurance. The Contractor shall have experience on at least five separate projects, in managing the startup commissioning of mechanical, electrical, instrumentation, HVAC, and piping systems. The quality assurance program shall include:

1. A testing plan setting forth the sequence in which all testing work required under this project manual will be implemented.

2. A documentation program to record the results of all equipment and system tests.

3. An installed performance testing program for all mechanical, electrical, instrumentation, and HVAC equipment and systems installed under this contract.

4. A calibration program for all instruments, meters, monitors, gages, and thermometers installed under this contract.

5. A calibration program for all instruments, gages, meters, and thermometers used for determining the performance of equipment and systems installed under this contract.

6. A testing schedule conforming to the requirements specified in paragraph 01660-2.02 C.

For the purposes of this section, a system shall include all items of equipment, devices and appurtenances connected in such a fashion as their operation or function complements, protects or controls the operation or function of the others. The Contractor shall coordinate the activities of all subcontractors and suppliers to implement the requirements of this section.

B. CALIBRATION:

All test equipment (gages, meters, thermometers, analysis instruments, and other equipment) used for calibrating or verifying the performance of equipment installed under this contract shall be calibrated to within plus or minus 2 percent of actual value at full scale. Test equipment employed for individual test runs shall be selected so that expected values as indicated by the detailed performance specifications will fall between 60 and 85 percent of full scale. Pressure gages shall be calibrated in accordance with ANSI/ASME B40.1. Thermometers shall be calibrated in accordance with ASTM E77 and shall be furnished with a certified calibration curve.

Liquid flow meters, including all meters installed in pipelines with diameters greater than 2 inches shall be calibrated in situ per AWWA Manual M6 standards for the type of meter installed. Gas flow meters installed in piping systems with diameters greater than 6 inches shall be calibrated in situ using the pitot tube velocity averaging method. Flow meter calibration work shall be performed by individuals skilled in the techniques to be employed. Calibration tests for flow metering systems shall be performed over a range of not less than 10 percent to at least 75 percent of system full scale. At least five confirmed valid data points shall be obtained within this range. Confirmed data points shall be validated by not less than three test runs with results which agree within plus or minus 2 percent.

C. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI/ASME B40.1	Gauges Pressure Indicating Dial Type-Elastic Element
ASTM E77	Method for Verification and Calibration of Liquid-in-Glass Thermometers
AWWA M6	Water Meters – Selection, Installation Testing and Maintenance

1.03 SUBMITTALS

Submittal material, to be submitted in accordance with Section 01300, shall consist of the following:

1. A complete description of the Contractor's plan for documenting the results from the test program in conformance with the requirements of paragraph 01660-2.02 A, including:

   a. Proposed plan for documenting the calibration of all test instruments.

   b. Proposed plan for calibration of all instrument systems, including flow meters and all temperature, pressure, weight, and analysis systems.

   c. Sample forms for documenting the results of field pressure and performance tests.

2. The credentials and certification of the testing laboratory proposed by the Contractor for calibration of all test equipment.

3. Preoperational check-out procedures, reviewed and approved by the respective equipment manufacturers.

4. Detailed testing plans, setting forth step-by-step descriptions of the procedures proposed by the Contractor for the systematic testing of all equipment and systems installed under this contract.

5. A schedule and subsequent updates, presenting the Contractor's plan for testing the equipment and systems installed under this contract.

6. A schedule establishing the expected time period (calendar dates) when the Contractor plans to commence operational testing of the completed systems, along with a description of the temporary systems and installations planned to allow operational testing to take place.

PART 2--PRODUCTS

2.01 GENERAL

The Contractor shall prepare test plans and documentation plans as specified in the following paragraphs. The Construction Manager will not witness any test work for the purpose of acceptance until all test documentation and calibration plans and the specified system or equipment test plans have been submitted and accepted.

2.02 DOCUMENTATION

A. DOCUMENTATION PLANS:

The Contractor shall develop a records keeping system to document compliance with the requirements of this Section. Calibration documentation shall include identification (by make, manufacturer, model, and serial number) of all test equipment, date of original calibration, subsequent calibrations, calibration method, and test laboratory.

Equipment and system documentation shall include date of test, equipment number or system name, nature of test, test objectives, test results, test instruments employed for the test and signature spaces for the Construction manager's witness and the Contractor. A separate file shall be established for each system and item of equipment. These files shall include the following information as a minimum:

1. Metallurgical tests
2. Factory performance tests
3. Field calibration tests[1]
4. Field pressure tests[1]
5. Field performance tests[1]
6. Field operational tests[1]

Section 01999 contains samples showing the format and level of detail required for the documentation forms. The Contractor is advised that these are samples only and are not specific to this project nor to any item of equipment or system to be installed under this contract. The Contractor shall develop test documentation forms specific to each item of equipment and system installed under this contract. Acceptable documentation forms for all systems and items of equipment shall be produced for review by the Construction Manager as a condition precedent to the Contractor's receipt of progress payments in excess of 50 percent of the contract amount. Once the Construction Manager has reviewed and taken no exception to the forms proposed by the Contractor, the Contractor shall produce sufficient forms, at his expense, to provide documentation of all testing work to be conducted as a part of this contract.

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[1]Each of these tests is required even though not specifically noted in detailed specification section.

B. TEST PLANS:

The Contractor shall develop test plans detailing the coordinated, sequential testing of each item of equipment and system installed under this contract. Each test plan shall be specific to the item of equipment or system to be tested. Test plans shall identify by specific equipment or tag number each device or control station to be manipulated or observed during the test procedure and the specific results to be observed or obtained. Test plans shall also be specific as to support systems required to complete the test work, temporary systems required during the test work, subcontractors' and manufacturers' representatives to be present and expected test duration. As a minimum, the test plans shall include the following features:

1. Step-by-step proving procedure for all control and electrical circuits by imposing low voltage currents and using appropriate indicators to affirm that the circuit is properly identified and connected to the proper device.

2. Calibration of all analysis instruments and control sensors.

3. Performance testing of each individual item of mechanical, electrical, and instrumentation equipment. Performance tests shall be selected to duplicate the operating conditions described in the project manual.

4. System tests designed to duplicate, as closely as possible, operating conditions described in the project manual.

Test plans shall contain a complete description of the procedures to be employed to achieve the desired test environment.

As a condition precedent to receiving progress payments in excess of 75 percent of the contract amount, or in any event, progress payments due to the Contractor eight weeks in advance of the date the Contractor wishes to begin any testing work (whichever occurs earliest in the project schedule), the Contractor shall have submitted all test plans required for the systematic field performance and operational tests for all equipment and systems installed under this contract. Once the Construction Manager has reviewed and taken no exception to the Contractor's test plans, the Contractor shall reproduce the plans in sufficient number for the Contractor's purposes and an additional ten copies for delivery to the Construction Manager. No test work shall begin until the Contractor has delivered the specified number of final test plans to the Construction Manager.

C. TESTING SCHEDULE:

The Contractor shall produce a testing schedule setting forth the sequence contemplated for performing the test work. The schedule shall be in bar chart form, plotted against calendar time, shall detail the equipment and systems to be tested, and shall be coordinated with the Contractor's construction schedule specified in Section 01310. The schedule shall show the contemplated start date, duration of the test and completion of each test. The test schedule shall be submitted no later than 2 weeks in advance of the date testing is to begin. The Construction Manager will not witness any testing work for the purpose of acceptance until the Contractor has submitted a schedule to

which the Construction Manager takes no exception. The test schedule shall be updated weekly, showing actual dates of test work, indicating systems and equipment testing completed satisfactorily and meeting the requirements of this project manual.

2.03 SYSTEM AND EQUIPMENT PERFORMANCE TESTS

Each item of mechanical, electrical, instrumentation, and HVAC equipment installed under this contract shall be tested to demonstrate compliance with the performance requirements of this project manual. Each electrical, instrumentation, mechanical, piping, and HVAC system installed or modified under this contract shall be tested in accordance with the requirements of this project manual.

2.04 OPERATIONAL TESTS

Once all equipment and systems have been tested individually, the Contractor shall fill all systems except wastewater, scum sludge and other wastewater derived systems with the intended process fluids. Wastewater-derived process systems shall be filled with water. After filling operations have been completed, the Contractor shall operate all systems for a continuous period of not less than 48 hours, simulating actual operating conditions to the greatest extent possible. The Contractor shall install temporary connections, bulkheads and make other provisions to recirculate process fluids or otherwise simulate anticipated operating conditions. During the operational testing period, the Contractor shall monitor the characteristics of each machine and system and report any unusual conditions to the Construction Manager.

2.05 PRODUCT DATA

Product data, to be provided in accordance with Section 01300, shall be the original and three copies of all records produced during the testing program.

PART 3--EXECUTION

3.01 GENERAL

The Contractor shall organize teams made up of qualified representatives of equipment suppliers, subcontractors, the Contractor's independent testing laboratory, and others, as appropriate, to efficiently and expeditiously calibrate and test the equipment and systems installed and constructed under this contract. The objective of the testing program shall be to demonstrate, to the Construction Manager's complete satisfaction, that the structures, systems, and equipment constructed and installed under this contract meet all performance requirements and the facility is ready for the commissioning process to commence. In addition, the testing program shall produce baseline operating conditions for the Owner to use in a preventive maintenance program.

3.02 CALIBRATION OF FIXED INSTRUMENTS

Calibration of analysis instruments, sensors, gages, and meters installed under this contract shall proceed on a system-by-system basis. No equipment or system performance acceptance tests shall be performed until instruments, gages, and meters to be installed in that particular system have been calibrated and the calibration work has been witnessed by the Construction Manager.

All analysis instruments, sensors, gages, and meters used for performance testing shall be subject to recalibration to confirm accuracy after completion, but prior to acceptance of each performance test.

3.03 PERFORMANCE TESTS

A. GENERAL:

Performance tests shall consist of the following:

1. Pressure and/or leakage tests.

2. Electrical testing as specified in Division 16.

3. Wiring and piping, individual component, loop, loop commissioning and tuning testing as described in Division 17.

4. Preoperational checkout for all mechanical and HVAC equipment. Preoperational check-out procedures shall be reviewed and approved by the respective equipment manufacturers.

5. Initial operation tests of all mechanical, electrical, HVAC, and instrumentation equipment and systems to demonstrate compliance with the performance requirements of this project manual.

In general, performance tests for any individual system shall be performed in the order listed above. The order may be altered only on the specific written authorization of the Construction Manager after receipt of a written request, complete with justification of the need for the change in sequence.

B. PRESSURE AND LEAKAGE TESTS:

Pressure and leakage tests shall be conducted in accordance with applicable portions of Divisions 3 and 15. All acceptance tests shall be witnessed by the Construction Manager. Evidence of successful completion of the pressure and leakage tests shall be the Construction Manager's signature on the test forms prepared by the Contractor.

C. FUNCTIONAL CHECKOUT:

Prior to energization (in the case of electrical systems and equipment), all circuits shall be rung out and tested for continuity and shielding in accordance with the procedures required in Division 16.

D. COMPONENT CALIBRATION AND LOOP TESTING:

Prior to energization (in the case of instrumentation system and equipment), all loops and associated instruments shall be calibrated and tested in accordance with the procedures required in Division 17.

E. ELECTRICAL RESISTANCE:

Electrical resistance testing shall be in accordance with Division 16.

F. PREOPERATIONAL TESTS:

Preoperational tests shall include the following:

1. Alignment of equipment using reverse dial indicator method.

2. Preoperation lubrication.

3. Tests per the manufacturers' recommendations for prestart preparation and preoperational check-out procedures.

G. FUNCTIONAL TESTS:

1. GENERAL: Once all affected equipment has been subjected to the required preoperational check-out procedures and the Construction Manager has witnessed and has not found deficiencies in that portion of the work, individual items of equipment and systems may be started and operated under simulated operating conditions to determine as nearly as possible whether the equipment and systems meet the requirements of these specifications. Potable water shall be employed as the test medium. The equipment shall be operated a sufficient period of time to determine machine operating characteristics, including noise, temperatures and vibration; to observe performance characteristics; and to permit initial adjustment of operating controls. When testing requires the availability of auxiliary systems such as looped piping, electrical power, compressed air, control air, or instrumentation which have not yet been placed in service, the Contractor shall provide acceptable substitute sources, capable of meeting the requirements of the machine, device, or system at no additional cost to the Owner. Disposal methods for test media shall be subject to review by the Construction Manager. During the 8 hour functional test period, the Contractor shall obtain baseline operating data on all equipment as directed by the Construction Manager. The baseline data shall be collected for the Owner to enter in a preventive maintenance system.

Test results shall be within the tolerances set forth in the detailed specification sections of this project manual. If no tolerances have been specified, test results shall conform to tolerances established by recognized industry practice. Where, in the case of an otherwise satisfactory functional test, any doubt, dispute, or difference should arise between the Construction Manager and the Contractor regarding the test results or the methods or equipment used in the performance of such test, then the Construction Manager may order the test to be repeated. If the repeat test, using such modified methods or equipment as the Construction Manager may require, confirms the previous test, then all costs in connection with the repeat test will be paid by the Owner. Otherwise, the costs shall be borne by the Contractor. Where the results of any functional test fail to comply with the contract requirements for such test, then such repeat tests as may be necessary to achieve the contract requirements shall be made by the Contractor at his expense.

The Contractor shall provide, at no expense to the Owner, all power, fuel, compressed air supplies, water, and chemicals, all labor, temporary piping, heating, ventilating, and air conditioning for any areas where permanent facilities are not complete and operable at the time of functional tests, and all other items and work required to complete the functional tests. Temporary facilities shall be maintained until permanent systems are in service.

2. RETESTING: If under test, any portion of the work should fail to fulfill the contract requirements and is adjusted, altered, renewed, or replaced, tests on that portion when so adjusted, altered, removed, or replaced, together with all other portions of the work as are affected thereby, shall, unless otherwise directed by the Construction Manager, be repeated within reasonable time and in accordance with the specified conditions. The Contractor shall pay to the Owner all reasonable expenses incurred by the Owner, including the costs of the Construction Manager, as a result of repeating such tests.

3. POSTTEST INSPECTION: Once functional testing has been completed, all machines shall be rechecked for proper alignment and realigned, as required. All equipment shall be checked for loose connections, unusual movement, or other indications of improper operating characteristics. Any deficiencies shall be corrected to the satisfaction of the Construction Manager. All machines or devices which exhibit unusual or unacceptable operating characteristics shall be disassembled and inspected. Any defects found during the course of the inspection shall be repaired or the specific part or entire equipment item shall be replaced to the complete satisfaction of the Construction Manager at no cost to the Owner.

3.04 OPERATIONAL TESTS

The Contractor shall provide system operation testing. After completion of all performance testing and certification by the Construction Manager that all equipment complies with the requirements of the specifications, the Contractor shall fill all process units and process systems, except those employing oil, air, or chemicals, with potable water. All oil, air, and chemical systems shall be filled with the specified fluid.

Upon completion of the filling operations, the Contractor shall circulate water through the completed facility for a period of not less than 4 hours, during which all parts of the system shall be operated as a complete facility at various loading conditions, as directed by the Construction

Manager. The operational testing period shall commence after this initial period of variable operation. The operational testing period shall be 48 hours. Should the operational testing period be halted for any reason related to the facilities constructed or the equipment furnished under this contract, or the Contractor's temporary testing systems, the operational testing program shall be repeated until the specified continuous period has been accomplished without interruption. All process units shall be brought to full operating conditions, including temperature, pressure, and flow.

As-built documents specified in Section 01720 of facilities involved shall be accepted and ready for turnover to the Owner at the time of operational testing.

END OF SECTION

SECTION 01664

TRAINING

PART 1--GENERAL

1.01 DESCRIPTION

This section contains requirements for training the Owner's personnel, by persons retained by the Contractor specifically for the purpose, in the proper operation and maintenance of the equipment and systems installed under this contract.

1.02 QUALITY ASSURANCE

Where required by the detailed specifications, the Contractor shall provide on-the-job training of the Owner's personnel. The training sessions shall be conducted by qualified, experienced, factory-trained representatives of the various equipment manufacturers. Training shall include instruction in both operation and maintenance of the subject equipment.

1.03 SUBMITTALS

The following information shall be submitted to the Construction Manager in accordance with the provisions of Section 01300. The material shall be reviewed and accepted by the Construction Manager as a condition precedent to receiving progress payments in excess of 80 percent of the contract amount and not less than 3 weeks prior to the provision of training.

1. Lessons plans for each training session to be conducted by the manufacturer's representatives. In addition, training manuals, handouts, visual aids, and other reference materials shall be included.

2. Subject of each training session, identity and qualifications of individuals to be conducting the training, and tentative date and time of each training session.

PART 2--PRODUCTS

2.01 GENERAL

Where specified, the Contractor shall conduct training sessions for the Owner's personnel to instruct the staff on the proper operation, care, and maintenance of the equipment and systems installed under this contract. Training shall take place at the site of the work and under the conditions specified in the following paragraphs. Approved operation and maintenance manuals shall be available at least 10 days prior to the date scheduled for the individual training session.

2.02 LOCATION

Training sessions shall take place at a site to be determined by the Owner.

2.03 LESSON PLANS

Formal written lesson plans shall be prepared for each training session. Lesson plans shall contain an outline of the material to be presented along with a description of visual aids to be utilized during the session. Each plan shall contain a time allocation for each subject.

One complete set of originals of the lesson plans, training manuals, handouts, visual aids, and reference material shall be the property of the Owner and shall be suitably bound for proper organization and easy reproduction. The Contractor shall furnish ten copies of necessary training manuals, handouts, visual aids and reference materials at least 1 week prior to each training session.

2.04 FORMAT AND CONTENT

Each training session shall be comprised of time spent both in the classroom and at the specific location of the subject equipment or system. As a minimum, training session shall cover the following subjects for each item of equipment or system:

1. Familiarization

    a. Review catalog, parts lists, drawings, etc., which have been previously provided for the files and operation and maintenance manuals.

    b. Check out the installation of the specific equipment items.

    c. Demonstrate the unit and indicate how all parts of the specifications are met.

    d. Answer questions.

2. Safety

    a. Using material previously provided, review safety references.

    b. Discuss proper precautions around equipment.

3. Operation

    a. Using material previously provided, review reference literature.

b. Explain all modes of operation (including emergency).

c. Check out Owner's personnel on proper use of the equipment.

4. Preventive Maintenance

a. Using material previously provided, review preventive maintenance (PM) lists including:

1) Reference material.

2) Daily, weekly, monthly, quarterly, semiannual, and annual jobs.

b. Show how to perform PM jobs.

c. Show Owner's personnel what to look for as indicators of equipment problems.

5. Corrective Maintenance

a. List possible problems.

b. Discuss repairs--point out special problems.

c. Open up equipment and demonstrate procedures, where practical.

6. Parts

a. Show how to use previously provided parts list and order parts.

b. Check over spare parts on hand. Make recommendations regarding additional parts that should be available.

7. Local Representatives

a. Where to order parts: name, address, telephone.

b. Service problems:

1) Who to call.

2) How to get emergency help.

8. Operation and Maintenance Manuals

a. Review any other material submitted.

b. Update material, as required.

2.05 VIDEO RECORDING:

The Owner reserves the right to retain the services of a commercial video taping service to record each training session. After taping, the material will be edited and supplemented with professionally produced graphics to provide a permanent record. The Contractor shall advise all manufacturers providing training sessions that the material will be video taped and shall make available to the Owner's video taping contractor such utility services and accommodation as may be required to facilitate the production of the video tape record.

PART 3--EXECUTION

Training shall be conducted in conjunction with the operational testing and commissioning periods. Classes shall be scheduled such that classroom sessions are interspersed with field instruction in logical sequence. The Contractor shall arrange to have the training conducted on consecutive days, with no more than 6 hours of classes scheduled for any one day. Concurrent classes shall not be allowed. Training shall be certified on Form 11000-B specified in Section 01999.

Acceptable operation and maintenance manuals for the specific equipment shall be provided to the Owner prior to the start of any training. Video taping shall take place concurrently with all training sessions.

The following services shall be provided for each item of equipment or system as required in individual specification sections. Additional services shall be provided, where specifically required in individual specification sections.

1. As a minimum classroom equipment training for operations personnel will include:

a. Using slides and drawings, discuss the equipment's specific location in the site and an operational overview.

b. Purpose and site function of the equipment.

c. A working knowledge of the operating theory of the equipment.

d. Start-up, shutdown, normal operation, and emergency operating procedures, including a discussion on system integration and electrical interlocks, if any.

e. Identify and discuss safety items and procedures.

f. Routine preventative maintenance, including specific details on lubrication and maintenance of corrosion protection of the equipment and ancillary components.

g. Operator detection, without test instruments, of specific equipment trouble symptoms.

h. Required equipment exercise procedures and intervals.

i. Routine disassembly and assembly of equipment if applicable (as judged by the Owner on a case-by-case basis) for purposes such as operator inspection of equipment.

2. As a minimum, hands-on equipment training for operations personnel will include:

a. Identify location of equipment and review the purpose.

b. Identifying piping and flow options.

c. Identifying valves and their purpose.

d. Identifying instrumentation:

1) Location of primary element.

2) Location of instrument readout.

3) Discuss purpose, basic operation, and information interpretation.

e. Discuss, demonstrate, and perform standard operating procedures and round checks.

f. Discuss and perform the preventative maintenance activities.

g. Discuss and perform start-up and shutdown procedures.

h. Perform the required equipment exercise procedures.

i. Perform routine disassembly and assembly of equipment if applicable.

j. Identify and review safety items and perform safety procedures, if feasible.

3. Equipment training for the maintenance and repair personnel will include:

a. Theory of operation.

b. Description and function of equipment.

c. Start-up and shutdown procedures.

d. Normal and major repair procedures.

e. Equipment inspection and troubleshooting procedures including the use of applicable test instruments and the "pass" and "no pass" test instrument readings.

f. Routine and long-term calibration procedures.

g. Safety procedures.

h. Preventative maintenance such as lubrication; normal maintenance such as belt, seal, and bearing replacement; and up to major repairs such as replacement of major equipment part(s) with the use of special tools, bridge cranes, welding jigs, etc.

4. Hands-on equipment training for maintenance and repair personnel shall include:

a. Locate and identify equipment components.

b. Review the equipment function and theory of operation.

c. Review normal repair procedures.

d. Perform start-up and shutdown procedures.

e. Review and perform the safety procedures.

f. Perform Owner approved practice maintenance and repair job(s), including mechanical and electrical adjustments and calibration and troubleshooting equipment problems.

END OF SECTION

SECTION 01700

RESTORATION OF IMPROVEMENTS

PART 1--GENERAL

1.01 STRUCTURES

The Contractor shall take all precautions necessary to protect the integrity and usefulness of all existing plant facilities. If necessary, the Contractor may, with the approval of the Owner, remove such existing structures, including curbs, gutters, pipelines and utility poles as may be necessary for the performance of the work, and shall rebuild the structures thus removed in as good a condition as found with the requirements specified. He shall also repair existing structures which may be damaged as a result of the work under this contract.

1.02 ROADS AND STREETS

Unless otherwise specified, roads and streets in which the surface is removed, broken, or damaged, or in which the ground has caved or settled during the work under this contract, shall be resurfaced and brought to the original grade and section. Roadways used by the Contractor shall be cleaned and repaired. Before resurfacing material is placed, edges of pavements shall be trimmed back far enough to provide clean, solid, vertical faces, and shall be free of loose material. All paved surfaces shall be cut with a pavement saw. Rough cuts are not allowed. Repair work shall conform to the paving specifications.

1.03 CULTIVATED AREAS AND OTHER SURFACE IMPROVEMENTS

Cultivated or planted areas and other surface improvements which are damaged by actions of the Contractor shall be restored as nearly as possible to their original condition. Restoration shall take place within 1 week or sooner as directed by the Construction Manager.

Existing guard posts, barricades, and fences shall be protected and replaced if damaged.

1.04 PROTECTION OF EXISTING INSTALLATIONS

The Contractor shall protect all existing operating facilities and structures from damages. However, if damage occurs, the Contractor shall immediately correct or replace existing equipment, controls, systems, structures, or facilities which are damaged in any way as a result of his operations.

PART 2--NOT USED

PART 3--NOT USED

END OF SECTION

SECTION 01720

RECORD DRAWINGS

Record drawings refer to those documents maintained and annotated by the Contractor during construction and are defined as (1) a neatly and legibly marked set of contract drawings showing the final location of piping, equipment, electrical conduits, outlet boxes and cables; (2) additional documents such as schedules, lists, drawings, and electrical and instrumentation diagrams included in the specifications; and (3) Contractor layout and installation drawings.

Unless otherwise specified, record drawings shall be full size and maintained in a clean, dry, and legible condition. Record documents shall not be used for construction purposes and shall be available for review by the Construction Manager during normal working hours at the Contractor's field office. At the completion of the work, prior to final payment, all record drawings shall be submitted to the Construction Manager.

Marking of the drawings shall be kept current and shall be done at the time the material and equipment are installed. Annotations to the record documents shall be made with an erasable colored pencil conforming to the following color code:

Additions - Red
Deletions - Green
Comments - Blue
Dimensions - Graphite*

*Legibly mark to record actual depths, horizontal and vertical location of underground raceways, cables, and appurtenances referenced to permanent surface improvements

If the Contractor opts to use electronic record drawing files, the above requirements shall be met within the electronic documentation. This includes, but is not limited to, the requirement that the annotation color codes be maintained in the electronic files such that when printed in color, the annotation colors are legible and distinguishable.

END OF SECTION

SECTION 01730

OPERATING AND MAINTENANCE INFORMATION

PART 1--GENERAL

1.01 SCOPE

Operation and maintenance (O&M) instructions shall be provided in accordance with this section and as required in the technical sections of this project manual. O&M information shall be provided for each maintainable piece of equipment, equipment assembly or subassembly, and material provided or modified under this contract.

O&M instructions must be submitted and accepted before on-site training may start.

1.02 TYPES OF INFORMATION REQUIRED

A. GENERAL:

O&M information shall contain the names, addresses, and telephone numbers of the manufacturer, the nearest representative of the manufacturer, and the nearest supplier of the manufacturer's equipment and parts. In addition, one or more of the following items of information shall be provided as applicable.

B. OPERATING INSTRUCTIONS:

Specific instructions, procedures, and illustrations shall be provided for the following phases of operations:

1. SAFETY PRECAUTIONS: List personnel hazards for equipment and list safety precautions for all operating conditions.

2. OPERATOR PRESTART: Provide requirements to set up and prepare each system for use.

3. START-UP, SHUTDOWN, AND POSTSHUTDOWN PROCEDURES: Provide a control sequence for each of these operations.

4. NORMAL OPERATIONS: Provide control diagrams with data to explain operation and control of systems and specific equipment.

5. EMERGENCY OPERATIONS: Provide emergency procedures for equipment malfunctions to permit a short period of continued operation or to shut down the equipment to prevent further damage to systems and equipment. Include emergency shutdown instructions for fire, explosion, spills, or other foreseeable contingencies. Provide guidance on

emergency operations of all utility systems including valve locations and portions of systems controlled.

6. OPERATOR SERVICE REQUIREMENTS: Provide instructions for services to be performed by the operator such as lubrication, adjustments, and inspection.

7. ENVIRONMENTAL CONDITIONS: Provide a list of environmental conditions (temperature, humidity, and other relevant data) which are best suited for each product or piece of equipment and describe conditions under which equipment should not be allowed to run.

C. PREVENTIVE MAINTENANCE:

The following information shall be provided for preventive and scheduled maintenance to minimize corrective maintenance and repair:

1. LUBRICATION DATA: Provide lubrication data, other than instructions for lubrication in accordance with paragraph 2.0-B6.

a. A table showing recommended lubricants for specific temperature ranges and applications;

b. Charts with a schematic diagram of the equipment showing lubrication points, recommended types and grades of lubricants, and capacities; and

c. A lubrication schedule showing service interval frequency.

2. PREVENTIVE MAINTENANCE PLAN AND SCHEDULE: Provide manufacturer's schedule for routine preventive maintenance, inspections, tests, and adjustments required to ensure proper and economical operation and to minimize corrective maintenance and repair. Provide manufacturer's projection of preventive maintenance man-hours on a daily, weekly, monthly, and annual basis including craft requirements by type of craft.

D. CORRECTIVE MAINTENANCE:

Manufacturer's recommendations shall be provided on procedures and instructions for correcting problems and making repairs.

1. TROUBLESHOOTING GUIDES AND DIAGNOSTIC TECHNIQUES: Provide step-by-step procedures to promptly isolate the cause of typical malfunctions. Describe clearly why the checkout is performed and what conditions are to be sought. Identify tests or inspections and test equipment required to determine whether parts and equipment may be reused or require replacement.

2. WIRING DIAGRAMS AND CONTROL DIAGRAMS: Wiring diagrams and control diagrams shall be point-to-point drawings of wiring and control circuits including

factory-field interfaces. Provide a complete and accurate depiction of the actual job-specific wiring and control work. On diagrams, number electrical and electronic wiring and pneumatic control tubing and the terminals for each type identically to actual installation numbering.

3. MAINTENANCE AND REPAIR PROCEDURES: Provide instructions and list tools required to restore product or equipment to proper condition or operating standards.

4. REMOVAL AND REPLACEMENT INSTRUCTIONS: Provide step-by-step procedures and list required tools and supplies for removal, replacement, disassembly, and assembly of components, assemblies, subassemblies, accessories, and attachments. Provide tolerances, dimensions, settings, and adjustments required. Instructions shall include a combination of test and illustrations.

5. SPARE PARTS AND SUPPLY LISTS: Provide lists of spare parts and supplies required for maintenance and repair to ensure continued service or operation without unreasonably delays. Special consideration is required for facilities at remote locations. List spare parts and supplies that have a long lead time to obtain.

6. CORRECTIVE MAINTENANCE MANHOURS: Provide manufacturer's projection of corrective maintenance man-hours including craft requirements by type of craft. Corrective maintenance that requires participation of the equipment manufacturer shall be identified and tabulated separately.

E. APPENDICES:

The following information shall be provided; include information not specified in the preceding paragraphs but pertinent to the maintenance or operation of the product or equipment.

1. PARTS IDENTIFICATION: Provide identification and coverage for all parts of each component, assembly, subassembly, and accessory of the end items subject to replacement. Include special hardware requirements, such as requirement to use high-strength bolts and nuts. Identify parts by make, model, serial number, and source of supply to allow reordering without further identification. Provide clear and legible illustrations, drawings, and exploded views to enable easy identification of the items. When illustrations omit the part numbers and description, both the illustrations and separate listing shall show the index, reference, or key number which will cross-reference the illustrated part to the listed part. Parts shown in the listings shall be grouped by components, assemblies, and subassemblies.

2. WARRANTY INFORMATION: List and explain the various warranties and include the servicing and technical precautions prescribed by the manufacturers or contract documents to keep warranties in force.

3. PERSONNEL TRAINING REQUIREMENTS: Provide information available from the manufacturers to use in training designated personnel to operate and maintain the equipment and systems properly.

4. TESTING EQUIPMENT AND SPECIAL TOOL INFORMATION: Provide information on test equipment required to perform specified tests and on special tools needed for the operation, maintenance, and repair of components.

1.03 TRANSMITTAL PROCEDURE

Unless otherwise specified, O&M manuals, information, and data shall be transmitted in accordance with Section 01300 accompanied by Transmittal Form 01730-A and Equipment Record Forms 01730-B and/or 01730-C, as appropriate, all as specified in Section 01999. The transmittal form shall be used as a checklist to ensure the manual is complete. Only complete sets of O&M instructions will be reviewed for acceptance.

Six copies of the specified O&M information shall be provided. For ease of identification, each manufacturer's brochure and manual shall be appropriately labeled with the equipment name and equipment number as it appears in the project manual. The information shall be organized in the binders in numerical order by the equipment numbers assigned in the project manual. The binders shall be provided with a table of contents and tab sheets to permit easy location of desired information. Binders shall be heavy 3-ring style, 3-inch maximum, suitable for bookshelf storage.

If manufacturers' standard brochures and manuals are used to describe O&M procedures, such brochures and manuals shall be modified to reflect only the model or series of equipment used on this project. Extraneous material shall be crossed out neatly or otherwise annotated or eliminated.

1.04 PAYMENT

Acceptable O&M information for the project must be delivered to the Construction Manager prior to the project being 65 percent complete. Progress payments for work in excess of 65 percent completion will not be made until the specified acceptable O&M information has been delivered to the Construction Manager.

1.05 FIELD CHANGES

Following the acceptable installation and operation of an equipment item, the item's instructions and procedures shall be modified and supplemented by the Contractor to reflect any field changes or information requiring field data.

PART 2--NOT USED

PART 3--NOT USED

END OF SECTION

SECTION 01800

ENVIRONMENTAL CONDITIONS

This section describes the environmental conditions which have been observed at the site of the work and which may reasonably be anticipated throughout the life of the project.

The site of the work is at an elevation of 1217feet above mean sea level. Climate conditions are described as follows:

Description	Range of Conditions
Winter	Several days each year have frost, with occasional rain and very rare occasions of snowfall. Most days are sunny and are mild.
Summer	Sunny and hot, with a late season thunder storm.
Relative humidity, percent	
Average outdoors	21 to 39
Air temperature, degrees F	
Outdoors	8 to 117
Barometric pressure, inches, mercury	28.7

Additional conditions which may be applicable are specified in other sections.

END OF SECTION

SECTION 01900

STRUCTURAL DESIGN AND ANCHORAGE REQUIREMENTS FOR NONSTRUCTURAL COMPONENTS AND NONBUILDING STRUCTURES

PART --GENERAL

1.01 SUMMARY

A. SCOPE

This section specifies the minimum structural requirements for the design, anchorage and bracing of architectural/mechanical/HVAC/electrical components, equipment, and systems, and nonbuilding structures. Design of supports, attachments and bracing for all parts or elements of the architectural, mechanical, HVAC and electrical systems shall be provided in accordance with this section. The requirements of this section shall apply to the design of the structural elements and features of equipment and to platforms/walkways that are provided with equipment or nonbuilding structures.

This section applies to nonstructural components that are permanently attached to structures, and nonbuilding structures as defined below in paragraph 1.01-B and ASCE 7-10. Note that equipment is defined as a non-structural component and tanks are defined as a nonbuilding structure.

Design shall be in accordance with the criteria listed within this section and shall conform to the provisions of the design codes listed within this section. Engineering design is not required for attachments, anchorage, or bracing detailed on the drawings or where the size of attachments, anchorage, or bracing is defined in the technical specification sections.

The following nonstructural components are exempt from the seismic design loading requirements of this Section.

1. Components in Seismic Design Category A.

2. Architectural components in Seismic Design Category B other than parapets supported by bearing walls or shear walls provided that the component importance factor, I_p, is equal to 1.0.

3. Mechanical and electrical components in Seismic Design Category B.

4. Mechanical and electrical components in Seismic Design Category C provided that the component importance factor, I_p, is equal to 1.0.

5. Mechanical and electrical components in Seismic Design Categories D, E or F where the component importance factor, I_p, is equal to 1.0 and both of the following conditions apply:

a. Flexible connections between the components and associated ductwork, piping and conduit are provided, and

b. Components are mounted at 4 ft or less above a floor level and weigh 400 lb or less (4 ft criteria applies to the mounting support elevation relative to the floor).

6. Mechanical and electrical components in Seismic Design Categories D, E or F where the component importance factor, I_p, is equal to 1.0 and both of the following conditions apply:

a. Flexible connections between the components and associated ductwork, piping and conduit are provided, and

b. The components weigh 20 lb or less or, for distribution systems, weighing 5 lb/ft or less.

B. DEFINITIONS:

1. STRUCTURES: The structural elements of a building that resist gravity, seismic, wind, and other types of loads. Structural components include columns, posts, beams, girders, joists, bracing, floor or roof sheathing, slabs or decking, load-bearing walls, and foundations.

2. NONSTRUCTURAL COMPONENTS: The nonstructural portions of a building include every part of the building and all its contents, except the structural portions, that carry gravity loads and that may also be required to resist the effects of wind, snow, impact, temperature and seismic loads. Nonstructural components include, but are not limited to, ceilings, partitions, windows, equipment, piping, ductwork, furnishings, lights, etc.

3. NONBUILDING STRUCTURES: All self-supporting structures that carry gravity loads and that may also be required to resist the effects of wind, snow, impact, temperature and seismic loads. Nonbuilding structures include, but are not limited to, pipe racks, storage racks, stacks, tanks, vessels and structural towers that support tanks and vessels.

1.02 QUALITY ASSURANCE

A. QUALITY CONTROL BY OWNER:

Special Inspection of nonstructural components and nonbuilding structures, and their anchorages shall be performed by the Special Inspector under contract with the Owner and in conformance with IBC Chapter 17. Special Inspector(s) and laboratory shall be acceptable to the Owner in their sole discretion. Special Inspection is in addition to, but not replacing, other inspections and quality control requirements herein. Where sampling and testing required herein conforms to Special Inspection standards, such sampling and testing need not be duplicated.

B. REFERENCES:

Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization, or if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued, or replaced. When conflicting requirements occur, the most stringent requirements will govern the design.

Reference	Title
AAMA	American Architectural Manufacturer's Association
ACI 318	Building Code Requirements for Structural Concrete
ACI 350	Code Requirements for Environmental Engineering Concrete Structures
AISC 341	Seismic Provisions for Structural Steel Buildings
ACI 360	Specification for Structural Steel Buildings
ASCE 7	Minimum Design Loads for Buildings and Other Structures
AWS D1.1	Structural Welding Code – Steel
AWS D1.2	Structural Welding Code - Aluminum
AWS D1.2	Structural Welding Code – Stainless Steel
IBC	International Building Code with local amendments
NFPA-13	Standard for the Installation of Sprinkler Systems
OSHA	U.S. Dept. of Labor, Occupational Safety and Health Administration
SMACNA	Seismic Restraint Manual Guidelines for Mechanical Systems

1.03 SUBMITTALS

For structural elements of nonstructural components and nonbuilding structures required to be designed per this specification section, drawings and design calculations shall be stamped by an Arizona licensed professional engineer qualified to perform structural engineering.

Submit drawings and calculations no less than four weeks in advance of the installation of any component to be anchored to the structure or installation of any structural member to which the component will be attached.

A. The following submittals shall be provided in accordance with Section 01300:

1. List of all nonstructural components and nonbuilding structures requiring wind and seismic design and anchorage.

2. Shop drawings showing details of complete wind and seismic bracing and anchorage attachment assemblies including connection hardware, and embedment into concrete.

3. Shop drawings showing plans, elevations, sections and details of equipment support structures and nonbuilding structures, including anchor bolts, structural members, platforms, stairs, ladders, and related attachments.

4. Identify all interface points with supporting structures or foundations, as well as the size, location, and grip of all required attachments and anchor bolts. Clearly indicate who will be providing each type of attachment/anchor bolt. Equipment vendor shall design anchor bolts, including embedment into concrete, and submit stamped calculations.

5. Calculations for all supports, bracing, and attachments shall clearly indicate the design criteria applied in the design calculations. Concrete embedment calculations shall be coordinated with thickness and strength of concrete members. Submit a tabulation of the magnitude of unfactored (service level) equipment loads at each support point, broken down by type of loading (dead, live, wind, seismic, etc.). Indicate impact factors applied to these loads in the design calculations.

6. Product Data: Manufacturer's certificates of compliance with the seismic force requirements of this section.

1.04 DESIGN CODES

The following standard codes have application at this site for:

Buildings/Structures:	International Building Code 2012 and ASCE 7-10
Reinforced concrete:	ACI 350-06 for Concrete Liquid Containing Tanks, ACI 318-11 for all other reinforced concrete
Structural steel:	AISC 360-10 and AISC 341-10
Welding:	AWS Welding Codes, Latest Edition
Occupational health and safety requirements:	U.S. Dept. of Labor, Occupational Safety and Health Administration (OSHA)

When conflicting requirements occur, the most stringent requirements will govern the design.

1.05 DESIGN LOADS

All nonstructural components and nonbuilding structures shall be designed for the following loads. Wind and snow loads shall not be applied to nonstructural components and nonbuilding structures that are located inside buildings.

A. DEAD LOADS:

An additional allowance will also be added for piping and conduit when supported and hung from the underside of equipment and platforms.

Typical allowance for piping and conduit unless noted otherwise: 20 psf

B. UNIFORM LIVE LOADS:

Equipment slabs at grade:	300 psf

C. WIND LOADS:

Code:	IBC 2012 & ASCE 7-10
Basic Wind Speed (3-second gust):	120 mph
Exposure:	C
Topographic Factor (K_{zt})	1.0

All exterior nonstrutural components and nonbuilding structures, unless located in a pit or basin, shall be designed to withstand the design wind loads without consideration of shielding effects by other structures.

D. SEISMIC LOADS:

Code:	IBC 2012 & ASCE 7-10
0.2 Sec. Mapped Spectral Response, S_S:	0.178 g
1.0 Sec. Mapped Spectral Response, S_1:	0.058 g
Site Class:	C
0.2 Sec. Design Spectral Response, S_{DS}:	0.142 g
1.0 Sec. Design Spectral Response, S_{D1}:	0.066 g
Importance Factor (I):	1.25
Component Importance Factor (I_p):	1.0, except I_p=1.5 for fire protection sprinkler systems or components containing hazardous materials
Seismic Design Category	A

Seismic loads shall be calculated on the basis of the governing building code. The structure dead load shall include equipment operating loads.

Individual members shall be checked for seismic and full member live load acting simultaneously, except that flooded equipment loads (infrequent occurrence) need not be combined with seismic loads. Equipment operating loads shall be combined with seismic loads.

E. IMPACT LOADS:

Impact loads shall be considered in the design of support systems.

The following impact load factors shall be used unless recommendations of the equipment manufacturer will cause a more severe load case.

Rotating machinery:	20% of moving load
Reciprocating machinery:	50% of moving load
Monorail Hoists:	
Vertical	25% of maximum wheel load
Longitudinal	10% of maximum wheel load
Hangers supporting floors and platforms:	33% of live and dead load

F. TEMPERATURE:

The effects of temperature shall be included in design where nonstructural components and nonbuilding structures are exposed to differential climatic conditions. See Section 1.07 for temperature extremes

1.06 LOAD COMBINATIONS

All nonstructural components and nonbuilding structures shall be designed to withstand the load combinations as specified in the governing building code. Where the exclusion of live load or impact load would cause a more severe load condition for the member under investigation, then the load shall be ignored when evaluating that member.

1.07 DESIGN CONSIDERATIONS

All nonstructural components and nonbuilding structures shall be designed for the following conditions:

A. CLIMATIC CONDITIONS:

Maximum design temperature:	120	degrees Fahrenheit
Minimum design temperature:	15	degrees Fahrenheit

B. FOUNDATIONS:

Consult project geotechnical report for allowable soil bearing recommendations at location of structure.

PART --PRODUCTS

2.01 GENERAL

Materials shall be in conformance with information shown on the drawings and in other technical specification sections. See individual component and equipment specifications for additional requirements

PART --EXECUTION

3.01 GENERAL

A. Attachments and braces shall be made in such a manner that the component force is transferred to the lateral force-resisting system of the structure. Attachment requirements and size and number of braces shall be based on the calculations submitted by the Contractor.

B. All anchorage of equipment is specified to be made by cast-in anchor bolts in concrete elements unless specifically noted otherwise on the drawings or other specification Sections. Contractor shall be responsible for any remedial work or strengthening of concrete elements because of superimposed seismic loading if anchor bolts are improperly installed or omitted due to lack of submittal review or improper placement for any reason, at no additional cost to the Owner.

C. Anchor bolts shall be provided and installed by the Contractor in accordance with Section 05501. Size of anchor bolts and embedment of anchor bolts shall be based on the calculations submitted by the Contractor.

D. Details of and calculations for all anchorages shall be submitted and accepted in accordance with paragraph 1.03 prior to placement of concrete or erection of other structural supporting members. Submittals received after structural supports are in place will be rejected if proposed anchorage method would create an overstressed condition of the supporting member. The Contractor shall be responsible for revisions to the anchorages and/or strengthening of the structural support so that there is no overstressed condition at no additional cost to the Owner.

END OF SECTION

SECTION 01999

REFERENCE FORMS

The forms listed below and included in this section are referenced from other sections of the project manual:

Form No.	Title
01300-A	Submittal Transmittal Form
01660-A	Equipment Test Report Form
01730-A	Operation and Maintenance Transmittal Form
01730-B	Equipment Record Form
01730-C	Equipment Record Form
09900-A	Coating System Inspection Checklist
11000-A	Manufacturer's Installation Certification Form
11000-B	Manufacturer's Instruction Certification Form
11000-C	Unit Responsibility Certification Form
16000-A	Wire and Cable Resistance Test Data Form
16000-B	Installed Motor Test Data Form
17000-A	Loop Wiring and Insulation Resistance Test Data Form
17000-C	Controller Calibration Test Data Form
17000-H	Transmitter Calibration Test Data Form
17000-I	Miscellaneous Instrument Calibration Test Data Form
17000-J	Individual Loop Test Data Form
17000-K	Loop Commissioning Test Data Form

01300-A. SUBMITTAL TRANSMITTAL FORM

SUBMITTAL TRANSMITTAL

Submittal Description. _____ Submittal No:[1] _____

Spec Section: _____

	Routing	Sent	Received
OWNER	Contractor/CM		
PROJECT	CM/Engineer		
	Engineer/CM		
CONTRACTOR	CM/Contractor		

We are sending you ☐ Attached ☐ Under separate cover via _____
☐ Submittals for review and comment ☐ Product data for information only

Remarks: _____

Item	Copies	Date	Section No	Description	Review action[a]	Reviewer initials	Review comments attached

[a]Note NET = No exceptions taken, MCN = Make corrections noted, A&R = Amend and resubmit, R = Rejected Attach additional sheets if necessary

Contractor

Certify either A or B:

☐ A. We have verified that the material or equipment contained in this submittal meets all the requirements, including coordination with all related work, specified (no exceptions).

☐ B. We have verified that the material or equipment contained in this submittal meets all the requirements specified except for the attached deviations

No.	Deviation

Certified by _____
Contractor's Signature

[1]See paragraph 01300-4 0 A, Transmittal Procedure

01660-A. EQUIPMENT TEST REPORT FORM

NOTE: This example equipment test report is provided for the benefit of the Contractor and is not specific to any piece of equipment to be installed as a part of this project The example is furnished as a means of illustrating the level of detail required for the preparation of equipment test report forms for this project

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CITY OF SAMPLE

EXAMPLE WATER TREATMENT PLANT
STAGE IV EXPANSION PROJECT

ABC Construction Company, Inc., General Contractor
XYZ Engineering, Inc., Construction Manager

EQUIPMENT TEST REPORT

Equipment Name: Sludge Pump 2
Equipment Number: P25202
Specification Ref: 11390
Location: East Sedimentation Basin Gallery

	Contractor		Construction Manager	
	Verified	Date	Verified	Date
PREOPERATIONAL CHECKLIST				
Mechanical				
Lubrication				
Alignment				
Anchor bolts				
Seal water system operational				
Equipment rotates freely				
Safety guards				
Valves operational				
O&M manual information complete				
Manufacturer's installation certificate complete				
Electrical (circuit ring-out and high-pot tests)				
Circuits.				
Power to MCC 5				
Control to HOA				
Indicators at MCC:				
Red (running)				
Green (power)				

	Contractor		Construction Manager	
	Verified	Date	Verified	Date
Amber (auto)				
Indicators at local control panel				
Wiring labels complete				
Nameplates:				
MCC				
Control station				
Control panel				
Equipment bumped for rotation				
Piping Systems				
Cleaned and flushed:				
Suction				
Discharge				
Pressure tests				
Instrumentation and Controls				
Flowmeter FE2502F calibration				
Calibration Report No				
Flow recorder FR2502G calibrated against transmitter				
Discharge overpressure shutdown switch calibration				
Simulate discharge overpressure Shutdown				
FUNCTIONAL TESTS				
Mechanical				
Motor operation temperature satisfactory				
Pump operating temperature satisfactory				
Unusual noise, etc?				
Pump operation: 1500 gpm/720' TDH				
Measurement.				
Flow.				
Pressure		Test gage number:		
Alignment hot				
Dowelled in				
Remarks:				

	Contractor		Construction Manager	
	Verified	Date	Verified	Date
Electrical				
Local switch function				
Runs in *HAND*				

No control power in *OFF*				
Timer control in *AUTO*				
Overpressure protection switch PS2502C functional in both *HAND* and *AUTO*				
Overpressure protection switch PS2502C set at 75 psig				
PLC 2500 set at 24-hour cycle, 25 min *ON*				
OPERATIONAL TEST				
48-hour continuous test Pump cycles as specified, indicators functional, controls functional, pump maintains capacity, overpressure protection remains functional, hour meter functional				

RECOMMENDED FOR BENEFICIAL OCCUPANCY

_____ _____

Construction Manager _____ Date _____

ACCEPTED FOR BENEFICIAL OCCUPANCY

_____ _____

Owner's Representative_____ Date _____

01730-A. OPERATION AND MAINTENANCE TRANSMITTAL FORM

Date. _____ Submittal No.[2] _____

To _____ Contract No _____

_____ Spec Section. _____

_____ Submittal Description. _____

_____ From _____

Attention _____ _____

Checklist	Contractor		Construction manager	
	Satisfactory	N/A	Accept	Deficient
1 Table of contents				
2 Equipment record forms				
3 Manufacturer information				
4 Vendor information				
5 Safety precautions				
6 Operator prestart				
7 Start-up, shutdown, and postshutdown procedures				
8 Normal operations				
9 Emergency operations				
10 Operator service requirements				
11 Environmental conditions				
12 Lubrication data				
13 Preventive maintenance plan and schedule				
14 Troubleshooting guides and diagnostic techniques				
15 Wiring diagrams and control diagrams				
16 Maintenance and repair procedures				
17 Removal and replacement instructions				
18 Spare parts and supply list				
19 Corrective maintenance man-hours				
20 Parts identification				
21 Warranty information				
22 Personnel training requirements				
23 Testing equipment and special tool information				

Remarks _____

_____
Contractor's Signature

[2]See paragraph 01300-4 0 A, Transmittal Procedure

01730-B. EQUIPMENT RECORD FORM

EQUIP DESCRIP		EQUIP LOC	
EQUIP NO	SHOP DWG NO	DATE INST	COST
MFGR		MFGR CONTACT	
MFGR ADDRESS			PHONE
VENDOR		VENDOR CONTACT	
VENDOR ADDRESS			PHONE

MAINTENANCE REQUIREMENTS	D	W	M	Q	S	A	Hours

LUBRICANTS	RECOMMENDED
	ALTERNATIVE
MISC NOTES	

RECOMMENDED SPARE PARTS			
PART NO	QUAN	PART NAME	COST

ELECTRICAL NAMEPLATE DATA			
EQUIP			
MAKE			
SERIAL NO		ID NO	
MODEL NO		FRAME NO	
HP	V	AMP	HZ
PH	RPM	SF	DUTY
CODE	INSL CL	DES	TYPE
NEMA DES	C AMB	TEMP RISE	RATING
MISC			

MECHANICAL NAMEPLATE DATA			
EQUIP			
MAKE			
SERIAL NO		ID NO	
MODEL NO		FRAME NO	
HP	RPM	CAP	SIZE
TDH	IMP SZ	BELT NO	CFM
PSI	ASSY NO	CASE NO	
MISC			

01730-C. EQUIPMENT RECORD FORM

EQUIP DESCRIP		EQUIP LOC	
EQUIP NO	SHOP DWG NO	DATE INST	COST
MFGR		MFGR CONTACT	
MFGR ADDRESS			PHONE
VENDOR		VENDOR CONTACT	
VENDOR ADDRESS			PHONE

MAINTENANCE REQUIREMENTS	D	W	M	Q	S	A	Hours

09900-A COATING SYSTEM INSPECTION CHECKLIST

09900-A Coating System Inspection Checklist			
Project Name			
Owner		Coating System Manufacturer (CSM)	
General Contractor (GC)		Coating System Applicator (CSA)	
Area or Structure		Location within Structure	
Coating System (eg E-1)		Coating Type (eg Epoxy, etc.)	

Step	Description		Name	Signature	Date
1	Completion of cleaning and substrate decontamination prior to abrasive blast cleaning.	GC QC			
		CSM QC			
		CSA QC			
2	Installation of protective enclosure of structure or area and protection of adjacent surfaces or structures that are not to be coated.	GC QC			
		CSM QC			
		CSA QC			
3	Completion of ambient condition control in structure or building area and acceptance of ventilation methods in structure or Area.	GC QC			
		CSM QC			
		CSA QC			
4	Completion of Surface Preparation for Substrates to Be Coated.	GC QC			
		CSM QC			
		CSA QC			
5	Completion of Primer Application.	GC QC			
		CSM QC			
		CSA QC			

Step	Description		Name	Signature	Date
6	Completion of Concrete Repairs If Required and Related Surface Preparation Rework Prior to Coating System Application.	GC QC			
		CSM QC			
		CSA QC			
7	Completion of Concrete Filler/ Surface Application to Concrete.	GC QC			
		CSM QC			
		CSA QC			
8	Completion of First Finish Coat Application and of Detail Treatment at Transitions or Terminations.	GC QC			
		CSM QC			
		CSA QC			
9	Completion of Second Finish Coat Application and of Detail Treatment at Transitions and Terminations.	GC QC			
		CSM QC			
		CSA QC			
10	Completion of Full and Proper Cure of Coating System.	GC QC			
		CSM QC			
		CSA QC			
11	Completion of Testing of Cured Coating System including Adhesion, Holiday (Continuity) Testing and Dry Film Thickness.	GC QC			
		CSM QC			
		CSA QC			
12	Completion of Localized Repairs to Coating System Following Testing.	GC QC			
		CSM QC			
		CSA QC			

Step	Description		Name	Signature	Date
13	Final Acceptance of Coating System Installation Including Final Clean-Up Complying with Specification Requirements and the CSM's Quality Requirements.	GC QC			
		CSM QC			
		CSA QC			

11000-A. MANUFACTURER'S INSTALLATION CERTIFICATION FORM

Contract No· _____ Specification section: _____

Equipment name: _____

Contractor: _____

Manufacturer of equipment item: _____

The undersigned manufacturer of the equipment item described above hereby certifies that he has checked the installation of the equipment and that the equipment, as specified in the project manual, has been provided in accordance with the manufacturer's recommendations, and that the trial operation of the equipment item has been satisfactory.

Comments: _____

_____

_____

_____

_____

_____	_____
Date	Manufacturer
	_____
	Signature of Authorized Representative
_____	_____
Date	Contractor
	_____
	Signature of Authorized Representative

11000-B. MANUFACTURER'S INSTRUCTION CERTIFICATION FORM

Contract No: _____ Specification section: _____

Equipment name: _____

Contractor: _____

Manufacturer of equipment item: _____

The undersigned manufacturer certifies that a service engineer has instructed the wastewater treatment plant operating personnel in the proper maintenance and operation of the equipment designated herein.

Operations Check List (check appropriate spaces)	
Start-up procedure reviewed	
Shutdown procedure reviewed	
Normal operation procedure reviewed	
Others.	
Maintenance Check List (check appropriate spaces)	
Described normal oil changes (frequency)	
Described special tools required	
Described normal items to be reviewed for wear	
Described preventive maintenance instructions	
Described greasing frequency	
Others:	

_____ Date

_____ Manufacturer

_____ Signature of Authorized Representative

_____ Date

_____ Signature of Owner's Representative

_____ Date

_____ Signature of Contractor's Representative

11000-C. UNIT RESPONSIBILITY CERTIFICATION FORM

Sweetwater Lift Station

CERTIFICATE OF UNIT RESPONSIBILITY
for Specification Section _____

_____
(Section title)

In accordance with paragraph 11000-1.02 C of the contract documents, the undersigned manufacturer of driven equipment ("manufacturer") accepts unit responsibility for all components of equipment furnished to the Project under specification Section_____ , and for related equipment manufactured under Sections_____, _____, and _____ .

We have reviewed the requirements for Sections 11000 (and 11050 where applicable) and all sections referencing this (these) section(s), including but not limited to drivers, supports for driving and driven equipment and all other specified appurtenances to be furnished to the Project by manufacturer. And, we have further reviewed, and modified as necessary, the requirements for associated variable speed drives and motor control centers. We hereby certify that all specified components are compatible and comprise a functional unit suitable for the specified performance and design requirements whether or not the equipment was furnished by us. We will make no claim nor establish any condition that problems in operation for the product provided under this specification Section _____ are due to incompatibility of any components covered by this Certificate of Unit Responsibility. Nor will we condition or void any warranty for the performance of the product of this specification Section _____ due to incompatibility of any components covered under this Certificate of Unit Responsibility

Our signature on this Certificate of Unit Responsibility does not obligate us to take responsibility for, nor to warrant the workmanship, quality, or performance of related equipment provided by others under specification Sections _____, _____, and _____. Our obligation to warranty all equipment provided by us shall remain unaffected

_____
Notary Public

_____
Name of Corporation

_____
Commission expiration date

_____
Address

Seal:

By: _____
Duly Authorized Official

_____
Legal Title of Official

Date: _____

16000-A. WIRE AND CABLE RESISTANCE TEST DATA FORM

Wire or Cable No.:_____ Temperature, °F: _____

Location of Test	Insulation resistance, megohms
1.	
2	
3.	
4.	
5.	
6	
7	

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

16000-B. INSTALLED MOTOR TEST FORM

Motor Equipment Number: _____ Date of test: _____

Equipment Driven: _____

MCC Location: _____

				Ambient temp	°F
Resistance.					
Insulation resistance phase-to-ground megohms					
Phase A		Phase B		Phase C	
Current at Full Load:					
Phase		Current, amps			
Phase		Current, amps			
Phase		Current, amps			
Thermal Overload Device:	Manufacturer/catalog #		Amperes		
Circuit breaker (MCP) setting:					

Motor Nameplate Markings:

Mfr		Mfr Model		Frame		HP	
Volts		Phase		RPM		Service factor**	
Amps		Freq		Ambient temp rating		°C	
Time rating			Design letter**				
	(NEMA 1-10 35)			(NEMA MG-1 16)			
Code letter			Insulation class				

**Required for 3-phase squirrel cage induction motors only

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

17000-A. LOOP WIRING AND INSULATION RESISTANCE TEST DATA FORM

Loop No.: _____

List all wiring associated with a loop in table below. Make applicable measurements as indicated after disconnecting wiring.

			Continuity Resistance[a]		Insulation Resistance[b]			
Wire No	Panel Tie	Field TB	Cond./ Cond	Cond./ Shield	Shield/ Gnd.	Shield/ Cond.	Cond./ Gnd	Shield/ Shield
A			--	(A/SH)				
B			(A/B)	--				
C			(A/C)	--				
D			(A/D)	--				
etc.								

NOTES

a Continuity Test Connect ohmmeter leads between wires A and B and jumper opposite ends together Record resistance in table Repeat procedure between A and C, A and D, etc Any deviation of ±2 ohms between any reading and the average of a particular run indicates a poor conductor, and corrective action shall be taken before continuing with the loop test

b Insulation Test Connect one end of a 500 volt megger to the panel ground bus and the other sequentially to each completely disconnected wire and shield Test the insulation resistance and record each reading

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

17000-C. CONTROLLER CALIBRATION TEST DATA FORM

Tag No. and Description: _____

Make & Model No.: _____ Serial No.: _____

Input: _____ Process Variable (PV) Scale: _____

Output: _____ Output Scale: _____

PV Scale Calibration

% of Range	Input	Expected Reading	Actual Reading	% Deviation
0				
50				
100				
			% Deviation Allowed:	

Connect output to PV for following tests:

Set Point (SP) Indicator Accuracy			Output Meter Accuracy			Controller Accuracy		
SP	PV Reading	Expected % Dev	Actual Reading	Expected Reading	Actual % Dev.	Output	Output	% Dev.
(0%)								
(50%)								
(100%)								
% Deviation Allowed:			% Deviation Allowed			% Deviation Allowed		

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

17000-H. TRANSMITTER CALIBRATION TEST DATA FORM

Tag No. and Description: _____

Make & Model No.: _____ Serial No.: _____

Input: _____

Output: _____

Range: _____ Scale: _____

Simulate process variable (flow, pressure, temperature, etc.) and measure output with appropriate meter.

% of Range	Input	Expected Reading	Actual Reading	% Deviation
0				
50				
100				
			% Deviation Allowed:	

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

17000-I. MISCELLANEOUS INSTRUMENT CALIBRATION TEST DATA FORM

(For instruments not covered by any of the preceding test forms, the Contractor shall create a form containing all necessary information and calibration procedures.)

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

17000-J. INDIVIDUAL LOOP TEST DATA FORM

Loop No.: _____

Description: (Give complete description of loop's function using tag numbers where appropriate.)

P&ID No.: (Attach copy of P&ID.)

a. Wiring tested:
(Attach test form 17000-A)

b. Instrumentation tubing/piping tested:
(Attach test form 17000-B)

c. Instruments calibrated:
(Attach test forms 17000-C through I)

d. List step-by-step procedures for testing loop parameters. Test loop with instruments, including transmitters and control valves, connected and functioning. If it is not possible to produce a real process variable, then a simulated signal may be used with the Construction Manager's approval.

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

17000-K. LOOP COMMISSIONING TEST DATA FORM

Loop No.: _____

a. Loop tested:
(Attach test form 17000-J)

b. Controlled or connected equipment tests confirmed:

c. Give complete description of loop's interface with process.

d. With associated equipment and process in operation, provide annotated chart trace of loop response to changes in set points for verification of performance. This chart should demonstrate 1/4-amplitude damping as output adjusts to set point change. Show set points, starting and finishing times on chart, as well as any other pertinent data.

Connect 2-pen recorder to process variable (PV) and to controller output. Use 1 inch/second chart speed.

Pen 1 - PV - Connections:

Pen 2 - Output - Connections.

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

SECTION 02100

SITE PREPARATION

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies site preparation which consists of clearing, grubbing and demolition.

B. EXISTING CONDITIONS:

The Contractor shall determine the actual condition of the site as it affects this portion of work.

C. PROTECTION:

Site preparation shall not damage structures, landscaping or vegetation adjacent to the site. The Contractor shall repair, or replace any damaged property.

PART 2--PRODUCTS

No products are included in this section.

PART 3--EXECUTION

3.01 CLEARING AND GRUBBING

Unless otherwise specified, the Contractor shall remove obstructions such as brush, trees, logs, stumps, roots, heavy sod, vegetation, rock, stones larger than 6 inches in any dimension, broken or old concrete and pavement, debris, and structures where the completion of the work require their removal.

Material that is removed and is not to be incorporated in the work shall be disposed of off the site.

3.02 DEMOLITION AND REMOVAL

A. STRUCTURES:

Demolition and removal of structures consist of removal of abandoned superstructures, foundation walls, footings, slabs and any other structures. Excavations caused by existing foundations shall be cleared of waste, debris and loose soil, and refilled as specified.

B. PAVEMENT:

When portions of asphalt pavements and concrete pads are to be removed and later construction is to be connected, edges shall be saw cut, on a neat line at right angles to the curb face.

C. SALVAGE:

The Owner has the right to salvage any items scheduled for removal. The Contractor shall notify the Construction Manager 5 days prior to any salvage or demolition work to determine the disposition of items to be removed. The Construction Manager will mark items to be salvaged. Such items shall be properly disconnected, removed from their foundations, cleaned, and stored at a location on the site as specified.

3.03 UTILITY INTERFERENCE

Where existing utilities interfere with the prosecution of the work, the Contractor shall relocate them at no additional cost to the owner.

END OF SECTION

SECTION 02145

SEWER BYPASSING AND DEWATERING

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section describes the existing conditions for temporary bypassing and dewatering of sewers during internal television inspection (CCTV), cleaning operations, rehabilitation, and inspection of the project pipelines and of service laterals during the rehabilitation prior to reconnection to the rehabilitated pipeline.

B. REQUIREMENTS:

1. Contractor shall provide labor, materials, and supervision to temporarily bypass flow around the Contractor's work in accordance with the specific needs of the rehabilitation method being utilized and dewater the pipelines in preparation for cleaning and rehabilitation. All references to the bypass pumping and/or bypass pumping system include, but are not limited to, all pumps, piping, valves and other equipment needed to move the intended flow from one location to another.

2. Sanitary sewer mains shall remain in service at all times throughout the duration of the project. Contractor shall be responsible for diverting flow away from the limits of construction through the use of bypass pumping or flow diversions with prior written approval by the Engineer.

3. Service to laterals shall be disrupted for a period of no more than 8 hours. Laterals within residential areas shall only be out of service between the hours of 8:00 am to 5:00 pm, Monday through Friday. Laterals within business areas shall be addressed on a case by case basis. If Contractor feels that it is necessary to disrupt lateral services for a period longer than 8 hours, Contractor shall provide alternate means of service without disrupting use of the service by the owner/resident.

4. Contractor shall maintain pedestrian and vehicular traffic and comply with ADA regulations for access to all residential and commercial property unless written approval is otherwise obtained from the property owner allowing for reduced access.

5. In areas where bypass piping crosses major streets, pipe must be laid in trench and backfilled with temporary trench patch. The Contractor may use ramps to cross streets, driveway, and business access, but must

maintain two (2) lanes of traffic in each direction at all times during the Project. Vehicle access to the ACDC shall maintain a minimum of 12 feet wide to allow passage of one vehicle and provide warning signs at any ramp crossings. Contractor must provide and maintain lighting to illuminate the ramps at night and provide approved traffic control plans to safely direct traffic over the ramps.

6. It is the Contractor's responsibility to arrange all necessary access and temporary construction agreements with all affected parties for the location of the bypass pumping system.

7. The bypass pumping system shall be designed to normally maintain the wastewater flow below the top of the pipe, without surcharging.

8. The Contractor shall have the complete bypassing system in place and successfully pressure tested at 1.5 times the maximum operating pressure of the system before bypassing any sewage.

9. The Contractor shall notify the Construction Manager 48 hours prior to shutting down or bypassing the pipeline.

10. Engines shall be equipped with mufflers and/or plywood/Styrofoam noise panels enclosing the engines to keep the noise level within limits specified in local codes and ordinances.

11. The Contractor shall have 24-hour monitoring of the bypass pumping system.

12. The bypass system shall remain in place for one week after construction is Substantially Complete.

13. The bypass system suction location shall be from Manhole 5 as referenced on Drawing C200. Bypass pumps shall be located within the Thunderbird Paseo/Arizona Canal Diversion Channel (ACDC) property. Pumps shall not be located in the residential area. The discharge location shall be to Manhole (MH) 32-15-006 at 57th Drive and Eugie Drive.

14. The bypass piping within the ACDC shall be located between the recreational walking path and the residential wall. The piping shall not obstruct vehicle and foot traffic along the path.

15. The suction, discharge and pump areas shall be enclosed with temporary chainlink fence. Warning signs shall be provided stating "Hazardous Area, Do Not Enter" at each area entrance.

16. Bypass piping shall be double contained in a pipe sleeve for the entire length of the bypass piping within the ACDC.

17. No part of the bypass system shall cross the Salt River Project Arizona Canal. Routing of the bypass system within residential areas shall be avoided where possible.

C. DESIGN CRITERIA

The following design criteria shall be followed for the bypass pumping system:

1. Discharge manifolds are not acceptable.
2. Intake manifolds are not acceptable.
3. Separate intakes with debris control shall be used for each pump.
4. Aluminum pipe is not acceptable.
5. Suction lines shall be steel reinforced pipe or better.
6. Adequate intake line spacing (center to center) shall be provided to avoid vortexing.
7. A float switch, battery operated high level alarm with notification to cell phones and a warning light shall be provided.
8. Redundant air release valves shall be provided.
9. Multiple fuel tanks with 24-hours of fuel supply shall be provided.
10. Discharge piping shall be protected from vandalism and vehicular damage.
11. Odor control shall be as required.

D. EXPERIENCE:

Contractor shall utilize staff and/or a subcontractor that has been directly responsible for completion of a project that required sewer bypass pumping of sewage flows in excess of 1 mgd.

1.02 SUBMITTALS

The following submittals shall be provided in accordance with Section 01300:

1. Bypass Plan per paragraph 02145-3.02.

1.03 JOB CONDITIONS

A. AVAILABLE FLOW DATA:

Available flow data for the sewers to be rehabilitated at the project site is located in paragraph 02145-3.01. Flow data for other mainlines and service laterals is not available. The Contractor shall determine these flows.

B. PROTECTION:

In areas where flows are bypassed, all bypass flows shall be discharged as approved by the Engineer. No bypassing to the ground surface, receiving waters, storm drains, or bypassing

which results in soil or groundwater contamination or any potential health hazards shall be permitted.

All pumps, generators, and other equipment shall be placed on new plastic tarps to protect against gasoline, oil, and hydraulic fluid spills. Spills and leaks shall be cleaned up immediately.

C. SCHEDULING:

The bypassing system shall not be shut down between shifts, on holidays or weekends, or during work stoppages without written permission from the Construction Manager. The bypass system will have an attendant around the clock whose only duty is to maintain the bypass pumping system until the bypassing of that specific pipeline is no longer required.

PART 2--PRODUCTS

2.01 PUMPING SYSTEMS

Two different bypass pumping system criteria have been identified for this project. These criteria are identified below. Projects that are in environmentally sensitive areas or that have a high sewage flows will require one or more of these criteria as specified herein.

A. CRITERION 1 - BYPASS PUMPING SYSTEM WITH REQUIRED CAPACITY EQUAL TO OR LESS THAN 2 MGD:

Contractor shall maintain on site, the following minimum requirements for all bypass pumping systems:

1. Sufficient equipment and materials to ensure continuous and successful operation of the bypass and dewatering systems. The COMPLETE bypass system, including all piping, shall be continuously monitored by Contractor personnel.

2. A system of pumps and piping operating on site to maintain a minimum 150% capacity of the anticipated maximum flow (as determined by the Contractor). In addition, the Contractor shall have a standby pump, equal in capacity to the largest pump in the system, piped, plumbed and ready for operation. Standby pumps shall be fueled and operational at all times.

3. The Contractor shall maintain on site a sufficient number of valves, tees, elbows, connections, tools, sewer plugs, piping, hoses and other parts of system hardware to ensure immediate repair or modification of any part of the system as necessary.

4. For bypass piping lengths greater than 1,000 feet, a minimum of one additional (redundant) pipeline will be constructed and plumbed for

immediate operation that is equal in diameter to the largest pipe size in use for the bypass setup.

B. CRITERION 2 - BYPASS PUMPING SYSTEM WITH REQUIRED CAPACITY GREATER THAN 2 MGD:

In addition to the requirements identified under Criterion 1, Contractor shall design construct, operate and maintain the bypass system specified herein:

1. All bypass piping shall be fused HDPE piping.

2. The bypass piping system shall include multiple pipelines to convey 150% of the maximum anticipated flow (as determined by the Contractor). A minimum of one additional (redundant) pipeline will be constructed and plumbed for immediate operation that is equal in diameter to the largest pipe size in use for the bypass setup. All other requirements shall be the same as identified under Criterion 1 of these specifications.

PART 3--EXECUTION

3.01 ESTIMATED FLOWS AND SEWER CAPACITY PROJECT PIPELINE

A. DAILY FLOW DATA:

The following paragraph provides observed daily flow information for the project pipeline. The information was obtained from the data provided by the City of Glendale. For additional information contact the City of Glendale, during normal business hours. Use of this flow data in no way relieves the Contractor from his responsibilities for design, construction and operation of an adequate and properly functioning bypass system. Any additional monitoring or gathering of flow data is the responsibility of the Contractor.

The average daily and peak flows for each of the projects are presented below. The average daily flows are based on daily reported averages for the monitoring periods from September 13 to September 20, 2006. The peak hour flows are based on the highest hourly reported flow for the time period. The Contractor is advised that flows during the construction time period may be greater than those measured above.

Metered Average Day And Peak Hour Sewage Flows		
Location	Average Daily Flow (mgd)	Peak Hour Flow (mgd)
1. Manhole 31-16-005 Sweetwater Ave & Arizona Canal Diversion Channel (ACDC)	0.43	0.82

Abbreviations: mgd – million gallons per day

B. FLOW CONDITIONS:

The Contractor is responsible for obtaining current flow condition information at the time of construction. The Owner is not responsible for any deviations in quantity of sewage flow at any time during the construction period. Higher flows may be encountered depending on weather and other upstream conditions.

3.02 BYPASS PLAN

The Contractor shall be responsible for preparing drawings and complete design data showing methods and equipment he proposes to utilize in sewer bypassing for approval by the Engineer as part of the Bypass Plan. The Bypass Plan shall include the following information:

1. Drawings indicating the scheme and location of pumps, temporary sewer plugs and bypass discharge lines, ramps, lighting for ramps, and hazardous area barricade locations. The drawings shall also show the method and location for draining bypass lines upon completion of the work.

2. Capacities of pumps, prime movers, and standby equipment.

3. Design calculations proving adequacy of the system and selected equipment.

4. Standby power source.

5. Staffing plan.

6. Show suction and discharge points with elevations & stationing on the Contract Drawings.

7. Pump performance curves.

8. Calculations to verify suction lift of pumps has not been exceeded.

9. Proposed noise control and exhaust control plans for pumping equipment.

10. Proposed plan for disruption of sewer service laterals.

11. Bypass piping inspection plan.

The actual design of the bypass arrangement shall be prepared by the Contractor or Subcontractor performing the work, and shall be submitted to the Engineer to determine conformance to project objectives. The Contractor shall be responsible for any Subcontractors design (if used) on this Project. Means and methods of accomplishing the bypassing shall be the responsibility of the Contractor.

Approval of submitted plans for sewer connection and temporary rerouting shall in no way relieve the Contractor of their responsibility for the protection of adjacent properties, downstream drainage systems and water tributaries against sewage spill. Any litigation, claims, fines, etc. associated with any sewage spill shall be the responsibility of the Contractor.

3.03 PERMITTING

The Contractor shall obtain a permit from the Flood Control District of Maricopa County (FCDMC) for access and use of the ACDC for the bypass pumping. The Contractor shall provide any information that FCDMC may require in order to obtain the permit. This information includes, but is not limited to the following:

1. Estimated duration of bypass pumping.

2. Drawings as referenced in paragraph 3.02.

3. Emergency Action Plan as required by FCDX.

The Construction Manager shall provide the Contractor with the appropriate permit number.

3.04 INSPECTION

The Contractor shall inspect the entire bypass pumping and piping system for leaks for spills on an hourly basis. The Contractor shall also create an inspection log and shall enter the time of the inspections and the condition of the piping and the name of the inspector into the log for review by the Engineer.

3.05 DAMAGES

The Contractor shall repair, without cost to the owner, any damage that may result from his negligence, inadequate or improper installation, maintenance and operation of bypassing system, including mechanical or electrical failures. Contractor is responsible for immediate and proper cleanup should any spill occur, regardless of amount.

3.06 CLEAN UP

Prior to breaking down bypass ramps and/or hard piping, the Contractor shall flush with potable water. Once flushed, the hard piping shall be pigged using air to remove water.

END OF SECTION

SECTION 02200

EARTHWORK

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies earthwork which consists of excavation, filling, grading, and disposal of excess material.

B. DEFINITIONS:

1. COMPACTION: The degree of compaction is specified as percent compaction. Maximum or relative densities refer to dry soil densities obtainable at optimum moisture content.

2. EXCAVATION SLOPE: Excavation slope shall be defined as an inclined surface formed by removing material from below existing grade.

3. EMBANKMENT SLOPE: Embankment slope shall be defined as an inclined surface formed by placement of material above existing grade.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

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

Reference	Title
ASTM C136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D698	Standard Test Methods for Laboratory Compaction Characteristics of Soils Using Standard Effort
ASTM D1556	Standard Test Method for Density of Soil in Place by the Sand-Cone Method
ASTM D1557	Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.5-kg) Rammer and 18-in. (457-mm) Drop
ASTM D2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM D3017	Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

B. TESTS:

The Contractor will take samples and perform moisture content, gradation, compaction, and density tests during placement of backfill materials to check compliance with these specifications. Tests will be made by the Contractor in accordance with the following:

Test	Standard Procedure
Moisture content	ASTM D3017
Gradation	ASTM C136
Density in-place	ASTM D1556
Moisture-density relationships	ASTM D698

The Contractor shall sample and test at locations designated by the Construction Manager based on the locations and minimum frequency of tests as follows:

Location	Minimum Frequency
Subgrade under concrete slabs	One under each slab
Pipeline backfill	One every 100 linear feet of pipeline
Site fill	One on each area of site fill less than 100 square feet or every 100 feet within site fill area greater than 100 square feet.

Additionally, the Construction Manager will take samples and perform moisture content, gradation, compaction, and density tests during placement of backfill materials to provide quality assurance. The Contractor shall remove surface material at locations designated by the Construction Manager and provide such assistance as necessary for sampling and testing. The

Construction Manager may direct the Contractor to construct inspection trenches in compacted or consolidated backfill to determine that the Contractor has complied with these specifications.

Tests will be made by the Construction Manager in accordance with the following:

Test	Standard Procedure
Moisture content	ASTM D3017
Gradation	ASTM C136
Density in-place	ASTM D1556
Moisture-density relationships	ASTM D698

1.03 SUBMITTALS

Gradations of materials to be used shall be submitted 2 weeks in advance of use. Samples shall consist of 0.5 cubic feet of each type of material.

PART 2--MATERIALS

2.01 BEDDING AND BACKFILL

Bedding and backfill shall meet the requirements of MAG Section 601.4

2.02 CRUSHED ROCK

Crushed rock shall meet the requirements of MAG Section 701.2

2.03 AGGREGATE BASE

Aggregate base shall meet the requirements of MAG Section 702.2

2.04 SITE FILL

Unless otherwise specified, site fill shall be unclassified material which is free from peat, wood, roots, bark, debris, garbage, rubbish, or other extraneous material. The maximum size of stone shall not exceed 6 inches. If the material excavated from the site meets these requirements, it may be classified as this type.

2.05 TYPE D:

Type D material shall be granular material commonly known as pea gravel and shall conform to the following gradation:

U.S. standard sieve size	Percent by weight passing
1/4 inch	100
No. 8	0-5

PART 3--EXECUTION

3.01 GENERAL

A. UTILITY TRENCHING:

Utility trenching shall be per MAG section 601 and the detail on the drawings.

B. OVEREXCAVATION:

Where the undisturbed condition of natural soils is inadequate for support of the planned construction, the Construction Manager will direct the Contractor to overexcavate to adequate supporting soils. The excavated space shall be filled to the specified elevation with backfill. The overexcavated space under footings may be filled with concrete. The quantity and placement of such material will be paid for as extra work.

C. SURPLUS MATERIAL:

Unless otherwise specified, surplus excavated material shall be disposed of off site in accordance with applicable ordinances and environmental requirements.

D. HAULING:

When hauling is done over highways or city streets, the loads shall be trimmed and the vehicle shelf areas shall be cleaned after each loading. The loads shall be watered after trimming to eliminate dust.

E. FINISH GRADING:

Finished surfaces shall be smooth, compacted and free from irregularities. The degree of finish shall be that normally obtainable with a blade-grader.

Finished grade shall be as specified by the contours plus or minus 0.10 foot except where a local change in elevation is required to match sidewalks, curbs, manholes and catch basins, or to ensure proper drainage. Allowance for topsoil and grass cover, and subbase and pavement thickness shall be made so that the specified thickness of topsoil can be applied to attain the finished grade.

When the work is an intermediate stage of completion, the lines and grades shall be as specified plus or minus 0.5 foot to provide adequate drainage.

If the soil is to be cultivated or straw is to be incorporated into the surface, rocks larger than 2-1/2 inches in maximum dimension, roots and other debris on the surface of the slope shall be removed and disposed of prior to cultivation or placement of straw.

F. CONTROL OF EROSION:

The Contractor shall maintain earthwork surfaces true and smooth and protected from erosion. Where erosion occurs, the Contractor shall provide fill or shall excavate as necessary to return earthwork surfaces to the grade and finish specified.

3.02 EARTHWORK FOR STRUCTURES

A. STRUCTURE EXCAVATION:

The bottom shall not be more than 0.15 foot above or below the lines and grades specified. If the elevation of structure excavation is not specified, the excavation shall be not more than 0.15 foot above or below the elevation specified for fill material below the structure. Slopes shall vary no more than 0.5 foot from specified grade unless the excavation is in rock where the maximum variation shall be 2 feet.

Should the excavation be carried below the lines and grades specified on the drawings or should the bottom of the excavation be disturbed because of the Contractor's operations and require overexcavation and backfill, the Contractor shall refill such excavated space to the proper elevation in accordance with the procedure specified for backfill. The cost of such work shall be borne by the Contractor.

Unless otherwise specified, excavations shall extend a sufficient distance from walls and footings to allow for placing and removal of forms, installation of services, and for inspection, except where concrete is specified to be placed directly against excavated surfaces.

B. STRUCTURE BACKFILL:

Unless otherwise specified, structure backfill shall be per MAG Section 206.

After completion of construction below the elevation of the final grade, and prior to backfilling, forms shall be removed and the excavation shall be cleaned of debris.

Structure backfill shall not be placed until the subgrade portions of the structure have been inspected by the Construction Manager. No backfill material shall be deposited against concrete structures until the concrete has developed a strength of not less than 2500 pounds per square inch in compression, or until the concrete has been in place for 28 days, whichever occurs first.

Backfill material shall be placed in uniform layers and shall be brought up uniformly on all sides of the structure. When compaction is done by ponding and jetting, thickness of uncompacted layers shall not exceed 4 feet.

Compaction of structure backfill may be performed by ponding and jetting if the backfill material is of such character that it will be self-draining when compacted and that foundation materials will not be damaged by the applied water and no damage from hydrostatic pressure will

result to the structure. Ponding and jetting shall not be used within 4 feet of finished grade and shall be performed in such a manner that water will not be impounded.

Unless otherwise specified, backfill around and above pipelines within the excavation line of any structure shall be the same as that specified for structures.

3.03 EARTHWORK FOR PIPELINES AND CONDUITS

A. GENERAL:

Earthwork for pipelines and conduits is specified in MAG Section 601 and in the following paragraphs.

B. PIPELINE EXCAVATION:

The bottom of the trench shall be carried to the specified lines and grades with proper allowance for pipe thickness and for bedding as specified in MAG Section 601.

C. PIPELINE BACKFILL:

1. BEDDING: The Contractor shall not proceed with backfill placement in excavated areas until the subgrade has been inspected by the Construction Manager. All pipe shall have a minimum thickness of bedding material below the barrel of the pipe as specified in MAG Section 601. Bedding material shall be placed in the bottom of the trench, leveled and compacted. Bell holes shall be excavated at each pipe joint to permit proper inspection and uniform bearing of pipe on bedding material.

After the pipe has been laid to alignment and grade, unless otherwise specified, additional bedding material shall be placed in layers the full width of the trench and compacted up to the specified level. Bedding shall be placed simultaneously on both sides of the pipe, keeping the level of backfill the same on each side. The material shall be carefully placed and compacted around the pipe to ensure that the pipe barrel is completely supported and that no voids or uncompacted areas are left beneath the pipe. Contractor shall use particular care in placing material on the underside of the pipe to prevent lateral movement during backfilling.

2. INITIAL BACKFILL: After pipe has been properly bedded, Contractor shall place and compact initial backfill as specified. Initial backfill, where specified below the springline of the pipe, shall be placed and compacted in accordance with paragraph 02200-3.03 C.1 for additional bedding material.

3. SUBSEQUENT BACKFILL:

a. GENERAL: Backfill material, placement and compaction above the pipe zone shall be as specified. Backfill above the pipe zone shall not commence until pipe zone backfill has been inspected and accepted by the Construction Manager.

b. IMPROVED AREAS: Unless otherwise specified, select granular backfill per MAG Section 702.2, Type A, shall be used under all paved and unpaved roadways and paved and unpaved roadway shoulders, roadway embankments, and in all public right-of-ways and easements. The trench shall be backfilled to an elevation which will permit the placement of the specified surface or paving. Paving shall be as specified in Section 02500. Other surfaces shall be restored, including compaction, to the condition existing prior to construction including restoration of yard areas.

3.04 SUBGRADE FOR PAVEMENT

The prepared subgrade shall be scarified to a depth of at least 12 inches and recompacted to at least 95 percent of the maximum density.

3.05 SITE FILL

Fill material shall be placed in horizontal layers and compacted with power-operated tampers, rollers, idlers or vibratory equipment. Maximum layer depth and relative compaction is specified in the following table:

Maximum uncompressed layer depth, inches	Minimum relative compaction, percent	Application
8	90	Site Fill
8	95	Below Equipment Pads

If the existing slope in an area to be filled is greater than 5:1, the Contractor shall bench the area prior to filling.

END OF SECTION

SECTION 02760

SEWER CLEANING

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies the requirements for cleaning of sewers prior to television inspection and rehabilitation. Cleaning may include sewer pipelines, manholes, wet wells, and other structures.

B. REQUIREMENTS:

The Contractor shall clean the sewers specified for television inspection and rehabilitation of debris, roots, and grease accumulations to the specifications of the CIPP lining manufacturer and to the satisfaction of the Engineer. All materials dislodged during cleaning shall be removed from the sewer and disposed of by the Contractor. Sewer cleaning methods shall include water jetting, pigging, rodding, or bucketing. Contractor shall not wash, flush, or discharge any debris from the sewer operation downstream of the setup point of cleaning operations.

Television inspection is not required during cleaning operations. If during the TV inspection, the sewers and manholes or other structures are not, in the opinion of the Engineer, adequately cleaned, the TV inspection shall stop and the areas in question shall be cleaned, or re-cleaned by the Contractor at their expense.

1.02 MAJOR BLOCKAGE

A major blockage shall be defined as an obstruction within the sewer which cannot be removed by cleaning with commercially available hydraulic or mechanical cleaning equipment. If a major blockage is discovered during cleaning, Contractor shall submit a proposed method for major blockage removal to the Engineer for approval.

PART 2--MATERIALS

2.01 EQUIPMENT

A. GENERAL:

All equipment specified in this section shall be in good working condition and manufactured or fabricated to withstand the severity of the work covered under this section.

B. HYDRAULIC AND MECHANICAL CLEANING:

All hydraulic cleaning equipment shall be truck mounted. Water jet cleaning equipment shall include a water tank, auxiliary engine, pumps, and hydraulically driven hose reel. The Contractor shall provide a minimum of 600 feet of high pressure hose and a selection of high velocity nozzles, each having a capacity of 60 gallons per minute at working pressures of 1000 to 1500 pounds per square inch. Pressure to the nozzle shall be regulated by a relief valve adjustable from 1 to 1500 psi. Nozzles shall be capable of producing a jet stream angle of 15 to 45 degrees from the horizontal. The Contractor shall also provide a high velocity gun with sufficient discharge and pressure to thoroughly clean manhole interiors.

Sewer pigs which are propelled by water shall be readily collapsible at any time during the cleaning operations to protect against flooding of the sewer lines. The Contractor shall provide pigs in sizes consistent with the pipe diameters encountered. Each pig shall have a flexible scraper at its periphery to ensure the total removal of grease. Sewer pigs which are not readily collapsible are prohibited.

Mechanically powered equipment such as bucket machines shall be provided in pairs and shall be belt-driven or employ an overload device. Power rodding machines shall be a "continuous rod" type capable of rodding distances of up to 1000 feet in one setup. Rodding machines shall have the ability to spin the rod either clockwise or counterclockwise and be able to be pushed straight out or pulled back without rotating the machine. It shall be capable of pulling pipe-size swabs or brushes back through the sewer for cleaning and flushing purposes. The rodding machine shall have a positive drive and shall be capable of producing a 2000-pound pull. The rod shall be specifically designed for use with the rodding machine.

C. ROOT REMOVAL:

The Contractor shall employ sewer cleaning equipment to cut all roots encountered back to the pipe surface.

D. DEBRIS REMOVAL:

The Contractor shall provide suitable equipment to remove all debris dislodged during cleaning operations from the nearest downstream manhole. Equipment or methods which require a member, or members of the Contractor s crew, to physically excavate debris from within the manhole is prohibited. All debris shall be promptly removed from the sewer from the nearest manhole and shall be disposed of off site in a lawful manner at an Owner-approved location. Hauling containers shall be watertight.

PART 3--EXECUTION

3.01 GENERAL

The Contractor shall at all times conduct his work so as to prevent any blockage and minimize surcharging in the sewer manholes and connecting sewer pipelines. Damage to existing facilities as a result of the Contractor's work shall be promptly repaired in kind at the Contractor's expense.

It shall be the Contractor's responsibility to locate and retrieve any lost or broken cleaning equipment at their expense. Any damage resulting in or repairs from lost or broken equipment shall be at the Contractor's expense.

3.02 SEWER BYPASSING AND DEWATERING

Contractor shall be responsible for bypassing sewer flow around his work and dewatering of sewer lines in accordance with the requirements of Section 02145.

3.03 CLEANING

Cleaning shall remove all sludge, rocks, debris, roots, grease accumulations and obstructions from the sewer. Sewer cleaning methods may include water jetting, rodding, pigging, or bucketing. Unless otherwise directed by the Construction Manager, the Contractor shall select the most effective of these cleaning methods according to the prevailing site condition. Where bucketing is warranted, bucket machines shall be used to remove the major portion of debris. Bucket operations shall proceed in the upstream direction in one sewer reach at a time. The operation shall continue until the buckets can pass the entire reach with minimum collection of debris. Upon completion, the line shall be cleaned using a sewer pig and then hydraulically cleaned.

During cleaning operations, the Contractor shall provide a means of catching and removing the dislodged debris conveyed downstream with the sewer flow. The method chosen shall not allow the transport of debris to downstream sewer reaches.

All debris removed from the sewer shall be stored until the day's end whereupon the Contractor shall be responsible for its proper disposal off site.

3.04 RECLEANING

Where the sewer is not adequately cleaned as determined by the Construction Manager through pre-rehabilitation television inspection review, Contractor shall remove all equipment or materials from the sewer and reclean the sewer at no additional expense to the Owner.

3.05 TAG LINES

The Contractor may install a tag line after cleaning for later TV inspection equipment connections. However, the tag line shall not be left in the sewer longer than overnight. This

allowance may be rescinded by the Construction Manager at any location if unacceptable procedures are used by the Contractor to secure the tag line. Damage caused by sewage backup due to the tag line shall be the responsibility of the Contractor.

END OF SECTION

SECTION 02761

TELEVISION INSPECTION OF EXISTING SEWERS

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

The Contractor shall perform Closed Circuit Television (CCTV) inspections of the project pipelines before and after rehabilitation and the post installation inspection of new sewerlines. This includes areas where point-repairs have been performed.

B. REQUIREMENTS:

The Contractor shall inspect the sewer interior using a color closed circuit television camera (CCTV) and document the inspection on a digital recorder. All inspection video shall be submitted in MPEG file format (.mpg) and saved on DVDs or external USB hard drives for submittal. Each inspected sewer reach, manhole to manhole, should have an associated MPEG file. Electronic PDF (.pdf) files of each inspection log and digital photographs (.jpg) files) shall accompany the video inspections for each sewer reach (manhole to manhole) inspected.

1.02 QUALITY ASSURANCE

Contractor's Qualifications: The Contractor shall have a minimum of three (3) years of experience in such work necessary to successfully meet this specification and provide references for five (5) sewer inspection projects involving remote CCTV pan and tilt inspection.

1.03 SUBMITTALS

The following submittals shall be provided in accordance with Section 01300:

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. A check mark shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Engineer shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the

specifications. *Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.*

2. Contractor reference projects per paragraph 02761-1.02.

3. Work Sample per paragraph 02761-2.05.

PART 2 --PRODUCTS

2.01 TELEVISION INSPECTION EQUIPMENT

CCTV Camera(s) shall be intrinsically safe and shall be operative in 100 percent humidity conditions. Lighting intensity shall be remote controlled and shall be adjusted to minimize reflective glare. Lighting and camera quality shall provide a clear, in-focus picture of the entire inside periphery of the sewer. The camera shall have an articulated head and be adjustable for height in order to have the camera centered in the pipe being televised. The camera shall have the capability of taking color still photos. The camera shall have pan and tilt capabilities.

2.02 DIGITAL FILES

All CCTV inspections shall be recorded digitally in MPEG format or approved equal. VHS recording only for transfer to digital will not be permitted. Two copies of the USB Flash Drive or DVD containing the digital files shall be surrendered to the Engineer upon completion of the inspection. The audio portion of the recording shall be sufficiently free from electrical interference and background noise to provide complete intelligibility of the oral report. If the Engineer determines that the recording is defective or not of adequate quality, the Contractor shall perform the CCTV inspection again at the Contractor's expense.

2.03 FOOTAGE COUNTER

A footage counter device, which measures the distance traveled by the camera in the sewer, shall be accurate to plus or minus 0.5 feet in 1,000 feet. This counter shall be displayed on the recorded image at all times while inspecting pipe.

2.04 TITLING

Equipment shall include genlocking capabilities to the extent that computer generated data, (i.e., footage, date, size, address and location, etc) as determined by the Owner that can be overlaid onto the image, and both indicated on the television monitor and permanently recorded on the inspection video.

2.05 WORK SAMPLES

The Contractor shall submit an example of their work consisting of video in MPEG format or approved equal of previous sewer inspection work complete with on-screen written commentary and both hardcopy and digital inspection log(s) in PDF format on a USB Flash Drive or DVD. Samples shall be with the same camera and lighting equipment proposed for this work.

The Contractor shall be responsible for modifications to their equipment and/or inspection procedures to achieve report material of acceptable quality. No work shall commence prior to approval of the material by the Engineer. Once accepted, the report material shall serve as a standard for the remaining work.

Contractor shall maintain a copy of all inspection documentation (digital files, databases, and logs) for the duration of the work and warranty period.

2.06 PRODUCT DATA

The Contractor shall provide the following information in accordance with Section 01300:

1. TV inspection reports as specified in paragraph 02761-3.03.B. shall be submitted each week covering the previous week's work. Two copies of each USB Flash Drive or DVD shall be submitted to the Engineer prior to payment of the final pay request.

PART 3--EXECUTION

3.01 FLOW IN SEWERS

All pipes shall be clean and free of standing water and debris from construction prior to inspection. During the CCTV inspection, the Contractor shall provide temporary dry condition in the sewer pipelines. Bypassing requirements are as provided in Section 02145 of these specifications.

3.02 CLEANING

The Contractors shall thoroughly clean and flush each pipe segment prior to CCTV inspection per Section 02760.

3.03 INSPECTION

A. CCTV INSPECTION

An inspection shall be performed and recorded after cleaning the pipeline as specified in Section 02760, and prior to CIPP lining the pipeline. The Contractor shall be responsible for properly inspecting the pipe. The pipeline shall be inspected again in the same direction as the pre-inversion inspection once the lining activities are completed. The pipeline shall be dry during the inspections to ensure complete viewing of the pipe sidewalls and invert.

The Contractor shall provide on-screen written narration of the inspection, the street location, upstream and downstream manhole control points from the Drawings, date, and time of the inspection. Each inspection shall begin with the camera looking up at the manhole lid and end at the very next manhole, looking up at the manhole lid. The Engineer shall be present at all video inspections and have access to observe the CCTV monitor at all times. The system of cabling employed to transport the camera and transmit its signal shall not obstruct the camera's view.

It shall be the Contractor's responsibility to locate and retrieve any non-functional, failed and/or stuck CCTV equipment at their expense. No spliced videos will be allowed for any single pipe section. Video must be obtained during one continuous pass beginning at a manhole and end at a manhole.

B. INSPECTION VIDEO AND LOG

Contractor shall submit a CCTV inspection video and written log of every pipeline after cleaning and prior to lining, and for each newly constructed pipeline. Contractor shall submit a CCTV inspection video and written log of every pipeline following lining. For new pipeline installed as part of this Project, Contractor shall submit a CCTV inspection video and written log for each reach of pipeline.

The Engineer will review the submitted material, not for accuracy of content, but to make sure that the required information is provided and the recording is of acceptable quality. If the Engineer determines that the CCTV is defective or not of adequate quality, the Contractor shall CCTV inspect again at the Contractor's expense.

3.04 INSPECTION RATE

The camera shall be driven or pulled through the sewer in either direction, but all inspections at each location shall be in the same direction. Maximum rate of travel shall be 30 feet per minute when recording.

3.05 IMAGE PERSPECTIVE

The camera image shall be down the center axis of the pipe when the camera is in motion. The Contractor will be required to provide a 360-degree view of the pipe interior.

Points of interest shall also be videotaped and shall include, but not be limited to, lateral connections, defects in the new pipe (including, but not limited to, bumps, folds, tears, dimples, etc.).

3.06 SEWER IDENTIFICATION

All inspection documentation shall include the City contract number, upstream and downstream manhole number identification, pipe identification, length of pipe inspected and date of inspection.

3.07 QUALITY CONTROL

The Engineer will review videos and logs to ensure compliance with the requirements listed in this specification and contract documents. If the sewer line is not adequately cleaned that will allow the visual inspection to be made adequately, the Contractor shall clean the pipe by hydro-flushing and re-inspect by CCTV at the Contractor's expense. Damage caused to the pipe during the cleaning operation shall be repaired by the contractor at no cost to the Owner.

END OF SECTION

SECTION 02767

CIPP LINING OF EXISTING SEWERS

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies the rehabilitation lining of the sewer project in the areas indicated on the Drawings.

The Contractor is made aware that the lining of the sewers may occur during the summer months with temperatures exceeding 115 degrees F and severe thunderstorms possible. The Contractor shall be prepared for these temperatures and rain events and alter his installation procedures accordingly.

B. REQUIREMENTS:

Contractor shall provide and install a resin impregnated needled polyester felt non-woven material tube with a plastic coated wearing surface in all sewers identified for CIPP lining in accordance with American Society for Testing and Materials (ASTM) F1216 for the inversion installation method.

1.02 QUALITY ASSURANCE

A. REFERENCES:

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

Reference	Title
ASTM D2990	Test Method for Tensile, Compressive and Flexural Creep and Creep-Rupture of Plastics
ASTM D543	Test Method for Resistance of Plastics to Chemical Reagents
ASTM D638	Test Method for Tensile Properties of Plastics
ASTM D790	Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

ASTM F1216 Rehabilitation of Existing Pipelines and Conduits by Inversion and Curing of a Resin Impregnated Tube

B. CHEMICAL RESISTANCE

The chemical resistance tests should be completed in accordance with Test Method D543. Exposure should be for a minimum of one (1) month at 73.4 degrees F. During this period, the CIPP test specimens should lose no more than twenty percent (20%) of their initial flexural strength and flexural modulus when tested in accordance with Section 8 of ASTM F1216 when subjected to the following solutions:

Chemical Solution	Concentration, percent
Tap Water (pH 6-9)	100
Nitric Acid	5
Phosphoric Acid	10
Sulfuric Acid	10
Gasoline	100
Vegetable Oil	100
Detergent	0.1
Soap	0.1

The Contractor shall be responsible for all costs associated with the chemical resistance tests. Proof of meeting these requirements shall be provided to the engineer for approval at least seven (7) days prior to commencement of work.

C. WARRANTY:

All lining work shall be fully guaranteed by the Contractor for a period of 1 (one) year from the date of Final Completion, unless otherwise stipulated in writing by the Owner prior to the date of Final Completion. During this period, all defects discovered by the Owner or the Engineer shall be removed and replaced or repaired by the Contractor in a satisfactory manner at no cost to the Owner. Methods of repair shall be proposed by the Contractor and submitted to the Engineer for review. The City may conduct independent television inspections, at its own expense, of the lining work at any time prior to the completion of the guarantee period.

1.03 SUBMITTALS

The following submittals shall be provided in accordance with Section 01300:

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a

number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Engineer or his designated representative shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

2. Structural calculations for each CIPP liner size, including the recommended thicknesses.

3. A list of identified insertion locations and/or locations where insertion points will be installed along with documentation that the Contractor has inspected the proposed location to assess the structure for use.

4. The methods and equipment used to reinstate connecting sewers, laterals, and inside drops.

5. Detailed method for addressing sampling requirements, including location and size of each sample, method of removal, and method of liner repair.

6. Detailed method for addressing resin and catalyst mixing, sampling and quality assurance testing requirements during the wet-out process.

7. Manufacturer's recommended installation procedures.

8. Certification of Contractor's licensure by the CIPP manufacturer.

9. Certification that CIPP tube is manufactured per ASTM F1216 and resin is suitable for its intended use.

10. Copy of all laboratory analysis reports for all CIPP test specimen chemical resistance tests as specified in paragraphs 02767-1.02.B. Testing for chemical resistance shall be performed on a previously prepared sample of the finished product proposed for this project. A certified affidavit, signed by an officer of the company, shall be provided stating that the resin the test applies to and the resin submitted for this project are the same.

11. Certification that independent testing laboratory utilized by the Contractor is accredited to perform the testing required in paragraph 02767-2.03.

12. Shop drawings which detail short and long term properties (providing all supporting test data) of all component materials and construction.

13. Shop drawings on hydrophilic end seal gaskets to be used at each end of the liner and epoxy material to be used to fully seal the liner ends at each manhole.

14. Recommendations for material storage and temperature control, CIPP liner handling, insertion, curing, trimming and finishing.

15. Material safety data sheets for all hazardous chemicals used or expected to be onsite. At a minimum, sheets for the resin, catalyst, cleaners and repair agents shall be submitted. Two copies of these sheets shall be onsite during construction.

16. Warranty per paragraph 02767-1.02.C.

PART 2--PRODUCTS

2.01 GENERAL

CIPP shall be a resin impregnated needled polyester felt non-woven material tube with a plastic coated wearing surface in all sewers identified for CIPP lining in accordance with American Society for Testing and Materials (ASTM) F-1216. All materials and installation procedures provided by the Contractor for use in the CIPP installation process shall be equal to or exceed the requirements of Sections 5 and 7 of ASTM F1216.

Contractor shall provide equipment, planning, and job execution necessary to accomplish the work in an efficient manner and consistent with the objectives of this Specification, including preventing damage to existing infrastructure and maintaining pedestrian and vehicle access during construction.

All equipment (engines, pumps, boilers) shall be equipped with mufflers and/or plywood/Styrofoam noise panels enclosing equipment to keep the noise level with limits specified in the local codes and ordinances.

2.02 COMPONENT PROPERTIES

A. FELT TUBING:

The tube shall consist of one or more layers of absorbent non-woven felt fabric that meets the requirements of ASTM F1216. The tube shall be homogeneous across the entire wall thickness containing no intermediate or encapsulated elastomeric layers. No material shall be included in the tube that may cause delamination in the CIPP. Non-woven felt tubes shall have a flexible polyurethane or polypropylene membrane coating to contain the resin. The seam of the flexible tube shall be sewn; seams that are heat-bonded or otherwise joined that prohibit complete impregnation with resin will not be allowed.

The needled interlocked polyester felt shall be free from tears, holes, cuts, foreign materials and other surface defects.

B. RESINS:

The physical properties listed in paragraph 02767-2.03 apply to CIPP manufactured polyester, vinylester, or epoxy resin. Resins shall be tinted for visibility and provide positive indication of adequate liner wet-out. Resins should be appropriate for conditions encountered.

2.03 FINISHED AND CURED CIPP LINER PROPERTIES

The physical properties of the cured CIPP shall have minimum initial test values as given in Table 1 of ASTM F1216 (and supplemented in Table 1 below) for polyester, vinylester, and epoxy resins. Properties for these or any other enhanced resins shall be substantiated with test data. Resins shall be tinted for visibility and provide positive indication of adequate liner wet-out. Liner thickness shall meet or exceed the submitted thickness for each reach.

Table 1. Standard Resin

Test Property	Test Value	Test Method
Flexural strength	4,500 psi	ASTM D790
Flexural modulus	300,000 psi	ASTM D790
50-year flexural creep modulus	120,000 psi*	ASTM D2990
Installed liner thickness	Varies	ASTM D5813

* Test shall be in at 10,000 hours If approved 10,000 hour tests are not available, a minimum 50% reduction (50% retention) of Flexural Modulus of Elasticity per ASTM F1216 shall be used for all formula calculations

2.04 DIMENSIONS

Contractor shall field verify pipe diameters prior to ordering liner tubes.

Contractor shall make allowances in determining the felt tube length and circumference for stretch during installation and shrinkage during curing. The minimum length shall be that which continuously spans half the distance from the center of the inlet manhole to the next manhole, plus the liner overlap shown on the Drawings. The Contractor shall verify the lengths in the field before the felt tube is cut and impregnated. Individual installation runs may include one or more manhole-to-manhole sections as approved by the Engineer.

The diameter of the existing pipes may be larger than the nominal inside diameter due to corrosion of the pipe. It is the Contractor's responsibility to determine the required diameter of the liner.

The nominal wall thickness shall be at least the calculated design thickness, or the minimum specified, and may be up to fifteen percent (15%) greater except where felt layers overlap, in which case it may be in excess of this value.

2.05 DESIGN CRITERIA

The liner shall be designed in accordance with the procedures of ASTM F 1216, Appendix X1 and these specifications. All material properties used in design calculations shall be long-term (time-corrected) values. All liner pipe to be used to line the existing sewer shall be designed to have a minimum service life of 50 years and to withstand the total vertical and lateral loads, including, but not limited to, soil load, live loads, and hydrostatic loads. Contractor shall familiarize himself with site conditions when preparing liner design.

Contractor shall calculate the required minimum thickness for each pipe based a fully deteriorated pipeline condition. Actual level of deterioration may vary within any given section of sewer.

The following parameters shall be assumed for the liner design:

1. Modulus of soil reaction, $E'_s = 1000$ psi for fully deteriorated pipes.
2. Unit weight of soil = 140 pcf.
3. The minimum design ovality for straight runs shall be 2.0 percent.
4. Factor of Safety = 2.0
5. Fully deteriorated gravity pipe for all projects.
6. Groundwater 2 feet above top of pipe.
7. Floodwater where noted.
8. AASHTO H20 Traffic loads or Cooper E-80 loads as applicable.
9. AREMA E-80 loads.

If it is recognized that there is a non-uniform cross-section and the requirement of liner bifurcation is present on the springline of pipelines, the Contractor can design for the bifurcation or provide a structural repair which eliminates the pronounced benches. A design for the bifurcation or structural repair shall be required for any bench in the proximity of the springline greater than 2-inches in depth. Accounting for this condition by the use of an ovality reduction factor alone is not acceptable. Calculations for the design of the bifurcation condition or statement of intent to apply grout shall be submitted to the Engineer 7 days after the date of contract award.

The wall thickness of the felt tube shall be ordered to the next standard 1.5 mm incremental thickness above the minimum calculated design thickness. Unless otherwise specified to provide for excess resin migration, the gap thickness of the wetting out equipment shall be sized to allow an excess of five to ten percent (5%-10%) resin to pass during impregnation.

2.06 CIPP TERMINATION POINTS

The Contractor shall provide CIPP liner terminations as shown on the Drawings.

2.07 PRODUCT DATA

The following information shall be provided in accordance with Section 01300:

1. Original and one (1) copy of all laboratory analysis reports per paragraph 02767-2.03 for all CIPP samples collected for each tube installed.

2. CCTV Inspection reports as specified in paragraph 02767- 3.01.

PART 3--EXECUTION

3.01 PREPARATORY PROCEDURES

A. SITE INSPECTION

Contractor shall determine location of and inspect all inversion manholes for any obstruction that may interfere with the liner installation prior to ordering felt tube and shall make any necessary improvements to manhole to allow for insertion at no additional cost to the Owner.

Contractor shall measure and verify in the field, the diameter and length of the pipe to be lined prior to ordering felt tubing. The Engineer has made a diligent effort to determine pipe diameters at each installation location. The Contractor acknowledges that the contract documents are not guaranteed to be entirely accurate and it is Contractor's responsibility to verify diameters and notify the Engineer immediately if discrepancies are discovered. Contractor shall not "Wet Out" any CIPP liner prior to verifying diameters at the locations where it is to be installed.

B. SEWER CLEANING:

Prior to CIPP tube installation, the Contractor shall clean the existing sewer in accordance with Section 02760. The Contractor shall clear the existing sewer to remove obstructions such as solids or collapsed pipe that will prevent or hinder CIPP liner installation.

C. SEWER BYPASSING AND DEWATERING:

The Contractor shall be responsible for bypassing flow around his work and dewatering of sewer lines in accordance with the requirements of Section 02145.

D. TV INSPECTION AND LINE OBSTRUCTIONS:

The interior of the sewer shall be carefully inspected in accordance with Section 02761 to determine the location of conditions, which may prevent proper installation of CIPP.

E. SPOT REPAIR:

The Contractor shall grout any holes or voids that would prevent the proper installation of the CIPP liner. The use of a pre-liner may be necessary based on the amount of lost pipe wall.

3.02 INSTALLATION PROCEDURES

A. GENERAL:

The Contractor shall designate the location where the CIPP felt tube would be impregnated with resin ("wet-out"). Locations shall be subject to approval by the Engineer and applicable local agencies. The Contractor shall allow the Engineer to inspect the materials and "wet-out" procedure.

If the "wet-out" location is not at the project site, the impregnated CIPP tube shall be transported to site under controlled environmental conditions. Transport vehicles shall include a tamper resistant, sealed temperature-recording device which records the temperature of the liner at all times after leaving the wet-out site. The Contractor shall decide when to transport the impregnated CIPP tube to site and when to commence insertion with respect to weather conditions.

Contractor is responsible for obtaining construction/ fire hydrant meters from the water system provider and for paying all applicable deposit fees and water usage fees.

Openings into the pipe at manholes along the alignment are limited in some cases and the Contractor shall make proper inspection prior to selecting manholes as inversion points.

B. INSTALLATION PROCESS:

No CIPP installations will be undertaken in weather conditions that could jeopardize the installation of the CIPP, or be detrimental to the long-term performance of the CIPP. The liner will be installed by the inversion tube method. For pipe diameters greater than 18-inches only water inversion/water cure is allowed. For pipe diameter equal to or less than 18-inches water inversion/water cure or air inversion/steam cure will be allowed.

If infiltration is observed in the pipe to be lined during the post cleaning inspection the Contractor shall inject grout to stop the infiltration prior to installation of the CIPP. Contractor shall also install a hydrophilic waterstop in each manhole along the shot length. The hydrophilic waterstop end seals shall be bands that are 20 mm wide and 5 mm high, with a double bump on one side and flat on the other as manufactured by Hydrotite, Style DS-0520-3.51 or approved equal, and shall be installed at both ends of the liner in each manhole. The waterstop should be installed such that expansion occurs after installation and curing of the CIPP liner. Adhesive used to bond hydrophilic waterstop to the pipe and any spliced joints shall be as recommended and approved by the manufacture of the waterstop. There will be no additional cost to the Owner for the grouting or the installation of the hydrophilic waterstop.

The impregnated tube shall lowered into the insertion point through an inversion tube. The inversion tube will then be filled with a sufficient head of water or compressed air so that the pressure will push the tube through the damaged pipe inside out, while pressing the resin impregnated side firmly against the inside walls of the damaged pipe. The smooth coated side of the liner shall become the new interior surface of the pipe. After the tube is inverted through the

pipe section, the Contractor shall use water heated by circulating it through a boiler, or steam to cause the resin to cure.

C. CURING:

The curing process shall follow a step cure or similar approach recommended by the manufacturer and approved by the Engineer, and shall be held at the top step for an adequate length of time as determined by the liner manufacturer to ensure that the design physical properties are attained. Circulation water/air shall be cooled down to at least 100 degrees F and held for a minimum of one (1) hour before releasing the hydrostatic head.

The rate of temperature rise and fall during heating and cooling shall not exceed two (2) degrees F per minute when using water.

3.03 CIPP LINER SAMPLING

The Contractor shall prepare samples of the installed CIPP liner for subsequent testing of its physical properties.

A. SAMPLE PREPARATION:

For pipelines up to 18-inches in diameter, the Contractor shall provide restrained samples of the installation by lining through a short piece of pipe of the same diameter of the existing sewer. The short piece of pipe shall be held in place by a suitable heat sink, such as sand bags. The sample shall be obtained from either or both ends of the CIPP section so a representative sample of the CIPP lining installed is provided for each reach. Each sample shall be cut in half and each half shall be signed and dated by both the Contractor and the Construction Manager. All CIPP samples shall be properly marked with the date of inversion or insertion and the inversion or insertion number. The Contractor shall retain one signed sample and provide the other signed sample to the testing facility approved as part of the submittal process.

Samples for pipelines larger than 18-inches in diameter shall be prepared and tested using the flat plate sampling method in accordance with the procedures in Section 8.1 of ASTM F1216. The sample will be constructed of the same materials (tube and resin/catalyst) as is used for that given liner installation. The flat plate sample shall be large enough to provide five sample specimens each for Short Term Flexural (Bending) properties and Tensile properties, as per ASTM D790 and ASTM D638 respectively. The sample will be clamped in a mold and placed in the downtube during the curing period of the CIPP tube. The samples shall be removed after all the water is removed from the cured pipe tube. The samples shall be identified by: Date, Project Name, Shot Number, Install Manhole, Size, thickness, Resin and Catalyst.

B. SAMPLE TESTING:

The cured sample shall be tested by an independent testing laboratory. Final payment will not be made until test results are received. The Contractor shall be responsible for any deviation from the specified physical properties and those evaluated through testing. Failure to meet the specified physical properties will result in the CIPP liner being considered defective work. The

Contractor shall be responsible for all costs associated with the testing of the liner physical properties.

Finished and cured CIPP liner properties specified in paragraph 02767-2.03 of these Specifications shall be tested as specified. Previous test data will not be acceptable.

C. SAMPLING FREQUENCY:

The above-stated sampling shall be performed for each separate installation of CIPP and each thickness calculated for reaches with tapered tubes. Example: one sample from each individual pipeline liner installed as a minimum and two or more samples where the individual liner is tapered to handle different loading conditions (railroad, high ground water).

The minimum wall thickness shall be determined at a minimum of three (3) locations on a cut section of the CIPP flat plate sample using a method of measurement accurate to the nearest 0.005 inch.

D. CIPP LINER HANDLING:

Contractor shall exercise adequate care during transportation, handling and installation to ensure the CIPP material is not torn, cut, or otherwise damaged. If any part or parts of the CIPP material becomes torn, cut or otherwise damaged before or during insertion, it shall be repaired or replaced in accordance with the manufacturer's recommendations and approval by the Engineer before proceeding further; and at the Contractor's expense.

E. CIPP LINER LABELING:

Each liner tube shall be labeled by the liner manufacturer with the name of the Contractor, the location of the liner manufacturer, the name of the project, the liner thickness, the diameter of the liner, the liner length, and the location (manhole number) where it is to be installed.

3.04 FINISHED PRODUCT

A. FINISH:

The finished product shall be continuous over the length of pipe reconstructed and be free from dry spots, delamination, and lifts. If these conditions are present, the Contractor shall remove and replace the CIPP.

There shall be no leakage of water between the liner and the host pipe following installation. If leakage is present, it shall be the Contractor's responsibility to take corrective measures to stop all flow prior to acceptance of the lining work. There will be no additional cost to the Owner for any sealing activities.

The Contractor shall seal the end points of the liner at each manhole with epoxy so that no leakage of fluids may infiltrate between the liner and the existing pipe. This seal is in

addition to any hydrophilic waterstop that may be installed and shall provide a smooth transition between the manhole and the installed liner completely around the pipe (360 degrees). The sealing mixture shall be compatible with the liner/resin system, shall provide a watertight seal, and shall be approved by the Engineer prior to start of construction. Hydraulic cements and quick-set cement products are not acceptable. Acceptable materials shall be approved epoxy type products that will bond, not crack, dry up, slough off, or shrink over time, and provide a smooth transition at the manhole invert and sidewalls. There will be no additional cost to the Owner for the sealing activities.

When cutting or trimming the installed CIPP liner, the Contractor shall remove all loose pieces of CIPP from the sewer. Nets and/or screening shall be installed to prevent even small pieces of removed CIPP material from washing downstream.

The Contractor shall install the liner to provide a smooth interior surface that is wrinkle free. If wrinkles are detected in the installed liner, the Contractor shall provide photographs and dimensions of the wrinkle including height, length, and direction. Wrinkles in the finished liner pipe which cause a backwater greater than one (1) inch, or reduce the hydraulic capacity of the pipe (wrinkles which exceed five percent (5%) of the pipe diameter) are unacceptable and shall be removed or repaired by the Contractor at no additional cost to the City. Wrinkles in the finished liner pipe that reduce the structural stability of the pipe are unacceptable. If a void between the wrinkle and the pipe exists, the Contractor shall repair or replace that section of the pipe at no additional cost to the City. Methods of repair shall be proposed by the Contractor and submitted to the Engineer for review.

B. LATERAL CONNECTIONS:

After the curing is complete, existing service connections (if applicable) shall be re-established. The opening in the liner for the lateral connection shall be one hundred percent of the existing lateral opening. All cut edges at the reinstated laterals shall be smooth and free of jagged edges.

C. INSPECTION:

The Contractor shall inspect the CIPP after installation. The inspection will be performed and recorded using closed circuit television equipment in accordance with Section 02761. If defects or voids exist, the Contractor shall repair or replace that section of the pipe at no additional cost to the Owner. Methods of repair shall be proposed by the Contractor and submitted to the Engineer for review and approval.

3.05 CLEANUP

Following inspection, the Contractor shall clean up the entire project area. The Contractor shall appropriately dispose of all excess material and debris not incorporated into the permanent installation off site.

END OF SECTION

SECTION 03100

FORMWORK

PART 1 -- GENERAL

1.01 DESCRIPTION

This section specifies formwork requirements for concrete construction.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the documents listed below. They are a part of this section as specified and modified. Where a referenced document cites other standards, such standards are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, has been discontinued or has been replaced.

Reference	Title
ACI 117	Standard Specifications for Tolerances for Concrete Construction and Materials
ACI 301	Specifications for Structural Concrete
ACI 318	Building Code Requirements for Structural Concrete
ACI 350	Code Requirements for Environmental Engineering Concrete Structures
ACI 347R	Guide to Formwork for Concrete
National Institute of Standards - PS1	Construction and Industrial Plywood

B. DESIGN:

Formwork design requirements shall conform to the following:

1. Formwork, shoring and reshoring shall be designed by a Professional Engineer currently registered in the State of **Arizona** having a minimum of 3 years experience in this type of design work.

2. Design and engineering of formwork, shoring and reshoring, as well as its construction, is the sole responsibility of the Contractor.

3. A procedure and schedule shall be developed for removal of shores (and installation of reshores) and for calculating the loads transferred to the structure during this process.

4. Structural calculations shall be prepared as required to prove that all portions of the structure, in combination with the remaining forming and shoring system, have sufficient strength to safely support their own weight plus the loads placed thereon.

5. When developing procedure, schedule and structural calculations, consideration shall be made regarding the structural system that exists, effects of all imposed loads and the strength of concrete at each stage of construction.

C. DESIGN CRITERIA:

Design of formwork shall conform to the following criteria:

1. Formwork shall be designed for loads, lateral pressures and allowable stresses outlined in ACI 347R and for design considerations, wind loads, allowable stresses and other applicable requirements of the controlling local building code. Where conflicts occur between the above two standards, the more stringent requirements shall govern.

2. Formwork shall be designed to limit maximum deflection of form facing materials reflected in concrete surfaces exposed to view to 1/240 of span between structural members.

1.03 SUBMITTALS

Submittals shall be provided in accordance with Section 01300 and shall include the following information

1. Manufacturer's product data, installation instructions and acknowledgement that products submitted meet requirements of standards referenced for:

   a. Form materials
   b. Form ties.
   c. Form release compound.

2. Formwork designer qualifications.

3. Submit letter of certification stamped by the registered Engineer referenced in paragraph 1.02B.1 that formwork has been designed in accordance with the specifications.

4. If requested, structural analysis and concrete strength data used in planning and implementing form removal and shoring.

PART 2--PRODUCTS

2.01 FORMS

A. WOOD FORMS:

Wood forms shall be new and unused exterior grade plywood panels manufactured in accordance with APA (American Plywood Association) and bearing the trademark of that group. Forms for all concrete surfaces exposed to view shall be APA High Density Overlay (HDO) Plyform Class I Exterior 48" X 96" X 3/4" minimum thickness. Forms for other concrete surfaces shall be APA Douglas Fir B-B Plyform Class I Exterior 48" X 96" X 3/4-inch minimum thickness.

When approved by the Construction Manager, plywood may be reused.

B. METAL FORMS:

Metal forms excluding aluminum may be used. Forms shall be free of rust and straight without dents to provide members of uniform thickness.

2.02 FORM TIES

Form ties shall be commercially fabricated for use in form construction and shall be constructed so that ends or end fasteners can be removed without causing spalling at surfaces of the concrete. Diameter on ends shall be 3/4 inch minimum to 1 inch maximum. Embedded portion of ties shall be not less than 1 1/2 inch from face of concrete after ends have been removed. Ties with integral waterstops shall be provided in all water-retaining structures and in below grade structures exposed to a ground water level above the base slab.

2.03 FORM RELEASE COMPOUND

Coat all forming surfaces in contact with concrete using an effective, non-staining, non-residual, water based, bond-breaking form coating unless otherwise noted. Form release agents used in potable water containment structures shall be suitable for use in contact with potable water and shall be non-toxic and free of taste and odor.

PART 3--EXECUTION

3.01 PREPARATION

Preparation shall conform to the following:

1. Surfaces of forms shall be covered with an approved form release compound prior to form installation. Application shall be in accordance with manufacturer's recommendations.

2. Excess form coating material shall not be permitted to stand in puddles in forms nor in contact with hardened concrete against which fresh concrete is to be placed.

3. Surfaces of forms, reinforcing steel and other embedded materials shall be cleaned of any accumulated mortar or grout from previous concreting and of all other foreign material before concrete is placed.

3.02 CONSTRUCTION

Formwork construction shall conform to the following:

1. Forms shall be used for all cast-in-place concrete including sides of footings.

2. Forms shall be constructed and placed so that the resulting concrete will be of the shape, lines, dimensions, and appearance indicated on the Drawings. Forms shall be braced or tied together to maintain their position and shape under a load of freshly-placed concrete.

3. Forms shall be sufficiently tight to prevent leakage.

4. Temporary openings shall be provided at base of column and wall forms and at other points where necessary to facilitate cleaning and observation immediately before concrete is placed, and to limit height of free fall of concrete to prevent aggregate segregation.

5. Temporary openings, also called form "windows", shall be used to limit height of free fall of concrete and to limit the lateral movement of concrete during placement. Openings are required in wall placements greater than 20 feet in height and shall be spaced so that no more than 8 feet of solid form exists between openings measured horizontally and vertically.

6. A 3/4-inch chamfer strip shall be placed in exposed to view corners of the forms to produce a 3/4-inch wide beveled edge.

7. At construction joints, contact surface of form sheathing for flush surfaces exposed to view over hardened concrete in previous placement shall be overlapped by at least 1 inch. Forms against hardened concrete shall be held to prevent offsets or loss of mortar at construction joint and to maintain a true surface. Where possible, juncture of built-in-place wood or metal forms shall be located at architectural lines, control joints or at construction joints.

8. Where circular walls are formed and forms made up of straight sections are proposed for use, straight lengths not exceeding 2 feet wide shall be provided for curved surfaces with a radius of 25 feet to 100 feet. Straight form lengths not exceeding 3 feet wide may be used for curved surfaces with a radius of 100 feet and larger. Formwork shall be braced and tied to maintain correct position and shape of members.

9. Wood forms for wall openings shall be constructed to facilitate loosening, if necessary, to counteract swelling. Formwork shall be anchored to shores or other supporting surfaces of members so that movement of any part of formwork system is prevented during concrete placement.

10. Runways for moving equipment shall be provided with struts or legs, supported directly on formwork or structural members without resting on reinforcing steel.

11. A positive means of adjustment (wedges or jacks) of shores and struts to take up all settlement during concrete placing operation shall be provided. Forms shall be securely braced against lateral deflection. Wedges used for final adjustment of forms shall be fastened prior to concrete placement in position after final check.

3.03 TOLERANCES

Formwork tolerances shall be in accordance with ACI 117 and the following. If a discrepancy is found between the requirements below and ACI 117, the more stringent requirement shall control:

1. Products shall be installed in accordance with manufacturer's written instructions.

2. Surfaces of columns, piers, walls, and risers shall vary from plumb a maximum of 1/2 inch for entire height and 1/4 inch in 10 feet of height. Exposed corner columns, control-joint grooves, and other exposed to view lines shall vary from plumb a maximum of 1/2 inch for entire length and 1/4 inch in 20 feet of length.

3. Maximum variation from level or from grade shall be 3/4 inch for entire length, 3/8 inch for any bay or 20 foot length, and 1/4 inch in 10 feet of length for slab soffits, ceilings, and beam soffits, measured before removal of supporting shores and shall be 1/2 inch for entire length and 1/4 inch in 20 feet of length for exposed lintels, sills, parapets, horizontal grooves, and other exposed-to-view lines.

4. Maximum variation of linear structure lines from established position in plan and related position of columns, walls, and partitions shall be 3/4 inch for entire length and 3/8 inch for any bay or 20 foot length.

5. Maximum variation in size and location of sleeves, floor openings, and wall openings and variation in horizontal plan location of beam, column and wall centerlines shall be ± 1/2 inch

6. Maximum variation in cross sectional dimensions of columns and beams and in thickness of slabs and walls shall be ± 3/8 inch and in concrete plan dimensions for footings and foundations shall be - 1/2 inch + 2 inches.

7. Maximum misplacement or eccentricity of footings and foundations shall be 2 percent of footing width in direction of misplacement, but not more than 2 inches.

8. Specified thickness of footings and foundations may be decreased by up to 5 percent with no maximum increase except that which may interfere with other construction.

9. Maximum step variance in the flight of stairs for Rise is ± 1/8 inch and for Tread is ± 1/4 inch and in consecutive steps for Rise is ± 1/16 inch and for Tread is ± 1/8 inch.

10. Sufficient control points and benchmarks to be used for reference purposes to check tolerances shall be established and maintained in an undisturbed condition until final completion and acceptance of the work.

11. Regardless of tolerances listed, no portion of a structure shall be allowed to extend beyond the legal boundary of work site.

12. To maintain specified tolerances, formwork shall be cambered to compensate for anticipated deflections in formwork prior to hardening of concrete.

3.04 REMOVAL OF FORMS

Removal of forms shall conform to the following:

1. No construction loads shall be supported on, nor any shoring removed from, any part of the structure under construction except when that portion of the structure in combination with remaining forming and shoring system has sufficient strength to safely support its weight and loads placed thereon.

2. When required for concrete curing in hot weather, required for repair of surface defects or when finishing is required at an early age, forms shall be removed as soon as concrete has hardened sufficiently to resist damage from removal operations or lack of support.

3. Top forms on sloping surfaces of concrete shall be removed as soon as concrete has attained sufficient stiffness to prevent sagging. Any needed repairs or treatment required on such sloping surfaces shall be performed at once, followed by curing specified in Section 03300.

4. Wood forms for wall openings shall be loosened as soon as this can be accomplished without damage to concrete.

5. Formwork for columns, walls, sides of beams, and other parts not supporting weight of concrete may be removed as soon as concrete has hardened sufficiently to resist damage from removal.

6. Where no reshoring is planned, forms and shoring used to support weight of concrete shall be left in place until concrete has attained its specified 28-day compressive strength.

7. When shores and other vertical supports are so arranged that non-load-carrying form facing material may be removed without loosening or disturbing shores and supports, facing material may be removed when concrete has sufficiently hardened to resist damage from removal.

END OF SECTION

SECTION 03200

CONCRETE REINFORCEMENT

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies reinforcing steel for use in reinforced concrete.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ACI 117	Standard Specifications for Tolerances for Concrete Construction and Materials
ACI 315	Details and Detailing of Concrete Reinforcement
ACI 318	Building Code Requirements For Structural Concrete and Commentary
ACI SP-66	ACI Detailing Manual
ASTM A82	Steel Wire, Plain, for Concrete Reinforcement
ASTM A185	Steel Welded Wire, Fabric, Plain for Concrete Reinforcement
ASTM A615/A615M	Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

Reference	Title
CRSI-PRB	Recommended Practice for Placing Reinforcing Bars
CRSI-MSP 1	Manual of Standard Practice
FEDSPEC QQ-W-461H	Wire, Steel, Carbon (Round, Bare, and Coated)

B. SHIPPING, HANDLING AND STORAGE:

Reinforcing steel shall be shipped to the jobsite with attached plastic or metal tags having permanent mark numbers which match the shop drawing mark numbers. All reinforcing shall be supported and stored above ground.

C. FABRICATION:

Reinforcing steel bars shall be fabricated in accordance with ACI 315 and the following tolerances:

1. Sheared lengths shall be within +/- 1 inch.
2. Overall dimensions of stirrups, ties, and spirals shall be within +/- ½ inch.
3. All other bends shall be within +0 inch, -½ inch
4. Minimum diameter of bends of reinforcing steel bars shall be as indicated in ACI-318 paragraph 7.2.

1.03 SUBMITTALS

Submittals shall be provided in accordance with Section 01300 and shall include the following:

1. Mill certificates for all reinforcing.

2. Manufacturer and type of proprietary reinforcing steel splices. A current ICC Report and manufacturer's literature that contains instructions and recommendations for each type of coupler used shall be submitted.

3. Manufacturer and type of reinforcing steel adhesive anchor. A current ICC Report and manufacturer's literature that contains instruction and recommendations for each type of adhesive anchor to be used shall be submitted.

4. Reinforcing steel shop drawings showing reinforcing steel bar quantities, sizes, spacing, dimensions, configurations, locations, mark numbers, lap splice lengths and locations, concrete cover and reinforcing steel supports. Reinforcing steel shop drawings shall be of sufficient detail to permit installation of reinforcing steel without reference to the contract drawings. Shop drawings shall not be prepared by reproducing the plans and details

indicated on the contract drawings but shall consist of completely redrawn plans and details as necessary to indicate complete fabrication and installation of reinforcing steel, including large scale drawings at joints detailing bar placement in congested areas. Placement drawings shall be in accordance with ACI 315. Reinforcing details shall be in accordance with ACI SP-66.

PART 2--PRODUCTS

2.01 BAR REINFORCEMENT

Reinforcing steel bars shall be deformed billet steel in conformance with ASTM A615, Grade 60.

2.02 WIRE FABRIC

Wire fabric shall be welded steel mesh conforming to ASTM A185.

2.03 WIRE AND PLAIN BARS

Wire used as reinforcement and bars used as spiral reinforcement in structures shall be cold drawn steel conforming to ASTM A82.

2.04 TIE WIRE

The wire shall be minimum 16 gage annealed steel conforming to FEDSPEC QQ-W-461H.

2.05 BAR SUPPORTS

Bar supports coming into contact with forms shall be CRSI Class 1 plastic protected or Class 2 stainless steel protected and shall be located in accordance with CRSI MSP-1 and placed in accordance with CRSI PRB.

1. Manufactured concrete block supports with embedded tie wires (wire dobies) shall be provided for footing and slabs on grade. Do not use brick, broken concrete masonry units, spalls, rocks, construction debris, or similar material for supporting reinforcing steel.

2. Stainless steel or plastic protected plain steel supports shall be provided for other work.

PART 3--EXECUTION

3.01 TOLERANCE

Reinforcing steel placement tolerance shall conform to the requirements of ACI 117, ACI 318, and the following:

1. Reinforcing steel bar clear distance to formed surfaces shall be within +/- ¼ inch of specified clearance and minimum spacing between bars shall be a maximum of ¼ inch less than specified.

2. Reinforcing steel top bars in slabs and beams shall be placed +/- $^3/_8$ inch of specified depth in members 8 inches deep or less and +/- ½ inch of specified depth in members greater than 8 inches deep.

3. Reinforcing steel spacing shall be placed within +/- one bar diameter or +/- 1 inch, whichever is greater.

4. The minimum clear distance between reinforcing steel bars shall be equal to the greater of 1 inch or the reinforcing steel bar diameter for beams, walls and slabs, and the greater of 1 ½ inches or 1.5 times the reinforcing steel bar diameter for columns.

5. Beam and slab reinforcing steel bars shall be threaded through column vertical reinforcing steel bars without displacing the column reinforcing steel bars and still maintain clear distances for beam and slab reinforcing steel bars.

3.02 CONCRETE COVER

Unless specified otherwise on the Drawings, reinforcing steel bar cover shall conform to the following:

1. Reinforcing steel bar cover shall be 3 inches for concrete cast against earth.

2. Reinforcing steel bar cover shall be 2 inches for reinforcing steel bars for formed concrete surfaces exposed to earth and weather.

3. Reinforcing steel bar cover shall be 2 inches for any formed surfaces exposed to or above any liquid.

3.03 SPLICING

Reinforcing steel splicing shall conform to the following:

1. Class B splice lengths in accordance with ACI 318, Chapter 12, shall be used for all reinforcing steel bars unless shown otherwise on the drawings.

2. For welded wire fabric the splice lap length measured between the outermost cross wires of each fabric sheet shall not be less than one spacing of cross

wires plus 2 inches, nor less than 1.5 times the development length nor less than 6 inches.

3. Splices of reinforcement steel bars not specifically indicated or specified shall be subject to the approval of the Construction Manager. Mechanical proprietary splice connections may be used when approved by the Construction Manager or as indicated on the drawings.

4. Welding of reinforcing steel bars is not allowed.

3.04 CLEANING

Reinforcing steel bars at time of concrete placement shall be free of mud, oil, loose rust, or other materials that may affect or reduce bond. Reinforcing steel bars with rust, mill scale or a combination of both may be accepted without cleaning or brushing provided dimensions and weights including heights of deformation on a cleaned sample are not less than required by applicable ASTM standards.

3.05 PLACEMENT

Reinforcing steel bar placement shall conform to the following:

1. Reinforcing steel bars shall be supported and fastened together to prevent displacement by construction loads or concrete placement. For concrete placed on ground, furnish concrete block supports or metal bar supports with non-metallic bottom plates. For concrete placed against forms furnish plastic or plastic coated metal chairs, runners, bolsters, spacers and hangers for the reinforcing steel bar support. Only tips in contact with the forms require a plastic coating.

2. Reinforcement shall be extended to within 2 inches of formed edges and 3 inches of the concrete perimeter when concrete is placed against earth.

3. Reinforcing steel bars shall not be bent after embedding in hardened concrete unless approved by the Construction Manager.

4. Tack welding or bending reinforcing steel bars by means of heat is prohibited.

5. Where required by the contract documents, reinforcing steel bars shall be embedded into the hardened concrete utilizing an adhesive anchoring system specifically manufactured for that application. Installation shall be per the manufacturer's written instructions.

6. Bars with kinks or with bends not shown shall not be used.

3.06 FIELD QUALITY CONTROL

Field quality control shall include the following:

1. The Construction Manager shall be notified whenever the specified clearances between the reinforcing steel bars can not be met. The concrete shall not be placed until the Contractor submits a solution to the congestion problem and it has been approved by the Construction Manager.

2. The reinforcing steel bars may be moved as necessary to avoid other reinforcing steel bars, conduits or other embedded items provided the tolerance does not exceed that specified in Section 3.01. The Engineer's approval of the modified reinforcing steel arrangement is required where the specified tolerance is exceeded. No cutting of the reinforcing steel bars shall be done without written approval of the Construction Manager.

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies cast-in-place concrete which consists of furnishing all material, mixing and transporting equipment, and performing all labor for the proportioning, mixing, transporting, placing, consolidating, finishing, and curing of concrete in the structure.

1.02 QUALITY ASSURANCE

A. QUALITY CONTROL BY OWNER:

Special Inspection of concrete work shall be performed by the Special Inspector under contract with the Owner and in conformance with the IBC Chapter 17. Special Inspector(s) and laboratory shall be acceptable to the Owner in their sole discretion. Special Inspection of concrete is in addition to, but not replacing, other inspections and quality control requirements herein. Where sampling and testing required herein conforms to Special Inspection standards, such sampling and testing need not be duplicated.

All structural concrete work shall receive Special Inspection in accordance with IBC Chapter 17. Structural concrete includes all elements which resist code-defined loads and whose failure would impact life safety. Non-structural site work concrete does not require Special Inspection. Anchor bolts and anchors installed in hardened concrete require Special Inspection.

B. QUALITY CONTROL BY CONTRACTOR:

Where required to demonstrate conformance with the specified requirements for cast-in-place concrete, the Contractor shall provide the services of an independent testing laboratory which complies with the requirements of ASTM E329. The testing laboratory shall sample and test concrete materials as specified in paragraphs 03300-2.01, 2.02, and 3.12. Costs of testing laboratory services shall be borne by the Contractor.

C. BASIS FOR QUALITY:

Cast-in-place concrete shall conform to the requirements of ACI 301, except as modified herein.

D. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event

of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization, or if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued, or replaced.

Reference	Title
ACI 117	Tolerances for Concrete Construction and Materials
ACI 211.1	Selecting Proportions for Normal, Heavy Weight and Mass Concrete
ACI 301	Structural Concrete for Buildings
ACI 305.1	Specification for Hot Weather Concreting
ACI 306.1	Standard Specification for Cold Weather Concreting
ACI 318	Building Code Requirements for Structural Concrete
ACI 350	Code Requirements for Environmental Engineering Concrete Structures
ASTM C31	Making and Curing Concrete Test Specimens in the Field
ASTM C33	Concrete Aggregates
ASTM C39	Compressive Strength of Cylindrical Concrete Specimens
ASTM C40	Organic Impurities in Fine Aggregate for Concrete
ASTM C42	Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C88	Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C94	Ready-Mixed Concrete
ASTM C117	Materials Finer Than 75-μm (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C131	Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136	Sieve Analysis of Fine and Coarse Aggregates
ASTM C142	Clay Lumps and Friable Particles in Aggregates
ASTM C143	Slump of Hydraulic Cement Concrete
ASTM C150	Portland Cement
ASTM C157	Length Change of Hardened Cement Mortar and Concrete
ASTM C172	Sampling Freshly Mixed Concrete

Reference	Title
ASTM C192	Making and Curing Concrete Test Specimens in the Laboratory
ASTM C231	Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260	Air-Entraining Admixtures for Concrete
ASTM C309	Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C494	Chemical Admixtures for Concrete
ASTM C618	Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C881	Epoxy-Resin-Base Bonding Systems for Concrete
ASTM D75	Sampling Aggregates
ASTM D2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM E329	Agencies Engaged in Construction Inspection and/or Testing
IBC	International Building Code with local amendments

1.03 SUBMITTALS

The following information shall be provided in accordance with Section 01300:

1. Each proposed mix design showing (a) the expected strength at 28 days, (b) corresponding slump before and after the introduction of high-range water-reducing admixtures, (c) water/cement ratios, (d) weights and test results of the ingredients, (e) aggregate gradation, (f) test results of mix design prepared by an independent testing laboratory, and (g) other physical properties necessary to review each mix design for conformance with these specifications.

2. Product literature and technical data for aggregates, cement, and pozzolan.

3. Product literature, technical data and dosage of all proposed admixtures including, but not limited to, air entraining, water reducing, and set retarding admixtures.

4. Anticipated average delivery time from batch plant to site. If this time exceeds the limit specified in paragraph 3.02, include proposed method to extend set time without deleterious effects on final product. Construction Manager reserves the right, in their sole discretion, to accept or reject such proposed methods.

5. Curing program description in sufficient detail to demonstrate acceptable strength, finish and crack control as specified.

6. Product literature and technical data for curing and sealing compounds, and bonding compounds.

7. Concrete delivery truck tickets showing the information listed in ASTM C94, section 14.

PART 2--PRODUCTS

2.01 MATERIALS

A. CEMENT:

Portland cement shall be ASTM C150, Type II or Type V, low alkali, containing less than 0.60 percent alkalis. In addition to standard requirements, cement shall satisfy optional chemical and physical requirements of ASTM C150, Tables 2 and 4, respectively.

Use cementitious materials that are of the same brand and type and from the same plant of manufacture as the cementitious materials used in the concrete represented by the submitted field test records or used in the trial mixtures. See Section 2.01F.

B. AGGREGATES:

1. GENERAL: Except as modified herein, fine and coarse aggregates shall conform to ASTM C33. Fine and coarse aggregates shall be regarded as separate ingredients. Aggregates shall be non-reactive and shall be washed before use.

Tests for size and grading of fine and coarse aggregates shall be in accordance with ASTM C136. Combined aggregates shall be well and uniformly graded from coarse to fine sizes to produce a concrete that has optimum workability and consolidation characteristics. The final combined aggregate gradation shall be established during the design mix.

Aggregates used in the concrete shall be obtained from the same sources and have the same size ranges as the aggregates used in the concrete represented by the submitted historical data or trial mixtures. See Section 2.01F.

2. FINE AGGREGATE: Fine aggregate shall be hard, dense, durable particles of either sand or crushed stone regularly graded from coarse to fine. Gradation shall conform to ASTM C33. For classes of concrete which will be used in liquid retaining structures, fine aggregate shall not exceed 40 percent by weight of combined aggregate total, except for concrete with coarse aggregate of less than maximum size 1/2 inch.

Variations from the specified gradations in individual tests will be acceptable if the average of three consecutive tests is within the specified limits and the variation is within the permissible variation listed below:

U.S. standard sieve size	Permissible variation in individual tests, percent
30 and coarser	2
50 and finer	0.5

Other tests shall be in accordance with the following specifications:

Test	Test method	Requirements
Amount of material	ASTM C117	3 percent passing No. 200 sieve maximum by weight
Sand equivalent	ASTM D2419	Minimum 70

3. COARSE AGGREGATE: Coarse aggregate shall be hard, dense and durable gravel or crushed rock free from injurious amounts of soft and friable particles, alkali, and organic matter. Other deleterious substances shall not exceed the limits listed in ASTM C33, Table 3 for Class Designation 5S. Gradation of each coarse aggregate size specified in paragraph 03300-2.02 A shall conform to ASTM C33, Table 2.

Variations from the specified gradations will be acceptable in individual tests if the average of three consecutive tests is within the specified limits.

C. POZZOLAN:

Pozzolan shall be Class F fly ash conforming to ASTM C618. Class C fly ash is not allowed. Pozzolan supplied during the life of the project shall have been formed at the same single source. See Section 2.01F.

The pozzolan color shall not substantially alter the resulting concrete from the normal gray color and appearance.

Use pozzolan materials that are of the same brand and type and from the same plant of manufacture as the materials used in the concrete represented by the submitted field test records or used in the trial mixtures.

D. ADMIXTURES:

1. GENERAL: Admixtures shall be compatible with the concrete and with each other. Calcium chloride or admixtures containing calcium chloride are not acceptable. Admixtures shall be used in accordance with the manufacturer's recommendations and shall be added separately to the concrete mix. The water reducing retarders and admixtures shall reduce the water required by at least 11 percent for a given concrete consistency and shall comply with the water/cement ratio standards of ACI 211.1. Retarder dosage shall result in set time consistent with paragraph 3.02.

2. WATER REDUCING ADMIXTURES: Water reducing admixtures shall conform to ASTM C494, Type A. Acceptable products include: BASF "Pozzolith 322N"; SIKA Chemical Corp. "Plastocrete 161"; Euclid Chemical Co. "Eucon WR91"; or equal.

3. WATER REDUCING AND RETARDING ADMIXTURES: Water reducing and retarding admixtures shall conform to ASTM C494, Type D. Acceptable products include: BASF "Pozzolith 300R"; Sika Chemical Corp. "Plastiment"; Euclid Chemical Co. "Eucon Retarder 75"; or equal.

4. HIGH RANGE WATER REDUCING ADMIXTURES: High range water reducing (superplasticizing) admixtures shall conform to ASTM C494, Type F. Acceptable products include: BASF "Glenium 3000NS"; Sika Chemical Corp. "Sikament FF or 686"; Euclid Chemical Co. "Eucon 37"; W.R. Grace "ADVA 195"; or equal.

5. HIGH RANGE WATER REDUCING AND RETARDING ADMIXTURES: High range water reducing and retarding admixtures shall conform to ASTM C494, Type G. Acceptable products include: W.R. Grace "Daracem 100"; Euclid Chemical Co. "Eucon 537"; or equal.

6. AIR ENTRAINING AGENT: Air entraining agent shall conform to ASTM C260. Acceptable products include: BASF "MB-AE 90"; Sika Chemical Corp. "AEA-15"; Euclid Chemical Co. "AEA-92"; or equal. The air entraining agent added shall produce, in accordance with ASTM C260, an entrained air content specified in paragraph 03300-2.02 A for each class of concrete.

E. WATER:

Water for washing aggregate, for mixing and for curing shall be free from oil and deleterious amounts of acids, alkalis, and organic materials; and shall comply with the requirements of ASTM C1602. Additionally, water used for curing shall not contain an amount of impurities sufficient to discolor the concrete.

F. CHANGE OF MATERIALS:

After each concrete mix design is approved by the Engineer, no changes of any sort or source will be allowed without prior written approval from the Engineer. When brand, type, size, or source of cementitious materials, aggregates, water, ice, or admixtures are proposed to be changed, new field data, data from new trial mixtures, or evidence that indicates that the change will not affect adversely the relevant properties of the concrete shall be submitted for approval by the Engineer before use in concrete.

2.02 CONCRETE CHARACTERISTICS

A. MIX PROPORTIONING:

Concrete shall be normal weight concrete composed of specified cement, pozzolan, admixtures, aggregates and water proportioned and mixed to produce a workable, strong, dense, and impermeable concrete. The Contractor may substitute interground Portland-pozzolan cement conforming to ASTM C595, containing the specified amount of pozzolan in lieu of Portland cement and pozzolan. Water-cementitious material (w/cm) ratio is based on the combined contents of cement and pozzolan in a given mix proportion.

Concrete shall be provided in accordance with the following:

Concrete class	ASTM coarse aggregate size	Maximum water-cementitious materials (w/cm) ratio	Minimum Cementitious Materials Content (pounds/CY)	Pozzolan, percent by weight of cementitious materials	Air content (percent)	Minimum[a] 28-day compressive strength, psi	Slump Range[d] (inches)
B	57 or 67	0 45	560	15-20[c]	4-6	3000	3-5
C-1	57 or 67	0.40	560	15-20[c]	4-6	4000	3-5
E[b]	57	--	-	15-20[c]	Not Required	2000	4-8

[a] Compressive strength shall be determined at the end of 28 days based on test cylinders made and tested in accordance with ASTM C39

[b] Concrete encasement for electrical conduit shall contain 3 pounds of red oxide per sack of cement

[c] Pozzolan use optional for this class of concrete.

[d] Slump before addition of high range water reducing admixture (superplasticizer) Maximum slump after addition of high range water reducing admixture shall be 8".

B. USE:

Concrete shall be provided by class for the corresponding use listed as follows:

Type of use	Class of concrete
Non-structural concrete (sidewalks, curbs, pavers, etc.)	B
Typical cast-in-place structural concrete	C-1
Pipe bedding and encasement, electrical conduit encasement (duct banks) and concrete fill	E

C. CONTROL TESTS:

1. GENERAL: Before beginning concrete work, the Contractor shall determine the proper proportions of materials for each class of concrete. The mix shall consist of specified cement, pozzolan, admixtures, aggregate and water. Methods for selecting and adjusting proportions of the ingredients shall be in accordance with ACI 211.1. Verification of mix characteristics for submittal may be achieved using either the Trial Mix Design method or Field Experience method. Concrete shall not be placed in the field prior to review and acceptance of mix proposed.

2. TRIAL MIX DESIGN: Each class of concrete and/or mix verified by this method shall be manufactured at the batch plant which will supply concrete to the project using materials proposed for the Work and material combinations listed in paragraphs 2.01 and 202. Testing, data and reporting shall conform to ACI 318 Section 5.3 and the following:

(a) Required compressive strength used as the basis for selecting concrete proportions (f'cr) shall be the specified concrete strength (f'c) + 1000 psi for specified concrete strengths less than 3,000 psi and f'c + 1200 psi for specified concrete strengths between 3000 psi and 5000 psi.

(b) Make at least three trial different mixtures for each class of concrete qualified by the Trial Mix Design. Each trial mixture shall have a different w/cm ratio or different cementitious materials content that will produce a range of compressive strengths encompassing f'cr.

(c) Trial mixtures shall be designed to produce a slump within ¾ in. of the maximum specified and for air-entrained concrete, an air content within 0.5% of the maximum allowable air content.

(d) For each w/cm ratio or cementitious materials content, at least twelve standard test cylinders shall be cast and cured in accordance with ASTM C192. Four cylinders from each batch shall be tested at age 7 days, 14 days, and 28 days or as required to comply with ACI 318 Section 5.3.

(e) From results of the cylinder tests, plot a curve showing the relationship between w/cm ratio and compressive strength.

(f) From the curve of w/cm ratio versus compressive strength, select the w/cm ratio that will produce f'cr. This is the maximum w/cm ratio that shall be used unless a lower w/cm ratio is specified in paragraph 2.02A.

3. FIELD EXPERIENCE DATA: When sufficient test data for a particular mix design is available which is identical or substantially similar to that proposed for use,

Contractor may substitute use of this data in lieu of a trial mix design. Field data, reports, and analysis shall conform to ACI 318 Section 5.3, except as modified herein. Historical mix design proportions for which data are submitted may vary from the specified mix within the following limits: (a) f'c as specified or up to 500 psi above; (b) w/cm ratio as specified or lower; (c) pozzolan content within 5 percent of that specified; (d) maximum coarse aggregate size may not vary smaller, but gradation of coarse aggregate may vary; (e) fine aggregate fraction within +0/ 5 percent of that specified; and (f) slump after introduction of admixtures +0/-1 inch. Use of historical mix design data does not allow modification of the project mix specifications herein without the express review and acceptance of the Engineer.

2.03 JOINT FILLERS

Preformed joint fillers shall be as specified in Section 07905.

2.04 BONDING COMPOUNDS

Epoxy resin bonding compounds shall conform to ASTM C881 Types IV or V, Class A, B, or C depending on temperature at use, and Grade to suit geometry and installation circumstances. Acceptable products include: BASF "Concresive Paste SPL" or "Concresive 1490", as applicable; Sika Chemical Corporation "Sikadur 35" or Sikadur 32", as applicable; or equal.

Bonding compounds shall be applied in accordance with the manufacturer's instructions.

2.05 CURING AND SEALING COMPOUNDS

Curing and sealing compound shall be BASF Sonneborn "Kure-N-Seal 25LV"; Edoco, "Spartan-Cote VOC"; or equal, conforming to ASTM C309.

Curing compound shall be clear and shall be applied in accordance with the manufacturer's instructions, except as otherwise specified. Curing and sealing compound shall be certified compliant with final finish systems.

PART 3--EXECUTION

3.01 GENERAL

This section covers the production of cast-in-place concrete. Included are methods and procedures for obtaining quality concrete through proper handling, placing, finishing, curing, and repair of surface defects.

3.02 CONCRETE

Concrete shall be truck-mixed, ready-mixed concrete conforming to the applicable portions of ASTM C94. Materials shall be proportioned by weighing. Pozzolan shall be introduced into the mixer with cement and other components of the concrete mix; pozzolan shall not be introduced into a wet mixer ahead of other materials or with mixing water. Water shall be introduced at the time of

charging the mixer; additional water may be introduced within 45 minutes from charging the mixer, provided the specified slump is not exceeded and the maximum total water per the approved mix design is not exceeded. Contractor shall arrange with the testing laboratory for inspection as required to comply with these specifications.

Concrete shall be delivered to the site and discharge shall be completed within 90 minutes after introduction of water to the mixture. Extension of allowable time beyond this limit requires a Contractor proposed remedial action plan to be reviewed and accepted by the Construction Manager.

3.03 CONVEYING AND PLACING CONCRETE

A. CONVEYING CONCRETE:

Concrete shall be conveyed from the mixer to the forms in accordance with ACI 301. Concrete which has segregated in conveying shall be removed from the site of the work.

B. PLACING CONCRETE:

1. GENERAL: Concrete shall be placed in accordance with ACI 301. Do not permit concrete to drop freely more than 4-ft.

2. PLACING CONCRETE BY PUMPING: Concrete may be placed by pumping at Contractor's discretion. Use of pumping shall not, however, be cause to change or relax specified mix design characteristics. Concrete shall possess the specified characteristics at the point of placement.

Slump shall be measured at the hose discharge, except as follows. Initial slump testing in each pour shall occur at both the pumping unit inlet hopper and hose discharge. Slump loss in pumping, measured between the inlet hopper and the hose discharge, shall not exceed 1 inch. After these criteria have been satisfied, slump may be measured at the inlet hopper with allowable slump increased by the earlier measured difference, not to exceed 1 inch.

Air content shall be measured at the hose discharge, except as follows. Initial air content testing shall occur at both the pumping unit inlet hopper and the hose discharge. Loss of air content shall be measured between the inlet hopper and the hose discharge. The air content of the delivered concrete at the inlet hopper shall be increased to provide the specified air content at the hose discharge. After these criteria have been satisfied, air content may be measured at the inlet hopper.

Before starting each pumping operation, the pump and line shall be primed with a cement slurry to lubricate the system. Cement slurry shall be wasted outside the forms. Hose tip shall be equipped with a safety chain for recovery in case of hose blowout during pumping, and in no case shall hose or accessories remain in the freshly placed concrete.

Proper tremie placing techniques and equipment shall be used for all pump placed concrete. Pump discharge system shall remain full of concrete from pump to discharge point at all times.

Concrete pumping shall not occur until Construction Manager has verified that the proper equipment is available, in particular, the tremie plug. Should the discharge line become open, with significant zones empty of concrete, then the pumping shall cease and the line re-primed with tremie plug installed before continuing the pour.

3. PLACING CONCRETE IN HOT WEATHER: In hot weather (above 80 degrees F), concrete shall be placed in accordance with ACI 305.1.

4. PLACING CONCRETE IN COLD WEATHER: In cold weather (below 45 degrees F), concrete shall be placed in accordance with ACI 306.1.

C. CONSOLIDATING CONCRETE:

Concrete shall be consolidated in accordance with ACI 301. If proper consolidation is not occurring, then concrete placing shall be suspended until proper consolidation can be achieved.

3.04 CURING AND SEALING

A. GENERAL:

Concrete curing shall be completed by water curing or by using a clear membrane curing compound or by a combination of both methods. Repairs or treatment of concrete surfaces shall be coordinated so that interruption of the curing will not be necessary.

Concrete surface temperature shall be maintained between 50 degrees F and 80 degrees F for at least 5 days. Curing concrete in hot weather (above 80 degrees F) shall be in accordance with ACI 305.1. Curing concrete in cold weather (below 45 degrees F) shall be in accordance with ACI 306.1.

B. WATER CURING:

When water curing is used, concrete shall be kept wet continuously for a minimum of 10 days after placement. Absorptive mats or fabric may be used to retain moisture during the curing period.

Unless otherwise specified, water curing shall be used in hot weather for water containment structures. Forms shall be covered and kept moist. The forms shall be loosened as soon as possible without damage to the concrete, and provisions made for curing water to run down inside them. During form removal, care shall be taken to provide wet cover to newly exposed surfaces.

C. CURING COMPOUND:

When curing compound is used, it shall be applied as soon as the concrete has set sufficiently so as not to be marred by the application or immediately following form removal for vertical and other formed surfaces. Preparation of surfaces, application procedures, and installation

precautions shall be followed in strict compliance with the manufacturer's instructions. Curing compound shall be applied at twice the manufacturer's recommended dosage rate in two coats applied perpendicular to each other. Use of curing compound for other than liquid containing structures shall be in accordance with the manufacturer's recommendations.

Curing compound shall not be used on concrete surfaces to be coated, waterproofed, moisture-proofed, tiled, roofed, or where other coverings are to be bonded, unless the curing compound is compatible with the final finish covering or it is removed prior to covering.

3.05 PROTECTION

Concrete shall be protected from injurious action by sun, rain, flowing water, frost and mechanical injury.

Loading green concrete will not be permitted. Green concrete is defined as concrete with less than 100 percent of the specified strength.

Unless otherwise shown on the Drawings, no backfill shall be placed against concrete walls until the concrete has reached the specified strength and the connecting slabs and beams have been cast and have reached the specified strength.

Arrangements for covering, insulating, and protecting concrete in cold weather shall be in accordance with ACI 306.1.

3.06 CONSTRUCTION JOINTS

A. GENERAL:

Concrete in each unit of construction shall be placed continuously. Before new concrete is placed on or against concrete which has set, forms shall be retightened and the surface of the set concrete shall be cleaned of foreign matter.

B. CONSTRUCTION:

Construction joints shall be formed as specified. A rough surface of exposed concrete aggregates shall be produced using a surface retardant at construction joints, including joints between the slab and topping concrete. The limit of the treated surfaces shall be 1 inch away from the joint edges. Within 24 hours after placing, retarded surface mortar shall be removed either by high pressure water jetting or stiff brushing or combination of both so as to expose coarse aggregates. A rough surface of exposed aggregate may also be produced by sandblasting followed by high pressure water jetting. Sandblasting, if used, shall remove 1/4 inch of laitance film and shall expose coarse aggregate to ensure adequate bond and watertightness at the construction joints.

Reinforcing steel and welded wire fabric shall be continued across construction joints. .

3.07 INSERTS AND EMBEDMENTS

A. INSERTS:

Where pipes, castings or conduits are to pass through structures, the Contractor shall place such pipes or castings in the forms before placing the concrete, or he may provide openings in the concrete for subsequent insertion of such pipes, castings or conduits. Such openings shall be provided with waterstops and V-shaped construction joint as shown and shall have a slight flare to facilitate grouting and permit the escape of entrained air during grouting.

Additional reinforcement shall be provided around openings as shown. Grout fill around inserts shall be non-shrink grout as specified in Section 03600.

Horizontal conduits and pipes, where shown in structural slabs and beams, shall be placed between the top and bottom layers of reinforcement. Spacing and size limitations shall conform to ACI 318 Section 6.3 unless specifically approved otherwise by the Engineer. Such conduits and pipes shall not run directly beneath a column or, if used, its steel base plate. Pipe, conduit, dowels, and other ferrous items required to be embedded in concrete construction shall be so positioned and supported prior to placement of concrete that there will be a minimum of 2-inches clearance between said items and any part of the concrete reinforcement. The outside diameter of such conduits should not exceed one-fourth the slab or beam thickness. Securing such items in position by welding them to the reinforcement will not be permitted.

B. EMBEDMENTS:

Metal parts that are to be embedded in the concrete shall be set and secured in the forms prior to concrete placement. Unless otherwise specified, anchor bolts and inserts shall be embedded in concrete as shown. The Contractor shall provide inserts, anchors or other bolts necessary for the attachment of piping, valves, metal parts and equipment. Nailing blocks, plugs, strips, and the like necessary for the attachment of trim, finish, and similar work shall be provided. Voids in sleeves, inserts and anchor slots shall be filled temporarily with readily removable material to prevent the entry of concrete into the voids. Operators or sleeves for gate or valve stems shall be positioned to clear reinforcing steel, conduit and other embedments, and to align accurately with equipment.

3.08 MODIFICATION OF EXISTING CONCRETE

A. GENERAL:

Structural dimensions related to or controlled by previously constructed or existing structures shall be verified in the field by the Contractor prior to concrete work.

B. CUTTING OR CORING CONCRETE:

Surfaces exposed to view shall be neatly saw cut to a depth of 1 inch prior to removing the existing concrete. Where existing reinforcement is exposed due to saw cutting or core drilling and no new material is to be placed on the sawcut surface, a coating or surface treatment of epoxy shall be applied to the entire cut surface. Areas that require an oversize opening shall be as shown on the

Drawings. The exposed surface of the oversized opening shall be coated with an epoxy bonding compound and re-finished with profiling mortar to the required opening size.

Existing joint edge shall be ground to create a chamfer matching those used adjacent, where occurs. Grind existing to imitate tooled edge.

Unless specifically notified otherwise, Contractor shall investigate concrete to be drilled, cored or sawcut to determine location of existing reinforcing steel. Penetrations shall be located so as to clear existing reinforcing steel if possible. Unless otherwise detailed on the drawings, or where not possible to avoid reinforcing steel, consult the Engineer as to acceptability of cutting reinforcing steel and provide new reinforcing systems as directed. Locating methods include chipping to expose reinforcing steel, ground penetrating radar, X-ray, or magnetic flux devices. Locates of existing reinforcing shall be paid for by the Contractor.

C. JOINING NEW CONCRETE TO EXISTING:

Existing concrete surfaces to be joined with new concrete shall be thoroughly cleaned and roughened by abrasive blasting, bush hammering or other method to achieve ¼-inch amplitude surface. Existing metalwork, embeds or other interfering items shall be removed. Coat existing surface with epoxy bonding compound just prior to placement of new concrete.

D. DOWELS:

Dowels to be installed in existing concrete shall utilize holes drilled with a hammer drill and carbide bit (core drilled holes not allowed), properly brushed and air-cleaned with oil-free compressed air, and an injectable two-component epoxy adhesive, as per Section 03600. Installation shall conform to manufacturer's recommendations and to ICC Evaluation Reports.

E. DRILLING HOLES IN EXISTING CONCRETE FOR POST-INSTALLED ANCHORS

Non-destructive methods shall be used for locating reinforcement prior to drilling operations. For anchor locations that interfere with reinforcement, the Contractor shall first attempt to relocate anchors to avoid drilling through the reinforcement.

For anchors that cannot be moved and that conflict with the above requirements, the Engineer shall be consulted for direction.

3.09 FORMED SURFACE FINISHES

A. REPAIR OF SURFACE DEFECTS:

Surface defects, including tie holes, minor honeycombing or otherwise defective concrete shall be repaired in accordance with ACI 301. Areas to be patched shall be cleaned. Minor honeycombed or otherwise defective areas shall be cut out to solid concrete to a depth of at least 1 inch. The edges of the cut shall be perpendicular to the surface of the concrete. Patches on exposed surfaces shall be finished to match the adjoining surfaces after they have set. Patches shall

be cured as specified for the concrete. Finished surfaces shall be protected from stains and abrasions. Finishes shall be equal in workmanship, texture, and general appearance to that of the adjacent concrete. Concrete with honeycombing which exposes the reinforcing steel or with defects which affect structural strength shall be corrected.

B. FORMED SURFACE FINISHING:

Formed surfaces shall be finished as soon as practicable after form removal and repair of surface defects. Finishes shall be as follows.

1. FINISH A: Finish A shall be a grout-cleaned rubbed finish in accordance with ACI 301 except that ALL FORM FINS AND OTHER PROTRUSIONS SHALL BE COMPLETELY REMOVED TO THE FINAL SURFACE. Surfaces shall be lightly sandblasted prior to sacking. Sandblasting shall occur after the specified curing period. For interior areas not exposed to moisture or weather, water used in the sacking mortar shall be mixed with a PVA bonding compound as recommended by the manufacturer. Finish A shall be provided for uncoated surfaces at surfaces of stair wells; interior surfaces of equipment rooms, galleries and tunnels; operations areas; exposed channels and tanks from 1 foot below minimum water surfaces and up; and permanently exposed vertical and sloped surfaces, such as pipe chases. Finish A shall not be provided at concrete surfaces receiving a coating.

2. FINISH B: Finish B shall be a smooth surface with all form fins and other protrusions completely removed to the final surface. Finish B shall be provided for coated surfaces. See specification 09900 for concrete surface coatings and surface preparation, including filling bug holes before coating.

3. FINISH C: Finish C shall be a finish which has surface imperfections less than 3/8 inch in any dimension. Surface imperfections greater than 3/8 inch shall be repaired or removed and the affected areas shall be neatly patched. Finish C or smoother shall be provided for interior surfaces of wet wells, tanks and channels from 1 foot below minimum water surfaces and down and otherwise unfinished interior surfaces.

4. FINISH D: Finish D shall be the finish for surfaces which may be left as they come from the forms, except that tie holes shall be plugged and defects greater than 1/2 inch in any dimension shall be repaired.

3.10 SLAB FINISHES

A. GENERAL:

The finishes specified herein include surface finishes and treatments for slabs. Dry cement shall not be used on new concrete surfaces to absorb excess moisture. Edges shall be rounded to a radius of 1/2 inch. Joints shall be grooved to a radius and depth of 1/4 inch each.

B. FLOAT FINISH:

Floating shall be performed with a hand or power-driven float in accordance with ACI 301. Begin floating when the bleed water sheen has disappeared and the surface has stiffened sufficiently to permit operation of the specific float apparatus. Floating of any one area shall be the minimum necessary to produce a finish that will meet tolerance requirements of ACI 117 for a conventional surface. Refloat the slab immediately to a uniform texture. Floating shall compact and smooth the surface and close any cracks and checking of surfaces. Float finish shall be applied to surfaces of channel, tank bottom slabs, tops of footings, and steps and surfaces to receive roofing and insulation.

C. BROOMED FINISH:

Immediately after concrete has received a floated finish, give the concrete surface a coarse transverse scored texture by drawing a broom or burlap belt across the surface in accordance with ACI 301. Broomed finish shall be provided for slabs-on-grade exposed to atmosphere, and where otherwise indicated or specified.

3.11 OTHER SURFACES

A. PAVEMENTS AND SIDEWALKS:

The surfaces of the concrete shall be screeded to grade and sloped to drain. After screeding, the surface shall receive a broomed finish. Edges and expansion joints shall be rounded to a radius of ½ inch. Joints shall be grooved to a radius and depth of 1/4 inch each.

3.12 FIELD SAMPLING AND TESTS

A. GENERAL:

Field sampling and testing shall be performed by the independent testing laboratory. Samples of aggregates and concrete shall be taken at such times to represent the quality of the materials and work throughout the project. The laboratory shall provide the necessary labor, materials and facilities for sampling the aggregate and for casting, handling and initially storing the concrete samples at the site of work. Aggregates shall be sampled in accordance with paragraph 03300-3.15 B not less than 30 days prior to the use of such aggregates in the work. The minimum number of samples and tests are specified in paragraph 03300-3.15 C.

B. SAMPLING:

1. AGGREGATES:

a. GENERAL: Fine and coarse aggregates shall be sampled in accordance with ASTM D75. Samples shall be taken at the discharge gates of the bins feeding the weigh hopper. The Contractor shall provide safe and suitable facilities for obtaining samples. Samples shall be obtained at the concrete batch plant at the frequency specified in paragraph 03300-3.15 C. Sampling shall be repeated when the source of material is changed or when unacceptable

deficiencies or variations from the specified requirements of materials are found in testing. Aggregate samples shall be tagged and their sources identified.

b. COARSE AGGREGATE: A sample weighing between 50 and 60 pounds shall be taken after the batch plant is brought up to full operation. The samples shall be taken so that a uniform cross section, accurately representing the materials on the belt or in the bins, is obtained.

c. FINE AGGREGATE: Samples shall be taken as specified for coarse aggregate. The samples shall be taken for sieve analysis of fine aggregate and specific gravity tests. Samples of sand shall be taken when the sand is moist.

2. CONCRETE: Samples of plastic concrete shall be obtained in accordance with ASTM C172. Samples shall be taken at the hopper of concreting equipment or transit mix truck, except as noted in 03300-3.03B.2

C. TESTING:

1. AGGREGATE: A minimum of one test of coarse aggregate per 400 cubic yards of concrete and a minimum of one test of fine aggregate per 200 cubic yards of concrete used shall be made to confirm continuing conformance with specifications for gradation, cleanliness and sand equivalent. A maximum of one test per day of each aggregate is required. The full test program is required before source changes will be accepted.

2. CONCRETE:

a. STRENGTH TESTS: The strengths specified for the design mix shall be verified by the independent testing laboratory during placement of the concrete. Verification shall be accomplished by testing standard cylinders of concrete samples taken at the job site. Cylinders shall be 4 by 8 inch or 6 x 12 inch.

Standard cylinders shall represent the concrete placed in the forms. One set of six standard 6 x 12 inch (or nine 4 x 8 inch) cylinders shall be cast of each class of concrete for each 100 cubic yards or less or for each 5,000 square feet of surface area placed per day. Casting, handling and curing of cylinders shall be in accordance with ASTM C31. Additional cylinders shall be provided when an error in batching is suspected. For the first 24 hours after casting, the cylinders shall be kept moist in a storage box constructed and located so that its interior air temperature will be between 60 and 80 degrees F. At the end of 24 hours, the cylinders shall be transported to the testing laboratory.

Testing of specimens for compressive strength shall be in accordance with ASTM C39. Tests shall be made at 7 and 28 days from time of casting. Two 6 x 12 inch (or three 4 x 8 inch) test cylinders from each group of six (or nine) shall be tested at the end of 7 days and two 6 x 12 inch (or three 4 x 8 inch) shall be tested at the end of 28 days. The two remaining 6 x 12 inch (or three 4 x 8 inch) cylinders shall be tested at the end of 56 days if the 28-day strength reports below specification. A strength test shall consist of the average strength of two 6 x 12 inch (or three 4 x 8) cylinders cast from material taken from a single load of concrete. If one cylinder shows evidence of

low strength due to improper sampling, casting, handling or curing, the result of the remaining cylinders may be used if approved by the Construction Manager.

The average of any three consecutive 28-day strength test results of the cylinders representing each class of concrete for each structure shall be equal to or greater than the specified strength and not more than 10 percent of the strength test results shall have values less than the specified 28-day strength for the total job concrete. No individual strength test result shall be less than the specified strength by more than 500 pounds per square inch.

Certified reports of the test results shall be provided directly to the Construction Manager. Test reports shall include sufficient information to identify the mix used, the stationing or location of the concrete placement, and the quantity placed. Slump, air content, temperature of concrete, and ambient temperature shall be noted. The 28-day strength test results shall be evaluated in accordance with ACI 214R. Quality control charts showing field test results shall be included with the test results for each class of concrete in each major structure. Charts shall be prepared in accordance with ACI 214R. Quality control charts shall be maintained throughout the entire job and shall be available for the Construction Manager's inspection at any time.

If the 28-day test results fall below the specified compressive strength for the class of concrete required for any portion of the work, adjustment in the proportions, water content, or both, shall be made as necessary at the Contractor's expense. Changes and adjustments shall be reported in writing to the Construction Manager.

If compressive test results indicate concrete in place may not meet structural requirements, tests shall be made to determine if the structure or portion thereof is structurally sound. Tests may include, but not be limited to, cores in accordance with ASTM C42 and any other analyses or load tests acceptable to the Construction Manager. Costs of such tests shall be borne by the Contractor.

b. TESTS FOR CONSISTENCY OF CONCRETE. The slump shall be as specified when measured in accordance with ASTM C143. Samples for slump determination shall be taken from the concrete during placement. Tests shall be made at the beginning of concrete placement operation and at subsequent intervals to ensure that the specification requirements are met. Slump tests shall also be performed whenever standard cylinders are cast. For pumped concrete, slump shall be measured in accordance with paragraph 3.03B.2.

When high range water reducers are added at the site, slump tests shall be taken before and after addition of high range water reducing admixtures.

c. TESTS FOR TEMPERATURE AND AIR CONTENT: Temperature tests shall be made at frequent intervals during hot or cold weather conditions until satisfactory temperature control is established. Whenever standard cylinders are cast, temperature tests shall be performed.

Air content shall be as specified when measured in accordance with ASTM C231. Air content shall be measured whenever standard cylinders are cast. For pumped concrete, air content shall be measured in accordance with paragraph 3.03B.2.

D. FINAL LABORATORY REPORT:

A final report, prepared by the testing laboratory, shall be provided at the completion of all concreting. This report shall summarize the findings concerning concrete used in the project and provide totals of concrete used by class and structure. Final quality control charts for compressive strength tests for classes of concrete specified in each major structure shall be included. The report shall also include the concrete batch plant's coefficient of variation and standard deviation results for each class of concrete.

3.13 REPAIR OF DAMAGED CONCRETE, CRACKING:

A. ACCEPTANCE OF CONCRETE:

Completed cast-in-place concrete work shall conform to the applicable requirements of ACI 301 and the Contract Documents. Concrete work that fails to meet the requirements of ACI 301 or the Contract Documents shall be repaired as approved by the Engineer to bring the concrete into compliance. Concrete that cannot be brought into compliance by approved repair methods will be rejected. Rejected concrete work shall be removed and replaced. Repair methods shall be in accordance with ACI standards and are subject to the approval of the Engineer. The cost of repairs and replacement of defective concrete shall be borne by the Contractor.

B. REPAIR METHODS:

Damaged or excessively cracked concrete, as determined by the Engineer in their sole discretion, shall be repaired by one of the following methods as approved by the Engineer:

1. Repair Method 1: Fill the joint or crack by drilling holes to the affected area, install injection ports and force epoxy or chemical grout (expanding urethane) into the joint under pressure. The material type, whether epoxy or chemical grout shall be approved by the Engineer. After injection and curing, ports, sealing mix and surface generally shall be cleaned and worked to match the specified finish.

2. Repair Method 2: Fill cracks with low viscosity epoxy, applied by pouring/flooding crack zone until cracks are filled. Prepare surface, install, and cure according to manufacturer's recommendations. At a minimum, prepare surface to result in a clean, dry surface and with no visible detrimental material in cracks to be filled. Conform to temperature limitations for epoxy to be used. Finish to match adjacent areas.

C. REPAIR METHOD USE:

1. Repair Method 1 shall be used for all cracks in walls, surfaces sloped 1:1 or greater, beams, columns, slabs, overhead surfaces and generally for liquid retaining surfaces. Need for repair depends upon crack width, location, and surface conditions under service conditions. Epoxy grout shall be used for

repair of structural cracks and chemical grout (expanding urethane) shall be used for repair of non-structural cracks at liquid-containing structures. The Engineer shall determine whether a crack is classified as structural or non-structural.

2. Repair Method 2 may be utilized in lieu of Method 1 for slabs which receive a raked finish. Method 2 may also be used with Construction Manager's approval for exposed troweled and broomed finishes after review of conditions, degree of exposure to public, and proposed repair product and installation. Finish shall substantially match adjacent surfaces.

3.14 CLEANUP

Upon completion of the work and prior to final inspection, the Contractor shall clean all concrete surfaces. The cleaning procedures shall be as follows: After sweeping with an ordinary broom to remove the loose dirt, the surface shall be flushed with clean water. Final scrubbing by hand or machine shall follow.

END OF SECTION

SECTION 03600

GROUT

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies grout for column and other structural support bases, equipment bases, crack repair, surface repair and uses other than masonry.

1.02 QUALITY ASSURANCE

A. QUALITY CONTROL BY CONTRACTOR:

To demonstrate conformance with the specified requirements for grout, the Contractor shall provide the services of an independent testing laboratory. Costs of testing laboratory services shall be borne by the Contractor.

B. SPECIAL INSPECTION:

Where Special Inspection is specified, noted on the drawings, required by Code or product manufacturer, Owner shall provide the services of a qualified Special Inspector.

C. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

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Reference	Title
ASTM C33	Concrete Aggregates
ASTM C40	Organic Impurities in Fine Aggregates for Concrete
ASTM C88	Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C117	Material Finer Than 75 μm (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C136 REV A	Sieve Analysis of Fine and Coarse Aggregates
ASTM C150	Portland Cement
ASTM C289	Potential Reactivity of Aggregates (Chemical Method)
ASTM C881	Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C1107	Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM D2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate

1.03 SUBMITTALS

The following information shall be provided in accordance with Section 01300:

1. Complete product literature and installation instructions for epoxy grout (all uses) and cementitious non-shrink grout.

2. Current ICC-ES Report, or equivalent in other jurisdictions, for epoxy adhesive used for dowels installed in existing concrete.

PART 2--PRODUCTS

2.01 MATERIALS

A. CEMENT:

Portland cement shall be ASTM C150, Type II or Type V, low alkali, containing less than 0.60 percent alkalies.

B. AGGREGATE:

1. GENERAL: Aggregate shall be nonreactive and shall be washed before use.

When sources of aggregate are changed, test reports shall be provided for the new material. The tests specified shall be performed prior to commencing grout work.

2. FINE AGGREGATE: Fine aggregate shall be hard, dense, durable particles of either sand or crushed stone regularly graded from coarse to fine and shall conform to ASTM C33 as modified herein. When tested in accordance with ASTM C136, gradation shall be such that 100 percent by weight will pass a standard No. 8 mesh sleeve and no less than 45 percent by weight will pass a standard No. 40 mesh sieve.

Variation from the specified gradations in individual tests will be acceptable if the average of three consecutive tests is within the specified limits and the variation is within the permissible variation listed below:

U.S. standard sieve size	Permissible variation in individual tests, percent
30 or coarser	2
50 or finer	0.5

Other tests shall be in accordance with the following specifications:

Test	Test method	Requirements
Organic Impurities	ASTM C40	Color lighter than standard
Amount of Material Passing No. 200 Sieve	ASTM C117	3% maximum by weight
Soundness	ASTM C88	10% maximum loss with sodium sulfate
Reactivity	ASTM C289	Innocuous aggregate
Sand Equivalent	ASTM D2419	Minimum 80

C. ADMIXTURES:

1. GENERAL: Admixtures shall be compatible with the grout. Calcium chloride or admixtures containing calcium chloride are not acceptable. Admixtures shall be used in accordance with the manufacturer's recommendations and shall be added separately to the grout mix.

2. ACCEPTABLE ADMIXTURES: Acceptable products including water reducing, water reducing and retarding, and superplasticizing are specified in Section 03300. Contractor shall select as appropriate for the use intended and in conformance with manufacturer's recommendations and these specifications.

D. WATER:

Water for washing aggregate, for mixing and for curing shall be free from oil and deleterious amounts of acids, alkalies, and organic materials; shall not contain more than 1000 mg/1 of chlorides as Cl, nor more than 1300 mg/1 of sulfates as SO_4; and shall not contain an amount of

impurities that may cause a change of more than 25 percent in the setting time of the cement nor a reduction of more than 5 percent in the compressive strength of the grout at 14 days when compared with the result obtained with distilled water. Additionally, water used for curing shall not contain an amount of impurities sufficient to discolor the grout.

2.02 GROUT

A. DRYPACK GROUT:

Drypack grout shall be a mixture of approximately one part cement, 1-1/2 to 2 parts fine aggregate, water reducing retarder, and sufficient water to make a stiff workable mix.

B. CEMENTITIOUS NONSHRINK GROUT:

Cementitious nonshrink grout is available with both metallic and nonmetallic aggregate. Metallic aggregate grout shall be Master Builders Embeco 636, Burke Company Metallic Spec Grout, Sonnoborn Ferrolith G Redimix, or equal. Nonmetallic aggregate grout shall be Five Star Products, Inc. Five Star Grout, Master Builders Masterflow 713, Burke Company Non-Ferrous, Non-Shrink Grout, Hi-Flow Grout by Euclid Chemical Company, or equal.

C. EPOXY GROUT FOR EQUIPMENT MOUNTING:

Epoxy grout for equipment mounting shall be a non-cementitious, resin based, muli-component formulation. Epoxy grout shall be flowable, with shrinkage minimized to achieve minimum 98% effective bearing area. Acceptable products include: Masterflow 648 CP Plus by Masterbuilders; Sikadur 42 by Sika Corporation; E3-G by Euclid Chemical Company; or equal.

D. EPOXY ADHESIVE FOR DOWELS INSTALLED IN EXISTING CONCRETE:

Epoxy shall evidence approval for the use intended by ICC-ES Report or other recognized and Code compliant agency.

Acceptable products include HIT-RE SD by Hilti, SET-XP by Simpson Strong-Tie Company, or equal.

2.03 PRODUCT DATA

The following information shall be provided in accordance with Section 01300.

A. MANUFACTURER'S DATA:

Manufacturer's data shall be provided for the following:

1. Bonding compounds
2. Retardants

B. LABORATORY TEST REPORTS:

Test reports on previously tested materials shall be accompanied by the manufacturer's statement that the previously tested material is the same type, quality, manufacture, and make as that proposed for use in this project. Test reports are required for the following:

1. Cement
2. Aggregates
3. Retardants
4. Bonding compounds
5. Epoxy resin

C. EVIDENCE OF TESTING LABORATORY COMPETENCE:

The Contractor shall require that the laboratory provide directly to the Construction Manager evidence of the most recent inspection of its facilities by the Cement and Concrete Reference Laboratory of the National Bureau of Standards. The evidences shall show that deficiencies mentioned in the report of that inspection have been corrected. The evidence of inspection shall be provided prior to delivery of materials to the job site.

PART 3--EXECUTION

3.01 GENERAL

Bonding compound for use with grout is specified in Section 03300.

3.02 DRYPACK GROUT

Drypack grout shall be used for small or shallow built-up surfaces and minor repairs.

Surfaces required to be built up with drypack grout shall be roughened by brushing, cleaned, and coated with the bonding compound specified in paragraph 03300-2.04 before the application of the grout. The drypack grout shall be applied immediately following the application of the bonding compound in bands or strips to form a covering of the required thickness. The covering shall be smooth. Construction joints in the grout shall be sloped and shall be cleaned and wetted before application is resumed.

Drypack grout shall be cured in accordance with Section 03300.

Grout shall not be placed during freezing weather unless adequate protection is provided.

3.03 CEMENTITIOUS NONSHRINK GROUT

Nonshrink, cementitious, nonmetallic aggregate grout shall be used for column base plates, structural bearing plates, and all locations where the general term "non-shrink grout" is indicated on the drawings. Use of non-shrink grout for equipment mounting shall be limited to equipment less than 20 horsepower or 1,000 pounds. Grout shall be placed and cured in accordance with manufacturer's instructions.

3.04 EPOXY GROUT FOR EQUIPMENT MOUNTING

Prepare concrete surfaces of equipment pads as indicated in details on the Drawings and as required by the epoxy grout manufacturer. Epoxy grout for equipment mounting shall be placed and cured in accordance with details on the Drawings, and in strict conformance with manufacturer's recommendations.

3.05 EPOXY ADHESIVE FOR DOWELS INSTALLED IN EXISTING CONCRETE

Use of epoxy adhesive for reinforcing dowels shall be subject to the following conditions:

1. Embedment depth and hole diameter shall be as specified.

2. Holes shall have rough surfaces, such as can be achieved using a rotary percussion drill.

3. Holes shall be blown clean with compressed air and be free of dust or standing water prior to application of epoxy adhesive.

4. Anchor shall be left undisturbed and unloaded for full curing period.

END OF SECTION

SECTION 05100

STRUCTURAL METALS

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies structural metals consisting of standard shapes, fasteners, rods and plates that are used in structural supports and connections.

1.02 QUALITY ASSURANCE

A. GENERAL:

Structural assemblies and shop and field welding shall meet the requirements of the AISC Manual of Steel Construction.

The use of salvaged, reprocessed or scrap materials shall not be permitted.

B. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

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Reference	Title
AISC Manual of Steel Construction	American Institute of Steel Construction, Manual of Steel Construction, Allowable Stress Design - 9th Edition
ASTM A36/A36M	Structural Steel
ASTM A53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

Reference	Title
ASTM A283/A283M	Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes and Bars
ASTM A307	Carbon Steel Externally Threaded Standard Fasteners
ASTM A320/A320M	Alloy-Steel Bolting Materials for Low Temperature Service
ASTM A500	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A666	Austenitic Stainless Steel, Sheet, Strip, Plate and Flat Bar for Structural Applications
ASTM B308	Aluminum-Alloy Standard Structural Shapes, Rolled or Extruded
AWS-B3.0	Welding Procedures and Performance Qualifications
AWS-Dl.1	Structural Welding Code--Steel

PART 2--PRODUCTS

2.01 MATERIALS

A. STEEL:

Materials for structural metals shall be as specified in Table A.

Table A, Steel Materials

Material	Specification
Standard rolled steel sections	ASTM A36
Pipe columns	ASTM A53, Grade B
Structural steel tubing	ASTM A500, Grade B
Structural bars, plates and similar items	ASTM A36 or A283
Stainless steel	ASTM A666, Grade A, Type 304
Stainless steel bolts, nuts and washers	ASTM A320, Type 304
Steel bolts	ASTM A307, Grade A

B. ALUMINUM:

Unless otherwise specified, aluminum shall be extruded from 6061-T6 or 6063-T6 alloy, conforming to ASTM B308.

2.02 FABRICATION

Fabrication shall be in accordance with the AISC Manual of Steel Construction.

PART 3--EXECUTION

3.01 INSTALLATION

A. GENERAL:

Measurements shall be verified at the job.

Holes shall be punched 1/16 inch larger than the nominal size of the bolts, unless otherwise specified. Whenever needed, because of the thickness of the metal, holes shall be subpunched and reamed or drilled. No drifting of bolts nor enlargement of holes will be allowed to correct misalignment. Mismatched holes shall be corrected with new material.

Dissimilar metals shall be protected from galvanic corrosion by means of pressure tapes, coatings or isolators. Aluminum in contact with concrete or grout shall be protected with a heavy coat of bituminous paint.

Metalwork to be embedded in concrete shall be as specified in Section 03300. Metalwork shall be placed accurately and held in correct position while the concrete is placed or, if specified, recesses or blockouts shall be formed in the concrete after design strength is attained, and the metalwork shall be grouted in place in accordance with Section 03300. The surfaces of metalwork in contact with or embedded in concrete shall be thoroughly cleaned.

Structural steel completely encased in concrete shall not be galvanized or painted and shall have a clean surface for bonding to concrete. Metalwork which is bent, broken or otherwise damaged shall be repaired or replaced by the Contractor.

B. WELDING:

Welding shall be done by operators who have been qualified by tests as prescribed by AWS WI Sect. 7 to perform the type of work required. The quality of welding shall conform to AWS Code for Arc Welding in Building Construction Section 4, Workmanship.

3.02 CORROSION PROTECTION

Unless otherwise specified, all structural metal and structural steel, including that used in the fabrication of process equipment, shall be coated in accordance with Section 09900. Surface preparation shall be as specified in paragraph 09900-3.02 and applicable COATSPECS and shall include the following operations:

1. Grind the exterior and interior edges of all flame-cut plates or members to a smooth surface.

2. Grind all sharp edges off of the sheared plates and punched holes.

3. Grind uneven or rough welds with high beads to a smooth finish.

Application requirements shall be as specified in paragraph 09900-3.03 and applicable COATSPECS.

3.03 CLEANING

After installation, damaged surfaces of shop primed metals shall be cleaned and touched up with the same material used for the shop coat.

Where zinc coating has been damaged after installation, substrate surface shall be first cleaned and then repaired with zinc dust-zinc oxide coating in accordance with ASTM A780. Application shall be as recommended by the zinc dust-zinc oxide coating manufacturer. Coating shall consist of multiple coats to dry film thickness of 8 mils.

Items not physically damaged, but which have insufficient or deteriorating zinc coatings, and items damaged in shipment or prior to installation, shall be removed from the project site for repair by the hot-dip zinc coating method.

END OF SECTION

SECTION 05501

ANCHOR BOLTS

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies anchor bolts complete with washers and nuts. Unless otherwise specified, anchor bolts shall be type 304 stainless steel.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

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Reference	Title
ASTM A320/A320M	Alloy-Steel Bolting Materials for Low Temperature Service

PART 2--PRODUCTS

2.01 GENERAL

Anchor bolt holes in equipment support frames shall not exceed the bolt diameters by more than 25 percent, up to a limiting maximum oversizing of 1/4 inch. Unless otherwise specified, minimum anchor bolt diameter shall be 1/2 inch.

Tapered washers shall be provided where mating surface is not square with the nut.

Adhesive anchors set in holes drilled in the concrete after the concrete is placed will not be permitted in substitution for anchor bolts except where otherwise specified. Upset threads shall not be acceptable.

2.02 MATERIALS

Anchor bolt materials shall be as specified in Table A.

Table A, Anchor Bolt Materials

Material	Specification
Stainless steel bolts, nuts, washers	ASTM A320, Type 304[a]
Epoxy Adhesive	HILTI HIT-RE 500 SD, or equal

[a]Use Type 316 where specified.

2.03 DESIGN

Anchor bolts for equipment frames and foundations shall be designed in accordance with Section 01900.

2.04 PRODUCT DATA

The following information shall be provided in accordance with Section 01300 for all bolt systems not cast-in-place:

1. Data indicating load capacities.
2. Chemical resistance.
3. Temperature limitations.
4. Installation instructions.
5. ICC ES Report for epoxy adhesive anchors.

PART 3--EXECUTION

3.01 GENERAL

Fieldwork, including cutting and threading, shall not be permitted on galvanized items. Dissimilar metals shall be protected from galvanic corrosion by means of pressure tapes, coatings or isolators.

3.02 CAST-IN-PLACE ANCHOR BOLTS

Anchor bolts to be embedded in concrete shall be placed accurately and held in correct position while the concrete is placed or, if specified, recesses or blockouts shall be formed in the concrete and the metalwork shall be grouted in place in accordance with Section 03600. The surfaces of metalwork in contact with concrete shall be thoroughly cleaned.

After anchor bolts have been embedded, their threads shall be protected by grease and the nuts run on.

3.03 ADHESIVE ANCHOR BOLTS

Use of epoxy adhesive anchors shall be subject to the following conditions:

1. Use shall be limited to locations where exposure, on an intermittent or continuous basis, to acid concentrations higher than 10 percent, to chlorine gas, or to machine or diesel oils, is extremely unlikely.

2. Use shall be limited to applications where exposure to fire or exposure to concrete or rod temperature above 120 degrees F is extremely unlikely. Overhead applications (such as pipe supports) because of the above concerns, shall be disallowed.

3. Approval from Construction Manager for specific application and from supplier of equipment to be anchored, if applicable.

4. Anchor diameter and grade of steel shall be per contract documents or per equipment supplier specifications. Anchor shall be threaded or deformed full length of embedment and shall be free of rust, scale, grease, and oils.

5. Embedment depth shall be as specified.

6. All installation recommendations by the anchor system manufacturer shall be followed carefully, including maximum hole diameter.

7. Holes shall have rough surfaces, such as can be achieved using a rotary percussion drill.

8. Holes shall be blown clean with compressed air and be free of dust or standing water prior to installation.

9. Anchor shall be left undisturbed and unloaded for full adhesive curing period.

10. Concrete temperature (not air temperature) shall be compatible with curing requirements of adhesives per adhesive manufacturer. Anchors shall not be placed in concrete below 25 degrees F.

3.04 EXPANSION ANCHORS

Use of expansion or wedge type anchors is prohibited.

END OF SECTION

SECTION 07905

PREFORMED JOINT FILLERS

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies preformed joint fillers for use in expansion joints in concrete slabs and in expansion joints.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

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Reference	Title
ASTM D994	Preformed Expansion Joint Filler for Concrete (Bituminous Type)
ASTM D1752	Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

PART 2--PRODUCTS

2.01 PREFORMED ASPHALT FIBERBOARD

Preformed asphalt fiberboard joint filler shall be in accordance with ASTM D994 and shall be 1/2 inch thick unless otherwise specified.

2.02 PREFORMED RESIN-BONDED CORK

Preformed resin-bonded cork joint filler shall be in accordance with ASTM D1752, Type II. Cork joint filler thickness shall match the specified joint width.

2.03 PRODUCT DATA

The following information shall be provided in accordance with Section 01300:

1. Manufacturer's recommendations for handling and installation of the material.

PART 3--EXECUTION

3.01 GENERAL

Preformed joint fillers shall be placed into position before the concrete is poured. Where it is necessary for the filler to be fixed to existing concrete or other building materials, a suitable adhesive recommended by the filler manufacturer shall be used. Filler surfaces shall be clean and dry prior to the placement of the concrete.

3.02 PREFORMED ASPHALT FIBERBOARD

Unless otherwise specified, preformed asphalt fiberboard joint fillers shall be used for expansion joints in concrete.

3.03 PREFORMED RESIN-BONDED CORK

Where specified, preformed resin-bonded cork joint filler shall be used for expansion joints in concrete structures.

END OF SECTION

SECTION 08305

ACCESS HATCHES

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies the access hatches located as indicated on the drawings.

1.02 SCHEDULE OF ACCESS HATCHES

Hatches to be provided by pump manufacturers are not included in this schedule.

Description	Number	Size	Arrangement
Wet Well Access	1	2' 10" x 5' 0"	Single leaf

1.03 QUALITY ASSURANCE

Construct all access hatches and accessories such that patterns, color, finish and dimensions are as represented in manufacturer's published literature. Specified materials are to establish expected quality and style.

1.04 SUBMITTALS

The following information shall be provided in accordance with Section 01300:

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

2. Layout drawings.

3. Support details and installation details

4. Manufacturer information and method of fabrication

5. Submit as product data instructions for storage, handling and installation

6. Submit as product data manufacturer's warranty.

1.05 PERFORMANCE AND DESIGN REQUIREMENTS

Unless otherwise specified, hatches shall be designed to withstand AASHTO H20 traffic loading in a non-street, low density setting.

1.06 WARRANTY

Provide manufacturer's warranty to include one (1) year from defects in materials and workmanship from date of substantial completion, and ten (10) years from degradation or failure due to corrosion from date of substantial completion, provided that the structural integrity of the doors and frames have not been violated or compromised.

PART 2--PRODUCTS

2.01 GENERAL

A. ACCEPTABLE PRODUCTS:

Hatches shall be manufactured by U.S.F. Fabrication or equal.

B. ACCESS DOORS:

1. Floor doors shall be installed flush with top of concrete surfaces. Frame shall be angle or channel type. If channel type, drain coupling shall be connected to drain pipe that shall discharge directly into the vault below. Frame shall be ASTM A276, Type 316 stainless steel with anchor tabs at perimeter.

2. Leaf shall be ASTM A276, Type 316 stainless steel diamond pattern tread plate, ¼" minimum thickness.

3. Doors shall be reinforced for low density, off street AASHTO H20 loading.

4. Hardware shall be type 316 stainless steel. Provide with compression spring operators enclosed in telescoping tubes and automatic hold-open aim with release handle, automatically locking in open position. Hinges shall be heavy forged type 316 stainless steel with ¼" type 316 stainless steel hinge pins. Latch shall be type 316 stainless steel slam lock with fixed interior handle and removable exterior turn-lift handle. Protect latch release by flush gasketed removable screw plug.

PART 3--EXECUTION

3.01 INSTALLATION

Installation shall conform to manufacturer's recommendations and as specified. Installation shall be complete with all required hardware and gasketing to provide a weatherproof and watertight installation. Spring operator and automatic hold-open device shall be checked after installation to insure proper operation.

END OF SECTION

SECTION 09900

COATING SYSTEMS

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This Section 09900 specifies coating systems, surface preparations, and application requirements for coating systems.

B. DEFINITIONS:

Specific coating terminology used in this Section 09900 is in accordance with definitions contained in ASTM D16, ASTM D3960, and the following definitions:

1. Abrasive: Material used for blast cleaning, such as sand, grit or shot.

2. Abrasive Blast Cleaning: Cleaning/surface preparation by abrasive propelled at high speed.

3. Anchor Pattern: Profile or texture of prepared surface(s).

4. ANSI: American National Standards Institute.

5. Bug Holes: Small cavities, usually not exceeding 15 mm in diameter, resulting from entrapment of air bubbles in the surface of formed concrete during placement and compaction.

6. Coating/Paint/Lining Thickness: The total thickness of primer, intermediate and/or finish coats.

7. Coating System Applicator (CSA): A generic reference to the specialty subcontractor or subcontractors retained by the Contractor to install the coating systems specified in this Section 09900.

8. Coating System Manufacturer (CSM): Refers to the acceptable coating system manufacturer, abbreviated as the CSM.

9. Coating System Manufacturer's Technical Representative(s) (CTR): Refers to the technical representative(s) of the acceptable Coating System Manufacturer and is abbreviated as CTR.

10. Dew point: Temperature of a given air/water vapor mixture at which condensation starts.

11. Dry Film Thickness (DFT): Depth of cured film, usually expressed in mils (0.001 inch). Use this definition as opposed to existing definition.

12. Drying Time: Time interval between application and curing of material.

13. Dry to Recoat: Time interval between application of material and ability to receive next coat.

14. Dry to Touch: Time interval between application of material and ability to touch lightly without damage.

15. Feather Edging: Reducing the thickness of the edge of paint.

16. Feathering: Operation of tapering off the edge of a point with a comparatively dry brush.

17. Field Coat: The application or the completion of application of the coating system after installation of the surface at the site of the work.

18. Hold Point: A defined point, specified in this Section 09900, at which work shall be halted for inspection.

19. Holiday: a discontinuity, skip, or void in coating or coating system film that exposes the substrate.

20. Honeycomb: Segregated condition of hardened concrete due to non-consolidation.

21. ICRI: International Concrete Repair Institute.

22. Incompatibility: Inability of a coating to perform well over another coating because of bleeding, poor bonding, or lifting of old coating; inability of a coating to perform well on a substrate.

23. Laitance: A layer of weak, non-durable concrete containing cement fines that is brought to the surface through bleed water because of concrete finishing and/or over-finishing.

24. Mil: 0.001 inch.

25. NACE: National Association of Corrosion Engineers.

26. Overspray: Dry spray, particularly such paint that failed to strike the intended surface.

27. Pinhole: A small diameter discontinuity in a coating or coating system film that is typically created by outgassing of air from a void in a concrete substrate resulting in exposure of the substrate or a void between coats.

28. Pot Life: Time interval after mixing of components during which the coating can be satisfactorily applied.

29. Resurfacer/Resurfacing Material: A layer of cementitious and/or resin-base material used to fill or otherwise restore surface continuity to worn or damaged concrete surfaces.

30. Shelf Life: Maximum storage time for which a material may be stored without losing its usefulness.

31. Shop Coat: One or more coats applied in a shop or plant prior to shipment to the site of the work, where the field or finishing coat is applied.

32. Spreading Rate: Area covered by a unit volume of paint at a specific thickness.

33. SSPC: The Society for Protective Coatings.

34. Stripe Coat: A separate coat of paint applied to all weld seems, pits, nuts/bolts/washers and edges by brush. This coat shall not be applied until any previous coat(s) have cured and, once applied, shall be allowed to cure prior to the application of the subsequent coat(s).

35. Surface Saturated Dry (SSD): Refers to concrete surface condition where the surface is saturated (damp) without the presence of standing water.

36. Tie Coat: An intermediate coat used to bond different types of paint coats. Coatings used to improve the adhesion of a succeeding coat.

37. Touch-Up Painting: The application of paint on areas of painted surfaces to repair marks, scratches, and areas where the coating has deteriorated to restore the coating film to an unbroken condition.

38. TPC: Technical Practice Committee.

39. Volatile Organic Compound (VOC) Content: The portion of the coating that is a compound of carbon, is photochemically reactive, and evaporates

during drying or curing, expressed in grams per liter (g/l) or pounds per gallon (lb/gal).

40. Immersion: Refers to a service condition in which the substrate is below the waterline or submerged in water or wastewater at least intermittently if not constantly.

41. Weld Splatter: Beads of metal scattered near seam during welding.

42. Wet Film Thickness (WFT): The primer or coating film's thickness immediately following application. Wet film thickness is measured in mils or thousandths of an inch (0.001 inch) and is abbreviated WFT.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued, or replaced.

Reference	Title
ANSI/ASC 29.4 Exhaust Systems	Abrasive Blasting Operations – Ventilation and Safe Practice
ANSI/NSF 61	Drinking Water System Components Health Effects
ANSI B74.18	Grading of Certain Abrasive Grain on Coated Abrasive Material
ASTM D16	Standard Terminology for Paint, Related Coatings, Materials, and Applications
ASTM D2200 (SSPC-VIS1)	Pictorial Surface Preparation Standards for Painting Steel Surfaces

Reference	Title
ASTM D3960	Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings
ASTM D4262	Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces
ASTM D4263	Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
ASTM D4414	Standard Practice for Measurement of Wet Film Thickness by Notch Gages
ASTM D4417	Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel
ASTM D4541	Standard Test Methods for Pull-Off Strength of Coatings On Metal Substrates Using Portable Adhesion Testers
ASTM D4787	Standard Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates
ASTM D5162	Standard Practice for Discontinuity (Holiday) Testing of Nonconductive Protective Coating on Metallic Substrates
ASTM D7234	Standard Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Adhesion Testers.
ASTM E337	Standard Test Method for Measuring Humidity With a Psychrometer
ASTM F1869	Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
FS 595b	Federal Standard Colors
ICRI 03732	Guideline for Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays
NACE Publication 6D-163	A Manual for Painter Safety
NACE Publication 6F-163	Surface Preparation of Steel or Concrete Tank/Interiors
NACE Publication 6G-164 A	Surface Preparation Abrasives for Industrial Maintenance Painting
NACE Standards	January 1988 Edition of the National Association of Corrosion Engineers, TPC.
NACE Standard RP0188	Standard Recommended Practice – Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates
NACE Standard RP0288	Standard Recommended Practice, Inspection of Linings on Steel and Concrete

Reference	Title
NACE Standard RP0892	Standard Recommended Practice, Linings Over Concrete in Immersion Service
NACE Publication TPC2	Coatings and Linings for Immersion Service
NAPF 500-03	Surface Preparation Standard for Ductile Iron Pipe and Fittings in Exposed Locations Receiving Special External Coatings and/or Special Internal Linings
NAPF 500-03-04	Abrasive Blast Cleaning for Ductile Iron Pipe
NAPF 500-03-05	Abrasive Blast Cleaning for Cast Ductile Iron Fittings
OSHA 1910.144	Safety Color Code for Marking Physical Hazards
OSHA 1915.35	Standards – 29CFR - Painting
SSPC	Paint Application Specification No. 1.
SSPC-AB 1	Mineral and Slag Abrasives
SSPC-PA 1	Shop, Field, and Maintenance Painting of Steel
SSPC-PA 2	Measurement of Dry Coating Thickness with Magnetic Gages
SSPC-PA 9	Measurement of Dry Coating Thickness on Cementitious Substrates Using Ultrasonic Gages
SSPC-PA Guide 1	Guide for Illumination of Industrial Painting Project
SSPC-PA Guide 3	A Guide to Safety in Paint Application
SSPC-PA Guide 6	Guide for Containing Debris Generated During Paint Removal Operations
SSPC-PA Guide 11	Guide for Coating Concrete
SSPC SP1	Solvent Cleaning
SSPC SP2	Hand Tool Cleaning
SSPC SP3	Power Tool Cleaning
SSPC SP5	White Metal Blast Cleaning
SSPC SP6	Commercial Blast Cleaning
SSPC SP7	Brush-Off Blast Cleaning
SSPC SP10	Near-White Blast Cleaning
SSPC SP11	Power Tool Cleaning to Bare Metal
SSPC SP12	Surface Preparation and Cleaning of Steel and Other Hard Materials by High and Ultra-High Pressure Water Jetting Prior to Recoating
SSPC SP13	Surface Preparation of Concrete

Reference	Title
SSPC-TR2	Wet Abrasive Blast Cleaning
SSPC-TU-3	Overcoating
SSPC-TU-4	Field Methods for Retrieval and Analysis of Soluble Salts on Substrates.
SSPC V2	Systems and Specifications: Steel Structures Painting Manual, Volume 2
SSPC-VIS 1	Visual Standard for Abrasive Blast Cleaned Steel
SSPC-VIS 3	Visual Standard for Power and Hand – Tool Cleaned Steel
SSPC-VIS 4	Visual Standards (Waterjetting)
SSPC-VIS 5	Visual Standards (Wet Abrasive Blast Cleaning)
WPCF Manual of Practice No. 17	Paints and Protective Coatings for Wastewater Treatment Facilities. Guide and Paint Application Specifications.

B. STANDARDIZATION:

Materials and supplies provided shall be the standard products of CSMs. Materials in each coating system shall be the products of a single CSM.

The standard products of CSMs other than those specified may be acceptable when it is demonstrated to the Construction Manager that they are equal in composition, durability, usefulness, and convenience for the purpose intended. Requests for consideration of CSMs other than those specified in this Section 09900 will be considered, provided the following minimum conditions are met. Such requests are not a substitution for submittals after the alternative CSMs have been considered and accepted.

1. The proposed coating system shall use an equal or greater number of separate coats to achieve the required total dry film thickness.

2. The proposed coating system shall use coatings of the same generic type as that specified including curing agent type.

3. Requests for consideration of products from CSMs other than those specified in this Section 09900 shall include information listed in paragraph 09900-1.04, Items 1, 2, and 3, demonstrating that the proposed CSM's product is equal to the specified coating system.

4. The Contractor and the proposed alternative CSM shall provide a list of references for the proposed product where the coating of the same generic type has been applied. The reference list shall include the project name, city, state, owner, phone number of owner; coating system reference and

number from this Section 09900; type of facility in which it was used, generic type, and year coating was applied.

C. QUALITY CONTROL REQUIREMENTS:

1. The Contractor is responsible for the workmanship and quality of the coating system installation. Inspections by the Construction Manager or the CTR will not relieve or limit the Contractor's responsibilities.

2. The Contractor's methods shall conform to requirements of this specification and the standards referenced in this Section 09900. Changes in the coating system installation requirements will be allowed only with the written acceptance of the Construction Manager before work commences.

3. Only personnel who are trained by the CTR specifically for this contract or who are approved by the CSM specifically for this contract shall be allowed to perform the coating system installation specified in this Section 09900.

4. Contaminated, outdated, diluted materials, and/or materials from previously opened containers shall not be used.

5. For repairs, the Contractor shall provide the same products, or products recommended by the CSM, as used for the original coating.

6. The Contractor shall identify the points of access for inspection by the Owner or the Construction Manager. The Contractor shall provide ventilation, ingress and egress, and other means necessary for the Construction Manager's personnel to access safely the work areas.

7. The Contractor shall conduct the work so that the coating system is installed as specified and shall inspect the work continually to ensure that the coating system is installed as specified. Coating system work that does not conform to the specifications or is otherwise not acceptable shall be corrected as specified.

8. The Contractor shall complete the Coating System Inspection Checklist, Form 09900-A, included in Section 01999, for coating system installations. Follow the sequential steps required for proper coating system installation as specified and as listed in the Coating System Inspection Checklist. For each portion of the work, install the coating system and complete sign-offs as specified prior to proceeding with the next step. After completing each step as indicated on the Coating System

Inspection Checklist, the Contractor shall sign the checklist indicating that the work has been installed and inspected as specified.

9. The Contractor shall provide written daily reports that present, in summary form, test data, work progress, surfaces covered, ambient conditions, quality control inspection test findings, and other information pertinent to the coating system installation.

D. INSPECTION AT HOLD POINTS

The Contractor shall conduct inspections at Hold Points during the coating system installation and record the results from those inspections on Form 09900-A. The Contractor shall coordinate such Hold Points with the Construction Manager such that the Construction Manager may observe Contractor's inspections on a scheduled basis. The Contractor shall provide the Construction Manager a minimum of two (2) hours of notice prior to conducting Hold Point Inspections. The Hold Points shall be as follows:

1. Environment and Site Conditions. Prior to commencing an activity associated with coating system installation, the Contractor shall measure, record, and confirm acceptability of ambient air temperature and humidity as well as other conditions such as proper protective measures for surfaces not to be coated and safety requirements for personnel. The acceptability of the weather and/or environmental conditions within the structure shall be determined by the requirements specified by the CSM of the coating system being used.

2. Conditions Prior to Surface Preparation. Prior to commencing surface preparation, the Contractor shall observe, record, and confirm that oil, grease, and/or soluble salts have been eliminated from the surface.

3. Monitoring of Surface Preparation. Spot checking of degree of cleanliness, surface profile, and surface pH testing, where applicable. In addition, the compressed air used for surface preparation or blow down cleaning shall be checked to confirm it is free from oil and moisture.

4. Post Surface Preparation. Upon completion of the surface preparation, the Contractor shall measure and inspect for proper degree of cleanliness and surface profile as specified in this Section 09900 and in the CSM's written instructions.

5. Monitoring of Coatings Application. The Contractor shall inspect, measure, and record the wet film thickness and general film quality (visual inspection) for lack of runs, sags, pinholes, holidays, etc. as the application work proceeds.

6. Post Application Inspection. The Contractor shall identify defects in application work including pinholes, holidays, excessive runs or sags, inadequate or excessive film thickness and other problems as may be observed.

7. Post Cure Evaluation. The Contractor shall measure and inspect the overall dry film thickness. The Contractor shall conduct a DFT survey, as well as perform adhesion testing, holiday detection, or cure testing as required based on the type of project and the specific requirements in this Section 09900 and/or in the CSM's written instructions.

8. Follow-up to Corrective Actions and Final Inspection. The Contractor shall measure and reinspect corrective coating work performed to repair defects identified at prior Hold Points. This activity also includes final visual inspection along with follow-up tests such as holiday detection, adhesion tests, and DFT surveys.

1.03 DELIVERY AND STORAGE

Materials shall be delivered to the job site in their original, unopened containers. Each container shall be properly labeled. Materials shall be handled and stored to prevent damage to or loss of label.

Labels on material containers shall show the following information:

1. Name or title of product.
2. CSM's batch number.
3. CSM's name.
4. Generic type of material.
5. Application and mixing instructions.
6. Hazardous material identification label.
7. Shelf life expiration date.

Materials shall be stored in enclosed structures and shall be protected from weather and excessive heat or cold in accordance with the CSM's recommendations. Flammable materials shall be stored in accordance with state and local requirements.

Containers shall be clearly marked indicating personnel safety hazards associated with the use of or exposure to the materials.

Material Safety Data Sheets (MSDS) for each material shall be provided to the Construction Manager.

The Contractor shall store and dispose of hazardous waste according to federal, state and local requirements. This requirement specifically addresses waste solvents and coatings.

1.04 SUBMITTALS:

Provide in accordance with Section 01300:

1. A copy of this specification section, with addendum updates included, and referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate specification compliance or marked to indicate requested deviations from specification requirements or those parts which are to be provided by the Contractor or others. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined shall signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for requested deviations to the specification requirements shall be cause for rejection of the entire submittal and no further submittal material will be reviewed.

2. CSM's current printed recommendations and product data sheets for coating systems including:

   a. Volatile organic compound (VOC) data

   b. Surface preparation recommendations.

   c. Primer type, where required.

   d. Maximum dry and wet-mil thickness per coat.

   e. Minimum and maximum curing time between coats, including atmospheric conditions for each.

   f. Curing time before submergence in liquid.

   g. Thinner to be used with each coating.

   h. Ventilation requirements.

   i. Minimum atmospheric conditions during which the paint shall be applied.

   j. Allowable application methods.

k. Maximum allowable moisture content.

l. Maximum shelf life.

3. Affidavits signed and sealed by an officer of the CSM's corporation, attesting to full compliance of each coating system component with current and promulgated federal, state, and local air pollution control regulations and requirements.

4. Material Safety Data Sheets (MSDS) for materials to be delivered to the job site, including coating system materials, solvents, and abrasive blast media.

5. List of cleaning and thinner solutions allowed by the CSMs.

6. Storage requirements including temperature, humidity, and ventilation for Coating System Materials as recommended by the CSMs.

7. CSM's detailed, written instructions for coating system treatment and graphic details for coating system terminations in the structures to be coated including pipe penetrations, metal embedments, gate frames, and other terminations to be determined from the contract drawings. This information shall also include detail treatment for coating system at joints in concrete.

8. The Contractor and CSA shall provide a minimum of five project references each including contact name, address, and telephone number where similar coating work has been performed by their companies in the past five years.

1.05 RESPONSIBILITIES OF THE CTR

The Contractor shall retain or obtain the services of the CTR to be on site to perform the Contractor and/or CSA application training and to routinely inspect and verify in writing that the application personnel have successfully performed surface preparation, filler/surface application, coating system application, and Quality Control Inspection in accordance with this Section 09900 and to warrantable level of quality. This must include checking the required degree of cleanliness, surface pH for concrete substrates, surface profile of substrates, proper mixing of coating materials, application (including checking the wet and dry film thickness of the coating systems), proper cure of the coating systems, and proper treatment of coating systems at terminations, transitions, and joints and cracks in substrates. Refer to Paragraph 1.05 B. for further details on these CTR requirements. This inspection is in addition to the inspection performed by the Contractor in accordance with this Section 09900.

A. COATING SYSTEM INSTALLATION TRAINING

1. Provide a minimum of 8 hours of classroom and off site training for application and supervisory personnel (both the Contractor's and CSA's). Provide training to a minimum of two supervisory personnel from the CSA and one supervisor from the Contractor. Alternatively, the CTR shall provide a written letter from the CSM stating that the application personnel (listed by name) who shall perform coating work are approved by the CSM without further or additional training.

2. One CTR can provide training for up to fourteen application personnel and three supervisory personnel at one time. The training shall include the following as a minimum:

   a. A detailed explanation of mixing, application, curing, and termination details.

   b. Hands-on demonstration of how to mix and apply the coating systems.

   c. A detailed explanation of the ambient condition requirements (temperature and humidity) and surface preparation requirements for application of the coating system as well as a detailed explanation of re-coat times, cure times, and related ambient condition requirements.

   d. When training is performed, the CTR shall provide a written letter stating that training was satisfactorily completed by the personnel listed by name in the letter.

B. COATING SYSTEM INSPECTION

While on site to routinely inspect and verify, the CTR shall perform the following activities to confirm acceptability and conformance with the specifications:

1. Inspect ambient conditions during various coating system installation at hold points for conformance with the specified requirements.

2 Inspect the surface preparation of the substrates where the coating system will terminate or will be applied for conformance to the specified application criteria.

3. Inspect preparation and application of coating detail treatment (for example, terminations at joints, metal embedments in concrete, etc.).

4. Inspect application of the filler/surface materials for concrete and masonry substrates.

5. Inspect application of the primers and finish coats including wet and dry film thickness of the coatings.

6. Inspect coating systems for cure.

7. Review adhesion testing of the cured coating systems for conformance to specified criteria.

8. Review coating system continuity testing for conformance to specified criteria.

9. Inspect and record representative localized repairs made to discontinuities identified via continuity testing.

10. Conduct a final review of completed coating system installation for conformance to the specifications.

11. Prepare and submit a site visit report following each site visit that documents the acceptability of the coating work in accordance with the CSM's recommendations.

C. FINAL REPORT

Upon completion of coating work for the project, the CTR shall prepare a final report. That report shall summarize daily test data, observations, drawings, and photographs in a report to be submitted in accordance with paragraph 09900-2.02. Include substrate conditions, ambient conditions, and application procedures, observed during the CTR's site visits. Include a statement that the completed work was performed in accordance with the requirements of this Section 09900 and the CSM's recommendations.

PART 2--PRODUCTS

2.01 MATERIALS

Notwithstanding the listing of product names in this Section 09900, the Contractor shall provide affidavits, signed and sealed by an officer of the CSM's corporation, attesting to full compliance of each coating system component with current and promulgated federal, state, and local air pollution control regulations and requirements. No coatings shall be applied to a surface until the specified affidavits have been submitted and have been reviewed and accepted. Failure to comply with this requirement shall be cause for rejection and removal of such materials from the site.

The following list specifies the material requirements for coating systems. Coating systems are categorized by generic name followed by an identifying abbreviation. If an abbreviation has a suffix number, it is for identifying subgroups within the coating system. Coating Systems E-5 and E-6 shall be NSF 61 certified.

Coating System	CSM	First Coat(s)	Finish Coat(s)
Epoxy Coatings			
E-2	PPG PMC	Amerlock 2/400 Series	Amerlock 2/400 Series
	Carboline	Carboguard 890	Carboguard 890
	International Paint/ICI	Bar-Rust 236	Bar-Rust 236
	Sherwin Williams	Sea Guard 6000 Epoxy N11-400	Sea Guard 6000 Epoxy N11-400
	Tnemec	Series V27 or V69	Series V69
Specialty Epoxy Linings			
EA-1	Carboline	Plasite 4500S	Plasite 4500S
	Sauereisen	Sewergard 210S	Sewergard 210S
	Tnemec	Series 435	Series 435

Epoxy Polyurethane				
		Primer Coat(s)	Intermediate Coat(s)	
EU-1	PPG PMC	Amercoat	Amercoat 385	Amercoat 450H
	Carboline	Carbozinc 859	Carboguard 890	Carbothane 134 VOC
	International Paint/ICI	Cathacoat 313	Devran 233 or 224HS	Devthane 379
	Sherwin Williams	Zinc Clad IV	Macropoxy 646	Hi Solids Polyurethane
	Tnemec	Series 90-97	Series V69	Series 1075
Latex Acrylic				
L-1	PPG PMC	Amercoat 148		Amercoat 220
	Carboline	Carbocrylic 120		Carbocrylic 3359
	International Paint/ICI	UH Gripper 3210		Dulux Pro 1406
	Sherwin Williams	Loxon Acrylic Primer		Sher Cryl HPA
	Tnemec	Series 1028 or 1029		Series 1028 or 1029

Coating System	CSM	First Coat(s)	Finish Coat(s)
Miscellaneous			
M-1	Carboline	Carbowrap Priming Paste	Tape A, B, or C (temp dependent)
	Denso	Denso Paste	Densyl Tape
	Trenton	Waxtape Primer	#1 Wax Tape
M-2	Carboline	Carbomastic 15	Carbomastic 15
	International Paint/ICI	Bar-Rust 231 (231K 9100)	Bar-Rust 231 (231K 9100)
	Sherwin Williams	Epoxy Mastic Aluminum II	Epoxy Mastic Aluminum II
	Tnemec	Series 135 (1243)	Series 135 (1243)

***See CSM's Product Data Sheets for acceptable thinners for VOC compliance or do not thin.**

2.02 PRODUCT DATA

1. Prior to application of coatings, submit letter(s) from the CTR(s) identifying the application personnel who have satisfactorily completed training as specified in paragraph 09900-1.05 or a letter from the CSM stating that personnel who shall perform the work are approved by the CSM without need for further or additional training.

2. Submit reports specified in paragraph 09900-1.02 C.10 and 09900-1.05 B.12 when the work is underway.

3. Submit the Coating System Inspection Checklists, using Form 09900-A, included in Section 01999, for the coating work.

4. CTR final report in accordance with paragraph 09900-1.05 C.

PART 3--EXECUTION

3.01 COATINGS

A. GENERAL:

Coating products shall not be used until the Construction Manager has accepted the affidavits specified in paragraph 09900-1.04 and 2.01, the Construction Manager has inspected the materials, and the CTR has trained the Contractor and CSA in the surface preparation, mixing and application of each coating system.

B. SHOP AND FIELD COATS:

1. SHOP APPLIED PRIME COAT: Except as otherwise specified, prime coats may be shop-applied or field-applied. Shop-applied primer shall be compatible with the specified coating system and shall be applied at the minimum dry film thickness recommended by the CSM. Data sheets identifying the shop primer used shall be provided to the on-site coating application personnel. Adhesion tests shall be performed on the shop primer as specified in paragraph 09900-3.01B.3. Damaged, deteriorated and poorly applied shop coatings that do not meet the requirements of this Section 09900 shall be removed and the surfaces recoated. If the shop primer coat meets the requirements of this Section 09900, the field coating may consist of touching up the shop prime coat and then applying the finish coats to achieve the specified film thickness and continuity.

2. FIELD COATS: Field coats shall consist of one or more prime coats and one or more finish coats to build up the coating to the specified dry film thickness. Unless otherwise specified, finish coats shall not be applied until other work in the area is complete and until previous coats have been inspected.

3. ADHESION CONFIRMATION: The Contractor shall perform an adhesion test after proper cure in accordance with ASTM D3359 to demonstrate that (1) the shop applied prime coat adheres to the substrate, and (2) the specified field coatings adhere to the shop coat. Test results showing an adhesion rating of 5A on immersed surfaces and 4A or better on other surfaces shall be considered acceptable for coatings 5 mils or more in thickness (Method A). Test results showing an adhesion rating of 5B on immersed surfaces and 4B or better on other surfaces shall be considered acceptable for coating thicknesses less than 5 mils.

C. APPLICATION LOCATION REQUIREMENTS:

1. EQUIPMENT, NONIMMERSED: Items of equipment, or parts of equipment that are not immersed in service, shall be shop primed and then finish coated in the field after installation with the specified or acceptable color. If the shop primer requires topcoating within a specified period, the equipment shall be finish coated in the shop and then touch-up painted after installation. If equipment removal and reinstallation is required for the project, touch-up coating work shall be performed in the field following installation.

2. EQUIPMENT, IMMERSED: Items of equipment, or parts and surfaces of equipment that are immersed when in service, with the exception of pumps and valves, shall have surface preparation and coating work performed in the field. Coating systems applied to immersed equipment shall be pinhole free.

D. Erect and maintain protective enclosures as stipulated per SSPC-Guide 6 Guide for Containing Debris Generated During Paint Removal Operations.

3.02 PREPARATION

A. GENERAL:

Surface preparations for each type of surface shall be in accordance with the specific requirements of each coating specification sheet (COATSPEC) and the following. In the event of a conflict, the COATSPEC sheets shall take precedence.

Surfaces to be coated shall be clean and dry. Before applying coating or surface treatments, oil, grease, dirt, rust, loose mill scale, old weathered coatings, and other foreign substances shall be removed. Oil and grease shall be removed before mechanical cleaning is started. Where mechanical cleaning is accomplished by blast cleaning, the abrasive used shall be washed, graded and free from contaminants that might interfere with the adhesion of the coatings. The air used for blast cleaning shall be sufficiently free of oil and moisture so as not to cause detrimental contamination of the surfaces to be coated.

Where deemed necessary by the Owner's representative, a NACE International certified coatings inspector, provided by the Owner, will inspect and approve surfaces to be coated before application of a coating. Surface defects identified by the inspector shall be corrected by the Contractor at no additional cost to the Owner.

Cleaning and painting shall be scheduled so that dust and spray from the cleaning process shall not fall on wet, newly coated surfaces. Hardware, hardware accessories, nameplates, data tags, machined surfaces, sprinkler heads, electrical fixtures, and similar uncoated items which are in contact with coated surfaces shall be removed or masked prior to surface preparation and painting operations. Following completion of coating, removed items shall be reinstalled. Equipment adjacent to walls shall be disconnected and moved to permit cleaning and painting of equipment and walls and, following painting, shall be replaced and reconnected.

B. BLAST CLEANING:

When abrasive blast cleaning is required to achieve the specified surface preparation the following requirements for blast cleaning materials and equipment shall be met:

1. Used or spent blast abrasive shall not be reused on this project.

2. The compressed air used for blast cleaning shall be filtered and shall contain no condensed water and no oil. Moisture traps shall be cleaned at least once every four hours or more frequently as required to prevent moisture from entering the supply air to the abrasive blasting equipment.

3. Oil separators shall be installed just downstream of compressor discharge valves and at the discharge of the blast pot discharges. These shall be checked on the same frequency as the moisture traps as defined in item 2 above.

Contractor to produce the specified surface profile. The solvent in solvent cleaning operations shall be as recommended by the CSM.

Preparation of metallic surfaces shall be based upon comparison with SSPC-VIS1-89 (ASTM D2200), and as described in the Coat Spec for each coating system. If dry abrasive blast cleaning is selected and to facilitate inspection, the Contractor shall, on the first day of cleaning operations, abrasive blast metal panels to the standards specified. Plates shall measure a minimum of 8-1/2 inches by 11 inches. Panels meeting the requirements of the specifications shall be initialed by the Contractor and the Construction Manager and coated with a clear non-yellowing finish. One of these panels shall be prepared for each type of abrasive blasting and shall be used as the comparison standard throughout the project.

Blast cleaning requirements for steel, ductile iron and stainless steel substrates are as follows:

1. Steel piping shall be prepared in accordance with SSPC SP-6 (Commercial Blast Cleaning) and primed before installation. Ductile iron piping surfaces including fittings shall be prepared in accordance with NAPF 500-03, NAPF 500-03-04, and NAPF 500-03-05.

2. Stainless steel surfaces shall be abrasive blast cleaned to leave a clean uniform appearance with a minimum surface profile of 1.5 to 2.5 mils that is uniform.

3. Remove traces of grit, dust, dirt, rust scale, friable material, loose corrosion products or embedded abrasive from substrate by vacuum cleaning prior to coating application.

4. Care must be taken to prevent contamination of the surface after blasting from worker's fingerprints, deleterious substances on workers' clothing, or from atmospheric conditions.

5. Ambient environmental conditions in the enclosure must be constantly monitored and maintained to ensure the degree of cleanliness is held and no "rust back" occurs prior to coating material application.

E. CONCRETE SURFACES:

1. Inspection of concrete surfaces prior to surface preparation and surface preparation of concrete surfaces shall be performed in accordance with SSPC-SP13 (also called NACE 6).

2. Prepare substrate cracks, areas requiring resurfacing and perform detail treatment including but not limited to, terminating edges, per CSM recommendations. This shall precede surface preparation for degree of cleanliness and profile.

4. Regulators, gauges, filters, and separators shall be in use on compressor air lines to blasting nozzles times during this work.

5. An air dryer or desiccant filter drying unit shall be installed which dries the compressed air prior to blast pot connections. This dryer shall be used and maintained for the duration of surface preparation work.

6. The abrasive blast nozzles used shall be of the venturi or other high velocity type supplied with a minimum of 100 psig air pressure and sufficient volume to obtain the blast cleaning production rates and cleanliness/specified.

7. The Contractor shall provide ventilation for airborne particulate evacuation (meeting pertinent safety standards) to optimize visibility for both blast cleaning and inspection of the substrate during surface preparation work.

8. If, between final surface preparation work and coating system application, contamination of prepared and cleaned metallic substrates occurs, or if the prepared substrates' appearance darkens or changes color, recleaning by water blasting, reblasting and abrasive blast cleaning shall be required until the specified degree of cleanliness is reclaimed.

9. The Contractor is responsible for dust control and for protection of mechanical, electrical, and other equipment adjacent to and surrounding the work area.

C. SOLVENT CLEANING:

Any solvent wash, solvent wipe, or cleaner used, including but not limited to those used for surface preparation in accordance with SSPC SP-1 Solvent Cleaning and shall be of the emulsifying type which emits no more than 340 g/l VOCs for AIM regions, 250 g/l for CARB regions and 100 g/l for SCAQMD regions, contains no phosphates, is biodegradable, removes no zinc, and is compatible with the specified primer.

Clean white cloths and clean fluids shall be used in solvent cleaning.

D. METALLIC SURFACES:

Metallic surfaces shall be prepared in accordance with applicable portions of surface preparation specifications of the Society for Protective Coatings (SSPC) specified for each coating system. See Coat Spec for each coating system in this Section 09900. The profile depth of the surface to be coated shall be in accordance with the COATSPEC requirements in this Section measured by Method C of ASTM D4417. Blast particle size shall be selected by the

3. The surface profile for prepared concrete surfaces to be coated shall be evaluated by comparing the profile of the prepared concrete with the profile of graded abrasive paper, as described in ANSI B74.18 or by comparing the profile with the ICRI 03732 (surface profile replicas). Surface profile requirements shall be in accordance with the Coat Spec requirements and the CSM's recommendations.

4. Surface cleanliness of prepared concrete substrates shall be inspected after cleaning, preparation, and/or drying, but prior to making repairs or applying a coat in the coating system. If concrete surfaces are repaired, they shall be reinspected for surface cleanliness prior to application of the coating system.

5. Surface preparation of concrete substrates shall be accomplished using methods such as dry abrasive blast cleaning, high, or ultra high-pressure water blast cleaning in accordance with SSPC-SP-13. The selected cleaning method shall produce the requirements set forth below.

   a. A clean substrate that is free of calcium sulfate, loose coarse or fine aggregate, laitance, loose hydrated cement paste, and otherwise deleterious substances shall be achieved. Blast cleaning and other means necessary shall be used to open up air voids or bugholes to expose their complete perimeter. Leaving shelled over, hidden air voids beneath the exposed concrete surface is not acceptable. Concrete substrate must be dry prior to the application of filler/surface or coating system materials.

      Acceptable surface preparation must produce a concrete surface with a minimum pH of 8.0 to be confirmed by surface pH testing. If after surface preparation, the surface pH remains below 8.0, perform additional water blasting, cleaning, or abrasive blast cleaning until additional pH testing indicates an acceptable pH level.

   b. Following inspection by the Contractor of the concrete surface preparation, thoroughly vacuum clean concrete surfaces to be coated to remove loose dirt, and spent abrasive (if dry blast cleaning is used) leaving a dust free, sound concrete substrate. Debris produced by blast cleaning shall be removed from the structures to be coated and disposed of legally off site by the Contractor.

6. Should abrasive blast cleaning or high or ultrahigh pressure water blasting not remove degraded concrete, chipping or other abrading tools shall be

used to remove the deteriorated concrete until a sound, clean substrate is achieved which is free of calcium sulfate, loose coarse or fine aggregate, laitance, loose hydrated cement paste, and otherwise deleterious substances. Concrete substrates must be dry prior to the application of filler/surfacers or coating system materials.

7. Surface cleanliness of prepared concrete substrates shall be inspected after cleaning, preparation, and/or drying, but prior to application of coating materials. If concrete surfaces are repaired, they shall be reinspected for surface cleanliness and required surface profile prior to application of the coating system.

8. Moisture content of concrete to be coated shall be tested in accordance with ASTM D4263, Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method and ASTM F 1869, Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride. The ASTM D4263 plastic sheet test shall be conducted at least once for every 500 sq. ft. of surface area to be coated. The presence of any moisture on plastic sheet following test period constitutes a non-acceptable test. For concrete surfaces to be coated which are on the negative or back side of concrete walls or structures exposed to soils (back filled) or immersed and waterproofed in accordance with Section 07100, perform calcium chloride tests in accordance with ASTM F-1869 once for each 500 sq. ft. of surface area to be coated. Comply with CSM's written recommendations regarding acceptance/non-acceptance of moisture vapor emissions.

F. MASONRY SURFACES:

1. Prepare masonry surfaces such as Concrete Masonry Units (CMU) to remove chalk, loose dirt, dried mortar splatter, dust, peeling, or loose existing coatings, or otherwise deleterious substances to leave a clean, sound substrate.

2. Be certain masonry surfaces are dry prior to coating application. If pressure washing or low-pressure water blast cleaning is used for preparation, allow the masonry to dry for at least 5 days under dry weather conditions or when the minimum ambient temperature is 70 degrees F prior to coating application work.

3.03 APPLICATION

A. WORKMANSHIP:

1. Coated surfaces shall be free from runs, drips, ridges, waves, laps, and brush marks. Coats shall be applied to produce an even film of uniform thickness completely coating corners and crevices.

2. The Contractor's equipment shall be designed for application of the materials specified. Compressors shall have suitable traps and filters to remove water and oils from the air. A paper blotter test shall be performed by the Contractor when requested by the Construction Manager to determine if the air is sufficiently free of oil and moisture so as not to produce deteriorating effects on the coating system. The amount of oil and moisture in spray air shall be less than the amount recommended by the CSM. Spray equipment shall be equipped with mechanical agitators, pressure gages, and pressure regulators, and spray nozzles of the proper sizes.

3. Each coat of coating material shall be applied evenly and sharply cut to line. Care shall be exercised to avoid overspraying or spattering paint on surfaces not to be coated. Glass, hardware, floors, roofs, and other adjacent areas and installations shall be protected by taping, drop cloths, or other suitable measures.

4. Coating applications method shall be conventional or airless spray, brush or roller, or trowel as recommended by CSM.

5. Allow each coat to cure or dry thoroughly, according to CSM's printed instructions, prior to recoating.

6. Vary color for each successive coat for coating systems when possible.

7. When coating complex steel shapes, prior to overall coating system application, stripe coat welds, edges of structural steel shapes, metal cut-outs, pits in steel surfaces, or rough surfaces with the primer coat. This involves applying a separate coat using brushes or rollers to ensure proper coverage. Stripe coat via spray application is not permitted.

B. COATING PROPERTIES, MIXING AND THINNING:

Coatings, when applied, shall provide a satisfactory film and smooth even surface. Glossy undercoats shall be lightly sanded to provide a surface suitable for the proper application and adhesion of subsequent coats. Coating materials shall be thoroughly stirred, strained, and kept at a uniform consistency during application. Coatings consisting of two or more

components shall be mixed in accordance with the CSM's instructions. Where necessary to suit the conditions of the surface, temperature, weather and method of application, the coating may be thinned as recommended by the CSM immediately prior to use. The volatile organic content (VOC) of the coating as applied shall comply with prevailing air pollution control regulations. Unless otherwise specified, coatings shall not be reduced more than necessary to obtain the proper application characteristics. Thinner shall be as recommended by the CSM.

C. ATMOSPHERIC CONDITIONS:

Coatings shall be applied only to surfaces that are dry, and only under conditions of evaporation rather than condensation. Coatings systems shall not be applied during rainy, misty weather, or to surfaces upon which there is frost or moisture condensation. During damp weather, when the temperature of the surface to be coated is within 10 degrees F of the dew point, forced dehumidification equipment may be used to maintain a temperature of minimum 40 degrees F and 10 degrees F above the dew point for the surfaces to be coated, the coated surface, and the atmosphere in contact with the surface. These conditions shall be maintained for a period of at least 8 hours or as recommended by the CSM. Where conditions causing condensation are severe, dehumidification equipment, fans, and/or heaters shall be used inside enclosed areas to maintain the required atmospheric and surface temperature requirements for proper coating application and cure.

D. CONCRETE SUBSTRATE TEMPERATURES AND DETAIL TREATMENT:

1. When the surface temperatures of the concrete substrates to be coated are rising or when these substrates are in direct sunlight, outgassing of air from the concrete may result in bubbling, pinhole formations, and/or blistering in the coating system. The application of the filler/surface and the coating system will only be allowed during periods of falling temperature. This will require that application of the filler/surface and coating system shall only occur during the cooler evening hours. Contractor shall include any cost for working outside of normal hours in the bid.

   Should bubbles, pinholes, or discontinuities form in the applied coating system material, they shall be repaired as recommended by the CSM. Should pinholes develop in the filler/surfacer material or in the first coat of the coating material, the pinholes shall be repaired in accordance with the CSM's recommendations prior to application of the next coat of material. Whenever pinholes occur, the air void behind or beneath the pinhole shall be opened up completely and then completely filled with the specified filler/surfacer material. Next, the coated area around the pinhole repair shall be abraded and the coating reapplied over that area.

2. Perform application detail work per CSM's current written recommendations and/or drawings.

E. PROTECTION OF COATED SURFACES:

Items that have been coated shall not be handled, worked on, or otherwise disturbed, until the coating is completely dry and hard. After delivery at the site, and upon permanent erection or installation, shop-coated metalwork shall be recoated or retouched with specified coating when it is necessary to maintain the integrity of the film.

F. METHOD OF COATING APPLICATION:

1. Where two or more coats are required, alternate coats shall contain sufficient compatible color additive to act as indicator of coverage, or the alternate coats shall be of contrasting colors. Color additives shall not contain lead, or lead compounds, which may be destroyed or affected by hydrogen sulfide or other corrosive gas, and/or chromium.

2. Mechanical equipment, on which the equipment manufacturer's coating is acceptable, shall be touch-up primed and coated with two coats of the specified coating system to match the color scheduled. Electrical and instrumentation equipment specified in Divisions 16 and 17 shall be coated as specified in paragraph 09900-3.03 I.

3. Coatings shall not be applied to a surface until it has been prepared as specified. The primer or first coat shall be applied by brush to ferrous surfaces that are not blast-cleaned. Coats for blast-cleaned ferrous surfaces and subsequent coats for nonblast-cleaned ferrous surfaces may be either brush or spray applied. After the prime coat is dry, pinholes and holidays shall be marked, repaired in accordance with CSM's recommendations and retested before succeeding coats are applied. Unless otherwise specified, coats for concrete and masonry shall be brushed, rolled, or troweled.

G. FILM THICKNESS AND CONTINUITY:

1. WFT of the first coat of the coating system and subsequent coats shall be verified by the Contractor, following application of each coat.

2. The surface area covered per gallon of coating for various types of surfaces shall not exceed those recommended by the CSM. The first coat, referred to as the prime coat, on metal surfaces refers to the first full paint coat and not to solvent wash, grease emulsifiers or other pretreatment applications. Coatings shall be applied to the thickness specified, and in accordance with these specifications. Unless otherwise specified, the average total thickness (dry) of a completed protective coating system on exposed metal surfaces shall be not less than 1.25 mils per coat. The

minimum thickness at any point shall not deviate more than 25 percent from the required average. Unless otherwise specified, no less than two coats shall be applied.

3. In testing for continuity of coating about welds, projections (such as bolts and nuts), and crevices, the Construction Manager shall determine the minimum conductivity for smooth areas of like coating where the dry-mil thickness has been accepted. This conductivity shall be the minimum required for these rough or irregular areas. Pinholes and holidays shall be recoated to the required coverage.

4. The ability to obtain specified film thickness is generally compromised when brush or roller application methods are used and, therefore, more coats may need to be applied to achieve the specified dry film thickness.

5. For concrete substrates, the Contractor shall apply a complete skim coat of the specified filler/surfacer material over the entire substrate prior to application of the coating system. This material shall be applied such that all open air voids and bugholes in the concrete substrate are completely filled prior to coating application.

H. SPECIAL REQUIREMENTS:

Before erection, the Contractor shall apply all but the final finish coat to interior surfaces of roof plates, roof rafters and supports, pipe hangers, piping in contact with hangers, and contact surfaces that are inaccessible after assembly. The final coat shall be applied after erection. Structural friction connections and high tensile bolts and nuts shall be coated after erection. Areas damaged during erection shall be hand-cleaned or power-tool cleaned and recoated with primer coat prior to the application of subsequent coats. Touch-up of surfaces shall be performed after installation. Surfaces to be coated shall be clean and dry at the time of application. Except for those to be filled with grout, the underside of equipment bases and supports that have not been galvanized shall be coated with at least two coats of primer specified for system E-2 prior to setting the equipment in place. Provide coating system terminations at leading edges and transitions to other substrates in accordance with the CSM's recommendations or detail drawings.

I. ELECTRICAL AND INSTRUMENTATION EQUIPMENT AND MATERIALS:

Electrical and instrumentation equipment and materials shall be coated by the equipment manufacturer as specified below.

1. FINISH: Electrical equipment shall be treated with zinc phosphate, bonderized or otherwise given a rust-preventive treatment. Equipment shall be primed, coated with enamel, and baked. Minimum dry film thickness shall be 3 mils.

Unless otherwise specified, instrumentation panels shall be coated with system E-1 for indoor mounting and system EU-1 for outdoor mounting.

Before final acceptance, the Contractor shall touch up scratches on equipment with identical color coating. Finish shall be smooth, free of runs, and match existing finish. Prior to touching up scratches, Contractor shall fill them with an appropriate filler material approved by the CSM.

2. COLOR: Exterior color of electrical equipment shall be FS 26463 (ANSI/NSF 61) light gray. Interior shall be painted FS 27880 white. Nonmetallic electrical enclosures and equipment shall be the equipment manufacturer's standard grey color.

Exterior color of instrumentation panels and cabinets mounted indoors shall be FS 26463 light gray; unless otherwise specified, exterior color for cabinets mounted outdoors shall be FS 27722, white. Cabinet interiors shall be FS 27880, white.

3.04 CLEANUP

Upon completion of coating, the Contractor shall remove surplus materials, protective coverings, and accumulated rubbish, and thoroughly clean surfaces and repair overspray or other coating-related damage.

3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating systems for different types of surfaces and general service conditions for which these systems are normally applied are specified on the following COATSPEC sheets. Surfaces shall be coated in accordance with the COATSPEC to the system thickness specified. Coating systems shall be as specified in paragraph 09900-3.06, Coating System Schedule. In case of conflict between the schedule and the COATSPECS, the requirements of the schedule shall prevail.

Coating Specification Sheets included in Table 09900A are included this paragraph 09900-3.05.

Table 09900A Coating Specification Sheets

Coating System ID	Coating Material	Surface	Service Condition
E-2	Epoxy	Metal	Immersed, nonpotable; non-immersed, moderately corrosive environment, color required.
EA-1	Blended Amine Cured Epoxy	Metal	Immersed, nonpotable; non-immersed, corrosive environment, color not required especially for headspace environments that are corrosive due to biogenic sulfide corrosion.
L-1	Latex	Concrete, masonry, plaster, gypsum board	Interior and Exterior including existing exterior coated concrete
M-1	Petrolatum based mastic or wax based wrapping tapes	Metal	Below grade (buried) or where little to no surface preparation can be performed on piping or structural steel
M-2	Epoxy mastic or equal	Ferrous Metal	Interior, corrosive environment, confined enclosures, where minimal surface preparation is possible
EU-1	Zinc-epoxy-polyurethane system	Ferrous Metal	Exterior, exposed to direct sunlight, moderately corrosive non-immersed.

3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification:	E-2
Coating Material:	Epoxy
Surface:	Metal
Service Condition:	Immersed, nonpotable; non-immersed, moderately corrosive environment, color required.
Surface Preparation:	
Ferrous Metal:	Ferrous metal surfaces shall be prepared in accordance with SSPC SP-5 (White Metal Blast Cleaning) to achieve a uniform surface profile of 2.0 to 2.5 mils. Damaged shop coating shall be cleaned in accordance with SSPC SP-5 (White Metal Blast Cleaning) and vacuum cleaning and spot primed with the primer specified. Shop epoxy primed surfaces shall require light abrasive blasting or abrading prior to receiving finish coats if the maximum recoat time for the primer has been exceeded. This cleaning must produce a uniform 1.0- to 1.5-mil profile in the intact shop primer. For ductile iron surfaces, refer to the requirements in paragraph 09900-3.02 D.
Nonferrous and Galvanized Metal:	Nonferrous and galvanized metal shall be prepared in accordance with SSPC SP-7 (Brush-off Blast Cleaning) to achieve a uniform surface profile of 1.0 to 1.5 mils. Galvanized steel with this E-2 coating system shall not be used in immersion service in wastewater.
Application:	Field
General:	Prime coat may be thinned and applied as recommended by the CSM, provided the coating as applied complies with prevailing air pollution control regulations.
Ferrous Metal:	Prime coat shall be an epoxy primer compatible with the specified finish coats.

3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification:	E-2 (continued)
Nonferrous and Galvanized Metal:	Nonferrous and galvanized metal, non-immersed, shall be coated prior to the application of the prime coat with a grease emulsifying agent in accordance with the CSM's written instructions. Nonferrous metal to be immersed shall not be painted. Galvanized metal shall not be immersed even if it is painted.
System Thickness:	16 mils dry film.
Coatings:	
Primer:	One coat at CSM's recommended dry film thickness.
Finish:	Two or more coats at CSM's recommended dry film thickness per coat to the specified system thickness.

3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification:	EA-1
Coating Material:	Blended Amine Cured Epoxy
Surface:	Metal
Service Condition:	Immersed, nonpotable; non-immersed, corrosive environment, color not required especially for headspace environments that are corrosive due to biogenic sulfide corrosion.
Surface Preparation:	
Ferrous Metal:	Ferrous metal surfaces shall be prepared in accordance with SSPC SP-5 (White Metal Blast Cleaning) to achieve a uniform surface profile of 3.0 to 3.5 mils. Blast Cleaning shall produce a minimum surface profile of 3.0 mils. Shop primed surfaces which are to be incorporated in the work shall be prepared in the field by cleaning surfaces in accordance with SSPC SP-11 (Power Tool Cleaning to Bare Metal). Damaged shop coated areas shall be cleaned in accordance with SSPC SP-5 (White Metal Blast Cleaning) and spot primed with the primer specified. Shop epoxy primed surfaces shall require light abrasive blasting and blow down cleaning prior to receiving finish coats. Cast or ductile iron surfaces to be coated shall be abrasive blast cleaned to a clean, gray uniform metal appearance free of variations in color and loose materials. Ductile iron surfaces shall be prepared in accordance with paragraph 09900-3.02 D.
Nonferrous and Galvanized Metal:	Nonferrous and galvanized metal shall be prepared in accordance with SSPC SP-7 (Brush-off Blast Cleaning) to achieve a uniform surface profile of 2.0 to 2.5 mils. Galvanized metal should generally not be used in these environments

3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification:	EA-1 (continued)
Application:	Field
General:	Prime coat may be thinned and applied as recommended by the CSM, provided the coating as applied complies with prevailing air pollution control regulations. Drying time between coats shall be as specified by the CSM for the site conditions. If the maximum recoat time is exceeded, surface preparation shall require solvent washing, light abrasive blasting, or other procedures per CSM's instructions.
Ferrous Metal:	If shop priming is required or field priming is necessary, the prime coat shall be an epoxy primer compatible with the specified coating system. Generally, the EA-1 coating system is self-priming and does not require a primer unless there is a special reason to prime the steel to hold the blast cleaning from rusting back.
System Thickness:	30 to 40 mils dry film.
Coatings:	
Primer:	One coat at CSM's recommended dry film thickness only if required by special circumstances.
Finish:	One or more coats at CSM's recommended dry film thickness per coat to the specified system thickness.
Testing:	Holiday detection shall be performed over 100% of the coated surface area to identify any holidays or pinholes that must be repaired.
Pinhole and Holiday Repair Procedure:	Pinholes and holidays identified by Holiday Detection shall be repaired as follows: • Using a pencil grinder, remove a 1/2-inch diameter area of the coating system material back to the ferrous metal substrate. The metal must be shiny.

- Aggressively sand or abrade the intact coating system surface 2 inches around the complete periphery of the 1/2-inch diameter removal area to produce a uniform 6 to 8 mils profile.

- Vacuum clean the prepared area to remove all dust and dirt to achieve a clean, sound surface. Tape the peripheral area to prevent coating application onto unprepared surfaces.

- Brush apply one coat of the finish coating material. Following proper recoat cure time, apply additional coats of the finish coating system to achieve 60 mils DFT at the coating removal area and feather the coating onto the roughened coated surfaces to form a neat repair outline.

3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification:	EU-1
Coating Material:	Zinc-Epoxy-Polyurethane System
Surface:	Ferrous Metal
Service Condition:	Exterior, exposed to direct sunlight, moderately corrosive, non-immersed.
Surface Preparation:	
General:	Shop primed surfaces which are to be incorporated in the work shall be prepared in the field by cleaning surfaces in accordance with SSPC SP-2 (Hand Tool Cleaning). Damaged shop coated areas shall be cleaned in accordance with SSPC SP-3 (Power Tool Cleaning) and recoated with the primer specified.
Ferrous Metal:	Bare ferrous metal surfaces shall be prepared in accordance with SSPC SP-6 (Commercial Blast Cleaning) 2.5 – 3.0. Ductile iron surfaces to be coated shall be abrasive blast cleaned in accordance with paragraph 09900-3.02 D. Ferrous metal with rust bleeding shall be cleaned in accordance with SSPC-SP-11 (Power Tool Cleaning to Bare Metal). Areas of rust penetration shall be spot blasted to SSPC SP-10 (Near White Blast) and spot primed with the specified primer.
Galvanized Metal:	Damaged galvanized steel areas with exposed ferrous metal and/or rusted shall be cleaned in accordance with SSPC SP-5 (White Metal Blast Cleaning) or Power Tool Cleaned to Bare Metal in accordance with SSPC-SP-11 to achieve a uniform 1.0- to 1.5-mil profile and spot primed with the primer specified. Nonferrous and galvanized metal shall be prepared in accordance with SSPC SP-7 (Brush-off Blast Cleaning) to impart a 1.0- to 2.0-mil profile to the galvanized steel surfaces. Where this cannot be performed, prepare by abrading in accordance with SSPC-SP-3, Power Tool Cleaning to impart a 1.0- to 1.5-mil profile uniformly to the galvanized steel surfaces.

3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification:	EU-1 (continued)
	For EU-1 over galvanized steel, delete the zinc rich primer.
Application:	Field
General:	Prime coat may be thinned and applied as recommended by the CSM, provided the coating as applied complies with prevailing air pollution control regulations.
Ferrous Metal:	Prime coats shall be a zinc rich epoxy or polyurethane primer compatible for use with urethane finish coats and applied in accordance with written instructions of the CSM or in the case of CARB or SCAQMD applications, prime with specified primer that is not zinc rich. In these cases, only a two-coat system is applied.
System Thickness:	3 to 4 mils of zinc rich primer, one intermediate or primer epoxy coat at 5 to 6 mils and one finish coat of polyurethane at 2 to 3 mils DFT.
Coatings:	
Primer:	One coat at CSM's recommended dry film thickness.
Intermediate:	One coat at CSM's recommended dry film thickness.
Finish:	One coat at CSM's recommended dry film thickness per coat to meet the specified system thickness.

3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification:	L-1
Coating Material:	Latex
Surfaces:	Concrete, masonry, plaster, gypsum board.
Service Condition:	Interior and exterior including existing exterior coated concrete.
Surface Preparation:	
Concrete:	Concrete surfaces shall be allowed to age for at least 28 days and allowed to dry to the moisture content recommended by the CSM. Moisture content may be tested by the Construction Manager with a Delmhorst Instrument Company moisture detector, or equal. Loose concrete and laitance shall be removed from surfaces, and voids and cracks shall be repaired as specified in Section 03300.
Existing Coated Concrete:	Remove all loose coating down to a sound substrate or intact, well-adhered existing coating by scraping or other means. Then, abrade all surfaces to achieve a 0.5- to 1.5-mil uniform profile and vacuum clean to remove all loose dirt, paint chips, and dirt.
Masonry:	Masonry surfaces shall be allowed to age for at least 28 days. Holes or other joint defects shall be filled with mortar and repointed. Loose or splattered mortar shall be removed by scraping and chipping. Masonry surfaces shall be cleaned with clear water by washing and scrubbing to remove foreign and deleterious substances. Muriatic acid shall not be used. After cleaning, masonry surfaces shall be filled with block filler compatible with the specified primer.
Plaster:	Plaster surfaces shall be dry, clean, and free from grit, loose plaster, and surface irregularities. Cracks and holes shall be repaired with acceptable patching materials, keyed to existing surfaces, and sandpapered smooth. Surfaces shall be cleaned with clear water by washing and scrubbing to remove foreign and deleterious substances. After cleaning, surfaces shall be sealed with a compatible sealer.

3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification:	L-1 (continued)
Gypsum Wallboard:	Tape joints and spackled nail heads shall be sanded smooth and dusted. Seal with PVA sealer for interior uses only.
Application:	Field
	Sealer or filler shall dry a minimum of 48 hours prior to primer application.
	Drying time between coats shall be as recommended by CSM.
System Thickness:	4 mils dry film.
Coatings:	
Primer:	One coat at CSM's recommended dry film thickness.
Finish:	Two or more coats at CSM's recommended dry film thickness per coat to the specified system thickness.

3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification:	M-1
Coating Material:	Petrolatum based mastic or wax based wrapping tapes.
Surfaces:	Metal
Service Condition:	Below grade (buried) or where little to no surface preparation can be performed on piping or structural steel.
Surface Preparation:	Remove loose scale, rust, dirt, excessive moisture, or frost from the surface in accordance with SSPC SP-2 (Hand Tool Cleaning).
Application:	All surfaces shall be hand rubbed or brushed with a priming paste recommended by the CSM. Sharp projections such as threads, irregular contours, or badly pitted areas shall receive a liberal amount of priming paste to ensure maximum protection of metal throughout.

On irregular shaped surfaces, i.e., nuts, bolts, flanges, valves, etc., the Contractor shall use either of the following systems recommended by the CSM.

A. Apply recommended mastic by hand in sufficient quantity to build an even contour over entire surface. The Contractor shall pay particular attention to ensure that folds and air pockets within the mastic layer are thoroughly pressed out prior to subsequent application of tape.

OR:

B. An extra layer of tape shall be cut and carefully molded around sharp projections, nuts, bolts, etc., before final application of tape, in order to meet specified system thickness.

3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification:	M-1 (Continued)
	Tape shall be spirally wrapped with a 55 percent overlap and sufficient tension and pressure to provide continuous adhesion without stretching the tape. Edges of tape must be continuously smoothed and sealed by hand during wrapping. On vertical application, contractor shall begin at bottom and proceed upward creating a weatherboard overlap.
System Thickness:	Smooth contours shall have a minimum thickness of 50 mils while nuts, bolts, and sharp projections shall be 100 mils.
Tape:	Number and types of tape wraps shall be in accordance with the CSM's written instructions.

3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

Coating System Identification:	M-2
Coating Material:	Epoxy mastic or equal
Surface:	Ferrous Metal
Service Condition:	Interior, corrosive environment, confined enclosures, where minimal surface preparation is possible.
Surface Preparation:	
Ferrous Metal:	All uncoated ferrous metal surfaces shall be prepared in accordance with SSPC SP-3 (Power Tool Cleaning), or SSPC-SP-11 (Power to Cleaning to Bare Metal) prior to assembly. Surface preparation to achieve a uniform surface profile of 2.0 to 2.5 mils. Shop primed ferrous metal surfaces and fabricated assemblies shall be clean and dry prior to the application of field coats. Following assembly, the Contractor shall smooth welds and prominences using power tools prior to the application of the field applied coatings.
Application:	Field
General:	Prior to the application of field applied coatings, welds, back-to-back angles, sharp or rough edges and weld splatter shall be brushed with the specified prime coat and allowed to cure overnight.
System Thickness:	15 mils dry film.
Coatings:	
Prime:	One coat of the CSM's recommended dry film thickness.
Finish:	One or more coats of CSM's recommended dry film thickness per coat to the specified system thickness.

3.06 COATING SYSTEMS SCHEDULE (FINISH SCHEDULE)

Specific coating systems, colors, and finishes for rooms, galleries, piping, equipment, and other items that are coated or have other architectural finishes are specified in the following coating system schedule. Unless otherwise specified in the coating system schedule, the word "interior" shall mean the inside of a building or structure, and the word "exterior" shall mean outside exposure to weather elements.

Location Description	Surface	Coating System Identification	Standard Color
A. General All surfaces not specified by area or structure	1 Structural Steel, Metal Decking, and Galvanized Acoustical Decking	Uncoated or E-2	
	2 Equipment and Metal Appurtenances		
	a Equipment, non immersed, unless otherwise specified		
	1) Outdoors	EU-1	PER CLIENT
	b Equipment, immersed, unless otherwise specified	E-2	Beige
	c Existing equipment		
	1) Not damaged nor modified by work in this contract	Uncoated	--
	2) Damaged, exposed, or modified by work in this contract		
	a) Outdoors	EU-1 without primer (see paragraph 09900-3 02)	Match existing color
	d. Electrical switchgear panels, unit substations, motor control centers, power transformers, distribution centers, and relay panels, indoors and outdoors	See paragraph 09900-3 03 I	ANSI 61 Grey (outside) FS 27880 White (inside)
	e Instrumentation panels, graphic indicating panels, indicating and transmitting field panels, unless otherwise specified		
	1) Outdoors	See paragraph 09900-3 03 I	FS 27722 White (outside) FS 27880 White (inside)
	f. Existing electrical and instrumentation panels		
	1) Not damaged by work in this contract	Uncoated	--
	2) Damaged or exposed to outside surfaces by work in this contract		

Location Description	Surface	Coating System Identification	Standard Color
	a) Outdoors	EU-1 without primer (see paragraph 09900-3 02 F)	FS 26306 Grey (Electrical) FS 27722 White (Instrumentation)
	3 Conduit, Piping and Ductwork		
	a Ferrous, non-ferrous and galvanized piping, and appurtenant hangers and supports, non-immersed, unless otherwise specified		
	1) Outdoors – noncorrosive	EU-1	FS 20040 Brown
	b. Ferrous piping, appurtenant and supports, immersed	E-2	To be determined
	c Conduit, outlet and junction boxes, lighting transformers, lighting, communication and small power panels, control stations, piping, lagged ductwork, appurtenant hangers, clamps, and supports on coated surfaces, unless otherwise specified		
	1) Outdoors	EU-1	Match background color
	d Conduit, outlets and junction boxes, lighting transformers, lighting, communication and small power panels, control stations, piping, lagged ductwork, appurtenant hangers, clamps and supports on uncoated surfaces, unless otherwise specified		
	1) Outdoors	EU-1	FS 20040 Brown
	e Existing conduit, outlet and junction boxes, lighting transformers, lighting communication and small power panels, control stations, piping, lagged ductwork, appurtenant hangers, clamps, and supports		
	1) Not damaged nor modified by work in this contract	Uncoated	--
	2) Damaged, exposed, or modified by work in this contract		
	a) Outdoors	EU-1 without primer (see paragraph 09900-3 02 F)	Match existing color
	f Racked conduits and cable trays	Uncoated	--
	g Insulated pipe jacketing	Uncoated	--
	4 Concrete, Grout, Masonry and Plaster		
	a Walls and ceilings		
	1) Precast concrete or colored masonry	Uncoated	--
	2) Outdoors, unless otherwise specified	Uncoated	--

Location Description	Surface	Coating System Identification	Standard Color
	b Existing coated surfaces	L-1	Match existing color
	5 Precast Concrete Metalwork Fasteners, anchors, supports, etc	EU-1	Match wall
	6 Other g. Buried, sleeve-type and flanged pipe, couplings, valves, mechanical and electrical penetrations	M-1 or M-2	Manufacturer's color
G. Wet well	1 Piping and appurtenant hangers and supports above max water level elevation 1188 47	EA-1	--
	2 Piping and appurtenance hangars and supports below max water level elevation 1188 47	E-2	--

Notes.

1 Owner will select color from coating manufacturer's list of EPA approved colors for potable water

3.07 INSPECTION AND TESTING BY OWNER

A. Inspection by the Owner or others does not limit the Contractor's or CSA's responsibilities for quality workmanship or quality control as specified or as required by the CSM's instructions. Inspection by the Owner is in addition to any inspection required to be performed by the Contractor.

B. The Owner may perform, or contract with an inspection agency to perform, quality control inspection and testing of the coating work covered by this Section 09900. These inspections may include the following:

1. Inspect materials upon receipt to ensure that are supplied by the CSM.

2. Inspect to verify that specified storage conditions for the coating system materials, solvents and abrasives are provided.

3. Inspect and record findings for the degree of cleanliness of substrates.

4. Inspect and record the pH of concrete and metal substrates.

5. Inspect and record substrate profile (anchor pattern).

6. Measure and record ambient air and substrate temperature.

7. Measure and record relative humidity.

8. Check for the presence of substrate moisture in the concrete.

9. Inspect to verify that correct mixing of coating system materials is performed in accordance with CSM's instructions.

10. Inspect, confirm, and record that the "pot life" of coating system materials is not exceeded during installation. Inspect to verify that recoat limitations for coating materials are not exceeded.

11. Perform adhesion testing.

12. Measure and record the thickness of the coating system.

13. Inspect to verify proper curing of the coating system in accordance with the CSM's instructions.

14. Perform holiday or continuity testing for coatings that will be immersed or coatings that will be exposed to aggressively corrosive conditions.

3.08 FINAL INSPECTION

A. Contractor shall conduct a final inspection to determine whether coating system work meets the requirements of the specifications.

B. The Construction Manager will subsequently conduct a final inspection with the Contractor to determine the work is in conformance with requirements of the contract documents.

C. Any rework required shall be marked. Such areas shall be recleaned and repaired as specified at no additional cost to the Owner.

09900-A Coating System Inspection Checklist			
Project Name:			
Owner		Coating System Manufacturer(CSM)	
General Contractor (GC)		Coating System Applicator(CSA)	
Area or Structure		Location within Structure	
Coating System (e.g E-1)		Coating Type (e.g. Epoxy, etc.)	

Step	Description		Name	Signature	Date
1	Completion of cleaning and substrate decontamination prior to abrasive blast cleaning.	GC QC			
		CSM QC			
		CSA QC			
2	Installation of protective enclosure of structure or area and protection of adjacent surfaces or structures that are not to be coated.	GC QC			
		CSM QC			
		CSA QC			
3	Completion of ambient condition control in structure or building area and acceptance of ventilation methods in structure or Area.	GC QC			
		CSM QC			
		CSA QC			
4	Completion of Surface Preparation for Substrates to Be Coated	GC QC			
		CSM QC			
		CSA QC			
5	Completion of Primer Application.	GC QC			
		CSM QC			
		CSA QC			

Step	Description		Name	Signature	Date
6	Completion of Concrete Repairs If Required and Related Surface Preparation Rework Prior to Coating System Application.	GC QC			
		CSM QC			
		CSA QC			
7	Completion of Concrete Filler/ Surface Application to Concrete.	GC QC			
		CSM QC			
		CSA QC			
8	Completion of First Finish Coat Application and of Detail Treatment at Transitions or Terminations.	GC QC			
		CSM QC			
		CSA QC			
9	Completion of Second Finish Coat Application and of Detail Treatment at Transitions and Terminations	GC QC			
		CSM QC			
		CSA QC			
10	Completion of Full and Proper Cure of Coating System.	GC QC			
		CSM QC			
		CSA QC			
11	Completion of Testing of Cured Coating System including Adhesion, Holiday (Continuity) Testing and Dry Film Thickness.	GC QC			
		CSM QC			
		CSA QC			
12	Completion of Localized Repairs to Coating System Following Testing.	GC QC			
		CSM QC			
		CSA QC			

Step	Description		Name	Signature	Date
13	Final Acceptance of Coating System Installation Including Final Clean-Up Complying with Specification Requirements and the CSM's Quality Requirements.	GC QC			
		CSM QC			
		CSA QC			

***END OF SECTION ***

SECTION 09901

CONCRETE STRUCTURE COATING SYSTEMS

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies the coating system used for rehabilitation of brick or concrete manholes and other concrete structures that come in contact with sewage flow to protect against corrosion.

The coating shall yield a hard, durable chemical resistant coating and shall be specifically designed to be applied on a dry surface. The finished coating shall provide a watertight seal and shall adhere to brick, PVC, and other components of the pipeline liner systems.

B. DEFINITIONS:

Specific coating terminology used in this section is in accordance with definitions contained in ASTM D16, ASTM D3960, and the following definitions:

1. COATING SYSTEMS: All components together as a unit used to repair the manhole and protect against further corrosion. These components include, as applicable: defect filler and reprofiling materials, material used to repair invert and bench, infiltration control, primer and finish coats.

2. DRY FILM THICKNESS (DFT): The thickness of one fully cured continuous application of coating.

3. APPLICATOR: The person assigned by the Contractor to apply the specified coating system.

4. STRUCTURE: For coating purposes, a structure is defined as all concrete surfaces including the invert, bench, barrel sections, cone, grade rings, walls, ceiling, floor, metal frame, and any other exposed concrete within the structure.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly.

In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall take precedence.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid and any subsequent addenda, (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM D16-93	Standard Terminology Relating to Paint, Varnish, Lacquer, and Related Products
ASTM D4258	Standard Practice for Surface Cleaning Concrete for Coating
ASTM D4262	Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces
ASTM D4541/D73234	Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM G20-88	Standard Test Method for Chemical Resistance of Pipeline Coatings
ASTM D714	Standard Test Method for Evaluating Degree of Blistering of Paints
OSHA 29CFR 1926 / 1910	Occupational Safety and Health Administration (OSHA), Safety and Health Standards.
SSPC	Steel Structures Painting Council Specifications, Vol. 2

B. STANDARDIZATION:

Materials and supplies provided shall be the standard products of manufacturers. Materials in each coating system shall be the products of a single manufacturer.

C. CERTIFIED APPLICATOR:

The coating system shall be applied by an Applicator certified by the coatings system manufacturer. The certification program shall include an annual renewal. The training outline

for the certification program shall be submitted to the Engineer for review. The Contractor shall provide evidence that the personnel performing the product application for each project received the manufacturer's training for certification.

The Applicator shall appoint a Quality Assurance Manager to take full responsibility for the quality of the work. The Quality Assurance Manager shall be fully certified and have a minimum of two (2) years of application experience with the particular coating system.

D. MANUFACTURER'S REPRESENTATIVE:

The Manufacturer's Representative is a representative authorized to act on behalf of the company regarding technical and commercial issues. The manufacturer's representative shall provide at least 8 hours of on-site observation and site specific recommendations relative to surface preparation, mixing, application, and curing of his product. The manufacturer's representative shall inspect the prepared surface of the first manhole to be coated prior to coating and verify the surface meets the requirements for the coating material. The Manufacturer's representative shall provide field inspection of the coating installation and shall verify in writing that the proper procedures and equipment are being used by the applicator and that the coating is being applied per the manufacturer's specifications and the Coating System Application plan.

E. MANUFACTURER'S WARRANTY:

The Contractor shall provide a written warranty from the coating manufacturer for the entire coating system, including all repair material, defect fillers, primers, intermediate, and finish coats. The minimum duration of the warranty shall be five (5) years. The product and the installation may both be covered by the manufacturer's warranty, or separate warranties may be issued by the manufacturer and the installer.

This warranty shall state that the coating will not fail for a minimum period of five years. Coating failure is defined as blistering, cracking, embrittlement, or softening, or failure to adhere to the substrate. The warranty shall also apply to any repair materials, primers, or other products used in the application. If any repair or replacement is necessary within the warranty period, a new 5 year warranty period shall start at the date that the structure is placed back into service.

1.03 DELIVERY AND STORAGE

Materials shall be delivered to the job site in their original, unopened containers. Each container shall bear the manufacturer's name, coating type, batch number, date of manufacture, storage life, and special directions.

Materials shall be stored in enclosed structures and shall be protected from weather and excessive heat or cold. Flammable materials shall be stored in accordance with state and local codes. The authorized Third-Party Inspector shall reject materials exceeding the storage life recommended by the manufacturer and they shall be removed from the site, and replaced at no additional cost to the City. Materials exceeding storage life recommended by the manufacturer shall be removed from the site.

1.04 ENVIRONMENTAL CONDITIONS:

The products furnished under this section will be installed in sanitary sewer manholes, wastewater conveyance channels, and wastewater treatment process tanks and basins. The products will be exposed to the extremes in temperatures and humidity. In addition, the products will be exposed to corrosive, abrasive and reactive liquids and gasses associated with wastewater conveyance and treatment. The products will be immersed or intermittently immersed in wastewater and the product surfaces are subject to splashing of wastewater.

1.05 PRODUCT TESTING

The manufacturer shall submit the results of third-party testing to the Engineer.

A. CHEMICAL RESISTANCE TESTING:

The chemical resistance tests should be completed in accordance with ASTM G 20, modified for use with concrete and brick specimens. Exposure shall be for a minimum of six (6) months at in each of the following fluids at 85 degrees F. Concentrations given are percent weight.

Chemical Solution	Concentration, Percent
Tap Water (pH 6-9)	100
Nitric Acid	5
Phosphoric Acid	10
Sulfuric Acid	20
Sodium Hydroxide	10
Gasoline	100
Vegetable Oil	100
Detergent	0.1
Soap	0.1

After exposure to the solutions, specimens shall not exhibit any weight loss, spalling, cracking or blistering. Adhesion of the coating to the substrate shall be tested per ASTM D4541, and the mode of failure shall be such that the substrate fails before the coating separates from the substrate. Any changes to appearance such as color and texture shall be noted.

B. PHYSICAL TESTING:

Results of the following tests, performed on cured and coated concrete specimens, shall be provided.

1. Compressive Strength – ASTM D695
2. Water Vapor Transmission – ASTM D1653
3. Impact Resistance – ASTM D256

4. Abrasion Resistance – ASTM D4060
5. Flexural Strength and Modulus of Elasticity – ASTM D790
6. Tensile Strength – ASTM D638

1.06 SUBMITTALS

The following submittals shall be provided in accordance with Section 01300.

A. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Engineer or his designated representative shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

B. A Coating System Application Plan shall be prepared that includes a description of the following:

1. Quality Assurance Procedures:

a. Detailed duties of the Applicator's Quality Assurance Manager.

b. Detailed duties of the Manufacturer's Representative.

c. Training program to qualify personnel in the correct storage and handling of coating materials, and the necessary safety requirements.

d. List of application and testing equipment to be used, including inspections confirming satisfactory condition of equipment.

e. Detailed procedures and methods for surface preparation including repair and reprofiling if required, application of primer and final coating, and testing.

2. Criteria for acceptance of the preparation of concrete and manhole surfaces:

3. Plan for sewage diversion.

4. Method and material for sealing active leaks.

5. Detailed plan of surface preparation, including repair and reprofiling.

6. Details of application of primer and finish coats, including required curing times.

7. Detailed environmental provisions such as shading from the sun.

8. Detailed scheduling provisions for environmental considerations such as working at night.

9. Testing procedures for pin holes, coating thickness, and adhesion.

10. Wet film thickness testing.

C. Certificate of responsibility attesting that the Contractor has assigned, and that the Applicator accepts responsibility for installation of the products specified herein.

D. Manufacturer's Certification attesting that the Applicator is qualified and approved to install the products specified herein. In addition, the following Applicator qualifications shall be provided:

1. Current Arizona Contractor's license or equivalent (specifically for the rehabilitation of concrete manholes). If the manhole(s) to be rehabilitated is brick, then the AE license or equivalent shall state for the rehabilitation of concrete and brick manholes.

E. Written warranty per paragraph 09901-1.02C of this section.

F. Product test results as described in paragraph 09901-1.05 of this section.

G. Manufacturer's specification containing instructions and quality control procedures meeting the following requirements:

1. Instructions must be written and published by the manufacturer for the purpose of giving complete instruction for the use and application of the proposed coating for the conditions for which the coating is specified herein.

2. Instructions shall include at a minimum: surface preparation (including repairs and reprofiling), curing times, curing methods, special equipment and coating dry film thickness.

3. Limitations, exceptions, precautions, and requirements that may adversely affect the performance of the coating shall be clearly and completely stated in the instructions and the bid documents. If the manufacturer's requirements differ from these Specifications, the instructions shall clearly state where deviations are required. Temperature and humidity limitations for minimum and maximum conditions are to be included.

H. Before materials are delivered to the job site, the Contractor shall provide the following information in accordance with Section 01300:

1. The Contractor shall furnish Material Safety Data Sheets (MSDS) for all products used in the coating system. Contractor must have two (2) copies of all MSDS sheets on site at all times during application.

2. For all coating system components, the Contractor shall provide the manufacturer's application instructions, which shall include the following:

a. Surface preparation recommendations.

b. Primer type, where required.

c. Maximum dry and wet mil thickness per coat.

d. Minimum and maximum curing time between coats, including atmospheric conditions for each.

e. Curing time before submergence in liquid.

f. Thinner to be used with coating material.

g. Ventilation requirements.

h. Minimum atmospheric conditions during which the coating shall be applied.

i. Allowable application methods.

j. Maximum allowable moisture content.

k. Maximum storage life.

3. List of materials proposed to be used under this section and manufacturer's data for each material.

PART 2--PRODUCTS

2.01 MATERIALS

A. COATING:

The coating for existing manhole lining shall be Sewer Shield Liner 100 as manufactured by Environmental Coatings, Mesa, Arizona, or Sauereisen No. 210 as manufactured by Sauereisen, Inc., Pittsburgh, Pennsylvania. The coating shall be ivory in color.

Coating Systems shall be compatible with the concrete or brick surface preparation methods as specified herein. Any limitations or deviations requested by the manufacturer shall be approved in writing by the Engineer prior to surface preparation.

B. PRIMER:

Primer shall be as recommended by the manufacturer for each installation.

C. DEFECT FILLER:

Product used for resurfacing manhole benches and walls, and repairing cracks, shall be the polymer concrete, "All Crete," as manufactured by Bomix or the concrete, "Speed Crete," as manufactured by W R. Meadows, or approved equal. Surface preparation and application shall be as recommended by the manufacturer.

D. INFILTRATION CONTROL:

Epoxy for pressure grouting shall be the two-component hydrophobic polyurethane compound SealGuard II, as manufactured by Seal Guard Inc., or approved equal. Surface preparation and application shall be as recommended by the manufacturer.

PART 3--EXECUTION

3.01 COATINGS

A. GENERAL:

Coating products shall not be used until the Engineer has inspected the materials and equipment. The coating manufacturer's technical representative must be a factory representative, not a local representative or an affiliate of the contractor.

Coatings shall only be applied by a Manufacturer's Certified Applicator. The Contractor must provide evidence that personnel assigned to the project have successfully completed the manufacturer's training.

A Manufacturer's Representative must be present during the first 25 percent of installations for the project or as deemed necessary by the Engineer.

Single finish coat systems shall be used, with a minimum thickness of 125 mils. Unless otherwise specified, the finish coat shall not be applied until other work in the area is complete and until the previous primer or underlayment coat has been inspected. The Contractor shall request approval authorization at all Inspection Hold Points, per paragraph 09901-3.06 of these Specifications.

B. COATING SYSTEMS:

Coating Systems shall be compatible with the concrete or brick surface preparation methods as specified herein. Any limitations or deviations requested by the manufacturer shall be approved in writing by the Engineer prior to surface preparation.

Epoxy based coatings shall be applied within six months of their date of manufacture (unless the manufacturer's requirements are more stringent), or otherwise approved in writing by the Engineer.

Field coats shall consist of one (1) or more finish coats to build up the coating to the specified dry film thickness. Thicknesses specified are the minimum dry film thickness and do not include the primer thickness unless otherwise noted. Unless otherwise specified, finish coats shall not be applied until other work in the area is complete and until all previous coats have been inspected.

3.02 PREPARATION

A. GENERAL:

Before applying coating or surface treatments, the Contractor shall install bypass pumping and/or flow diversion to provide a DRY structure for coating.

The structure shall be cleaned and prepared as specified in paragraph 3.02.C of this section. The Contractor shall examine all surfaces to be coated and shall correct all surface defects as specified in paragraph 09901-3.02D before application of any coating. Prior to applying any primer or coating material the Contractor shall certify that the structure sidewalls, cone, bench, riser rings, invert, ceiling, walls and floor have been correctly prepared to facilitate the proper bonding required to pass the adhesion testing required in paragraph 09901-3.05B. The Engineer shall inspect and approve the cleaning and preparation prior to any subsequent work.

B. SEWAGE FLOW AND DIVERSION:

The Contractor shall provide means, labor, and equipment to divert flow from pipelines entering the structure to prevent sewage flow from entering the structure to be coated. See Section 02145 for by pass pumping requirements.

The Contractor shall provide means, labor, and equipment to prevent solid waste generated during construction activities from entering the sewage flow.

C. STRUCTURE CLEANING AND SURFACE PREPARATION:

For those installations requiring inspection by the Manufacturer's representative per paragraph 09901-3.01A of this section, the Manufacturer's inspection shall include surface cleaning and preparation.

Contractor and Manufacturer's Representative shall inspect all surfaces specified to receive a coating system prior to surface preparation. Contractor shall notify Engineer of any noticeable disparity in the surfaces, which may interfere with the proper preparation, or application of the coating system.

The entire structure interior including frame, walls, and bench shall be cleaned prior to rehabilitation using either abrasive blasting and/or high-pressure water blast as recommended by the coating and/or repair product manufacturer, and approved by the Engineer. Where mechanical cleaning is accomplished by blast cleaning, the abrasive used shall be washed, graded and free of contaminants, which might interfere with the adhesion of the coatings. The air used for blast cleaning shall be sufficiently free of oil and moisture to not cause detrimental contamination of the surfaces to be coated. All concrete, brick, or mortar that is not sound or has been damaged by chemical exposure shall be removed to a sound, neutralized surface.

All contaminants including oil, grease, incompatible existing coatings, waxes, form release, curing compounds, efflorescence, sealers, salts, or other contaminants shall be removed. Detergent water cleaning and hot water blasting may be necessary to remove oils, grease, or other hydrocarbon residues from the concrete. A mild chlorine solution may be used to neutralize the surface to diminish microbiological bacteria growth prior to final rinse and coating system.

Contractor shall also remove all dirt, rocks, rust, spalled masonry (including mortar, concrete, and brick), roots, sludge, grit, and other deleterious materials and debris from the interior manhole. If required by the Engineer, the structure shall be restored to the original surface profile. The finished interior surface shall consist of sound concrete or brick with adequate profile and porosity to provide a strong bond between the necessary repair materials and/or coating and the substrate.

Surface preparation method(s) should be based upon the conditions of the substrate, service environment and the requirements of the coating to be applied. Debris from cleaning operations shall be collected within the manhole and disposed of at an approved off-site location at the Contractor's expense. Hauling containers shall be watertight.

Contractor shall remove all manhole steps prior to cleaning. Unless otherwise directed by the Engineer, manhole steps shall be cut using a handsaw flush with the manhole wall. Voids or holes remaining from removal of the steps shall be filled and troweled flush with the wall

using a manhole patching material approved by the Manufacturer's Representative and the Engineer.

Contractor shall also be responsible for any additional surface preparation beyond water blasting as required by the coating manufacturer. Where additional preparation is required, including abrasive blasting, shotblasting, grinding, scarifying or acid etching, the Contractor shall provide all labor, materials, and equipment as necessary, and at no additional cost to the City. Solid blast materials shall be collected, removed and disposed of in the same manner as other cleaning debris. No debris shall be allowed to enter the sewer.

Manhole benches and channels shall be resurfaced using polymer concrete with a minimum thickness of ½-inch, or per manufacturer requirements. Manhole channels shall be toweled, so that a smooth uninterrupted surface is achieved. The top of the base block shall have a rough, non-slip finish and shall be toweled to slope towards the channel at an approximate slope of one (1) inch in six (6) inches.

Full depth of cracks shall be filled, and the surface troweled so that a smooth, uninterrupted surface is achieved.

Infiltration shall be stopped by using a material that is compatible with the coating system and is approved for use by the Manufacturer's Representative and the Engineer. Infiltration shall be stopped by using a material that is compatible with the coating system and is approved for use by the Manufacturer's Representative and the Engineer. Hydrophobic polyurethane shall be injected into a predrilled injection hole through a static mixer until refusal or seal, per manufacturer's recommendations. The injection process shall be repeated until infiltration is stopped completely, at no additional cost to the Owner. It is the Contractor's responsibility to ensure that all infiltration into the structure has been eliminated, including infiltration caused by sealing points of infiltration lower in the structure. Excess polyurethane shall be removed and all manhole surfaces shall be cleaned until a smooth, uninterrupted surface is achieved. No voids, including injection hole, shall remain after polyurethane injection.

Test prepared surfaces after cleaning but prior to application of the epoxy coating system to determine pH and moisture content of the concrete, as required according to manufacturer's recommendations.

Ensure that the moisture content of the surface is in accordance with the coating manufacturer's recommendations and/or requirements.

The area between the manhole and the manhole ring and any other area that might exhibit movement or cracking due to expansion and contraction, shall be grouted with a watertight, expansive grout, approved for use by the Manufacturer's Representative and the Engineer.

It is anticipated that the Contractor will have to apply an approved underlayment to a minimum thickness of ½" on 20% of the manholes coated during this Project.

If installed, the underlayment shall be installed over a clean surface prepared in accordance with the manufacturer's instructions and the requirements of this specification. The Contractor shall employ whatever means necessary (e.g., humidity control, temperature control, additional blasting, mechanical surface preparation, etc.) to ensure strong adherence of the underlayment layer to the prepared manhole surface.

Underlayment shall be spray or trowel applied and in accordance with the manufacturer's recommendations. After installation, the underlayment shall be free of trowel marks and irregularities.

D. DEFECT REPAIR:

All surface defects including tie holds, any honeycombing or otherwise defective concrete or brick shall be repaired. All voids, holes, and rough or irregular surfaces shall be filled.

The Contractor shall use the repair and fill material recommended by the coating manufacturer and approved by the Engineer to repair or fill all defects. Areas to be patched shall be cleaned. Minor honeycombed or otherwise defective areas shall be removed to solid concrete. The edges of the cut shall be perpendicular to the surface of the concrete. Patches on exposed surfaces shall be finished to match the adjoining surfaces after they have set. Finishes shall be equal in workmanship, texture and general appearance to that of the adjacent undamaged concrete or brick. Concrete with honeycombing which exposes the reinforcing steel or with defects that affect the structural strength shall be repaired. The proposed repair method shall be approved by the Engineer.

Where indicated on plans, manhole benches shall be removed and reconstructed. Work shall include the demolition and removal of the manhole bench and invert, and the reconstruction of the manhole bench and invert.

3.03 APPLICATION

All Coatings shall be applied in strict accordance with the manufacturer's requirements and recommendations and any specific City requirements. ALL EXPOSED SURFACE AREAS OF THE STRUCTURE TO INCLUDE THE WALLS, CEILING, FLOOR, INVERT, BENCH, BARREL SECTIONS, CONE, RISER RINGS, AND FRAME SHALL BE COATED.

Confirm that the ambient temperature and humidity, the prepared surface temperature and moisture content, and the temperature of the coating material to be applied are within the manufacturer's recommended ranges. Coatings shall be applied at a time of day when the ambient temperature and humidity is expected to be steady or falling.

The prime and finish coast (as applicable) shall be a contrasting color. The color of the final coat shall be chosen by the Engineer, if different colors are available.

Ensure that pump, hoses, gun, tip, and pressure are properly matched for the coating to be applied. Ensure that the application equipment has been properly cleaned prior to application of coating. Test spray pattern for uniformity of distribution.

Protect surfaces from rapid drying due to heavy wind or hot sun.

Cure coatings in strict accordance with the manufacturer's recommendations, prior to putting into service.

Drying time between coats shall be as recommended by coating manufacturer.

The coating shall be applied to a minimum thickness of 125 mil in a single coat when possible. If application of a single coat at the required thickness is not possible, multiple coats may be applied per the manufactures instructions and within the time period allowed for proper application.

The Contractor shall follow coating manufacturer's requirements for bonding the coating systems to the installed sewer liner, if applicable.

3.04 SAFETY AND VENTILATION REQUIREMENTS:

Requirements for safety and ventilation shall be in accordance with SSPC Paint Application Guide No. 3, and all applicable federal, state and local regulations.

3.05 FIELD TESTING

A. SPARK TESTING:

All coated surfaces shall be spark tested for holes. The spark tester used shall provide 12,000 volts for 125 mil thickness coatings. If pinholes are found, the Contractor shall repair the coating as recommended by the manufacturer and retest. All testing and repair work shall be at the Contractor's expense.

The spark testing will be performed by the Contractor and witnessed by the Engineer, and shall be completed (and any repairs made) prior to the final acceptance inspection.

B. ADHESION TESTING:

At a minimum of 15% of the structures coated, but in no case less than one of the structures, the Contractor shall perform an adhesion test after proper cure in accordance with ASTM D4541 to demonstrate that the specified field coatings adhere to the substrate. Contractor shall use a Defelsko PosiTest AT, or approved equal unit to perform testing. Testing equipment must have ability to store readings in memory and apply smooth and continuous pull-off pressure. A minimum of two test dollies shall be utilized for each manhole selected for testing.

Manholes to be tested will be chosen by the Engineer, as well as the test location within each manhole, and the adhesion test shall be witnessed by the Engineer. Test results showing an adhesion rating of 400 psi or better for all surfaces shall be considered acceptable provided the test results in failure at or within the substrate. All other concrete structures (concrete tanks, vaults and other non-manhole structures) shall have adhesion testing conducted. A minimum of 4 test dollies shall be installed and tested at each structure.

If either test dolly should pull off with failure in the epoxy or coating at an adhesion rating below 400 psi, additional manholes above the 15% requirement will be tested. For each manhole with a test dolly failure, two additional manholes will be tested. Where unacceptable test results are obtained, the Contractor shall be responsible for removing and reapplying the specified coatings at no expense to the Owner.

3.06 INSPECTION HOLD POINTS

At certain stages in the coating application process, the Contractor shall request approval from the Engineer, to proceed with the next stage of the installation. The Contractor shall provide 24 hour ***written*** notice that approval of an Inspection Hold Point is needed. The Engineer shall respond to the approval request within 12 hours. Failure to receive authorization from the Engineer at one of the designated Inspection Hold Points, may prevent the acceptance of the work by the Engineer. The following are the designated Inspection Hold Points for each installation.

1. Cleaning and sandblasting of existing concrete structures.
2. Completion of surface repairs, reprofiling, and preparation.
3. Completion of primer application.
4. Completion of each application of final coating.
5. Completion of holiday testing and retesting.

3.07 CLEANUP

Upon completion of coating, the Contractor shall remove surplus materials, protective coverings, and accumulated rubbish, and thoroughly clean all surfaces and repair any overspray or other coating-related damage. Surfaces damaged resulting from this clean up shall also be cleaned, repaired and refinished to the original or required condition.

END OF SECTION

SECTION 10440

IDENTIFICATION SIGNS

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies all interior room and exterior building identification signs.

1.02 SUBMITTALS

The Contractor shall submit three samples of sign lettering, materials, finishes and wording.

PART 2--PRODUCTS

2.01 SIGNS

A. Access signs shall be die-raised aluminum. Background shall be sprayed-on baked enamel. Raised characters shall be a natural alumilited finish. Letter style shall be 2-inch tall capitals, unless otherwise specified, Helvetica Medium, all uppercase.

B. Signs shall be flanged edge panels with radial corners, and shall be supplied with concealed supports, studs and lead sleeves necessary for mounting to the access gate.

2.02 SITE SIGN

A. Site sign shall be as above with a white background with 2 inch reflective black lettering. The signs will be mounted where directed on the exterior of each well site. The signs shall read:

1.	Sweetwater Lift Station	(2-Inch Lettering)
	City of Glendale	(1-1/2 Inch Lettering)
	XXXX ADDRESS	(1-1/2 Inch Lettering)
	In Case of Emergency Call	(1-1/2 Inch Lettering)
	Phone No. 623-XXX-XXXX	(1-1/2 Inch Lettering)

B. Site sign shall be mounted to the main site access gate.

PART 3--EXECUTION

3.01 INSTALLATION

Sign units and components shall be installed at the locations shown or scheduled, or as directed by Construction Manager, securely mounted with concealed fasteners. Signs shall be attached to substrates in accordance with the manufacturer's instructions.

Signs shall be installed level, plumb and at the proper height. Contractor shall cooperate with other trades for installation of sign units to finish surfaces and shall repair or replace damaged units as directed by the Construction Manager.

END OF SECTION

SECTION 10441

WARNING SIGNS

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies informational and accident prevention signs.

1.02 OPERATING AND DESIGN REQUIREMENTS

A. GENERAL:

Accident prevention signs shall conform as to design with OSHA Section 1910.145 of Subpart J, Part 1910, Chapter XVII, Title 29 of the Code of Federal Regulations. Exit signs shall conform with Section 1910.37(g) of the OSHA Safety and Health Standard for General Industry, Article 10, Section 10.113 of the Uniform Fire Code, and where applicable with local fire regulations.

In addition to the signs identified on the schedule in Part 3 of this section, the following shall be provided:

1. Exit signs shall be provided in accordance with Section 16500.

2. "Caution Automatic Equipment May Start At Any Time" signs shall be provided in accordance with paragraph 11000-2.07.

B. DESIGN REQUIREMENTS:

1. SIZE: Sign size shall be as follows:

A - 20 inch x 14 inch
B - 14 inch x 10 inch
C - 10 inch x 7 inch

2. TYPE: The sign type shall be as follows:

Type	Message
II	DANGER--480 VOLTS EQUIPMENT MAY START AT ANY TIME
IX	DANGER--CONFINED SPACE ENTRY
XXVI	STANDBY GENERATOR LOCATED WEST OF SES

1.03 SUBMITTALS

The Contractor shall submit construction details, showing dimensions, materials, sign lettering and wording.

PART 2--PRODUCTS

2.01 GENERAL

Sign lettering shall be single stroke and shall contrast in color with the background. For those messages for which there are international symbols, the international symbols shall be used. Chain mounted signs shall have lettering on both sides.

2.02 MATERIALS

Signs shall be minimum 40-mil vinyl clad aluminum, suitable for indoor or outdoor mounting.

PART 3--EXECUTION

Signs shall be distributed as follows:

Location	Size	Message	Mount
Wet well	B	IX	Post
All 480 volt electrical equipment: SES, all MCC doors, Standby Generator	C	II	Equipment
Electrical Service Entrance Section (SES)	B	XXVI	Equipment

END OF SECTION

SECTION 11000

GENERAL REQUIREMENTS FOR EQUIPMENT

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies general requirements which are applicable to all mechanical equipment. The Contractor is responsible for ensuring that all mechanical equipment meets the requirements of this section in addition to the specific requirements of each individual equipment specification section.

B. EQUIPMENT LISTS:

Equipment lists, presented in these specifications and as specified on the drawings, are included for the convenience of the Construction Manager and Contractor and are not complete listings of all equipment, devices and material required to be provided under this contract. The Contractor shall prepare his own material and equipment takeoff lists as necessary to meet the requirements of this project manual.

1.02 QUALITY ASSURANCE

A. ARRANGEMENT:

The arrangement of equipment shown on the drawings is based upon information available to the Owner at the time of design and is not intended to show exact dimensions conforming to a specific manufacturer. The drawings are, in part, diagrammatic, and some features of the illustrated equipment installation may require revision to meet actual submitted equipment installation requirements; these may vary significantly from manufacturer to manufacturer. The contractor shall, in determining the cost of installation, include these differences as part of his bid proposal. Structural supports, foundations, connected piping, valves, and electrical conduit specified may have to be altered to accommodate the equipment actually provided. No additional payment shall be made for such revisions and alterations.

B. REFERENCES:

This section contains references to the documents listed below. They are a part of this section as specified and modified. Where a referenced document cites other standards, such standards are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, has been discontinued or has been replaced.

Reference	Title
ABMA Std 9	Load Ratings and Fatigue Life for Ball Bearings
ABMA Std 11	Load Ratings and Fatigue Life for Roller Bearings
ANSI B1.1	Unified Inch Screw Threads (UN and UNR Thread Form)
ANSI B1.20.1	Pipe Threads, General Purpose (Inch)
ANSI B16.1	Gray Iron Pipe Flanges and Flanged Fittings, (Classes 25, 125, and 250)
ANSI B18.2.1	Square and Hex Bolts and Screws (Inch Series)
ANSI B18.2.2	Square and Hex Nuts (Inch Series)
ANSI S2.19	Mechanical Vibration – Balance Quality Requirements of Rigid Rotors, Part 1: Determination of Permissible Unbalance, Including Marine Applications

C. UNIT RESPONSIBILITY:

The Contractor shall cause equipment assemblies made up of two or more components to be provided as a working unit by the unit responsibility manufacturer, where specified. The unit responsibility manufacturer shall coordinate selection, coordinate design, and shall provide all mechanical equipment assembly components such that all equipment components furnished under the specification for the equipment assembly, and all equipment components specified elsewhere but referenced in the equipment assembly specification, is compatible and operates reliably and properly to achieve the specified performance requirements. Unless otherwise specified, the unit responsibility manufacturer shall be the manufacturer of the driven component equipment in the equipment assembly. The unit responsibility manufacturer is designated in the individual equipment specifications found elsewhere in this project manual. Agents, representatives or other entities that are not a direct division of the driven equipment manufacturing corporation shall not be accepted as a substitute for the driven equipment manufacturer in meeting this requirement. The requirement for unit responsibility shall in no way relieve the Contractor of his responsibility to the Owner for performance of all systems.

The Contractor shall ensure that all equipment assemblies provided for the project are products for which unit responsibility has been accepted by the unit responsibility manufacturer(s), where specified. Unit responsibility for related components in a mechanical equipment assembly

does not require or obligate the unit responsibility manufacturer to warranty the workmanship or quality of component products not manufactured by them. Where an individual specification requires the Contractor to furnish a certificate from a unit responsibility manufacturer, such certificate shall conform to the content, form and style of Form 11000-C specified in Section 01999, shall be signed by an officer of the unit responsibility manufacturer's corporation and shall be notarized. No other submittal material will be processed until a Certificate of Unit Responsibility has been received and has been found to be satisfactory. Failure to provide acceptable proof that the unit responsibility requirement has been satisfied will result in withholding approval of progress payments for the subject equipment *even though the equipment may have been installed in the work.*

D. BALANCE:

Unless specified otherwise, for all machines 10 HP and greater, all rotating elements in motors, pumps, blowers and centrifugal compressors shall be fully assembled, including coupling hubs, before being statically and dynamically balanced. All rotating elements shall be balanced to the following criteria:

$$U_{per} = 6.015\frac{GW}{N}$$

Where:

U_{per}	=	permissible imbalance, ounce-inches, maximum
G	=	Balance quality grade, millimeters per second
W	=	Weight of the balanced assembly, pounds mass
N	=	Maximum operational speed, rpm

Where specified, balancing reports, demonstrating compliance with this requirement, shall be submitted as product data. Equipment balance quality grade shall be G 2.5 (G = 2.5 mm/sec) or better in accordance with ANSI S2.19.

PART 2--PRODUCTS

2.01 FLANGES AND PIPE THREADS

Flanges on equipment and appurtenances provided under this section shall conform in dimensions and drilling to ANSI B16.1, Class 125. Pipe threads shall conform in dimension and limits of size to ANSI B1.1, coarse thread series, Class 2 fit.

Threaded flanges shall have a standard taper pipe thread conforming to ANSI B1.20.1. Unless otherwise specified, flanges shall be flat faced.

Flange assembly bolts shall be heavy pattern, hexagonal head, carbon steel machine bolts with heavy pattern, hot pressed, hexagonal nuts conforming to ANSI B18.2.1 and B18.2.2. Threads shall be Unified Screw Threads, Standard Coarse Thread Series, Class 2A and 2B, ANSI B1.1.

2.02 BEARINGS

Unless otherwise specified, equipment bearings shall be oil or grease lubricated, ball or roller type, designed to withstand the stresses of the service specified. Each bearing shall be rated in accordance with the latest revisions of ABMA Methods of Evaluating Load Ratings of Ball and Roller Bearings. Unless otherwise specified, equipment bearings shall have a minimum L-10 rating life of 50,000 hours. The rating life shall be determined using the maximum equipment operating speed.

Grease lubricated bearings, except those specified to be factory sealed and lubricated, shall be fitted with easily accessible grease supply, flush, drain and relief fittings. Extension tubes shall be used when necessary. Grease supply fittings shall be standard hydraulic alemite type.

Oil lubricated bearings shall be equipped with either a pressure lubricating system or a separate oil reservoir type system. Each oil lubrication system shall be of sufficient size to safely absorb the heat energy normally generated in the bearing under a maximum ambient temperature of 60 degrees C and shall be equipped with a filler pipe and an external level indicator gage.

All bearings accessible to touch, and located within 7 feet measured vertically from floor or working level or within 15 inches measured horizontally from stairways, ramps, fixed ladders or other access structures, shall either incorporate bearing housings with sufficient cooling to maintain surface temperature at 65 degrees C or less for continuous operation at bearing rated load and a 50 degrees C ambient temperature or shall be provided with appropriate shielding shall be provided that will prevent inadvertent human contact.

2.03 V-BELT ASSEMBLIES

Unless otherwise specified, V-belt assemblies shall be Dodge Dyna-V belts with matching Dyna-V sheaves and Dodge Taper-lock bushings, Wood's Ultra V-belts with matching Ultra-V sheaves and Wood's Sure-Grip bushings, or equal.

Sheaves and bushings shall be statically balanced. Additionally, sheaves and bushings which operate at a peripheral speed of more than 5500 feet per minute shall be dynamically balanced. Sheaves shall be separately mounted on their bushings by means of three pull-up grub or cap tightening screws. Bushings shall be key seated to the drive shaft.

Belts shall be selected for not less than 150 percent of rated driver horsepower and, where two sheaves sizes are specified, shall be capable of operating with either set of sheaves. Belts shall be of the antistatic type where explosion proof equipment is specified.

2.04 PUMP SHAFT SEALS

A. GENERAL:

Seals for water and wastewater pump shafts shall be either stuffing box or mechanical seals. For industrial wastewater service, or for fluids other than water or municipal wastewater, the recommendations of the seal manufacturer shall be followed for selection of appropriate seals. Unless specified otherwise, stuffing boxes and mechanical seals shall conform to the requirements set forth in this paragraph.

B. MECHANICAL SEALS:

Unless otherwise specified in the detailed pump specifications, mechanical seals shall be split mechanical seals requiring no field assembly, other than assembly around the shaft and insertion into the pump. They shall be self-aligning, and self-centering, single seals. They shall be of a nondestructive (nonfretting) type requiring no wearing sleeve for the shaft. Shafts for pumps specified with mechanical seals shall be furnished with no reduction in size through the seal area (no shaft sleeve). Where the detailed specifications call for cartridge instead of split seals, all other requirements of this paragraph apply.

Metal parts shall be Type 316 or 316L stainless steel. Springs shall be Hastelloy C, Elgiloy, or other Duplex SS selected for resistance to chloride attack. Rotary faces shall be silicon carbide or chrome oxide. Stationary faces shall be silicon carbide for solids bearing fluid service and carbon for clean water service. Elastomers shall be ethylene propylene or fluorocarbon. Mechanical seals shall be suitable for operation between full vacuum (0 psia) up to 200 percent of the maximum specified operating pressure, but in any event not less than 200 psig.

Seal chambers shall be provided with vented solids removal restriction bushings except for enclosed line shaft pumps where the seal barrier fluid is used for line shaft bearing lubrication. The bushing shall both control the amount of flushing water flow and restrict solids and gas accumulation from the seal face area.

Candidate seals include:

1. Chesterton 442 seals provided with Chesterton/SpiralTrac solids removal restriction bushings Version N or D, as recommended by EnviroSeal Engineering Products, Ltd, Nova Scotia, Canada.

2. AESSEAL RDS seals with Cyclops bushing.

3. John Crane 3710 seals with Type 24SL bushing.

Seals on pumps for contaminated water service (sludge, grit, wastewater, scum, reclaimed water, etc.) shall be drilled and tapped for connection of a clean water flushing supply.

Seals for all vertical pumps (whether column or volute type) shall be provided with a second flush connection. Vertical pumps shall have a vent valve attached to the mechanical seal to eliminate air from the seal chamber prior to pump start; start-up procedures shall include venting instructions; and for remotely started pumps, the vent system shall be automated. Where specified in the detailed specifications, permissive confirmation automatic vent systems shall be provided.

C. SHAFT PACKING:

Where shaft packing is specified, stuffing boxes shall be tapped to permit introduction of seal liquid and shall hold a minimum of five rows of packing. Stuffing boxes shall be face attached. Stuffing box and shaft shall be suitable for field installation, without machining or other modifications, of the mechanical seal specified in paragraph 11000-2.04.B for the applicable pump and operating conditions.

Unless otherwise specified, lantern rings shall be bronze or Teflon, packing shall be die-molded packing rings of non-asbestos material suitable for the intended service and as recommended by the manufacturer, and glands shall be bronze, two piece split construction. Lantern rings shall be of two-piece construction and shall be provided with tapped holes to facilitate removal. Lantern rings shall be drilled and tapped 1/4 NC-20. The impeller end of the packing on all but line shaft pumps with external source water lubricated bearings shall be fitted with a SpiralTrac, Version P packing protection system as manufactured by EnviroSeal Engineering Products, Ltd, Nova Scotia, Canada.

The section of each shaft or impeller hub that extends through or into the stuffing box shall be fitted with a replaceable stainless steel sleeve with a Brinell hardness of not less than 500. The sleeve shall be held to the shaft to prevent rotation and shall be gasketed to prevent leakage between the shaft and the sleeve. Minimum shaft sleeve thickness shall be 3/8 inch.

2.05 COUPLINGS

Unless otherwise specified in the particular equipment sections, equipment with a driver greater than 1/2 HP, and where the input shaft of a driven unit is directly connected to the output shaft of the driver, shall have its two shafts connected by a flexible coupling which can accommodate angular misalignment, parallel misalignment and end float, and which cushions shock loads and dampens torsional vibrations. The flexible member shall consist of a tire with synthetic tension members bonded together in rubber. The flexible member shall be attached to flanges by means of clamping rings and cap screws, and the flanges shall be attached to the stub shaft by means of taper lock bushings which shall give the equivalent of a shrunk-on fit. There shall be no metal-to-metal contact between the driver and the driven unit. Each coupling shall be sized and provided as recommended by the coupling manufacturer for the specific application, considering horsepower, speed of rotation, and type of service.

Where torque or horsepower capacities of couplings of the foregoing type is exceeded, Thomas-Rex, Falk Steel Flex, or equal, couplings will be acceptable provided they are sized in accordance with the equipment manufacturer's recommendations and sizing data are submitted. They shall be installed in conformance to the coupling manufacturer's instructions.

2.06 GUARDS

Exposed moving parts shall be provided with guards which meet all applicable OSHA requirements. Guards shall be fabricated of 14-gage steel, 1/2-13-15 expanded metal screen to provide visual inspection of moving parts without removal of the guard. Guards shall be galvanized after fabrication and shall be designed to be readily removable to facilitate maintenance of moving parts. Reinforced holes shall be provided. Lube fittings shall be extended through guards.

2.07 CAUTION SIGNS

Equipment with guarded moving parts which operates automatically or by remote control shall be identified by signs reading "CAUTION - AUTOMATIC EQUIPMENT MAY START AT ANY TIME". Signs shall be constructed of minimum 40 mil vinyl clad aluminum material, rigid, suitable for post mounting. Letters shall be white on a red background. The sign size and pattern shall be per Section 10441. Signs shall be installed near guarded moving parts.

2.08 GAGE TAPS, TEST PLUGS AND GAGES

Gage taps shall be provided on the suction and discharge sides of pumps, blowers and compressors. Pressure and vacuum gages shall be provided where specified. Gage taps, test plugs, and gages shall be as specified in Divisions 15 and 17, respectively.

2.09 NAMEPLATES

Nameplates shall be provided on each item of equipment and shall contain the specified equipment name or abbreviation and equipment number. Equipment nameplates shall be engraved or stamped stainless steel and fastened to the equipment in an accessible and visible location with stainless steel screws or drive pins.

2.10 LUBRICANTS

The Contractor shall provide for each item of mechanical equipment a supply of the required lubricant adequate to last through the specified commissioning period. Lubricants shall be of the type recommended by the equipment manufacturer and shall be products of the Owner's current lubricant supplier. The Contractor shall limit the various types of lubricants by consolidating them, with the equipment manufacturer's approval, into the least number of different types. Not less than 90 days before the date shown in his construction schedule for starting, testing and adjusting equipment (Section 01660), the Contractor shall provide the Owner with three copies of a list showing the required lubricants, after consolidation, for each item of mechanical equipment. The list shall show estimated quantity of lubricant needed for a full year's operation, assuming the equipment will be operating continuously.

2.11 ANCHOR BOLTS

Anchor bolts shall be designed for lateral forces for both pullout and shear in accordance with the provisions of Section 05501. Unless otherwise stated in the individual equipment specifications, anchor bolt materials shall conform to the provisions of Section 05501.

2.12 SPARE PARTS

Spare parts, wherever required by detailed specification sections, shall be stored in accordance with the provisions of this paragraph. Spare parts shall be tagged by part name and project equipment number and identified by part number, equipment manufacturer, and subassembly component (if appropriate). Spare parts subject to deterioration, such as ferrous metal items and electrical components, shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

PART 3--EXECUTION

Installation of equipment accessories included in this section shall be as recommended by the equipment manufacturer unless otherwise specified in the individual equipment specification section.

END OF SECTION

SECTION 11050

GENERAL REQUIREMENTS FOR CENTRIFUGAL AND AXIAL FLOW PUMPING EQUIPMENT

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section, when referenced in the detailed specification section, provides minimum requirements applicable to centrifugal and axial flow pumping equipment furnished under this contract. More restrictive requirements, where found in individual pump specifications, shall supersede requirements of this section.

"Detailed pump specification", "detailed specification", "individual pump specification", "referencing section", or words of similar import in this section, shall mean the specification section where the requirements for specific pump performance are presented. "Pumping unit", whenever and wherever used, shall mean the complete pumping assembly, including driver (whether engine, turbine, or motor) and shall include all accessories such as variable speed drives required for motor operation, gear reducers, intermediate shafting and bearings, flywheels, and all supports for all equipment furnished with the pump.

A number of provisions of this section shall be required for a subset of pumps. These requirements (refer to Paragraphs 1.05 and 1.07.A, in this Section) are in addition to requirements applicable to all pumps. This subset of pumps is defined as pumping equipment meeting any of the following criteria:

- Pumps with motor sizes 250 Hp and greater
- Pumps with discharge nozzles 20-inches in diameter and larger
- Pumps with variable speed drives
- Pumps operating at speeds 720 rpm and less
- All flywheel-equipped pumps
- All engine-driven pumps
- All pumps driven by synchronous motors
- Where a particular Section 11050 provision is specifically cited in the detailed section

B. DEFINITIONS:

The following definitions apply for classifying pumps specified in this and referencing sections:

1. GENERAL: Terminology and definitions in this Section follow those established in ANSI/HI 9.1 - 9.5, unless otherwise noted.

2. SOLIDS BEARING LIQUIDS: Liquids to be pumped containing, or assumed to contain, solids that require appropriate pump design considerations and/or materials of construction. Solids Bearing Liquids are liquids with settleable solids exceeding 50 mg/L and shall include wastewater, stormwater, primary effluent, return sludge, return activated sludge (RAS), trickling filter circulation, and similar services.

3. CLEAR LIQUIDS: Liquids to be pumped generally free of deleterious solids. Clear Liquids shall include, potable water, heat reservoir, raw water, secondary effluent pumping, and similar services.

4. EFFICIENCY: For the purposes of this section and sections referencing this section, efficiency, as related to pumps, shall be the ratio of the pump output power (water horsepower) divided by the pump input power (brake horsepower) required to deliver the total head, with meanings as defined in HI 1.2.3.8 and 2.2.3.8. For column type pumps, it shall be computed inclusive of inlet, bowl, column and discharge head losses.

5. NET POSITIVE SUCTION HEAD – 3 PERCENT REDUCTION (NPSH3): For the purposes of this section and sections referencing this section, NPSH3 shall mean the value of net positive suction head resulting in a reduction of 3 percent in the developed pump discharge head when the pump is tested in accordance with procedures established by the Hydraulic Institute. NPSH3 is the successor designation to NPSHR (net positive suction head required). Where NPSHR is used in the Contract Documents it shall be taken to mean NPSH3.

6. NPSH MARGIN: For the purposes of this section and sections referencing this section, "NPSH Margin" wherever used shall mean Net Positive Suction Head Available (NPSHA) divided by the candidate pump's Net Positive Suction Head-3 Percent Reduction (NPSH3) for the specific operating condition in question.

1.02 TYPE

Provisions and requirements contained in this section apply specifically to centrifugal and axial flow pumps, both vertical and horizontal, commonly falling into the generic types covered by ANSI/HI 1.1 through 1.4 and 2.1 through 2.4. This section does not apply, except by specific reference, to positive displacement pumps of any type.

1.03 REFERENCES

This section (Section 11050) contains references to the following documents. They are a part of this section and any referencing section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section or any referencing section and those of the listed documents, the following order of precedence shall prevail (in the order of primacy):

1. The referencing section.
2. This section.
3. The referenced document.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ABMA 9	Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	Load Ratings and Fatigue Life for Roller Bearings
AISC	American Institute of Steel Construction –Manual of Practice
ANSI/API 610	Standard for Centrifugal Pumps for Petroleum, Petrochemical and Natural Gas Industries
ANSI/ASME B46.1	Surface Texture, Surface Roughness, Waviness and Lay
ANSI/HI 1.1 – 1.4	Rotodynamic (Centrifugal) Pumps
ANSI/HI 2.1 – 2.4	Rotodynamic (Vertical) Pumps
ANSI/HI 9.1 – 9.5	Pumps – General Guidelines
ANSI/HI 9.6.2	Centrifugal and Vertical Pumps for Allowable Nozzle Loads
ANSI/HI 9.6.3	Centrifugal and Vertical Pumps Allowable Operating Region
ANSI/HI 9.6.4	Centrifugal and Vertical Pumps. Vibration Measurements and Allowable Values
ANSI/HI 9.8	Pump Intake Design
ANSI/HI 11.6	Submersible Pump Tests
ANSI/HI 14.6	Rotodynamic Pumps for Hydraulic Performance Acceptance Tests
API 686/PIP REIE 686	Recommended Practices for Machinery Installation and Installation Design
ASME B18.8.2	Taper Pins, Dowel Pins, Straight Pins, Grooved Pins, and Spring Pins (Inch Series)
ASME Code	ASME Boiler and Pressure Vessel Code
ASTM A27	Steel Castings, Carbon, for General Application
ASTM A36	Carbon Structural Steel

Reference	Title
ASTM A148	Steel Castings, High Strength, for Structural Purposes
ASTM A322	Steel Bars, Alloy, Standard Grades
ASTM A564	Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes
ASTM A571	Austenitic Ductile Iron Castings for Pressure-Containing Parts Suitable for Low-Temperature Service
ASTM A995	Standard Specification for Castings, Austenitic-Ferritic (Duplex) Stainless Steel, for Pressure-Containing Parts, Grades 2A, 3A, or 6A
ASTM B148	Aluminum-Bronze Sand Castings
AWWA C213	Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines
AWWA C550	Protective Epoxy Coatings for Valves and Hydrants
NSF/ANSI 61	Drinking Water System Components – Health Effects
ISO 9001	Quality Management Systems – Requirements, 3rd Ed. (2000)
ISO 10816-1	Mechanical Vibration—Evaluation of Machine Vibration by Measurement on Non-rotating Parts—Part 1: General Guidelines, Annex B, Table B.1. Zone A, Class I, II or II, as applicable. For the purposes of this specification, Annex B of ISO 10816, Part 1 shall form a part of this specification and ISO 10816, Part 1.
ISO 10816-7	Mechanical Vibration—Evaluation of Machine Vibration by Measurement on Non-rotating Parts—Part 7: Rotordynamic Pumps for Industrial Applications, Including Measurements on Rotating Shafts, Annex A, Tables A-1 and A-2 as applicable. For the purposes of this specification, Annex A of ISO 10816, Part 7 shall form a part of this specification and ISO 10816, Part 7.
MIL STD 167-2	Mechanical Vibrations of Shipboard Equipment (Reciprocating Machinery and Propulsion System and Shafting)
Vibration Institute	Vibration Specialist Certification Requirements
Corbo and Malanoski, 1996	Practical Design Against Torsional Vibration, 25th Turbomachinery Symposium, Turbomachinery Laboratory, Texas A & M University, p. 186 – 222
Corbo and Malanoski, 1998	Pump Rotordynamics Made Simple, Pumping Technology, June 1998, p. 202 – 236

1.04 DESIGN REQUIREMENTS – ALL PUMPS:

A. GENERAL:

Equipment furnished under all sections referencing this section shall conform to the requirements and objectives of paragraph 6.1, ANSI/API 610, unless specifically stated in this and the detailed specification section. All components associated with the rotating elements in the drive train, including equipment supports and supports for rotating elements, shall be selected and designed to function without damage or disassembly at reverse rotational speeds up to 150 percent of maximum operational speed during flow reversals through the pump. The complete pumping unit shall operate without overload on any component at any point along the pump's entire full-speed operating curve. Pumps required by virtue of the specified operating conditions to operate against a closed valve or throttled for any period of time exceeding five seconds shall be furnished with drivers sized to operate continuously at the power requirement for that condition even though the power requirements at the rated condition may be less.

With the exception of submersible pumps and the inlet connection for pumps designed to operate in open forebays or wet wells, pump connection nozzles shall be designed for the loads and moments stipulated in ANSI/HI 9.6.2. Where ANSI/HI 9.6.2 does not cover a specific pump type or category, or where that document is silent on allowable nozzle loads or a particular type of nozzle load (e.g. thermal pipe strain), the Contractor shall furnish documentation from the manufacturer attesting to the limitations on loads and moment forces that can be tolerated on each connection and recommended connection details to be used.

B. PUMP SELECTION:

1. PROVEN DESIGNS: Pumps furnished under all sections referencing this section shall be proven designs that shall have been in service under similar conditions of service with no objectionable performance characteristics for a period of not less than five years. The Contractor shall furnish a detailed list, duly signed by an officer of the pump manufacturer's corporation and notarized, of installations with contact information supporting qualification under this requirement with the information required under paragraph 11050-1.08. In order to satisfy this requirement, listed pump shall be of the same size volute or bowl, discharge case and nozzle size, impeller design (including number of vanes) and shall be operating under similar conditions of pumped fluid, head, capacity, speed, rotation, and Net Positive Suction Head Available (NPSHA).

The Contractor may propose equipment that cannot meet this requirement only under the following conditions:

a. The proposed design has been in successful operation under similar conditions of volute or bowl, discharge case and nozzle size, impeller design (including number of vanes), pumped fluid, head, capacity, rotation and NPSHA, but at a higher speed for a period of not less than three years.

or

b. The proposed design has been in operation in designs where both larger and smaller nozzle size pumps have been in service for a period of not less than five years, and impeller design (including number of vanes), pumped fluid, head, capacity, speed and NPSHA are similar to that for the proposed installation. Under no circumstances will an existing pump design operating at a higher speed than those currently in service in similar applications be considered.

If the proposed pump qualifies under either exception (a. or b.), the Contractor shall demonstrate, by operation of a test pump in a fully equipped hydraulic test facility, that the proposed pump in the size and at the speed proposed, with the proposed impeller design will have acceptable operating characteristics under the conditions specified for the proposed installation. The test pump shall be set up and a witnessed demonstration shall be performed prior to designing, fabrication and testing any of the equipment proposed for the specific installation."

2. GENERAL PERFORMANCE CRITERIA: Pumps furnished under this section and any referencing section shall operate without loss of head due to cavitation or vibration over the entire specified range of flow and head conditions and shall be specifically selected for NPSH margin requirements detailed in paragraph 11050-1.04.F. Pump selections which do not provide the specified margin will be rejected.

Under no circumstances will centrifugal pumps with suction specific speeds in excess of 10,000 be considered unless specifically allowed in the detailed specification. Suction specific speed shall be calculated (using NPSH3) in accordance with ANSI/HI 1.3, paragraph 1.3.4.1.15. Each pump shall be subjected to a factory NPSH3 test at the pump's BEP to confirm that the suction specific speed limitation has not been exceeded.

The pump selection for a given application shall be predicated on locating the specified most frequent operating condition (usually Condition Point B in the detailed specification sections, but other specified operating conditions may apply as well) in the proposed pump's Preferred Operating Region (POR), as defined in ANSI/HI 9.6.3. The Preferred Operating Region (POR) shall be not less than that specified in paragraph 6.1.12, ANSI/API 610. Condition A shall be the pump's rated condition and shall be guaranteed to meet both specified head and flow within the limit established in ANSI/HI 14.6, acceptance grade 1E. All other Condition Points indicated to be for sustained (not momentary or startup) operation specified in the detailed section referencing this Section may be located in the manufacturer's Allowable Operating Region (AOR) as depicted in published catalog information. The pump's AOR shall be as defined under ANSI/HI 9.6.3. If the pump manufacturer's information is silent on the boundaries of the AOR and POR for the proposed selection, the submittal will be rejected.

3. GENERAL DESIGN CRITERIA: All pumps furnished under sections referencing this section shall be designed in accordance with applicable portions of ANSI/HI 1.1 – 1.4, 2.1 – 2.4 and ANSI/HI 9.6.2 – 9.6.6 and the requirements of this section. The pumps shall be specifically designed to pump the fluid described in the detailed specification and shall

operate without clogging or fouling caused by material in the pumped fluid at any operating condition within the range of service specified.

Unless otherwise noted or specified, pump head capacity curves shall slope in one continuous curve within the specified operating conditions. No points of reverse slope inflection capable of causing unstable operation will be permitted within the specified zone of continuous duty operation. Pumps with head/capacity curves with a reverse inflection are specifically prohibited if these characteristics will cause unstable operation within the specified range of operating conditions and where startup/shutdown conditions entail operation against a slow opening/closing valve.

Column type (vertical turbine, vertical column solids handling, and axial flow propeller and mixed flow) pumps shall have bells selected to provide a maximum intake velocity of 4.0 feet/second when operating at the maximum specified flow or the flow resulting from the lowest specified operating head at maximum speed, whichever is the greatest ("peak flow"). Pump discharge column sizes shall be selected to limit the calculated average velocity at peak flow to no more than 12 feet/second. Pump discharge column sizes shall be selected to limit the calculated average velocity at peak flow (Condition Point B, as defined previously) to no more than 12 feet/second.

Pumps furnished under this section and any referencing section shall operate without loss of head due to cavitation or vibration over the entire specified range of flow and head conditions and shall be specifically selected for NPSH margin requirements detailed in paragraph 11050-1.04.F. Pump selections which do not provide the specified margin will be rejected.

Under no circumstances will centrifugal pumps with suction specific speeds in excess of 10,000 be considered for variable speed applications. Selections for constant speed applications with suction specific speeds no greater than 11,500 will be acceptable so long as all specified operating points fall within 80 to 110 percent of the Best Efficiency Point capacity on the pump's head/capacity curve at the specified operating speed. Suction specific speed shall be calculated in accordance with ANSI/HI 1.3, paragraph 1.3.2.2. Each pump shall be subjected to a factory NPSH3 test at the pump's BEP to confirm the suction specific speed limitation has not been exceeded.

C. CRITICAL SPEEDS AND NATURAL FREQUENCIES:

1. GENERAL: The following criteria shall apply to the equipment in like new condition as well as the as worn condition (i.e., when all parts, individually and as a composite, reach the manufacturers' maximum tolerances).

2. LATERAL ROTOR DYNAMICS: The complete pumping unit, including all related frames, supports, enclosures, and casings, shall be free from dangerous critical speeds from 20 percent below to 30 percent above the operating speeds required to achieve the specified performance characteristics. The logarithmic decrement for each damped natural frequency (forward or backward) shall be greater than +0.3, and the amplitude magnification factor shall not exceed 3, for any natural frequency within this range.

Process sensitivities are such that operation at infinitely variable speed within the specified operational conditions is an absolute requirement. Any remedy imposing a locked-out speed interval or intervals will not be considered an acceptable remedy for identified critical speeds. Acceptable remedies include combinations of adjustments in rotor geometry or materials, and the substitution of energy absorbing couplings. Other remedies may be considered so long as they are justified in writing and the proposal sealed and signed by the design professional retained by the manufacturer to perform the system mass elastic system analyses.

3. TORSIONAL AND COMBINED SHAFT STRESS: For constant torque applications, the pump rotor shall be free from torsional response which produces combined (steady plus alternating torque induced) stresses exceeding 30 percent of the material's elastic limit (but no more than 18 percent of the material's ultimate tensile strength) at any speed from 10 percent below to 20 percent above that required by the specified operating conditions, or during startup, shutdown or motor control transients.

For variable torque applications (including variable speed pumps, vertical pumps and pumps with large overhung loads) the pump rotor and any intermediate shafting shall be free from torsional responses which, in accordance with MIL STD 167-2, produce combined (torsional steady and alternating) peak shear stresses at points of stress concentration (calculated in accordance with the requirements of this section) that exceed 4 percent of the material's ultimate tensile strength, nor more than 50 percent of the material's fatigue limit, whichever is less.

D. IMPELLER CLEARANCES, VANE PASSING FREQUENCY AND IMPELLER KEYWAYS:

The radial clearance between the tip of the impeller vane and diffuser or volute vanes shall be not less than 3 percent and 6 percent, respectively, of impeller diameter. The ratio of liquid channel widths (diffuser or volute/impeller) shall be not less than 1.15 nor more than 1.3 for diffuser pumps and 1.4 – 1.5 for volute-type pumps. The pump shall be designed so that internal geometry shall not cause uneven flow distribution at impeller vane inlets.

Impeller vane combinations shall not be an even multiple of diffuser vanes in column type pumps.

Impeller keyways for multistage column type pumps shall be cut at differing positions and equal angular spacing on the impeller shaft to avoid multiple simultaneous vane passing pulses.

E. COMPONENT DESIGN CRITERIA:

1. GENERAL: Unless otherwise specified, combined stresses in steel frames and supports shall not exceed those permitted by the AISC Manual of Practice. Combined stresses in cast, forged, rolled, or fabricated pressure retaining components, frames and supports shall not exceed that allowed for the given material in Section VIII, Division 1 of the ASME

Code. Design pressures for pressure-retaining parts shall be not less than twice the pump's shutoff head at the manufacturer's listed maximum operating speed. Pump casing strain at any head on the full speed operating curve (including allowances for increases caused by specified multi-stage applications) shall not result in distortions at the bearing housings greater than the maximum allowable by the bearing manufacturer to provide the specified bearing life.

The term "combined stresses" in this section shall mean the sum of all operating stresses, including stresses induced by dynamic and static forces as developed via the analysis procedures stipulated in this section. Static forces (x, y, z, and moments in all planes) shall include the relevant maximum nozzle loads specified in ANSI/HI 9.6.2 or as stipulated by the pump manufacturer. Dynamic forces shall include both steady state and transient stresses induced by operating conditions within the zone of operation established by the specified operating conditions.

2. ANCHORAGE AND EQUIPMENT MOUNTS: The Contractor shall cause the pump manufacturer to be responsible for the design of the anchor bolting system and equipment supports for each separately mounted component furnished under the detailed specification. Anchorage and equipment support requirements for pumps shall conform to the requirements of Section 11002 and the standards of the Hydraulic Institute.

Anchor bolts and connecting bolts for all pumps and assemblies supported by other assemblies furnished under this section, or sections referencing this section, shall be designed in accordance with Section 05501. All operation and maintenance manuals for all pumps and assemblies shall contain criteria for anchor and baseplate bolt torque values.

Unless otherwise recommended by the equipment manufacturer, all pump discharge nozzles shall be restrained using the equipment connection fitting specified in Section 15085.

Equipment mounts for vertical (column and volute type) pumps weighing more than 1000 pounds, with discharge nozzles 6 inches in diameter and greater, shall employ soleplates conforming to the requirements of Section 11002. Soleplate mounting conforming to Section 11002 shall also be provided for all separately supported components in the pump drive system. Fabricated steel supports regardless of design and the nature of the structural shapes used for such proposed supports, will not be accepted.

Soleplates shall be designed to span openings for equipment connections and provide access to maintenance points. Soleplates shall be of sufficient section to key, not less than 1 inch, into the supporting grout provided for bonding the soleplate to the structure. Soleplates shall be of sufficient size to bolt the pump base to the soleplate and allow dowelling the pump base to the soleplate without encumbering the anchor bolts required for clamping the soleplate to the structure.

Equipment mounts for horizontal pumps shall be designed in accordance with Section 11002 and paragraph 7.3, ANSI/API 610 and shall provide common support for the pump and motor (and flywheel, if one is specified). Baseplate bolting shall conform to assumptions

contained in ANSI/HI 9.6.2. Pump base shall be drilled and dowel pinned to the base plate in addition to bolting.

Tapered dowel pins shall be used to record the final position of all machine bases on soleplates or pump baseplates. Dowel pins shall be hardened and machine-ground conforming to the requirements of ANSI/ASME B18.8.2. Holes for tapered dowels shall conform to the requirements set forth in Appendix A of ANSI/HI B18.8.2.

3. TORSIONAL AND COMBINED SHAFT STRESSES: Shaft stresses shall be calculated using the following equation and the stress concentration factors in the table below.

$$S = S_{cf} \times \frac{G \times D \times \Delta_{\Theta}}{2 \times L}$$

where.

S	=	stress, psi
S_{cf}	=	stress concentration factor, dimensionless
D	=	minimum shaft diameter at point of concentration, inches
Δ_{Θ}	=	twist in shaft between adjacent masses, radians
L	=	effective length between masses, inches
G	=	shear modulus of shaft material, lb/in2

The S_{cf}, to be applied at all the roots of all keyways and changes in shaft diameter shall be as follows:

S_{cf}	Ratio of fillet radius to shaft diameter
4.3	0.0025
3.7	0.01
3.05	0.02
2.75	0.03
2.6	0.04
2.55	0.05 and greater

Values of S_{cf} between data points in the table above shall be based upon a straight line interpolation.

4. SHAFT DEFLECTION: Pump shafts on volute type pumps shall be designed to provide sufficient stiffness to operate without distortion or damaging vibration throughout the range of service specified. Shaft deflection at the face (impeller side) of the shaft seal shall be limited to no more than 1.5 mils at any operating condition within the zone described by the specified continuous duty operating conditions. Deflection at the shaft seal shall be calculated as required by provisions set forth in paragraph 11050-1.05.B.5.c.

5. BEARINGS: Unless otherwise specified, anti-friction bearings for pumps below the Size Threshold Criteria (paragraph 11050-1.01.B.5) shall be selected for an L–10 life of 50,000 hours in accordance with ABMA 9 or 11. Anti-friction bearings for pumps meeting the Size Threshold Criteria shall have bearings selected for an L–10 life of 100,000 hours in accordance with ABMA 9 or 11. Bearings for other elements in the rotating system such as motors, intermediate shaft bearings, and flywheel bearings shall be selected using the same criteria as specified for the pump. Bearing selection shall be based upon the worst combination of continuous duty operating conditions specified and shall include both steady state and transient loads. Calculations supporting the selection of bearing sizes shall be provided as Product Data.

6. BEARING ISOLATORS: Unless otherwise specified, all pump and motor bearings shall be fitted with bearing isolators, specifically selected for the size and type bearing. Bearing isolators shall be labyrinth, non-fretting type designed to expel contaminants by centrifugal force and prevent escape of lubricants. Vapor block capability shall be provided. Bearing seals shall be Inpro/Seal or approved equal.

7. PUMP SHAFT SEALS: Unless otherwise specified in the detailed specification, pump shaft seals shall be packing as specified in Section 11000.

F. NET POSITIVE SUCTION HEAD MARGIN LIMITATIONS:

1. GENERAL: Pumps furnished under this section and sections referencing this section shall be selected for NPSH (Net Positive Suction Head) margin limitations using the criteria set forth in this section. Net Positive Suction Head Required - 3 Percent Reduction (NPSH3) characteristics for the candidate pump shall be based upon documented test data not more than five years old, performed on a pump not more than two nominal pump diameters larger or smaller than the proposed pump with an impeller of the same geometry as that proposed for the pump to be used for the subject application, and operating at the same speed as the pump for the proposed application. The Contractor shall document the basis for pump selection based upon NPSH margin limitations as set forth in this paragraph.

The detailed specification sections provide NPSHA (Net Positive Suction Head Available) information for anticipated operating conditions for each application. This information is generally referenced to a specific elevation, stated in terms of project datum. It shall be the Contractor's responsibility to cause the pump manufacturer to adjust the NPSHA information in the specification section to the elevation of the pump impeller eye for the specific pump model and size proposed for the application. NPSH3, as used in the following paragraphs, shall mean the NPSH3 at the impeller eye, determined in accordance with ANSI/HI 11.6 or 14.6, as applicable for the proposed pump. The Contractor shall cause the pump manufacturer to

document the method used to determine NPSH3 for the proposed pump and justifying compliance with the NPSH margin limitations established under this paragraph for each specified operating condition in material submitted under paragraph 11050-1.08. The documentation shall include justification of the NPSH3 tests used to develop NPSH3 characteristics, including the following:

a. Date, test procedure, and test logs of original NPSH3 information used to project requirements for pump selected for the application.

b. Test pump size, impeller diameter, impeller model, eye diameter, and speed.

c. Calculations projecting NPSH3 test information to NPSH3 curve information for the pump proposed for the application.

d. Calculations demonstrating compliance with the NPSH margin requirements established in this paragraph.

The Contractor shall submit the manufacturer's margin calculations justifying the proposed pump selection with the material required under paragraph 11050-1.08. The NPSH margin ratios specified in this paragraph shall be the minimum acceptable margin ratios. If the proposed pump requires greater margin ratios to operate within the specified operating conditions without loss of head due to cavitation, then it shall be the responsibility of the Contractor to bear all costs associated with achieving the required margin ratio by lowering the elevation of the pump setting, lowering the elevation of the structure or other means. Any such adjustments shall be subject to review and acceptance by the Construction Manager.

Individual restrictions that apply to NPSH margin shall be as set forth below, depending upon the type of pumping equipment and the fluid to be pumped.

2. CENTRIFUGAL PUMPS – WASTEWATER SERVICE: The following restrictions shall apply to pumps for wastewater and all solids bearing liquids applications including storm water.

a. Pumps classified as centrifugal pumps under ANSI/HI 1.1 – 1.2 with specific speeds less than 7000 with cast duplex stainless steel impellers and to vertical column-type sewage pumps with cast duplex stainless steel impellers and specific speeds less than 5000, a minimum NPSHA/NPSH3 margin ratio of 1.1 shall apply to pumps at any operating condition within 85 percent and 115 percent of best efficiency capacity. The minimum acceptable NPSH margin ratio at any other location on the pump's head/capacity curve shall be 1.2.

b. Pumps with specific speeds greater than the above limitations shall have NPSH margins of 1.5 and 2 applicable to the capacity

envelope limitations defined previously. Under no circumstances shall the absolute value of the margin above NPSH3 be less than 3.5 feet.

c. Pumps with specific speeds greater than the above limitations, pumps with impeller materials that do not meet the requirement for duplex cast stainless steel set forth in this section, and all pumps with suction specific speeds greater than 10,000 shall have NPSH margins not less than 2.5 at operating conditions within ±15 percent of best efficiency capacity and not less than 3.5 for all operating conditions falling outside the ±15 percent of best efficiency capacity envelope. Under no circumstances shall the absolute value of the margin for pumps qualifying with the foregoing restrictions, be less than 3.5 feet greater than NPSH3.

3. CENTRIFUGAL PUMPS - CLEAR LIQUID SERVICE:

a. The minimum NPSH margin requirements set forth in the table below shall apply to water and all non solids bearing liquid pumps classified as centrifugal pumps under ANSI/HI 1.1 – 1.2 with specific speeds less than 7000 fitted with cast duplex stainless steel or aluminum bronze impellers and to vertical column-type pumps with cast duplex stainless steel impellers or aluminum bronze impellers and specific speeds less than 4000. Under no circumstances shall the absolute value of the margin above NPSH3 be less than 3.5 feet.

Power per stage, kW	Operating Condition Within POR	Operating Conditions Outside POR
< 75	1.1	1.2
≥ 75 but ≤ 225	1.05	1.1
>225	1.2	1.3

b. Pumps with specific speeds greater than the above limitations, pumps with impeller materials that do not meet the requirement for duplex cast stainless steel set forth in this section, and all pumps with suction specific speeds greater than 10,000 shall have NPSHA margins not less than 3.0 at operating conditions within ±15 percent of the best efficiency capacity and not less than 4.0 for all operating conditions falling outside the ±15 percent of best efficiency envelope. Under no circumstances shall the absolute value of the margin above NPSH3 be less than 3.5 feet.

G. ELECTRIC MOTORS:

1. GENERAL: Unless otherwise specified, pumps shall be electric motor driven. All motors shall be selected to be non-overloading at any operating point along the pump's full speed operating curve, including all points located beyond specified operating conditions. All vertical motors shall be solid shaft construction. Hollowshaft motors will not be accepted. Motors furnished with pumps specified for operation at variable speed shall be inverter duty types conforming to the requirements of Section 11060 and shall be compatible with the variable speed equipment furnished with the pump.

Motor bearings shall be protected with bearing isolators as specified in paragraph 11050-1.04.E.

2. MOTORS FOR CUSTOM ENGINEERED PUMPS: In addition to the information submitted under the requirements of Section 11060, the Contractor shall provide certified reed frequency calculations for both the motor rotor and frame for vertical motors driving custom engineered pumps with the data to be submitted under paragraph 11050-1.08. Upon completion of construction of motors for custom engineered pumps, each rotor and frame and the completed assembly shall be given a bump test to confirm reed frequency calculations in the dynamic analysis modeling work performed under paragraph 11050-1.05.B. The results of the bump test, certified by an officer of the manufacturing corporation and notarized, shall be submitted as Product Data under paragraph 11050-2.09.

All vertical motors shall meet motor face dimension tolerances as follows:

Motor face bolt circle diameter, inches	Motor face runout, inches
12	0.002
16.5 through 24.5	0.002
30 through 42	0.003
42 and larger	0.005

Motor face register concentricity, referenced to the shaft centerline, shall be not greater than 0.002 inches, if the motor is furnished without jack screws. Motor shaft total indicated runout (TIR) shall not exceed 0.002 inches.

3. BALANCE: Motors rated 50 horsepower and greater, all motors driving custom engineered pumps and all motors operating at less than 1200 rpm shall be precision balanced motors conforming to the requirement set forth in the table below.

Speed, rpm	Mils displacement (peak to peak)
3000 and above	0.5
1500 - 2999	1.0
1000 - 1499	1.0
<1000	1.5

The Contractor shall provide certified balance logs attesting to achieving these requirements, as Product Data under paragraph 11050-2.09. Displacement readings shall be taken at the shaft with an FFT analyzer at 1X speed. Balance logs shall be notarized and signed by an officer of the manufacturing corporation.

1.05 ADDITIONAL DESIGN REQUIREMENTS

A. SCOPE

The following paragraphs present requirements that apply to only some pumps on the project. In each following paragraph, the first sub-paragraph titled GENERAL explains when the paragraph applies.

B. ROTOR CRITICAL SPEED ANALYSIS AND SYSTEM DESIGN:

1. GENERAL: The requirements of this paragraph shall apply to all pumps meeting the Size Threshold Criteria and all pumping unit specifications where the words "Custom Engineered" appear in the title of the specification section, and elsewhere when the referencing specification section stipulates. The analyses shall be applied to the equipment in like new condition as well as the as worn condition (i.e., when all parts, individually and as a composite, reach the manufacturers' maximum tolerances).

2. REQUIREMENTS: The complete pumping unit, including rotating elements, frames, supports, and all related structural elements, including pump, motor and bearing supports, shall be subjected to a lateral rotordynamic analysis, including a rotordynamic critical speed analysis, to identify and eliminate harmful resonant conditions.

The complete pumping unit rotating element including pump, motor, intermediate shafting and flywheel rotors (if specified), and all other elements in the power train (or powered via the power train) shall be designed and manufactured to limit torsional stresses.

Overhung shaft pumps and between bearings pumps operating in single volute casings shall be subject to analysis for shaft deflection in accordance with the terms of this section.

The torsional and rotordynamic analyses shall together be termed the pumping equipment's "mass elastic design". No fabrication work on any component for the equipment specified under this section and any referencing section shall be started until the mass elastic design has been completed and has been reviewed by the Construction Manager.

If the Contractor proposes the use of alternative methods for the required analyses, documentation shall be submitted justifying the substitution. The documentation shall include justification that product results will be equivalent to that specified and with an equivalent level of accuracy. The location and description of projects of an equivalent size where the procedure has been employed and the length of time these projects have been in actual service shall also be included.

3. PROFESSIONAL QUALIFICATIONS: The Contractor shall cause the manufacturer of the pumping equipment to retain the services of an independent professional engineering firm, employing a qualified design professional, which has been engaged in performance of the required, mass elastic design analyses for not less than ten years on equipment of similar size and complexity. The design professional shall not have been in the employ of any pump manufacturer, for a period of not less than 10 years from the date of the request for proposals for this project. The design professional's firm shall submit a notarized certification attesting to having no contractual arrangements with the proposed pump manufacturer. The pump manufacturer's internal engineering organizations, regardless of qualifications, are specifically prohibited from doing this work. This provision, however, shall not be construed as relieving the Contractor of overall responsibility for this portion of the work.

The mass elastic design shall be the product of a registered design professional who has been responsible for the design of not less than five systems similar to that specified in the detailed specification section. The design professional shall have been engaged in this type of analysis for not less than 10 years and shall directly supervise the performance of the work and be responsible for analysis of results and recommendations for any corrections to the specific rotating system and the associated frames and supports. The Contractor shall submit the design professional's qualifications as a part of the initial submittal information required under this section.

The Owner and Construction Manager believe the following firms are capable of providing services which will satisfy the requirements of this paragraph. This statement, however, shall not be construed as an endorsement of a particular firm, nor shall it be construed that a named firm's standard service will comply with the requirements of this Section. Candidate firms performing these analyses satisfactorily in the past include:

a. DynaTech , Roseville, California

b. Engineering Dynamics Incorporated, Houston, Texas

c. No Bull Engineering (Corbo, Malanoski & Associates), Brandon, Vermont

The Contractor may propose a firm other than those listed. However, before a substitute firm can perform the analyses, the proposed firm's qualifications, the qualifications of personnel proposed for assignment to this project, along with examples of analyses performed on similar pumping equipment using the Corbo and Malanoski procedures specified in this section shall be submitted for review by the Construction Manager. Examples shall include the types of graphical displays required under this section as well as a complete report describing the analyses performed and the recommendations arising out of the analysis results. Construction Manager retains the right to reject any proposed firm with justification.

4. REPORTS, CALCULATIONS AND RECOMMENDATIONS: All reports, calculations and recommendations resulting from the required analyses shall bear the

design professional's original signature and professional registration seal. All reports, recommendations and calculations produced under this paragraph shall be submitted under the requirements of this section, as follows:

a. Following completion of the pumping equipment's mass elastic design, Contractor shall cause the design professional to prepare a plain-English "Executive Summary" report with a narrative including: a description and assumptions about proposed operating system; detailed description of the analysis process; results of analyses and findings; detailed recommendations for modification of the Pumping Unit (defined in paragraph 11050-1.01.A), if any; and sufficient graphical depictions to describe the information to a lay reader. Detailed calculations and extensive data reports are not to be submitted at this time and will cause the entire report to be rejected, if included. This Executive Summary shall be submitted for review and acceptance prior to pump or component fabrication. The Executive Summary report shall state that analysis procedures have complied fully with the requirements of this section and that the proposed system will meet all of the requirements set forth herein for limitations in stresses, deflection and fatigue limits. The design professional shall affirm in writing that all requirements of this section have been achieved or shall specifically state where exceptions have been taken, with justification citing recognized authorities for taking such exceptions. The reports shall be signed and sealed by the design professional, as specified, and shall be notarized.

b. Following review and approval of the Executive Summary, the Contractor shall cause the design professional to review and address any comments from the Construction Manager and incorporate all changes that may be required. Subsequently, Contractor shall direct the design professional to issue a complete, "Final Report" with a revised Executive Summary, recommendations binding on the manufacturer, calculations, data and other supporting information. The format and documentation for this report shall follow the requirements of ANSI/HI 9.6.4. The Contractor shall submit this report as Product Data.

c. Upon completion and receipt of certified results of the bump tests required for the motor rotor, frame and assembly specified under paragraph 11050-1.04.G., the design professional shall review the data and submit a "Supplemental Report", as Product Data, either accepting the test results or recommending alterations to assembly structures to adjust for differences between calculated values used for the original analyses and actual values determined subsequent to motor fabrication.

d. Upon completion of installation and as a part of the initial test procedures specified under Section 01660, the design professional responsible for the mass elastic design shall visit the site and inspect the installed equipment. Prior to the initiation of any field tests, the design professional shall issue a report bearing the design professional's original signature and original registration seal attesting that the equipment, as installed, conforms to the recommendations contained in the report setting forth the results of the mass elastic system design.

e. During initial testing of the equipment, the design professional shall be prepared with all necessary monitors, instruments and recorders, and shall conduct an in-situ torsional vibration test on one of the installed pumping units, to be selected by the Construction Manager, to confirm the torsional natural frequency results of the original mass elastic system design. The torsional vibration test shall be conducted with transducers suitable for narrow band spectrum analysis, including strain gauges, magnetic or optical pulse demodulation, or shaft position encoders. If the torsional vibration test should reveal any anomalies that cause the equipment to be out of compliance with the requirements of this section, the design professional shall conduct torsional vibration tests on all other like pumping units and submit a comprehensive report, sealed and signed as specified above, detailing the reasons for failure to comply with these specifications and recommendations for attaining compliance. The design professional shall consider all feasible options for compliance and shall provide detailed descriptions of the modifications required to achieve the required performance. Those recommendations accepted by the Construction Manager shall be implemented by the Contractor at no cost to the Owner.

5. METHODOLOGY:

a. LATERAL ROTOR DYNAMIC ANALYSIS: The rotor dynamic analysis shall follow the procedure prescribed in Corbo and Malanoski, 1998, and shall include the following features:

1) The procedure shall consider all speeds required to operate the equipment within the envelope of specified continuous operating conditions specified.

2) The procedure shall produce Campbell diagrams for the proposed operating conditions depicting all potential sources of excitation to check interference with all relevant

frequencies up to, and including, not less than 6 times (6X) operating speed.

3) For all pumps, the analysis shall also consider vane pass excitation at rev/2.

For column type pumps only, the procedure shall consider variations in assumed coefficients for seal and wearing ring clearances (Lomakin effect), bearing stiffness and damping, rotor imbalance (up to 10 percent of rotor disc weight at each disc position), impeller destabilizing forces, rotor shaft bending, hydraulic imbalance at not less than five operating conditions within the envelope of continuous operating conditions specified in addition to the specified continuous operating conditions.

Unless specifically accepted by the Construction Manager, the range in variation of component characteristics shall comply with the ranges recommended in Corbo and Malanoski, 1998.

4) The mathematical modeling tools to be employed for the analyses and the procedure to be used shall be as described in the references specified in paragraph 11050-1.05.B.5.a, Item 3) with the following modifications:

a) The mathematical model of the rotating element shall be built on a rotordynamics code such as FEATURE or DYROBES. Use of a finite element modeling program for this purpose will be unacceptable. The model shall specifically be constructed to contain axisymmetrical models of the rotor and casing. This model shall be used to determine the natural frequencies of the rotating elements.

b) A finite element code such as NASTRAN or ANSYS shall be used to construct three dimensional models of the casing and support structures for the equipment furnished under this contract. This model shall be used to determine the natural frequencies of the support structures and casing as well as the pump bearing frames.

c) The axisymmetrical model shall then be adjusted, preferably by changing component materials or sizes, or by changing component type, until its output frequencies agree with the models constructed under b).

5) Physical adjustments to provide the required characteristics shall be preferably by changes in component dimensions and secondarily by providing torsionally resilient dampening devices such as fluid-damped couplings or all metallic couplings such as manufactured by Bibby and Holset. Couplings or dampeners using rubber or similar elastic materials shall not be used.

6) The final report shall include three-dimensional graphic presentation of frame and shaft distortion and rotor element performance at identified critical speeds within the pump's operating range.

b. TORSIONAL DYNAMIC ANALYSIS: The methodology used for evaluation of the mass elastic system and shaft combined stresses shall follow the approach prescribed in Corbo and Malanoski, 1996, using either the Matrix-Eigenvalue or Holzer methods for determining natural frequencies. The computer analysis results shall be verified by hand calculations for the fundamental frequency and for mode shapes. Exciting frequencies to be considered during the analysis shall be 0.5, 1, and 2 times running speed, vane passing frequencies and twice vane passing frequencies for the pump impeller/cutwater-diffuser vane combinations, line and twice line frequency, motor pole frequency and motor starting transients. Forcing function magnitudes used for the analysis shall be not less than 10 percent of the maximum transmitted torque. The analysis shall also include evaluation of control pulse frequencies induced by variable frequency drives or engine power stroke frequencies, if provided as part of the specified system. The analysis report shall include a statement produced by the variable frequency drive manufacturer detailing all control pulse frequencies generated by the equipment between 1/4 and 18 times motor running speed.

Unless otherwise justified by documentation supported by independent studies, the analysis procedure shall use the range of factors recommended in Corbo and Malanoski, 1996. The Contractor shall produce a Campbell-type interference diagram showing the relationship between operating range, natural frequencies and exciting frequencies with all relevant frequencies up to, and including, not less than 6 times (6X) operating speed. The stress analysis procedure shall be based upon a finite element analysis technique using a digital computer program that has been field calibrated with not less than five similar installations

The analysis shall include a time-integration study showing transient peak stresses resulting from startup, shutdown and motor control transients if synchronous drives are specified. The diagrams shall include calculated stresses throughout the range of frequencies considered in the analysis. Tomographic diagrams, displaying colorimetrically stresses at all positions in the

pump shaft and all frames, including roots at changes in section and keyways or other stress concentrating locations, shall be provided with the analysis report. The diagram shall indicate operating speeds identified that produce the peak stresses and shall be specific for speeds inducing identified peak stresses at keyways, changes in section and at connections to other components. The reported stresses shall be combined stresses incorporating all identified loads from torsional, lateral and hydraulic sources.

c. SHAFT RADIAL LOAD AND DEFLECTION: Calculation of radial thrust loads shall be performed in accordance with the methodology set forth in ANSI/HI 1.3, paragraph 1.3.5.1. Shaft deflection calculations shall be performed in accordance with ANSI/HI 1.3.5.4. Shaft deflection criteria and limits shall be as required by API 610 (ISO 13709). Calculations justifying the shaft and bearing sizes (selected in accordance with the requirements of this Section, performed at 0%, 20%, 40% 60%, 80% 100% and 120% of BEP Flow and head shall be submitted with the information specified under paragraph 11050-1.08.

C. SUCTION WELLS FOR COLUMN PUMPS:

1. GENERAL: This paragraph applies where the detailed specification requires a column type pump to be installed in a suction or inlet well.

2. REQUIREMENTS: Where the detailed specification requires a column type pump to be installed in a suction or inlet well, the Contractor shall cause the well to be designed and provided by the pump manufacturer. The design shall include an arrangement that results in acceleration of flow down the suction well and into the cone. These provisions, however, shall not be construed as relieving the Contractor of responsibility for this portion of the work. Inlet wells shall be designed in accordance with the requirements of ANSI/HI 9.8 and design documentation shall be provided as a part of the information to be submitted under paragraph 11050-1.08.

3. MODEL TESTING: The Contractor shall cause the pump manufacturer to verify the design of suction or inlet wells for pumps meeting the Size Threshold Criteria by physical model tests conducted in accordance with ANSI/HI 9.8. Acceptance criteria for design confirmation and final report of the model study shall be as set forth in ANSI/HI 9.8.

The physical modeling effort shall be the product of a commercial hydraulics laboratory specializing in physical model studies of this type. Hydraulics laboratories associated with colleges or universities and pump manufacturer's hydraulics laboratories are specifically prohibited from providing this service. All development work required for the conduct of the study shall be under the direct supervision of an engineer licensed to practice in at least one of the states comprising the United States of America, hereinafter called 'the design professional' for the purposes of this paragraph. The design professional shall have not less than 10 years experience in hydraulic modeling of pump intake designs of at least the magnitude required by these specifications, using physical modeling techniques. Computation Fluid Dynamics (CFD) modeling techniques are not an acceptable substitute for the requirements of this paragraph. The final report, describing the work performed and the results and recommendations arising out of the study, shall bear the original seal and signature of the design professional.

1.06 QUALITY ASSURANCE – ALL PUMPS

A. QUALITY CERTIFICATION:

All manufacturers and manufacturing sites proposed by the Contractor for supply of equipment furnished under this section and sections referencing this section shall hold current certification under ISO 9001. Application for certification under ISO 9001 shall not be deemed as an acceptable substitute for current certification. Documentation attesting to current certification shall be signed by an officer of the manufacturer's corporation and shall be notarized. The documentation shall also include the manufacturer's written Quality Assurance/Quality Confirmation (QA/QC) program and the documentation plan necessary for ISO 9001 certification.

B. UNIT RESPONSIBILITY:

The Contractor shall assign Unit Responsibility to the pump manufacturer in conformance with the requirements of Section 11000.

C. PERFORMANCE CONFIRMATION:

1. HYDROSTATIC TESTS: All pressure sustaining parts shall be subjected to factory hydrostatic tests. Hydrostatic tests shall conform to the requirements of paragraph 8.3.2 of ANSI/ ANSI/API 610. Castings shall be held at the test pressure for 30 minutes for all pumps with discharge nozzles 14 inches in diameter and less and for 60 minutes for pumps with discharge nozzles 16 inches in diameter and greater. Test results shall be certified correct by an officer of the pump manufacturer's corporation, and shall be notarized.

2. PERFORMANCE GUARANTEE: Unless specified otherwise in the detailed specification, pump performance (flow and head, efficiency and NPSH3) shall be guaranteed by the pump manufacturer to the criteria specified under this paragraph.

Equipment performance documentation, including test data, where tests are specified, shall include sufficient test points (not less than 8) to document hydraulic performance along the complete head/capacity curve from shutoff to maximum capacity and shall cover all full speed operating points specified in the detailed specification section referencing this Section. Tests conducted at specified operating conditions shall be the inlet throttled to product the NPSHA indicated for that specific condition in the detailed specification. NPSH3 tests shall be performed for not less than four full speed operating conditions, but not less than all specified operating conditions and at Best Efficiency.

Test procedures shall conform to those set forth in ANSI/HI 14.6 acceptance grade 1E, and as specifically detailed in these specifications. Performance tests shall be conducted at the specified maximum speed. Affinity relationship-predicted test results will not be accepted. For column type pumps, performance documentation shall include curves showing both bowl efficiency and overall efficiency (including inlet, bowl, column and discharge head losses) at maximum operating speed for the application.

Acceptance criteria for head and capacity test results, based upon the rated condition specified in the detailed specification shall be as required in ANSI/HI 11.6 and 14.6, acceptance grade 1E.

Acceptance criteria for NPSH3 at any specified operating condition shall be the values proposed by the Contractor in the submittal curves submitted under paragraph 11050-1.08 and duly accepted by the Construction Manager, with a tolerance of plus 0, minus unlimited, with the exception that suction specific speed, as calculated for the specific pump, shall not exceed the limitation established under paragraph 11050-1.04.B.

The guarantee shall include a statement to the effect that the pump will operate within the operating regions specified in the detailed specification. The guarantee shall be in writing, shall be signed by an officer of the manufacturing corporation, and shall be notarized. Under no circumstances shall deviations from specified operating conditions result in overload of the driver furnished with the equipment, nor shall such deviations result in power requirements greater than the driver's nameplate (1.0 service factor) rating.

3. NON-WITNESSED TESTS: Unless specified otherwise, all pumps shall be performance tested in accordance with ANSI/HI 14.6, Acceptance Grade 1E. The factory tests shall include test data for each full speed performance requirement (Condition Points A and B specified in the detailed specification) and any other points stipulated for this test procedure in the detailed specification. These tests shall be conducted with the pump inlet throttled to provide the specified NPSHA. For large column pumps, model performance testing with reduced NPSHA, pursuant to paragraph 11050-1.07.B.2, may be used. If specified in the detailed specification, test data at the full speed operating conditions shall include shaft vibration and case noise.

The test setup in the manufacturer's test facility shall duplicate as closely as possible the inlet conditions in the proposed installation, using temporary baffles and other means. Where centrifugal pumps are furnished with inlet elbows, inlet adapters or inlet reducers, the pumps shall be tested with the elbow, adapter or reducer fitted to the pump and specified performance criteria shall apply to the complete pump assembly, including losses through any elbow, adapter or reducer. Where submersible pumps are to be furnished with inlet nozzles and/or discharge elbows or adapters, the pumps shall be tested with these components fitted to the pumps. The specified performance requirements shall apply to the complete pumping assembly including any inlet nozzles, and discharge elbows or adapters. Certified test data shall include separate readings for inlet and discharge head for each data point.

Not less than eight test points shall be taken, including not less than three within ± eight percent (in terms of rated flow) of the rated condition (Condition Point A) and not less than two test points within ±4 percent of the pump's best efficiency point at the test speed. In addition, one test point shall be sufficient to define head and power requirements at shutoff head.

NPSH3 tests shall be performed to confirm the data used to establish NPSHA margin for each specified operating condition as specified in paragraph 11050-1.04.F. NPSH3 tests for column type (axial and mixed flow and vertical turbine) pumps shall be performed using the

method described for Figure 2.74 or Figure 2.75 in ANSI/HI 2.6. NPSH3 tests for submersible wastewater pumps shall be performed using the method described in Figure 11.6.8 in ANSI/HI 11.6. All NPSH3 tests shall extend from 30 percent to 140 percent of Best Efficiency Flow at full speed, or to not less than 10 percent (in terms of flow) past the flow at Operating Condition B, whichever is greater. Failure to achieve specified performance or performance proposed in accepted submittal documents (capacity and head, efficiency or NPSH3), whichever is more restrictive, shall be cause for rejection. Acceptance tolerances shall be as set forth in paragraph 11050-1.06.C.2.

All test procedures shall be in strict conformance with the referenced standards, except prediction of performance of a trimmed impeller from test data of the larger impeller will not be permitted. If trimming is required, the pump shall be retested. Under no circumstances shall deviations from specified operating conditions, though allowed by the referenced standards, result in overload of the driver furnished with the equipment, nor shall such deviations result in power requirements greater than the driver's nameplate (1.0 service factor) rating.

The Contractor shall furnish the Construction Manager with not less than two weeks' advance written notice of the date and place of the non-witnessed tests.

All test results, including test logs and generated curves, shall be certified correct by an officer of the pump manufacturer's corporation and shall be notarized. Contractor shall submit test results as Product Data.

1.07 QUALITY ASSURANCE – ADDITIONAL REQUIREMENTS

A. SCOPE:

In addition to the requirements under Section 11050-1.06 applicable to all pumps, the following are required for the subset of larger and custom engineered pumps defined in Section 11050-1.01.A.

B. PERFORMANCE TESTING:

1. WITNESSED TESTS: All custom engineered pumps, and other pumps where required by the detailed specification, shall be subject to a witnessed performance test in accordance with ANSI/HI 14.6, Acceptance Grade 1E. The factory tests shall include test data for each full speed performance requirement (Condition Points A and B specified in the detailed specification) and any other points stipulated for this test procedure in the detailed specification. These tests shall be conducted with the pump inlet throttled to provide the specified NPSHA. For large column pumps, model performance testing with reduced NPSHA, pursuant to 11050-1.07.B.2, may be used. If specified in the detailed specification, test data at the full speed operating conditions shall include shaft vibration and case noise.

The test setup in the manufacturer's test facility shall duplicate as closely as possible the inlet conditions in the proposed installation, using temporary baffles and other means. Where centrifugal pumps are furnished with inlet elbows, inlet adapters or inlet reducers, the pumps shall be tested with the elbow, adapter or reducer fitted to the pump and specified performance

criteria shall apply to the complete pump assembly, including losses through any elbow, adapter or reducer. Where submersible pumps are to be furnished with inlet nozzles and/or discharge elbows or adapters, the pumps shall be tested with the inlet nozzles or adapters and the specified performance requirements shall apply to the complete pumping assembly including any inlet nozzles, and discharge elbows or adapters. Under no circumstances shall NPSHA exceed that specified in the detailed specification during any performance test. Certified test data shall include separate readings for inlet and discharge head for each data point.

Not less than eight test points shall be taken, including not less than four within ±8 percent (on the basis of rated flow) of the rated condition (Condition Point A) and not less than two test points within ±4 percent of the pump's best efficiency point at the test speed. In addition, one test point shall be sufficient to define head and power requirements at shutoff head.

NPSH3 tests shall also be performed to confirm the data used to establish NPSHA margin for each specified operating condition as specified in paragraph 11050-1.04.F. NPSH3 tests for submersible wastewater pumps shall be performed using the method described in Figure 11.6.8 in ANSI/HI 11.6. All NPSH3 tests shall extend from 30 percent to 140 percent of Best Efficiency Flow at full speed, or to not less than 10 percent (in terms of flow) past the flow at Operating Condition B, whichever is greater. Failure to achieve guaranteed performance or performance proposed in accepted submittal documents, whichever is the more restrictive (capacity and head, efficiency or NPSH3) shall be cause for rejection. Tolerances and restrictions shall be as set forth in paragraph 11050-1.06.C.3, above, for non-witnessed tests.

The Contractor shall furnish the Construction Manager with not less than two weeks' advance written notice of the date and place of the witnessed tests.

2. MODEL TESTS: Where allowed in the detailed specification or upon specific application with adequate justification by the manufacturer, confirmation of performance of large pumps may be demonstrated by testing the prototype at reduced speed or by testing a model of the prototype pump. NPSH3 tests shall also be performed to confirm the data used to establish NPSHA margin for each specified operating condition as specified in paragraph 11050-1.04.F. Failure to achieve guaranteed performance (capacity and head, efficiency or NPSH3) shall be cause for rejection. Physical model testing shall be performed at qualified, commercial facilities, with at least 10 years of continuous operation. All tests shall be conducted in accordance with ANSI/HI 1.6 or 2.6. with the following restrictions:

a. If the prototype is tested at reduced speed the ratio of test speed to prototype speed shall not be less than 0.66:1.

b. Model test ratios shall not be less than 0.33:1, model to prototype.

c. Impellers for model tests shall be not less than 12 inches in diameter.

d. Impellers for prototype pumps shall be subject to a model-to-prototype profile comparison using templates ratioed from the

impeller used for the completed and accepted model test. Impeller profiles shall be compared for the x, y and z planes. If model testing is proposed for any or all of the specified tests, the Contractor shall include the proposed methodology for profile confirmation as a part of the submittal material required under paragraph 11050-1.08. Impeller profile comparison shall be performed with a representative of the Construction Manager present. All costs associated with travel and subsistence of the Construction Manager's representative shall be borne by the Contractor.

e. Acceptance criteria, based upon projected prototype performance from model test results using Hydraulic Institute approved affinity relationships, shall be as set forth above under paragraph 11050-1.06.C. 3.

f. Restrictions set forth above for witnessed tests shall apply.

The Contractor shall furnish the Construction Manager with not less than two weeks' advance written notice of the date and place of the model tests.

3. TEST CERTIFICATION AND REPORTING: All test results, including test logs and generated curves, shall be certified correct by an officer of the pump manufacturer's corporation and shall be notarized. Contractor shall submit test results as Product Data.

C. CONFIRMATION OF PASSAGE GEOMETRY:

For solids handling pumps, the design waterway passages and mating passages between rotating and stationary portions of such passages shall be subjected to confirmation that no mismatch of exiting and entering angles or angular discontinuities exist in all pumps furnished under specification sections containing the words 'Custom Engineered' in the title and/or all pumps meeting the Size Threshold Criteria (paragraph 11050-1.01.B.5). The confirmation process shall employ Computational Fluid Dynamics (CFD) modeling techniques in which mesh generation is optimized and mesh size reduce in the regions of flow attachment, detachment and separation regions of the impeller and cutwater to detect angular mismatches of 0.25 degrees or greater.

A number of different convergence criteria shall be used to assess whether or not a solution is converged. These criteria may include, the residuals given by the software, global imbalances in momentum, energy etc, whether key global quantities have reached an equilibrium value, and whether information from various solution monitoring points have stabilized. Note that these monitoring points should be in areas where the flow could be much weaker, and not where the flow could be converged easily. High convergence criteria shall be utilized and runs shall be repeated with different monitoring points to assure proper convergence.

The modeling software shall be one that is professionally customized and optimized for the determination pump fluid dynamics especially flow attachment, detachment and separation. The mathematical model and software accuracy shall be verified by experimental data from test cases including similar dynamics. The individual conducting the modeling effort shall be a computational fluid dynamics specialist with graduate level education in the subject and over 5 years of relevant experience. The model graphic outputs, signed and notarized by the pump manufacturer's officer in charge of engineering, shall be submitted as a part of the documentation required under paragraph 11050-1.08.

1.08 SUBMITTALS

In addition to the material listed in the detailed specification, the following submittals shall be provided in accordance with Section 01300:

1. Documentation of successful pump designs as specified under paragraph 11050-1.04.B.1. If included as part of the design, the documentation shall include applications where pump cans of a similar size have been provided as part of the design.

2. Certificate of Unit Responsibility attesting that the Contractor has assigned unit responsibility in accordance with the requirements of this section and paragraph 11000-1.02.C. No other submittal material will be reviewed until the certificate has been received and found to be in conformance with these requirements.

3. A copy of this specification section and the referencing section and all other applicable specification sections governing the pump, drive and driver, supports and specified appurtenances. The specification copies shall be complete with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check-marks shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

4. A copy of the contract document control diagrams and process and instrumentation diagrams relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the

submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.

5. Documentation of certification in accordance with ISO 9001 as specified under paragraph 11050-1.06.A.

6. Predicted pump performance curves for each condition point specified showing head, power, efficiency, and NPSH required on the ordinate plotted against capacity (in mgd) on the abscissa. Curves for variable speed pumps shall be provided to demonstrate operation at all speeds required to achieve the specified reduced speed operating conditions. All curves shall clearly display the specified operating conditions and the manufacturer's limits for the POR and AOR, as specified in paragraph 11050-1.04.B. Curves for column type pumps shall show bowl efficiency and allowances for inlet, column and discharge head losses separately.

7. NPSH margin calculations performed for each specified operating condition in accordance with paragraph 11050-1.04.F.2 or .3 as applicable and including the information required under paragraph 11050-1.04.F.1.

8. Motor submittal information as specified in Section 11060. In addition, this information shall include certified calculations for motor rotor and frame reed frequencies, as specified under paragraph 11050-1.04.G.

9. Complete description and sketch of proposed test setup for factory test if a factory test has been required under the detailed specification section. Submittal material shall include sample calculations and proposed test log format. If the Contractor proposes a model test for a part or all of the specified performance tests, the submittal information shall include the proposed model details and a complete description of the proposed method for comparing the model impeller profiles with the impeller profiles for the prototype pumps.

10. Drawings showing general dimensions and confirming the size of pumps, motors, drives and specified appurtenances; piping connections; construction details of equipment (including bearings and bearing isolators); wiring diagrams; and weight of equipment.

11. Variable-speed drive information as required under Section 11069 if the equipment specified includes variable speed capability.

12. Driver unit support calculations and data if the driver is separately supported and if the analysis under the requirements of paragraph 11050-1.05.B. has been required by the terms of these specifications.

13. If shaft deflection calculations have been required by the terms of these specifications, provide calculations to demonstrate compliance with paragraph 11050-1.04.E, per the methodology set forth as required by Section 11050-1.05.B.5.c.

14. Detail drawings of the pump and driver unit foundation demonstrating conformance to this Section and Section 11002. Submittal shall include drawings depicting type, size, number, projection, and arrangement of anchor bolts, dimensional drawings of the sole and baseplates, dimensional drawings for the concrete supports for both the pump and motor, if applicable. Drawings shall also depict all other pertinent information, including: location of equipment pads and reinforcement; equipment drains; expansion joint locations; elevation of top of grout and grout thickness; elevation of top of baseplate; soleplate; or mounting block; size and location of electrical conduits; and any other equipment mounting features embedded in equipment pads.

15. Limiting nozzle loading criteria, if different from that established by ANSI/HI 9.6.2.

16. The qualifications of the independent testing laboratory and individual personnel proposed by the Contractor to perform field vibration testing, analysis and reporting in accordance with the requirements of paragraph 11050-3.06.

17. The qualifications of the personnel proposed by the Contractor to perform field alignment procedures in accordance with the requirements of paragraph 11050-3.04.

The following are applicable for pumps meeting specified applicability criteria:

1. Qualifications of the design professional, and firm name, proposed to perform the mass elastic design analyses specified under paragraph 11050-1.05.B. if the subject analyses are required by the terms of these specifications.

2. Notarized certification attesting that the firm proposed to perform the mass elastic design analyses specified under paragraph 11050-1.05.B has no contractual arrangements with the proposed pump manufacturer.

3. Descriptive material outlining the methodology and software to be used in the analyses required under paragraph 11050-1.05.B.

4. "Executive Summary" report of the mass elastic design analyses for pumps as specified in paragraph 11050-1.05.B.

5. The proposed instrumentation setup for the in-situ torsional vibration test specified under paragraph 11050-1.05.B.4.d.

6. Suction or inlet well design documentation specified under paragraph 11050-1.05.C.2, including bolt patterns for pump base and soleplate on suction or inlet well.

7. Final report of the model study specified under paragraph 11050-1.05.C.3.

8. Model graphic outputs specified in paragraph 11050-1.07.C.

PART 2--PRODUCTS

2.01 MATERIALS

A. GENERAL:

Where this section and sections referencing this section are silent with respect to materials of construction on any component, material selection shall follow the requirements of Table H.1, ANSI/API 610, Materials Class I-1, with the exception that all shafts for vertical column type pumps shall be 12 percent chromium stainless steel. Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The Contractor may propose alternative materials for the purpose of providing greater strength or to meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose.

B. PUMPS:

1. FINISH FOR SURFACES IN CONTACT WITH PUMPED FLUID: All pump components in contact with the pumped fluid shall conform to the following requirements.

Surfaces to be machine-finished shall be indicated on the shop drawings by symbols which conform to ANSI B46.1, Surface Texture, Surface Roughness, Waviness and Lay. Machine surfaces shall be finished to at least the following tolerances (SI units):

Nominal Roughness:

Surface	Grade, Ref: ANSI B46.1 (SI units)
General Machine Work	3.2 or better
Flange Faces	3.2
Journal Surfaces at Sleeve Bearings	0.4
Hydraulic Surfaces	
Impeller	4.5 or better
Impeller Bowl and Diffuser	3.2 or better

All other wetted surfaces	6.3 or better

Flaws such as scratches, ridges, holes, peaks, cracks or checks which will make the part unsuitable will be cause for rejection. Machine finished surfaces shall be thoroughly cleaned and coated with protective layer of rust preventive. Small pieces, unassembled pipe or finished bolts, shall be oiled and wrapped with moisture resistant paper.

2. MATERIALS: Unless otherwise specified, wetted cast iron parts for pumps for solids bearing liquid services shall have 2 to 3 percent nickel added to the cast iron.

Stainless steel impellers shall be provided for the first stage of all custom engineered pumps, pumps intended for pumping screened or unscreened wastewater and elsewhere when specified. Stainless steel impellers shall be cast duplex stainless steel conforming to ASTM A995, Grades 2A, 3A, or 6A, with Charpy impact energies greater than 40 ft-lbs at -40°C per ASTM A923 method B. Where cast nickel aluminum bronze (C95800) impellers are specified, the materials shall conform to ASTM B148. Unless otherwise specified, second and successive stage impellers on multistage column pumps may be porcelain coated cast iron or bronze.

Materials for all shaft sleeves for packed boxes, fretting seals and interstage seals shall conform to ANSI/API 610, Annex H; 12 percent chromium hardened; or hard-faced 316 austenitic stainless steel. Materials for seal glands for packed boxes and shaft sleeves shall be AISI 316 stainless steel. Fastener parts of all types in wetted areas shall conform to ANSI/API 610, Materials Class S-5 requirements. Regardless of the seal construction, all seal chambers shall be adequately sized to accommodate specified mechanical seals.

C. FLYWHEELS:

Where flywheel assemblies are to be provided with the pumping equipment, pump pressure containing parts shall be of ductile iron conforming to ASTM A571. Materials of construction for the flywheels shall be as follows:

Frame:	Steel, ASTM A-36, welded and stress relieved.
Shaft:	Alloy Steel, ASTM A322, Grade 4142 HT, ST, BHN 375-388 for shafts 3.5 inches in diameter and less; Stainless steel, ASTM A564, Type 630 HT, Condition H1150 for shafts larger than 3.5 inches in diameter.
Rotor :	Steel, ASTM A36, or cast steel, ASTM A27 for flywheels 3 feet in diameter or less; Cast steel, ASTM A148 for flywheels greater in diameter than 3 feet. All stress relieved after machining.

2.02 GENERAL QUALITY

Details of manufacture and assembly of equipment furnished under this section and referencing sections shall follow the requirements of ANSI/API 610 with respect to the following features (paragraph references, ANSI/API 610):

1. Alignment aids (paragraph 6.1.24).

2. Removal of rotating element (paragraph 6.1.25).

3. Jackscrews for assistance in alignment on all baseplates and equipment supports (paragraph 9.3.8.3.2).

4. Castings (paragraph 6.12.2).

All components or subassemblies weighing 50 pounds or more shall have at least one lifting eye or a provision for threading in a lifting eye. Components 250 pounds or greater shall have lifting eyes or provisions for at least two lifting eyes. Components 1000 pounds or greater shall have at lest 3 lifting eyes or provisions for inserting lifting eyes.

2.03 BASEPLATES AND SOLE PLATES

Unless otherwise noted in the detailed specification, all pumps shall be furnished by the pump manufacturer with baseplates or soleplates conforming to the requirements of Section 11002. Baseplates and sole plates shall be designed to be installed in the housekeeping curb shown and shall be machined flat and co-planar to within 0.002 inch per foot in all directions on the face mating with the pump and motor or driver support. Sole plates shall have the words "THIS SIDE DOWN" permanently affixed to the underside using welding rod material prior to milling. Alternative marking methods, using heavy scribing or machining, are acceptable provided that they may be observed following blasting in preparation for coating.

2.04 WEARING RINGS

Where specified, pumps shall be fitted with both stationary and rotating wearing rings. Except for the difference in hardness between stationary and rotating rings, wearing rings shall be of stainless steel and shall conform to the requirements of ANSI/API 610, paragraph 6.7 and material class S-8 (Table H.1, Annex H). Maximum wearing ring clearances shall not exceed 150 percent of the values stated in Table 6, ANSI/API 610. Minimum wearing ring hardness on the rotating ring shall be 350 Brinnel Hardness Number (BHN), with the stationary ring not less than 100 hardness points greater.

L-form wearing rings are not acceptable for wastewater, sewage, stormwater, thickener overflow, mixed sludge, digester circulation, digested sludge, waste activated sludge, return activated sludge or primary effluent pumping service.

2.05 BALANCE

Balancing for pumps with suction nozzle sizes 6 inches in diameter and greater and all associated components shall conform to the requirements set forth in ANSI/API 610, paragraph 6.9.4.1 (equivalent to ISO 1940 or ANSI 2.19 Grade 2.5), unless other portions of this project manual impose more restrictive requirements. It is the intent that the components be balanced as an assembly ("rotor") in accordance with ANSI/API 610 definitions. For extended shaft pumps, balance impeller(s) and shaft up to the first coupling with the line-shaft.

For separately balanced components, perform a residual unbalance inspection after rotor assembly per ANSI/API 610 requirements, as described in Annex J of that document. Provide copies of worksheets and demonstrate that tolerances are in compliance (i.e. rotor has passed) in addition to other reporting requirements of this paragraph.

All balance logs, certified correct and signed by an officer of the manufacturing corporation and notarized, shall be furnished as Product Data in accordance with paragraph 11050-2.09.

2.06 DRIVE UNIT SUPPORTS FOR SEPARATELY SUPPORTED MACHINES AND INTERMEDIATE SHAFT SUPPORTS

Supports for separately mounted vertical pump drivers and intermediate shaft bearings shall be composite structures of fabricated steel, ASTM A36. Unless otherwise specified, the supports shall be designed to span an opening in the floor sufficient to allow removal for the complete pump. Rolled steel beams shall be provided to stiffen the support and a fabricated steel driver unit support pedestal shall be mounted on the support plate. The support pedestal top plate and all portions of the support plate assembly intended to join with surfaces in the installation structure shall be milled flat and parallel to 0.002 inches per foot. Pedestals shall be provided with access provisions to adjust or assemble/disassemble couplings. The support shall be designed to be supported on a sole plate or sole plates embedded in a house keeping pad at the edges of the floor opening or as indicated. Other details for the driver unit support shall be as indicated.

2.07 FLYWHEEL ASSEMBLIES

When a flywheel assembly is specified, the moment of inertia (WR^2) of the rotating element for each complete motor/pump set, including entrained water, pump rotor, shafting, couplings, and motor rotor shall be adjusted to provide the value specified in the detailed specification by providing a flywheel.

The flywheel shall consist of cast or fabricated steel weight in the form of a torus with supporting struts, keyed and locked on a shaft supported by bearings at each end of the shaft. Flywheels with diameters greater than three feet shall be double keyed to the shafts. If cast construction is used, the struts and weight shall be cast as a unit. The flywheel shall be designed and fabricated for a coefficient of fluctuation no larger than 0.05. A factor of safety of 5 shall be used for the ratio of operating speed to maximum safe operating speed. The lateral critical

frequency of the flywheel assembly shall be shall be higher than the maximum safe operating speed by a factor of 1.5.

If the weight is to be fabricated steel, it shall be machined from a single billet to the diameter and shape required. All flywheels (cast and fabricated alike) shall be stress relieved before balancing. The size of the weight and the distance of the torus centroid from the center of the shaft shall be sufficient to achieve the overall rotating moment of inertia (WK^2) specified for the pump rotating system. Cantilevered designs employing only one set of bearings will not be permitted in stand-alone flywheel assemblies. Flywheels mounted on the motor shaft and using the bearings of a custom designed drive motor may be of the cantilever type. The flywheel assembly shall be included in the lateral, torsional and rotordynamic analyses specified under paragraph 11050-1.05.B.

Bearings shall be selected in accordance with ABMA 9 or 11 for an L-10 life of not less than 100,000 hours. Input and output bearings shall be held in place by rigid fabricated steel struts. The entire rotating assembly shall be balanced in accordance with paragraph 11050-2.05.

The flywheel assembly shall be furnished with a fabricated steel enclosure designed to provide protection against accidental entry of tools or other objects and to provide enclosure protection in accordance with OSHA requirements. The flywheel enclosure shall have an outside width of at least that of the motor, but not greater than 110 percent of the motor's width. The housing shall match the quality of the motor enclosure and shall be equipped with at least two lifting eyes. A mounting pad shall be located on the upper portion of the flywheel housing to permit installation of the vibration detector specified in Division 17 or the referencing section. The flywheel bearing housings shall be supported independently by a rigid frame to maintain alignment.

Where horizontal flywheels are required, the flywheel assembly shall be mounted on a baseplate common with the pump and motor. Frames for horizontally mounted flywheel assemblies shall be fitted with mounting pads for bolting to the pumping unit baseplate. Sufficient space shall be provided on each pad to permit dowelling to the baseplate after final alignment. End plates shall be similar to those provided for the motor and shall provide complete closure to prevent incidental access to the flywheel. The flywheel input shaft shall be direct connected to the motor output shaft by means of a flexible coupling, and the output shaft shall be designed to accommodate the shaft spacer coupling specified.

Where vertical flywheel assemblies are shown supporting the electric motor, the frame shall be designed to support the weight of the motor in accordance with the design requirements of this section. The flywheel assembly frame shall be extended to carry a support plate which shall be rabbetted to provide self-aligning features with the motor base. The frame extension shall have access openings to permit assembly/disassembly of the motor output shaft coupling. The lower flywheel assembly end plate shall be finished flat for mating with the support pedestal on the driver unit support, if so mounted, or rabbetted for alignment with the pump drive shaft if mounted on a column pump discharge head.

Where vertical flywheel assemblies are mounted separately from the pump and motor, the lower end plate shall be finished flat. The input shaft shall be keyed for the specified flexible coupling and shaft guards shall be provided

2.08 INLET WELLS FOR COLUMN TYPE PUMPS

Unless specified otherwise, suction or inlet wells for column type pumps shall be fabricated from ASTM A36 steel with internal baffles fillet welded to the interior surface of the inlet well. Seal welds all around shall be provided at all welded joints and all welds shall be ground smooth. All internal surfaces shall be prepared and coated after welding with fusion-bonded epoxy conforming to the requirements of AWWA C213 using NSF/ANSI 61-compliant materials (3M Scotchkote 134, or approved equal). Minimum coating thickness shall be 12 mils. External epoxy coating shall be in accordance with Section 09900 requirements.

Where the detailed specification requires an inlet well suitable for service with an upstream hydraulic gradient in excess of the elevation required for the pump discharge head, the flanged connection to the pump discharge head shall be gasketed or fitted with a double O-ring seal designed to withstand not less than twice the pressure specified in the detailed specification.

2.09 MACHINING

All machined surfaces shall have a 90 micro inch Ra finish without any grooves, surface imperfections or machining marks of any sort. Mating surfaces shall be coplanar within a maximum of 0.001 inches. Surfaces that are in contact with a gasket such as flanges and casing joints shall have the customary concentric grooves pattern to increase leak path. Bearing housings and seals shall all have collinear centerlines within less than 0.001 inch total difference. Shafts shall have a 64 micro inch Ra finish.

2.10 PRODUCT DATA

The following information shall be provided in accordance with Section 01300.

1. Performance guarantee as specified in paragraph 11050-1.06.C.
2. Equipment anchor calculations specified in paragraph 11050-1.04 E.2.
3. Operation and maintenance information specified in Section 01730.
4. Motor Product Data as specified in Section 11060.
5. Bearing L-10 life calculations.
6. Critical speed calculations demonstrating compliance with paragraph 11050-1.05.B shall be provided if a lateral rotordynamic analysis is required. Otherwise, critical speed calculations demonstrating compliance with paragraph 11050-1.04.C shall be provided.

7. Nozzle loading information required under paragraph 11050-3.01.

8. Motor balance logs, certified and notarized as specified in paragraph 11050-1.04.G.3.

9. Certified balance logs and worksheets, as specified in paragraph 11050-2.05.

10. Installation Certification Form 11000-A as specified in paragraph 11050-3.01.

11. Training Certification Form 11000-B as specified in paragraph 11050-3.08.

12. If factory tests are specified in the detail specification section, certification of satisfactory testing of each unit as specified. The certified material shall include copies of test logs and resulting performance curves.

13. Documentation of field alignment data in accordance with Section 11005.

The following are applicable for pumps meeting specified applicability criteria:

1. Results of model tests for pump inlet wells if model tests are required by the provisions for paragraph 11050-1.05.C.

2. "Final Report" of mass elastic systems analyses for pumps as specified in paragraph 11050-1.05.B.

3. Results of motor rotor, frame and assembly bump tests, certified as specified under paragraph 11050-1.04.G., along with the design professional's "Supplemental Report" as specified under paragraph 11050-1.05 B.2.

4. Pump inlet well installation acceptance certification, as specified in paragraph 11050-3.03, if applicable.

5. Results of field vibration tests as specified under paragraph 11050-3.06.

PART 3--EXECUTION

3.01 GENERAL

With the exception of submersible pumps and the inlet connection for column type pumps installed in open forebays or wet wells, all pump inlet and discharge nozzles shall be

connected to field piping using equipment connection fittings conforming to the requirements of Section 15085. Restraining rods on equipment connection fittings shall be designed specifically to restrain the unbalanced hydraulic thrust developed by the pump when operating at full speed against a closed valve. All restraining rod nuts shall be torqued to assure that any moment or shear transmitted to the pump nozzles is within the values permitted under ANSI/HI 9.6.2 or that permitted by the equipment manufacturer, whichever is greatest. Where ANSI/HI 9.6.2 is silent with respect to any particular aspect of allowable nozzle loads, the Contractor shall follow the written requirements provided by the equipment manufacturer. Equipment meeting the Size Threshold Criteria shall be installed under the presence of a factory authorized installation specialist or specialists. Under no circumstances shall any installation procedures take place without the installation specialists present. Equipment installation procedures shall conform to the requirements of Section 11002. Upon completion of installation work, the Contractor shall submit a complete, properly signed certification Form 11000-A as specified in Section 01999.

3.02 SOLE PLATES

Sole plates, if provided as required by this section, or any section referencing this section, or where required by the equipment manufacturer's recommendation, shall be leveled in the presence of a factory authorized installation specialist to a maximum tolerance of 0.002 inches/foot in all directions. Where the equipment manufacturer requires more stringent tolerances, those tolerances shall prevail.

3.03 PUMP INLET WELLS

When specified, pump inlet wells shall be installed as indicated to the following tolerances:

Horizontal position:	± 0.125 inches in all directions
Vertical axis:	within ½ degree from vertical
Level:	0.02 inches per foot of diameter at the pump baseplate bolt circle
Elevation:	± 0.125 inches from planned elevation

Where the equipment manufacturer requires more stringent tolerances, those tolerances shall prevail.

Installation of equipment in pump inlet wells shall not take place until the pump manufacturer's factory trained and authorized installation specialist has furnished the Construction Manager with written and signed certification that the inlet well has been installed satisfactorily and is acceptable for installation of the equipment.

3.04 ALIGNMENT

Journeymen millwrights shall perform alignment of equipment furnished under this section and any referencing section. Carpenters, laborers or any other trades are specifically excluded from performing this work. In locations where such trades are not available, the Contractor shall retain the services of a firm specializing in this type of work to perform the setting and alignment work. The Contractor shall submit the qualifications of the proposed firm to the Construction Manager for acceptance prior to performing the work. The Construction Manager shall personally witness final alignment procedures for each item of equipment as a condition precedent to beginning any work required under Section 01660. Alignment techniques shall conform to the requirements of Section 11005.

3.05 FIELD TESTING

Field testing shall conform to the requirements of Section 01660. For all units meeting the Size Threshold Criteria, the testing procedure shall be a plan developed jointly by the Contractor and the equipment manufacturer to demonstrate performance of each item of equipment at all specified operating conditions.

Field testing may include vibration and torsional vibration testing, as applicable.

3.06 FIELD VIBRATION

Vibration shall be measured in accordance with ISO 10816 for all pumps meeting the Size Threshold Criteria. An independent testing laboratory specializing in this work, retained by the Contractor but acceptable to the Construction Manager, shall perform the measurements and shall submit the results directly to the Construction Manager.

The independent laboratory shall provide the services of a vibration specialist to supervise all data collection work, analysis and reporting, and who shall hold a current certificate as an ISO qualified - Level IV Vibration Analyst as recognized by the Vibration Institute. Data collection and analysis shall be conducted by the vibration specialist or may be conducted by an individual holding a current ISO Level III Vibration Analyst certificate with vibration specialist oversight.

The independent testing laboratory shall be fully equipped to provide continuous velocity and displacement values for all rotating equipment installed under the requirements of this section. Vibration testing equipment shall include sufficient calibrated pressure and flow monitoring devices to determine pump operating conditions as well as vibration levels. RMS vibration velocity on any component when the pump is operating at any specified continuous duty operating condition shall not exceed the limits established for the appropriate machine by Tables 8 and 9 in ANSI/API 610 when the pump is operating within the manufacturer's listed POR. Field vibration for custom engineered column type vertical pumps and motors shall not exceed 2.5 mils peak to peak RMS when the pump is operated at any capacity condition within 85 percent and 115 percent of the pump's capacity at full speed, when measured at the top of the

pump motor. When operating at any combination of conditions outside the POR for any pump, regardless of type, limiting values shall be 25 percent greater than the above limits.

Vibration test reports shall be submitted as Product Data, directly to the Construction Manager, and shall bear the signature of the responsible vibration specialist. Vibration spectra shall be of sufficient resolution for legibility of magnitude and frequency data to be properly reviewed by the Construction Manager. Cascade diagrams are not sufficient for variable speed drive application unless supported by the required data in a format suitable for more detailed analyses. Separate spectra shall be provided at the maximum and minimum operating speeds and any potential resonant frequencies.

3.07 FIELD TORSIONAL VIBRATION TESTING

Where required by these specifications, field torsional vibration tests shall be performed under the direct supervision of the design professional responsible for the mass elastic system design on a pumping unit selected by the Construction Manager.

3.08 TRAINING

Training shall conform to the requirements of Section 01664 and shall include separate training sessions for each operator shift maintained by the Owner and a separate session for maintenance personnel. Unless otherwise specified in the referencing section, the training requirement is waived for constant speed pumping equipment with suction nozzle sizes 6 inches in diameter and smaller and for all pumps with connected power requirements 10 horsepower and less. The training session for maintenance personnel shall include a comprehensive presentation, employing cut-away models or comparable graphics, and documentation on the step-by-step disassembly and subsequent reassembly of a pumping unit. Upon completion of all training requirements, the Contractor shall submit certified Form 11000-B as specified in Section 01999.

END OF SECTION

SECTION 11347

SUBMERSIBLE WASTEWATER PUMPS FOR CONSTANT SPEED APPLICATIONS

PART 1—GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies pumps and associated accessories for municipal wastewater pumping applications. Equipment furnished under this specification shall have discharge nozzles 4 inches in diameter and larger and shall have motors 7.5 horsepower and larger.

B. TYPE:

The pump shall be of the heavy-duty, submersible, vertical shaft, centrifugal nonclog "N" impeller type, suitable for pumping fluids containing unscreened wastewater solids. The pump shall be designed for continuous or cyclic operation under submerged, partially submerged or totally dry condition without damage to the pump and motor. Special attention shall be devoted to the shaft design to limit deflection under all operating conditions, as specified in this section.

C. EQUIPMENT LIST:

Item	Equipment No.
LIFT STATION PUMP 1	W 55SLS-PMP-1711
LIFT STATION PUMP 2	W 55SLS-PMP-1721
LIFT STATION PUMP 3	SPARE
JIB CRANE	W 55SLS-BCR-1741
JIB CRANE LOCAL CONTROL PANEL	W 55SLS-LCP-1741

D. OPERATING CONDITIONS:

The fluid to be pumped will be unscreened municipal wastewater. The temperature is anticipated to range between 65 degrees F and 95 degrees F and contain up to 500 mg/l of solids consisting of grit and organic material with small quantities of petroleum products and animal fats and greases. The pumped material will have a tendency to form long fibrous strings due to the rotation of the water through piping passageways.

The pump will be operated by a control system that will operate the pump in accordance with control strategies specified in Section 17900.

The pumps will be installed in a reinforced trench-type or confined inlet self-cleaning wet well designed in accordance with ANSI/HI 9.8. In either application, the pumps will be operated at constant speed, responding to a control system that will cycle the pumps in accordance with the specified program and will be used periodically to remove trapped floating and settleable solids by operating the pump to draw down the wet well to break suction. Pumps furnished under this section shall be certified and warranted for a period of not less than 5 years.

E. PERFORMANCE REQUIREMENTS:

The performance requirements presented in tabular form below are intended to describe the results of hydraulic calculations developed using a mathematical modeling program specifically developed for the purpose. The model was intentionally used to develop the limits of expected extremes in variation of static head, coefficients for pipeline resistance and turbulence losses through fittings and valves. Equipment furnished under this section shall be fully suitable for continuous operation at any specified condition or any condition lying between the extremes of the operating conditions specified in the following table. The notes presented at the end of the table are intended to be complimentary to the information presented in the table.

Equipment number	W 55SLS-PMP-1711 W 55SLS-PMP-1721
<u>Operating Condition</u>	
Condition A[1,4]	
Capacity, gpm	550
Total head, feet	43.3
NPSHA, feet	28
Condition B[2,]	
Capacity, mgd	from pump H/Q curve
Total head, feet	40.6
NPSHA, feet	32

NOTES:

1. Condition A shall be taken as the rated operating condition. Performance at the rated condition shall be guaranteed in accordance with Section 11050. Condition A has been selected to obtain the rated pumping capacity for the installation. It is not intended that the pumps be selected for maximum efficiency at Condition A. Pumps furnished under this section should be selected to achieve Condition A performance, but also operate continuously without objectionable vibration or cavitation at the head specified under Condition B. Condition A may be located in the Allowable Operating Region as established by the pump manufacturer in accordance with ANSI/HI 9.6.3 and published in the manufacturer's published

application data for the specific model proposed for this application. However, if Condition A is located in the AOR, the limiting suction specific speed for the pump selection will change (refer to paragraph 11347-1.01 F.

2. Condition B head is presented to indicate operating conditions when the pump is operating against minimum anticipated system head, assuming a hypothetical head-capacity curve. Condition B shall be used for pump selection. Condition B shall be located within the Preferred Operating Region (POR) as established by the pump manufacturer in accordance with ANSI/HI 9.6.3 and listed in the manufacturer's published application data for the specific model proposed for this application. NPSHA, as listed for Condition B is calculated on a pumped flow of 550 gpm. Pumps with head-capacity curves steeper than that assumed will produce somewhat less flow at somewhat lower head. The reverse will occur with pumps having a shallower head-capacity curve.

3. Total head in the above tabulation is the algebraic difference between the discharge head and suction head as defined in ANSI/HI 1.1 – 1.6. Net positive suction head available (NPSHA) in the above tabulation is referred to the wet well invert as shown and is calculated in accordance with ANSI/HI 1.3 for average barometric pressure and maximum temperature conditions. An allowance of five feet has been included for the presence of volatile constituents in the pumped fluid. NPSHA at the pump impeller eye can be determined by adjusting the given value by proposed pump dimensions and the indicated requirements for pump installation details. *It is the Contractor's responsibility to make this adjustment and produce calculations justifying the proposed selection.* Required NPSHA margin shall be as specified in Section 11050.

F. DESIGN REQUIREMENTS:

Equipment provided under this section shall conform to the following:

<u>Pump</u>

Rigid sphere, inches diameter (min.), capable of passing through the pump from inlet to discharge[1]	1.5
Maximum efficiency, minimum, percent[2]	72.5
Piping connection size, inches, minimum	
Inlet fitting[3]	4
Discharge	4
Operating speed, rpm, maximum	1720
Suction specific speed, dimensionless, maximum[4]	9500

Motor

Motor horsepower, maximum	10
Motor voltage	460

NOTES:

1. For pumps 10 inches in discharge nozzle diameter and less, this dimension shall be the minimum clearance between the outside diameter of the impeller and the volute cutwater. The sphere shall be a solid sphere, incapable of compression or distortion of any kind.

2. Efficiency is the minimum acceptable value at the maximum efficiency point on the pump's efficiency/capacity curve for the selected impeller, and is not necessarily to be associated with any specified operating condition. The efficiency stated shall include losses from the inlet through the pump to the discharge fitting. Any additional losses associated with the cooling water system shall also be included.

3. The inlet velocity shall not exceed 4 feet per second at Condition Point B as specified in paragraph 11347-1.01 E. A suction nozzle, fitted with a flared inlet, will be required to reduce the suction velocity to 4.0 feet per second or less, and the nozzle length must exceed the difference between the inlet and outlet diameter of the nozzle.

4. The suction specific speed limitation listed applies only to pump selections where both Operating Conditions A and B reside within the proposed pump selection's POR. Proposed selections with Operating Condition A residing in the AOR shall be limited to designs with suction specific speed less than 8500. Suction specific speed shall be calculated for the maximum pump design speed and impeller diameter, using the capacity in gallons per minute and NPSH3 at Best Efficiency in accordance with the procedures set for in the standards of the Hydraulic Institute.

Except as specifically referenced in this section, Section 11050 provisions will not apply to equipment furnished under this section.

Equipment furnished under this section shall be specifically certified by the manufacturer as suitable for operation in trench type or confined inlet wet wells where the wet well will be cleaned using the pumping equipment. Pump anchorage systems, including the discharge piping, shall be restrained against the short-term buffeting caused by the cleaning process, where velocities in the wet well trench or inlet well are expected to reach 15 ft/sec, with the liquid level at or below the top of the motor housing. The design of the anchorage system shall be the responsibility of the pump manufacturer and shall be the product of a structural engineer licensed to practice in the State of Arizona. This requirement, however, shall not be construed by any party as one which relieves the Contractor of overall responsibility for the conformance to all project requirements.

Pump anchorage systems shall be designed to restrain the unbalanced hydraulic thrust developed by the pump at the specified speed and during the starting and stopping conditions. In applications within known seismic zones, the pump anchorage provisions shall be designed in accordance with Section 01900. The analysis for the anchorage system in known seismic zones shall include the affect of differential loads imposed by water in the wet well moving in response to the design seismic event.

G. VIBRATION AND CRITICAL SPEED:

The pump, when operating within the manufacturer's listed POR, as specified in Section 11050, with wet well levels as indicated for normal (not cleaning) operation, shall comply with the requirements of ISO 10816, Zone B. Vibration at any specified operating condition that is located outside the manufacturer's listed POR shall not exceed 125 percent of the limiting values in ISO 10816, Zone B. Vibration levels shall be subject to field verification as specified in paragraph 11347-3.02.

1.02 QUALITY ASSURANCE

A. REFERENCES:

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ISO 9001-2001	Quality Systems
ISO 10816	Machine Vibration – Evaluation of machine vibration by measurements on non-rotating parts
NEMA MG 1	Motors and Generators
UL 674	Motors and Generators, Electric, for Use in Hazardous Locations, Class I, Groups C and D, Class II, Groups E, F, and G.
UL 1207	Sewage Pumps for Use in Hazardous (Classified) Locations

B. UNIT RESPONSIBILITY:

The Contractor shall assign unit responsibility, as specified in paragraph 11000-1.02 C, to the manufacturer of the submersible wastewater pumps provided under this section. This manufacturer is the unit responsibility manufacturer and has unit responsibility, as specified in paragraph 11000-1.02, for both the equipment assembly specified in this section and for all other equipment assembly components specified elsewhere but referenced in this section. A completed, signed, and notarized Certificate of Unit Responsibility (Form 11000 C, Section 01999) shall be provided.

C. FACTORY TESTS:

The pump shall be subject to a non-witnessed factory test in accordance with the requirements of Section 11050. The test procedure shall follow the requirements of ANSI/HI 14.6, acceptance grade 1E. All other tests shall conform to the requirements set forth in ANSI/HI 11.6 and the requirements set forth in this section. Failure to achieve guaranteed performance or performance proposed in accepted submittal documents, whichever is the more restrictive (capacity and head, efficiency or NPSH3) shall be cause for rejection. Any deviations from specified limiting values shall be subject to review by the Construction Manager. In addition, the following procedures shall be followed:

1. Impeller, motor rating and electrical connections shall first be checked for compliance with the specifications.

2. Prior to submergence, the pump shall be run dry to establish correct rotation and mechanical integrity.

3. The pump shall be run for 30 minutes submerged, with a minimum of 6 feet of water over the top of the motor. Following this warm-up period, the pump shall be subjected to the performance and NPSHR tests specified in Section 11050.

4. After satisfactory completion of the performance and NPSHR tests, the motor shall be subjected to a housing leakage test performed under vacuum in accordance with paragraph 11.6.7.2.2 of ANSI/HI 11.6.

5. All motor circuits, including thermal and moisture sensors and the moisture sensors in the shaft seal area shall be subjected to electrical resistance tests to determine functionality.

A written report stating the tests have successfully been completed along with the results of the tests required under Section 11050 shall be provided, certified in accordance with Section 11050, as product data.

D. MANUFACTURER CERTIFICATION:

Manufacturers proposing to furnish equipment specified under this section shall hold current certification under ISO 9001-2001. Application for certification under ISO 9001 shall not be deemed as an acceptable substitute for current certification. Documentation attesting to current certification shall be signed by an officer of the manufacturer's corporation and shall be notarized.

E. WARRANTY:

In addition to the guarantee specified in the General Conditions, the manufacturer shall furnish an unqualified warranty guaranteeing (full replacement at no cost to the Owner) the performance of the motors furnished under this project for a period of five years when operating under the specified conditions. In addition, the Contractor shall cause the pump manufacturer to warrant the units against defects in materials and workmanship for a period of 5 years beginning with the date of beneficial occupancy. This warranty shall be delivered, in writing, to the Owner and shall include, as a minimum, 100 percent full payment coverage for parts and labor.

F. SHIPMENT, PROTECTION AND STORAGE:

Equipment shipment, protection and storage shall conform to the requirements specified in Section 01605.

1.03 SUBMITTALS

The following submittals shall be provided in accordance with Section 01300:

A. SHOP DRAWINGS:

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Referenced and applicable sections to be marked up and submitted include:

   Section 11000: GENERAL REQUIREMENTS FOR EQUIPMENT

   Section 11050: GENERAL REQUIREMENTS FOR CENTRIFUGAL AND AXIAL FLOW PUMPING EQUIPMENT

   A <u>check mark</u> shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The

Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. *Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.*

2. Certificate of Unit Responsibility attesting that the Contractor has assigned, and that the manufacturer accepts, unit responsibility in accordance with the requirements of this Section and paragraph 11000-1.02 C. No other submittal material will be reviewed until the certificate has been received and found to be in conformance with these requirements.

3. A copy of the contract document Drawings E10, E12, and process and instrumentation diagram Drawing P100 relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked *"no changes required"*. Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review."

4. Marked product literature and pump curves.

5. Motor data.

6. Proof of service of previously installed units of similar size and configuration in wet wells of the type described in paragraph 11347-1.01 D.

7. Proof, in the form of certified laboratory tests documenting the wire-to-water efficiency for the proposed equipment to be provided under this section

8. Shaft deflection calculations.

9. Anchorage calculations and required documentation.

10. Cooling system calculations.

11. ISO certification per paragraph 1.01.

12. Moisture and temperature detection relay product literature and connection diagrams.

13. List of spare parts to be provided.

14. Proof of service of previously installed units of similar size and configuration in wet wells of the type described in paragraph 11347-1.01 D.

15. Field vibration test protocol as specified in Part 3 – Execution.

16. Field discharge connection leakage test, as specified in Part 3 – Execution.

PART 2--PRODUCTS

2.01 ACCEPTABLE PRODUCTS

The Owner and Construction Manager believe the following manufacturers are capable of producing equipment and products, which will satisfy the requirements of this Section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's product, nor shall it be construed that a named manufacturer's standard product will comply with the requirements of this Section. Candidate manufacturers include FLYGT (a Xylem brand).

2.02 MATERIALS

Material employed for the construction of equipment provided under this specification shall be as follows:

Component	Material
Pump and motor casing	
Specified head < 100 ft	Cast iron, ASTM A48, Class 30
Specified head > 100 ft	Cast ductile iron, ASTM A536, Class 65-45-12
Discharge elbow	
Specified head < 100 ft	Cast iron, ASTM A48, Class 30
Specified head > 100 ft	Cast Ductile iron, ASTM A536, Class 65-45-12
Inlet nozzle and bell	Cast Iron, ASTM A48, Class 30 or forged steel
Impeller	Cast Chrome Iron, ASTM A532
Motor and pump shaft	Stainless steel, ASTM A276 Type 329, 403, 420 or ASTM A479 Type 403, 431
Insert ring	Cast Chrome Iron, ASTM A532
External bolts and nuts	Stainless steel, ASTM A276 Type 316
Guide bar brackets	Stainless steel, ASTM A276 Type 316

Component	Material
Anchor bolts	Stainless steel, ASTM A276 Type 316
Guide rails, lifting assemblies	Stainless steel, ASTM A276 Type 316

Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The Contractor may propose alternative materials for the purpose of providing greater strength or to meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose. If alternatives are proposed, the proposals shall be accompanied with documentation supporting the claimed superiority of the proposed substitutions.

2.03 EQUIPMENT FEATURES

A. GENERAL:

The motor and rotating parts shall be removable from the motor end of the pump. All motor mating surfaces where watertight sealing is required shall be machined and fitted with nitrile O-rings. The pump shall be fitted with a dynamically balanced nonclog impeller designed to pass coarse solids and stringy materials. The pump shall be listed by Factory Mutual or Underwriters Laboratory as conforming in all respects to the requirements in UL 1207.

B. CASING:

The volute casing shall be a one-piece casting with a tangential or center discharge nozzle. The volute shall be designed for efficient conversion of kinetic to potential energy and shall have clear passageways designed to pass the solid sphere specified under paragraph 11347-1.01 F. The solids passing capability of the furnished equipment will be subjected to a field test in accordance with paragraph 11347- 3.02 B.

The cutwater shall be specifically designed for use in fluids with stringy solids and rags. The volute casting shall be specifically designed to bear the loads associated with removal and placement of the pump when submerged or exposed and to withstand the loads imposed by the operations specified under paragraphs 11347-1.01 E and 11347-1.01 F. The discharge nozzle shall be not less than the diameter specified under paragraph 11347-1.01 F. and shall be reinforced for the loads imposed by the specified conditions of service. The nozzle flange face shall be designed to mate with the discharge fitting specified in paragraph 11347-2.03 L. The volute casing shall be drilled and tapped or otherwise fitted with an inlet nozzle conforming to the requirements specified in paragraph 11347-2.03 K.

C. SHAFT.

The pump shaft shall be turned, ground and polished, of proportions suitable for use in the specified application. The shaft shall be of sufficient section to limit deflection at the shaft seal to not more than 1.5 mils when the pump is operating at any continuous-duty point defined by the envelope of conditions specified under paragraph 11347-1.01 E. The method for

calculating shaft deflection shall be as established in Section 11050. Additionally, under no circumstances shall the distance from the lower bearing and the hub of the impeller exceed two times the diameter of the shaft. The documentation required under Section 11050 shall be included as a submittal along with all other documentation required by paragraph 11347-1.03.

D. BEARINGS:

Bearings shall be heavy-duty, oil lubricated or permanently greased lubricated anti-friction type double shielded and factory sealed. Bearings shall be designed for an L-10 rating life of at least 50,000 hours at any operating condition specified under paragraph 11347-1.01 E. Loads for radial bearing calculations shall be calculated in accordance with paragraph 11347-2.03 C.

E. IMPELLER:

Impeller shall be "N Type" or approved equal. The impeller shall be dynamically balanced after trimming to the diameter required by the specified operating conditions, and have a nonclog cutter design capable of passing solids, fibrous materials, heavy sludge, and other matter found in wastewater applications through to the discharge nozzle. Fit between the impeller and the shaft shall be a sliding fit with a taper-lock bushing pressed by a screw, which is threaded into the end of the shaft, or a slip fit onto the shaft and drive key and fastened to the shaft by an impeller nut having cover for protection from pumped fluid. A wearing ring system designed for abrasion resistance shall provide efficient sealing between the volute and impeller.

F. MECHANICAL SEALS:

The pump shall be provided with a tandem double mechanical seal running in an oil reservoir, composed of two separate lapped face seals. The lower seal unit, between the pump and oil chamber, shall consist of one stationary and one positively driven, rotating tungsten-carbide ring, with each pair of rings held in contact by a separate spring. The upper seal unit, between the oil sump and the motor housing, shall consist of one stationary tungsten-carbide and one positively driven tungsten-carbide rotating ring. Ceramic seals will not be acceptable. The seals shall require neither maintenance nor adjustment and shall be easily replaceable. Conventional double mechanical seals with a single or a double spring between the rotating faces, or that require constant differential pressure to effect sealing and are subject to opening and penetration by pumping forces, will not be acceptable. The pump shall be capable of continuous submergence without loss of watertight integrity to a depth of 65 feet.

Each pump shall be provided with a seal lubricant chamber for the shaft sealing system. The seal lubricant chamber shall be designed to assure that an air pocket is provided in the seal lubricant chamber, to absorb the expansion of the seal lubricant due to temperature variations. The drain and inspection plug with positive anti-leak seal shall be easily accessible from the outside.

G. MOTOR:

The motor case shall be a single casting with an integral lifting bail designed to support at least 4 times the weight in air of the pump and motor assembly, configured to accept a lifting hook and balance the pump and motor assembly as it is removed or placed in position. All castings shall be pressure tested to not less than 3 atmospheres prior to assembly or equivalent. Cast housings shall be provided for the cable entry capsule and coolant inspection ports.

The pump motor shall be a squirrel-cage induction, shell type design, housed in an air-filled or an oil-filled, watertight chamber, NEMA design B, premium efficiency with a service factor of 1.15 based upon nameplate rating. The stator winding and stator leads shall be insulated with moisture resistant Class H insulation, which shall be rated at a temperature of 155 degrees C. The motor shall be designed for continuous duty, capable of sustaining a minimum of 12 starts per hour. The temperature rise of the motor shall not be in excess of that specified in NEMA MG-1 for class B insulating materials when operating continuously under load. Motors shall be Factory Mutual or UL listed in accordance with UL 674 and 1207 for Class I, Group D hazardous atmospheres. The junction chamber, containing the terminal board, shall be hermetically sealed from the motor. Connection between the cable conductors and stator leads shall be made with threaded compressed type binding post permanently affixed to a terminal board. The submersible electrical cable shall be of sufficient length to reach the junction box indicated.

The cooling system may be of the oil filled or air filled motor housing type. Thermal sensors shall be provided to monitor stator temperatures. The stator shall be equipped with three thermal sensors, embedded in the end coils of the stator winding (one sensor in each stator phase). These shall be used in conjunction with external motor overload protection and wired to the MCC. Temperature detection relays shall be provided for installation in the MCC by others. The design shall be suitable for continuous motor operation at listed motor rating in 95 degree F water.

The cooling system may rely on radiation of excess heat energy to the fluid in the wet well or, alternatively, the pumped fluid via a closed circuit circulating system utilizing either oil or glycol, or a combination of these. It is specifically required that the cooling system must be compatible with the contemplated control schedule, which may require that the motor case to be exposed continuously or intermittently. Cooling systems shall not employ the pumped fluid to directly cool the motor through wastewater passageways incorporated into the motor shell. It is preferred that the motor be cooled by the wastewater via fins incorporated into the motor shell. If an internal liquid circulation system is employed for cooling purposes, the liquid shall be glycol or heat transfer oil, which shall in turn circulate a heat exchanger incorporated into the cavity behind the pump impeller.

If the motor is an oil-filled type, it shall be positively cooled by circulating non-toxic oil through the windings to passages within the pump designed as a heat exchanger to transfer heat to the pumped fluid. Vanes cast into the rear impeller shroud shall be provided to circulate pumped flow past a heat exchanger in the shaft seal area to provide the required cooling. Cooling water passages in the motor's shell designed to convey the pumped fluid for cooling purposes are specifically prohibited. The system shall be designed to prevent clogging by virtue

of dimensions and configuration and shall be specifically configured to maintain motor temperatures within conservative limits when the pump is operating at variable speed under the operating conditions specified.

H. MOISTURE DETECTORS:

Air-filled motors 10 horsepower and larger shall be provided with an electronic moisture detection system. A leakage sensor shall be provided to detect water in the stator chamber. The Float Leakage Sensor (FLS) is a small float switch used to detect the presence of water in the stator chamber. When activated, the FLS will stop the motor and send an alarm both local and/or remote. **USE OF VOLTAGE SENSITIVE SOLID STATE SENSORS AND TRIP TEMPERATURE ABOVE 125°C (260°F) SHALL NOT BE ALLOWED.**

All moisture detectors shall be wired to the junction box for connection to the specified monitoring system. Moisture detection relays shall be provided for installation in the MCC by others.

I. CABLES:

1. CABLE: The pump manufacturer shall provide the power/control cable(s) to connect motor to starter and sensors for leakage and over temperature to supervision relay. The cable(s) shall include seven conductors: three conductors for power, two conductors for control, and two ground conductors. Cable construction shall be stranded copper conductor; color coded heat resistant synthetic rubber insulation, with fillers, separators, and an oil resistant thermoset jacket per UL-62 with temperature range of -37°C to +90°C and voltage rating of 600 volts with water resistant jacket, UL or CSA Listed for extra hard usage for Class I, Group D hazardous atmospheres.

The cable length shall not exceed the product manufacturer's recommended length. Provide the length of cable required to wire the motors and sensors from the wet well to the wetwell junction boxes provided by others. Provide additional cable length for slack to allow the pumps to be removed from the wet well. A cable rack shall be provided and installed in the wet well to neatly store the cable slack when the pumps are in service.

2. CABLE SEAL: The cable entry water seal design shall preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall be comprised of individual cylindrical elastomer clamps having a close tolerance fit against the cable conductor insulation and the entry inside diameter and compressed by the entry body containing a strain relief function, separate from the function of sealing the cable. The cable entry junction chamber and motor shall be separated by a stator lead sealing gland, potting chamber or terminal board, which shall isolate the motor interior from foreign material gaining access through the pump top. If a potting chamber is used, the potting procedure shall employ an epoxy-potting compound combined with a procedure that insures penetration of the compound into the individual cable conductor strands to prevent development of wicking pathways for entrance of water into the motor.

J. NOT USED

K. INLET NOZZLE:

The wet well design has been developed on the basis of a limiting velocity at the pump inlet of 4 feet per second and a confined inlet designed for cleaning by operating the pump until it breaks suction . Inlet nozzles are required for all pumps with entrance velocities exceeding this limitation. If a nozzle is required, the pump casing shall be drilled and tapped to receive an inlet nozzle and bell fitting to extend the pump inlet connection into the confines of the wet well or sump to achieve the floor separation required by the Hydraulic Institute Intake Standard (ANSI/HI 9.8). The inlet nozzle may be of commercially available forged steel fittings or cast iron and shall have a smooth, flared transition from a bell fitting at the entrance to the nozzle and a smooth, direct entry to the connection at the impeller inlet. The final configuration of the inlet bell and nozzle shall be selected to efficiently convey the pumped fluid into the impeller eye. Dimensions shall be as specified in paragraph 11347-1.01 F.

L. PUMP DISCHARGE CONNECTION SEAL:

Sealing design shall incorporate a metal-to-metal contact between machined surfaces of pump discharge connection and the pump discharge itself. Leakage through the seal shall not exceed 1.5 percent of the flow specified for Condition Point A when operating at pump shutoff head and not more than 1 percent of total pump flow at Condition Point B. (Reference: Condition points specified in paragraph 11347-1.01 D.)

The seal shall be subject to field test for acceptance in accordance with the requirements of paragraph 11347-3.02.

M. PUMP ANCHORAGE, GUIDE SYSTEM AND ACCESS HATCH:

The pump shall be provided with a guide system to allow easy removal of the pump without entering the wet well. The guide rail system may be of either the single or dual rail type. The discharge connection shall be bolted to the structure as indicated and shall serve as a lower attachment for the guide rails. The discharge connection shall be either horizontal or elbow discharge type, as indicated. The anchorage system shall be designed to transmit the forces specified under paragraph 11347-1.01 F safely to the structure. Calculations and supporting documentation justifying the support design shall be provided with the submittals required under Section 11050.

The pump and guide rail system shall be designed to automatically connect the pump to the discharge piping when lowered into place on the discharge connection. The design shall be non-sparking and shall conform to UL requirements for installation in a location classified in accordance with NFPA 70, Article 500 for Class 1, Group D, Division 1 locations. The pump shall be easily removable for inspection or service, requiring no bolts, nuts, or other fastenings to be removed for this purpose, and no need for personnel to enter the pump wet well or sump. Sealing of the pumping unit to the discharge connection shall be accomplished by a simple linear downward motion of the pump with the entire weight of the pumping unit guided to and pressing

tightly against the discharge connections. No portion of the pump shall bear directly on the floor of the sump and no rotary motion of the pump shall be required for sealing. Guide bars provided for directing the pump into position or for removing the pump for maintenance shall steer the pump into proper contact with the discharge elbow. Once the pump has been positioned on its support fitting at the discharge fitting, the guide bar system shall not be required for pump support.

See Section 08305 for access hatch specifications.

2.04 MECHANICAL HOIST

One telescoping davit crane and mechanical winch assembly shall be provided to allow operating personnel to raise and lower the pumps from and into the wet well for maintenance purposes. The davit crane shall be mounted to the wetwell top slab with a mounting base that will be bolted into the slab. The crane shall be secured to the mounting base or wetwell slab to protect against theft, in a manner up to the Contractor. The method of securing the crane shall not hinder the function of the crane in any way. The davit crane shall be capable of supporting the full weight of the pump at the full extension of the boom. The davit, winch, hook and cable shall be of stainless steel and shall be provided from the pump manufacturer. The winch shall be motorized, NEMA 4X corrosion resistant, and powered by 115 Vac single phase. If motor or controls are located within 18" of the top of the wetwell, those components shall be UL listed for Class I Group D hazardous location.

2.05 ACCESSORIES

The pump shall be provided with lifting chains, guide bars, upper guide bar brackets, intermediate guide bar brackets, cable holder assemblies, safety chain hook assemblies, discharge elbow connections, anchor bolts, and all other accessories necessary to complete the installation as specified. All connecting hardware and miscellaneous attachments shall be constructed out of ASTM A276, Type 316 stainless steel. Dielectric isolation shall be provided for dissimilar metals.

2.06 SPARE PARTS

A. A third pump and motor shall be provided to the Owner as spares. The spare pump and motor shall be identical to those installed in the wetwell.

B. The following spare parts shall be provided for each pump:

2 sets--all gaskets
2 sets--all bearings
1 set--mechanical seals

C. Spare parts shall be packed and boxed as specified in paragraph 11000-2.12.

2.07 PRODUCT DATA

Product data shall be as specified in Section 11050 and shall also include the extended warranty as specified in paragraph 11347-3.03.

PART 3—EXECUTION

3.01 INSTALLATION

Execution shall conform to the requirements set forth in Section 11050.

3.02 FIELD TESTS

A. GENERAL:

In addition to the field test required under Section 01660, each pump shall be subjected to field tests for vibration and leakage at the connection between the pump discharge flange and the pump anchorage fitting. All field tests shall be witnessed by the Construction Manager.

B. STATIC SOLID PASS TEST:

Upon arrival and before installation in the project, each pump shall be given a solids pass test. The test shall consist of inserting a rigid ball of the diameter specified in paragraph 11347-1.01 F in the pump discharge opening. The Contractor shall demonstrate that the ball will pass clear though the pump to the inlet bell with no force other than the weight of the ball used to demonstrate compliance with the requirements of this Section

C. VIBRATION:

Vibration levels shall be determined by affixing suitable sensors to the top of the motor housing in both the x-x (parallel to the nozzle) and y-y (perpendicular to the nozzle) directions. The Contractor shall provide all sensors and monitoring equipment. As a condition precedent to final acceptance of the equipment, the pumps shall be individually operated at all specified operating conditions. The Contractor shall provide the means to recirculate pumped fluid or alternatively throttle the pumps to achieve the specified head at specified flow. Vibration levels shall not exceed that specified in paragraph 11347- 1.01 G when the pump is operating within the manufacturer's listed POR as determined in accordance with Section 11050. When operating at conditions outside the POR, vibration levels shall be no more than 125 percent of that specified in paragraph 11347-1.01 G.

D. LEAKAGE TEST:

The leakage test shall utilize a boot seal supplied by the pump manufacturer. The boot seal shall effect a complete water tight seal around the pump discharge and anchor fitting mating flanges at a pressure equal to 125 percent of the pump shutoff head. The boot shall have a

discharge connection fitted to a pressure hose which can be used to determine the rate of leakage during the acceptance testing of the equipment furnished under this section. Five sets of tests, each set consisting of two tests, one with the pump operating against a closed discharge valve and one with the pump operating at Condition B, as specified in paragraph 11347-1.01 E. Each test shall be not less than 60 seconds in duration, with the rate of leakage determined either by displacement in a vessel of known dimensions or by inline flow meter. The tests results shall be recorded and shall be averaged after discarding the test sets with the greatest and least leakage rates. The average rate of leakage from the three remaining test sets shall be determined, averaging the tests against a closed valve and at Condition Point B separately. The average rate of leakage shall not exceed that specified in paragraph 11347-2.03 L. If the discharge connection leakage rate at either against a closed valve or at Condition Point B exceeds the specified allowance, the Contractor shall cause the pump manufacturer to correct the defect and the pump shall be tested again as described in this paragraph. If the pump should fail the second test, the pump shall be removed from the site and the Contractor shall furnish a replacement which in turn shall be tested for acceptance in accordance with this paragraph.

END OF SECTION

SECTION 15050

PIPING SYSTEMS

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies systems of process piping and general requirements for piping systems. Detailed specifications for the components listed on the Piping System Specification Sheets are found in other sections of Division 15. This section shall be used in conjunction with those sections.

B. DEFINITIONS:

Pressure terms used in Section 15050 and elsewhere in Division 15 are defined as follows:

1. Maximum: The greatest continuous pressure at which the piping system operates.

2. Test: The hydrostatic pressure used to determine system acceptance.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AASHTO M36/M36M	Metallic (Zinc or Aluminum) Coated Corrugated Steel Culverts and Underdrains
ANSI A13.1	Scheme for the Identification of Piping Systems
ANSI B1.20.1	Pipe Threads, General Purpose (Inch)
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800
ANSI B16.3	Malleable Iron Threaded Fittings Class 150 and 300
ANSI B16.5	Pipe Flanges and Flanged Fittings
ANSI B16.9	Factory-Made Wrought Steel Buttwelding Fittings
ANSI B16.11	Forged Steel Fittings, Socket Welding and Threaded
ANSI B16.12	Cast Iron Threaded Drainage Fittings
ANSI B16.22	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ANSI B16.26	Cast Copper Alloy Fittings for Flared Copper Tubes
ANSI B31.1	Power Piping
ANSI B31.3	Chemical Plant and Petroleum Refinery Piping
ASME Section IX	Boiler and Pressure Vessel Code; Welding and Brazing Qualifications
ASTM A47	Malleable Iron Castings
ASTM A53	Pipe, Steel, Black and Hot Dipped, Zinc-Coated Welded and Seamless
ASTM A74	Cast Iron Soil Pipe and Fittings
ASTM A105/A105M	Forgings, Carbon Steel, for Piping Components
ASTM A106	Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A126	Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A197	Cupola Malleable Iron
ASTM A234/A234M	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM A312/A312M	Seamless and Welded Austenitic Stainless Steel Pipe
ASTM A403/A403M	Wrought Austenitic Stainless Steel Piping Fittings
ASTM A536	Ductile Iron Castings
ASTM A570/A570M	Hot-Rolled Carbon Steel Sheet and Strip, Structural Quality
ASTM B88	Seamless Copper Water Tube

Reference	Title
ASTM C76	Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C296	Asbestos-Cement Pressure Pipe
ASTM C443-REV A	Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
ASTM C564	Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM D1248	Polyethylene Plastics Molding and Extrusion Materials
ASTM D1784	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D1785	Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR)
ASTM D2513	Thermoplastic Gas Pressure Pipe, Tubing, and Fittings
ASTM D2665	Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D2996	Filament-Wound Reinforced Thermosetting Resin Pipe
ASTM D3034	Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3261	Butt Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D4174	Cleaning, Flushing, and Purification of Petroleum Fluid Hydraulic Systems
ASTM D4101	Propylene Plastic Injection and Extrusion Materials
ASTM F441	Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
AWWA C105	Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids
AWWA C110	Ductile-Iron and Gray-Iron Fittings, 3 Inch Through 48 Inch, for Water and Other Liquids
AWWA C111	Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings
AWWA C115	Flanged Ductile-Iron and Gray-Iron Pipe with Threaded Flanges
AWWA C151	Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids
AWWA C200	Steel Water Pipe 6 Inches and Larger

Reference	Title
AWWA C205	Cement-Mortar Protective Lining and Coating for Steel Water Pipe--4 In. and Larger--Shop Applied
AWWA C206	Field Welding of Steel Water Pipe
AWWA C207	Steel Pipe Flanges for Waterworks Services--Sizes 4 In. through 144 In.
AWWA C208	Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C209	Cold-Applied Tape Coating for Special Sections, Connections, and Fittings for Steel Water Pipelines
AWWA C210	Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipe
AWWA C214	Tape Coating Systems for the Exterior of Steel Water Pipelines
AWWA C301	Prestressed Concrete Pressure Pipe, Steel Cylinder Type, for Water and Other Liquids
AWWA C303	Reinforced Concrete Pressure Pipe--Steel Cylinder Type, Pretensioned, for Water and Other Liquids
AWWA C600	Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA C651	Disinfecting Water Mains
AWWA C900	Polyvinyl Chloride (PVC) Pressure Pipe, 4 Inches Through 12 Inches, for Water
AWWA M11	Steel Pipe--A Guide for Design and Installation
CISPI 301	Specification Data for Hubless Cast Iron Sanitary System with No-Hub Pipe and Fittings
FEDSPEC L-C-530B(1)	Coating, Pipe, Thermoplastic Resin or Thermosetting Epoxy
MIL-H-13528B	Hydrochloric Acid, Inhibited, Rust Removing
MIL-STD-810C	Environmental Test Methods
SAE J1227	Assessing Cleanliness of Hydraulic Fluid Power Components and Systems
UPC	Uniform Plumbing Code

B. FITTINGS AND COUPLING COMPATIBILITY:

To assure uniformity and compatibility of piping components, fittings and couplings for grooved end piping systems shall be furnished by the same manufacturers.

1.03 SUBMITTALS

Piping layout drawings shall be transmitted to the Construction Manager a minimum of 2 weeks prior to construction. Drawings shall be original layouts by the Contractor; photocopies of contract drawings are not acceptable.

PART 2--PRODUCTS

2.01 PIPING MATERIALS

Unless otherwise specified, piping materials, including pipe, gaskets, fittings, connection and joint assemblies, linings and coatings, shall be selected from those listed on the piping system specification sheets. Piping materials shall conform to detailed specifications for each type of pipe and piping appurtenance specified in other sections of Division 15. All piping shall be compatible with the fluid to which it is exposed.

2.02 PIPING IDENTIFICATION

A. NOT USED

B. PLASTIC TRACER TAPE:

Tracer tape shall be per MAG Section 616.4, colored the same as the background colors as specified in Table A, paragraph 15050-3.06. Tape shall be capable of stretching to twice its original length and shall be as manufactured by Allen Systems, W. H. Brady Co., Seton Name Plate Corporation, Marking Services Inc., or equal.

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

C LOCATOR TAPE

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

2.03 VALVES

Valves of the same size and service shall be provided by a single valve manufacturer. Packing shall be nonasbestos material. Actual length of valves shall be within 1/16 inch (plus or minus) of the manufacturer's specified length. Flanges shall meet the requirement of ANSI B16.5. Push-on and mechanical joints shall meet the requirements of AWWA C111. Valve operators are specified in Sections 15184 and 15185.

2.04 PRODUCT DATA

Product data on piping materials shall be provided in accordance with Section 01300 where specified.

PART 3--EXECUTION

3.01 INSTALLATION

A. LOCATION:

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

B. PIPING SIZES:

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

C. PIPE SUPPORT, ANCHORAGE AND SEISMIC BRACING:

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

2. PIPING CONNECTIONS TO MACHINES: Piping at machine connections shall be aligned in all planes to permit insertion of bolts at bolted connections or coupling screwed connections without using jacks, come-a-longs or other mechanical means to align field piping with the connections at the machines. Bolts shall not be forced into mating flange bolt holes and shall be capable being withdrawn using finger pressure alone. The use of 'dutchmen' mitered sections or similar specials to achieve the required alignment with machine connections is strictly prohibited.

D. ANCHORAGE FOR BURIED PIPING:

All plugs, caps, tees and bends in buried pressure piping systems shall be anchored by means of reaction backing or restrained joints as specified.

E. BEDDING AND BACKFILL:

Bedding and backfill for buried piping shall be in accordance with the trench detail on the Drawings and MAG Section 601.

F. EQUIPMENT CONNECTION FITTINGS

Where shown, equipment connection fittings as specified in Section 15085 shall be provided between field piping systems and equipment inlet and outlet connections.

G. FLEXIBILITY

Unless otherwise specified, piping passing from concrete to earth shall be provided with two pipe couplings or flexible joints as specified in Section 15085.

3.02 PIPING IDENTIFICATION

A. NOT USED

B. PLASTIC TRACER TAPE:

A single line of tape as specified in paragraph 15050-2.02 B shall be provided 2.5 feet above the centerline of buried pipe. For pipelines buried 8 feet or greater below finished grade, contractor shall provide a second line of tape 12 inches below finished grade, above and parallel to each buried pipe. Tape shall be spread flat with message side up before backfilling.

C. LOCATOR TAPE

Detectable locator tape as specified in Section 15050-2.02C shall be installed per MAG Section 616.5.

3.03 NOT USED

3.04 TESTING

A. GENERAL:

Upon completion of piping, but prior to application of insulation on exposed piping, the Contractor shall test the piping systems in accordance with the appropriate MAG Section. Pressures, media and test durations shall be as specified in the PIPESPEC. Equipment which may be damaged by the specified test conditions shall be isolated. Testing shall be performed using calibrated test gages and calibrated volumetric measuring equipment to determine leakage rates. Each test gage shall be selected so that the specified test pressure falls within the upper half of the

gage's range. Unless otherwise specified, the Contractor shall notify the Construction Manager 24 hours prior to each test.

Unless otherwise specified, testing, as specified herein, shall include existing piping systems which connect with new pipe systems. Existing pipe shall be tested to the nearest existing valve. Any piping which fails the test shall be repaired. Repair of existing piping will be considered and paid for as extra work.

Where testing existing chlorine and sulfur dioxide systems to the nearest isolation valve, Contractor shall provide a tee in the line adjacent to the valve. The branch outlet on the tee shall be valved and used for cleaning, pressure testing, draining, and drying the line. Unless otherwise indicated, the existing chlorine or sulfur dioxide system shall not be shut down during testing or connecting the tee and valve. Prior to placing the line in service, the valve on the branch outlet shall be plugged or sealed with a blind flange or threaded plug. Contractor shall be responsible for all damage to the existing system as a result of this work.

B. NOT USED

C. LIQUID SYSTEMS:

Pressure and leakage testing for pressure systems shall be in accordance with MAG Section 610.15 and MAG Section 615.10 for gravity systems. Testing procedures for chlorine and sulfur dioxide systems are specified in paragraph 15050-3.04 D. Testing procedures for hydraulic and lube oil systems are specified in paragraph 15050-3.04 E. Unless otherwise specified, leakage from other buried liquid piping systems shall be less than 0.02 gallon per hour per inch diameter per 100 feet of buried piping.

D. NOT USED

E. NOT USED

F. NOT USED

3.05 CLEANING AND FLUSHING

A. GENERAL:

Piping systems shall be cleaned following completion of testing and prior to connection to operating, control, regulating or instrumentation equipment. The Contractor may, at his option, clean and test sections of buried or exposed piping systems. Use of this procedure, however, will not waive the requirement for a full pressure test of the completed system. Unless specified otherwise, piping 24 inches in diameter and smaller shall first be cleaned by pulling a tightly fitting cleaning ball or swab through the system. Piping larger than 24 inches in diameter may be cleaned manually or with a cleaning ball or swab.

B. NOT USED

C. NOT USED

D. LIQUID SYSTEMS:

After completion of cleaning, liquid systems, unless otherwise specified, shall be flushed with clean water.

E. NOT USED

F. NOT USED

G. NOT USED

H. WATER SYSTEMS:

Potable water piping systems shall be flushed and disinfected in accordance with AWWA C651 and MAG Section 611, except as noted otherwise. The Contractor shall collect all samples and send to an independent laboratory. Results of the test shall be interpreted by the Contractor and reported to the Owner. For non-potable water systems, final flushing and microbiological testing as specified in MAG 611.15 is not required.

3.06 PIPING SPECIFICATION SHEETS (PIPESPEC)

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

Table A, Piping Services

Symbol	Service	System	Fluid Category	Pipe Marker background color
W	Potable Water	7	Water	Blue
FM	Force Main	12	Wastewater	Green
SS	Sanitary Sewer	12	Wastewater	Green
DR	Drain	24	Wastewater	Green

3.06 PIPING SPECIFICATION SHEETS--PIPESPEC

Piping Symbol/Service	W--Potable Water	System--7

Test Requirements:

Medium:	Water; ref. spec paragraph 15050-3.04 C.
Pressure:	150 psig
Duration:	60 minutes

Gasket Requirements:

Flange:	Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder
Push-on/Mech Cpl:	EPDM

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

(3" and smaller)

Pipe:	Copper tube; ASTM B88, Type L, drawn. Ref. spec Section 15066. Conn; solder type with threaded or flanged adapters for valves. Ftgs; wrought copper or bronze, ANSI B16.22.

(2" and smaller)

Valves:	Ball; Jamesbury Fig. 351, Nibco T-580, or equal. Globe; Crane 7TF or 17TF, Lunkenheimer 123 or 214, or equal. Swing check; Crane 137, Lunkenheimer 230, or equal.

Buried and Encased Pipe and Valves:
(See drawings for pipe size and valve type. Omit coating on encased pipe. See Remarks for insulation requirements.)

(3" and smaller)

Pipe:	Copper tube; ASTM B88, Type K, annealed or drawn. Conn; solder type, with threaded or flanged adapters for valves. Ftgs; wrought copper or bronze, ANSI B16.22.
Valves:	Gate; ref. spec Section 15101, with extension stem and valve box. Coating M-1 per spec Section 09900.

3.06 PIPING SPECIFICATION SHEETS--PIPESPEC

Piping System: 7 (continued)

Remarks:

1. Manual air vents shall be provided at the high points and drains provided at the low points of each reach of pipeline as specified in paragraph 15095-3.03.

3.06 PIPING SPECIFICATION SHEETS--PIPESPEC

Piping Symbol/Service:	FM--Force Main SS--Sanitary Sewer	System--12

Test Requirements:

Pressurized Pipe

Medium:	Water; ref. spec paragraph 15050-3.04 C.
Pressure:	125 psig
Duration:	120 minutes

Non-pressurized Pipe

Medium:	Water or Air; ref MAG 615
Pressure	
Duration:	

Gasket Requirements:

Flange:	Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder
Push-on/Mech Cpl:	Nitrile or Neoprene

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(3" and smaller)

Pipe:	Steel; ASTM A53, galvanized. Ref. spec Section 15061. Conn; taper threaded, ANSI B1.20.1. Ftgs; malleable iron, ASTM A197, ANSI B16.3, Class 150, galvanized.
Valves:	Eccentric plug; per spec Section 15110. Install valve with seat upstream. Swing check; Lunkenheimer 230, Crane 137, or equal.

(4" thru 8")

Pipe:	Ductile Iron; AWWA C151,Ref. spec Section 15062 Conn; flanged. Ftgs; ductile iron, per spec Section 15062; ends to match pipe.
Valves:	Eccentric plug; per spec Section 15110. Install valve with seat upstream. Swing check; spring loaded per spec Section 15118.

3.06 PIPING SPECIFICATION SHEETS--PIPESPEC

Piping System: 12 (continued)

Buried and Encased Pipe and Valves:
(See drawings for pipe size and valve type. Omit coating on encased pipe.)

(3" and smaller)

Pipe:	PVC; ASTM D1784, Class 12454-B, ASTM D1785, Sch. 80. Ref. spec Section 15064. Provide magnetic tracer tape. Conn; plain end; solvent weld with threaded or flanged adapters for valves. Ftgs; PVC, Sch. 80, socket weld.
Valves:	Eccentric plug; same as exposed with extension stem and valve box. Coating per spec Section 09900.

(4" thru 12")

Pipe:	Ductile iron; AWWA C151. Ref. spec Section 15062. Conn; restrained push-on rubber gasket joint. Flanged adapters for valves. Ftgs; ductile iron, per spec Section 15062; coating, lining and ends to match pipe.
Valves:	Eccentric plug; same as exposed with extension stem and valve box. Coating M-1 per spec Section 09900.

Exposed Pipe and Valves in and within 5 feet of Discharge Manhole:
(See drawings for pipe size and valve type)

(8" and smaller)

Pipe:	PVC; ASTM D1784, Class 12454-B, ASTM D1785, Sch. 80. Ref. spec Section 15064. Conn; plain end; solvent weld with threaded or flanged adapters for valves. Ftgs; PVC, Sch. 80, socket weld.
Valves:	None

Remarks:

1. Manual air vents shall be provided at the high points and drains provided at the low points of each reach of pipeline as specified in paragraph 15095-3.03.

Piping Symbol/Service:	DR--Drain System--24

Test Requirements:

Medium:	In accordance with Section 712, Uniform Plumbing Code.
Pressure:	In accordance with Section 712, Uniform Plumbing Code.
Duration:	In accordance with Section 712, Uniform Plumbing Code.

Gasket Requirements:

Flange:	Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder
Push-on/Mech Cpl:	Nitrile or neoprene

Exposed Pipe and Valves:
(See drawings for pipe size.)

(3" and smaller)

Pipe:	Steel; ASTM A53, galvanized. Ref. spec Section 15061. Conn; taper threaded, ANSI B1.20.1. Ftgs; cast iron, threaded drainage fittings, ASTM A126, ANSI B16.12, galvanized.
Valves:	None

Buried and Encased Pipe and Valves
(See drawings for pipe size.)

(8" and smaller)

Pipe:	PVC; ASTM D1784, Class 12454-B, ASTM D2665, Sch. 40. Ref. spec Section 15064. Provide magnetic tracer tape. Conn; plain end, solvent weld. Ftgs; PVC, socket type, DWV, ASTM D2665.
Valves:	None

Remarks:

END OF SECTION

SECTION 15061

STEEL PIPE

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies steel pipe and fittings.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI B16.3	Malleable Iron Threaded Fittings, Class 150 and 300
ANSI B16.9	Factory-Made Wrought Steel Buttwelding Fittings
ANSI B16.11	Forged Steel Fittings, Socket-Welding and Threaded
ASTM A36/A36M	Structural Steel
ASTM A47	Ferritic Malleable Iron Castings
ASTM A53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A105/A105M	Forgings, Carbon Steel, for Piping Components
ASTM A106 REV A	Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A197	Cupola Malleable Iron

Reference	Title
ASTM A234/A234M	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM A283/A283M REV A	Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes and Bars
ASTM A536	Ductile Iron Castings
ASTM A570/A570M	Hot-Rolled Carbon Steel Sheet and Strip, Structural Quality
ASTM A572/A572M REV B	High Strength Low Alloy Columbium-Vanadium Steels of Structural Quality
AWWA C200	Steel Water Pipe 6 Inches and Larger
AWWA C205	Cement-Mortar Protective Lining and Coating for Steel Water Pipe--4 In. and Larger-- Shop Applied
AWWA C206	Field Welding of Steel Water Pipe
AWWA C207	Steel Pipe Flanges for Waterworks Services--Sizes 4 In. Through 144 In.
AWWA C208	Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C209	Cold-Applied Tape Coating for Special Sections, Connections, and Fittings for Steel Water Pipelines
AWWA C210	Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipe
AWWA C214	Tape Coating Systems for the Exterior of Steel Water Pipelines
AWWA C600	Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA M11	Steel Pipe--A Guide for Design and Installation
SSPC-SP10	Near-White Blast Cleaning

B. TESTING:

Factory testing shall conform to the requirements of ASTM A53, ASTM A106, or AWWA C200 as applicable.

PART 2--PRODUCTS

2.01 PIPE MATERIALS

Steel pipe and fittings shall be provided in accordance with ASTM A53, ASTM A106, or AWWA C200 as specified in Section 15050, Piping Systems.

Steel for pipe fabricated to meet requirements of AWWA C200 shall conform to the requirements of ASTM A36, ASTM A572, Grade 42, ASTM A570, Grades 33 and 36, or ASTM A283, Grade D. Steel for ASTM A53 and ASTM A106 pipe shall be Grade B.

2.02 PIPE MANUFACTURE

Unless otherwise specified, ASTM A53 pipe shall be Type E, electric resistance welded or Type S, seamless pipe as specified in Section 15050. The minimum wall thickness for ASTM A53 or ASTM A106 pipe shall be Schedule 40 for pipe 10 inch diameter and less and 3/8 inch for pipe 12 inch through 24 inch diameter. Increased shell thickness shall be provided where specified.

AWWA C200 pipe shall be straight or spiral seam. The minimum wall thickness shall be 7 gage for pipe 6 inch through 24 inch diameter and 1/4 inch for pipe 26 inch diameter and larger. Increased shell thickness shall be provided where specified.

2.03 CONNECTIONS

Connections shall be as specified in Section 15050 and shall conform to Section 15085. Coating for buried connections shall be as specified in paragraph 15085-2.06.

2.04 FITTINGS AND APPURTENANCES

Malleable iron threaded fittings and appurtenances shall conform to the requirements of ASTM A47 or ASTM A197, ANSI B16.3.

Unless otherwise specified, steel fittings and appurtenances shall conform to the requirements of ASTM A234, ASTM A105, or ANSI B16.11; and fabricated steel fittings and appurtenances shall conform to AWWA C208.

Fittings for grooved end piping systems shall be full flow cast fittings, steel fittings, or segmentally welded fittings with grooves or shoulders designed to accept grooved end couplings. Cast fittings shall be cast of ductile iron conforming to ASTM A536 or malleable iron conforming to ASTM A47. Standard steel fittings, including large size elbows, shall be forged steel conforming to ASTM A106. Standard segmentally welded fittings shall be fabricated of Schedule 40 carbon steel pipe.

Unless otherwise specified, all fittings shall be rated for pressure and loadings equal to the pipe.

2.05 PIPE LINING

A. EPOXY:

Unless otherwise specified, pipe and fittings shall be lined with a liquid epoxy as specified in AWWA C210 with the following exceptions:

1. No coal tar products shall be incorporated in the liquid epoxy.

2. The curing agent may be an amidoamine as well as the other curing agents listed in AWWA C210.

The lining shall be applied to a minimum thickness of 16 mils in not less than two coats.

B. CEMENT MORTAR:

Where specified, pipe and fittings shall be lined with cement mortar as specified in AWWA C205. Fittings and specials larger than 24 inches, not fabricated from centrifugally lined straight sections, shall require 2-inch by 4-inch by 13-gage self-furring wire mesh reinforcement for hand-applied lining.

C. HIGH TEMPERATURE SERVICE EPOXY:

Where specified, steel pipe and fittings shall be epoxy lined with not less than 10 mils of epoxy suitable for temperatures of 225 degrees F. Epoxy lining shall be 3M Scotchkote 306, Porter MCR 65 High Solids Epoxy, or equal. Surfaces shall be prepared in accordance with SSPC-SP 10 Near White Blast Cleaning, and the lining applied as recommended by the manufacturer.

D. GLASS LINING:

Where specified, pipe and fittings shall be glass lined with a dual layer coating system of vitreous material to a minimum thickness of 10 mils. Glass lining shall provide continuous coverage as tested by a low voltage holiday detector with only isolated voids permitted due to casting anomalies. Voids, other than isolated pinholes, shall be cause for rejection.

Pipe and fittings shall have all internal welds ground smooth and any voids or slag holes ground out, rewelded and ground smooth.

Glass lining shall be Ferrock MEH-32, Vitco SG-14, or equal.

2.06 PIPE COATING

A. EPOXY:

Unless otherwise specified, pipe and fittings shall be coated with a liquid epoxy as specified in AWWA C210 with the following exceptions:

1. No coal tar products shall be incorporated in the liquid epoxy.

2. The curing agent may be an amidoamine as well as the other curing agents listed in AWWA C210.

The coating shall be applied to a minimum thickness of 16 mils in not less than two coats.

B. POLYETHYLENE TAPE:

Where specified, pipe and fittings shall be coated and wrapped with prefabricated multilayer cold applied polyethylene tape coating in accordance with AWWA C214. The coating application shall be a continuous step operation in conformance with AWWA C214, Section 3. The total coating thickness shall be not less than 50 mils for pipe 24 inches and smaller and not less than 80 mils for pipe 26 inches and larger.

2.07 FUSION EPOXY COATING AND LINING

Where specified, steel pipe and fittings shall be fusion epoxy coated and lined. The fusion epoxy coating shall be 3M Scotchkote 203, or equal. Surface preparation shall be in accordance with SSPC-SP 10 Near White Blast Cleaning. The application method shall be by the fluidized bed method and shall attain 12 mils minimum dry film thickness.

Field welds, connections and otherwise damaged areas shall be coated and patched according to the manufacturer's instructions with 3M Scotchkote 306.

2.08 JOINT GASKETS

Joint gaskets shall be as specified in Section 15075.

2.09 PRODUCT DATA

The following information shall be provided in accordance with Section 01300:

1. Affidavits of Compliance with AWWA C200, ASTM A53, or ASTM A106 as applicable.

2. Contractor's layout drawings as specified in paragraph 15050-2.04.

PART 3--EXECUTION

3.01 INSTALLATION

A. GENERAL:

Pipe shall be installed in accordance with AWWA M11, Chapter 16. Welded joints shall be in accordance with AWWA C206 and Section 15085.

Sleeve-type mechanical pipe couplings shall be provided in accordance with AWWA M11 and paragraph 15085-2.02 A.

Pipe lining and coatings at field joints shall be applied as specified in paragraphs 15061-2.05 and 2.06.

Unless otherwise specified, buried mechanical couplings and valves shall be field coated as specified in paragraph 15085-2.06.

B. ANCHORAGE:

Anchorage shall be provided as specified. Calculations and drawings for proposed alternative anchorage shall be submitted in accordance with Section 01300.

3.02 TESTING

Hydrostatic testing shall be in accordance with Section 4 of AWWA C600 except that test pressures and allowable leakage shall be as listed in Section 15050.

END OF SECTION

SECTION 15062

DUCTILE IRON PIPE

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies ductile iron pipe, ductile fittings and gaskets.

B. DEFINITION:

Where cast iron pipe is specified, the term and symbol shall mean ductile iron pipe.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800
ANSI B16.5	Pipe Flanges and Flanged Fittings
ASTM C150	Portland Cement
AWWA C104 (ANSI A21.4)	Cement-Mortar Lining for Ductile- Iron and Gray-Iron Pipe and Fittings for Water
AWWA C105 (ANSI A21.5	Polyethylene encasement for Ductile Iron Piping for Water and Other Liquids

Reference	Title
AWWA C110 (ANSI A21.10)	Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In., for Water and Other Liquids
AWWA C111 (ANSI A21.11)	Rubber-Gasket Joints for Ductile- Iron and Gray-Iron Pressure Pipe and Fittings
AWWA C115 (ANSI A21.15)	Flanged Ductile-Iron and Gray-Iron Pipe With Threaded Flanges
AWWA C150 (ANSI A21.50)	Thickness Design of Ductile-Iron Pipe
AWWA C151 (ANSI A21.51)	Ductile-Iron Pipe, Centrifugally Cast, in Metal Molds or Sand-Lined Molds, for Water or Other Liquids
AWWA C153 (ANSI A21.53)	Ductile-Iron Compact Fittings, for Water and Service
AWWA C600	Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA C606	Grooved and Shouldered Type Joints

1.03 SUBMITTALS

The following information shall be provided in accordance with Section 01300:

1. Shop drawings.

2. Alignment drawings.

3. Certifications specified in the following documents:

   ANSI A21.14, Paragraph 14-4.2
   ANSI A21.52, Paragraph 52-4.2
   ASTM A716, Paragraph 4.2
   AWWA C110, Paragraph 10-5.3
   AWWA C111, Paragraph 11-7.1
   AWWA C115, Paragraph 15-4.2
   AWWA C151, Paragraph 51-5 2
   AWWA C153, Paragraph 53-6.3
   AWWA C606, Paragraph 4.1.1.1

PART 2--PRODUCTS

2.01 GENERAL

Pipe design, materials and manufacture shall comply with the following documents:

Item	Document
Thickness design	AWWA C150
Manufacturing requirements	
Water or other liquid	AWWA C151
Gravity service pipe	ASTM A716
Joints	
Rubber gasket	AWWA C111
Threaded flange	AWWA C115
Fittings	
Water or other liquid	AWWA C110/AWWA C153
Cement mortar lining	AWWA C104
Polyethylene encasement	AWWA C105

2.02 PIPE

Unless otherwise specified, ductile iron pipe shall be Pressure Class 350 for buried installations and Thickness Class 53 for above ground and have nominal laying lengths of 18 or 20 feet. For flanged-end pipe, wall thickness shall be minimum Class 53 except where the specified pressure requires heavier pipe.

2.03 GASKETS

Unless otherwise specified, gasket stock shall be a synthetic rubber compound in which the elastomer is nitrile or neoprene. The compound shall contain not less than 50 percent by volume nitrile or neoprene and shall be free from factice, reclaimed rubber and other deleterious substances. Gaskets shall, in addition, comply with AWWA C111 for push-on and mechanical joints.

2.04 FITTINGS

Unless otherwise specified, fittings shall conform to AWWA C110. Ends shall be flanged, restrained mechanical joint or restrained push-on to suit the conditions specified. The AWWA C153 compact ductile iron fittings are an acceptable substitute for standard fittings unless otherwise specified. Long-radius elbows shall be provided where specified.

2.05 JOINTS

A. UNRESTRAINED JOINTS:

1. PUSH-ON JOINTS: Unrestrained joints, where specified, shall be the rubber ring compression, push-on type joint suitable for buried service. Unrestrained joints shall be the Fastite Joint as manufactured by American Cast Iron Pipe Company, the Tyton Joint as manufactured by U.S. Pipe, or equal. This joint is not permitted on fittings or specials, unless otherwise specified. Unless otherwise specified, joints shall have an allowable deflection up to 5 degrees at specified pressures. Joint assembly and field cut joints shall be made in strict conformance with AWWA C600 and manufacturer's recommendations.

2. MECHANICAL JOINTS: Where specified, mechanical joints for above or below ground service shall meet the requirements of ANSI/AWWA A21.10/C110 and ANSI/AWWA A21.11/C111. Gaskets and bolts and nuts shall comply with paragraphs 15062-2.03 and 2.05 D, respectively.

B. RESTRAINED JOINTS:

1. GENERAL: Unless otherwise specified, restrained joints are required for all exposed and buried piping. Unless otherwise specified, restrained joints shall be flanged for exposed service and restrained push-on for buried service.

2. PUSH-ON JOINTS: Restrained push-on joints shall be as specified in paragraph 15062-2 05 A.1., modified for restraint. Joints shall be the Flex-Ring or Lok-Ring Joint as manufactured by American Cast Iron Pipe Company, TR Flex Joint as manufactured by US Pipe, or equal. Restrained joints shall be capable of being deflected after full assembly. Joint assembly shall be in strict conformance with AWWA C600 and manufacturer's recommendations. No field cuts of restrained pipe are permitted without prior approval of the Construction Manager.

3. FLANGE ASSEMBLIES: Unless otherwise specified, flanges shall be ductile iron and shall be threaded-on flanges conforming to ANSI/AWWA A21.15/C115 or cast-on flanges conforming to ANSI/AWWA A21.10/C110. Flanges shall be adequate for 250 psi working pressure. Bolt circle and bolt holes shall match those of ANSI B16.1, Class 125 flanges and ANSI B16.5, Class 150 flanges. Where specified, flanges shall be threaded-on or cast-on flanges conforming to ANSI B16.1, Class 250.

Unless otherwise specified, bolts and nuts for flange assemblies shall conform with paragraph 15085-2.01 C. Gaskets shall be as specified in paragraph 15085-2.01 B.

4. MECHANICAL JOINTS: Where specified, restrained mechanical joints shall be the positive restraint type. Mechanical joints with retainer glands are not acceptable.

Locked mechanical hydrant tees, bends and adapters are an acceptable substitute for anchoring fire hydrants and valves to the pipe main.

C. NOT USED

D. BOLTS AND NUTS:

Corrosion-resistant bolts and nuts for use with ductile iron joints shall be high-strength, low-alloy steel as specified in ANSI/AWWA C111/A21.11.

2.06 PIPE COATING

A. ASPHALTIC COATING

Unless otherwise specified, pipe and fittings shall be coated with asphaltic material as specified in AWWA C151.

B. POLYETHYLENE ENCASEMENT

All buried ductile iron pipe and fittings shall be wrapped with polyethylene film in tube form as specified in AWWA C105 and MAG Section 610

2.07 PIPE LINING

A. NOT USED

B. CEMENT MORTAR LINING:

Where specified, interior surfaces of pipe and fittings shall be cement mortar lined in accordance with AWWA C104. Cement shall be ASTM C150, Type II or V, low alkali, containing less than 0.60 percent alkalies.

C. CERAMIC EPOXY LINING

Where specified, ductile iron pipe and fittings shall be lined with a high build, ceramic epoxy lining. Lining shall be a multi-component amine cured Novalac epoxy lining, containing at least 20 percent by volume of ceramic quartz pigment. Lining shall be Protecto 401, or equal.

1. CHARACTERISTICS: The lining material shall exhibit the following characteristics following exposure to salt spray and immersion testing: (a) salt spray—no undercutting on a scribed ductile iron panel after 3,400 hours when measured using ASTM B117 and when rated using ASTM D714 evaluating degrees of blistering, (b) 20 percent sulfuric acid immersion—no effect after 2,200 hours when rated using ASTM D714 evaluating degrees of blistering, (c) immersion in 25 percent sodium hydroxide at 140 degrees F—no effect after 3,500 hours when rated using ASTM D714 evaluating degrees of blistering, and (d) deionized water immersion at 160 degrees F—no effect after 2,400 hours when rated using ASTM D714 evaluating degrees of blistering. Lining shall be resistant to oils, grease, solvents, and detergents that may be present in domestic sewage.

2. APPLICATION: Lining shall be applied by an experienced applicator with demonstrated experience applying linings to ductile iron pipe and fittings. Prior to abrasive blasting, the pipe interior shall be inspected for oil, grease, and other substances removable with solvent. Any such substances shall be removed by solvent cleaning in accordance with SSPC-SP1. The pipe interior shall then receive a near white blast cleaning in accordance with SSPC-SP10. Any areas when rust reappears prior to coating shall be re-blasted to remove all rust. Within 8 hours of surface preparation, the pipe interior shall receive 40 mils dry film thickness of the protective lining. No lining shall be performed when the ambient temperature is below 40 degrees F. Surfaces to receive protective lining shall be dirt and dust free. All fittings shall be lined with 40 mils of the protective lining. The 40-mil system shall not be applied in the gasket grooves. The gasket area and spigot end up to 6 inches back from the end of the spigot shall be coated with 6 miles nominal, 10 mils maximum joint compound applied by brush to assure an even coating without excess buildup. All materials for the gasket groove and spigot end shall be applied after the application of the lining. Application, including the number of coats to be applied, the thickness of the individual coats, and drying/curing times shall be as recommended by the coating manufacturer.

3. INSPECTION AND TESTING: All pipe and fittings shall be checked for lining thickness in accordance with SSPC-PA-2. Interior lining of all pipe and fittings shall be holiday tested for pinholes with a nondestructive 2,500-volt test. The manufacturer shall certify the lining installation, inspection and testing.

PART 3--EXECUTION

3.01 INSTALLATION

A. GENERAL:

Piping runs specified on the drawings shall be followed as closely as possible. Proposed deviations shall be submitted in accordance with Section 01300.

Pipe shall be installed in accordance with AWWA C600 and MAG Part 600.

Connections to existing structures and manholes shall be made so that the finished work will conform as nearly as practicable to the requirements specified for the new manholes, including necessary concrete work, cutting and shaping. Concrete mortar shaping within any structure and manhole shall be as specified.

B. INSULATING SECTIONS:

Where a metallic nonferrous pipe or appurtenance is connected to ferrous pipe or appurtenance, an insulating section shall be provided as specified in paragraph 15085-3.05.

C. ANCHORAGE:

Anchorage shall be provided as specified. Calculations and drawings for proposed alternative anchorage shall be submitted in accordance with Section 01300.

3.02 ACCEPTANCE TESTING

Hydrostatic pressure tests shall be conducted in accordance with Section 4 of AWWA C600 and MAG Part 600except that test pressures and allowable leakage shall be as listed in Section 15050.

The Contractor shall conduct the tests in the presence of the Construction Manager.

3.03 POLYETHYLENE TUBE

Polyethylene encasement shall be used on all buried ductile iron pipe unless otherwise specified. Installation of polyethylene shall be as specified in ANSI A21.5, Section 5-4.2.1, MAG Section 610 and these specifications. Pipe, fittings, valves and couplings shall be wrapped. Fittings that require concrete backing shall be wrapped prior to placing the concrete.

The polyethylene tube seams and overlaps shall be wrapped and held in place by means of a 2-inch wide plastic backed adhesive tape. The tape shall be Polyken No. 900 (polyethylene), Scotchwrap No.50 (polyvinyl), or equal. The tape shall be such that the adhesive shall bond securely to both metal surfaces and polyethylene film. Bedding and initial backfill for polyethylene wrapped pipe shall be a well-graded granular material which will not cut or damage the polyethylene tube during placement and backfilling. Sharp angular material over 0.5 inch shall not be used with polyethylene encasement.

END OF SECTION

SECTION 15064

PLASTIC PIPE

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies polyvinylchloride, chlorinated polyvinylchloride, polyethylene, and polypropylene pipe and fittings. High density polyethylene (HDPE) piping for gravity and pressure pipelines is specified in Section 15065.

B. PIPE DESIGNATIONS:

For use in the Piping System Specification Sheets (PIPESPEC) in Section 15050 and in this section, the following plastic pipe designations are defined:

Designation	Definition
PVC	Polyvinylchloride
CPVC	Chlorinated polyvinylchloride
PE	Polyethylene
PP	Polypropylene

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

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Reference	Title
ASTM D1248	Polyethylene Plastics Molding and Extrusion Materials
ASTM D1784	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
ASTM D1785	Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR)
ASTM D2464	Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2466	Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2467	Socket-Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2564	Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings
ASTM D2657	Heat-Joining Polyolefin Pipe and Fittings
ASTM D2665	Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D3034	Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D4101	Propylene Plastic Injection and Extrusion Materials
ASTM F402	Safe Handling of Solvent Cements and Primers Used for Joining Thermoplastic Pipe and Fittings
ASTM F437	Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F438	Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40
ASTM F439	Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F441	Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
ASTM F477	Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F493	Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings

PART 2--PRODUCTS

2.01 PVC PIPE

A. PRESSURE PIPE:

PVC material for pipe and fittings shall conform to ASTM D1784, Class 12454-B. Pipe and fittings shall either be in accordance with ASTM D1785 or shall conform to ASTM D2241 for standard dimension ratios: 160 psi pipe--SDR 26; 200 psi pipe--SDR 21; 250 psi--SDR 17. Pressure rating for pipe shall be in excess of test pressure specified in Section 15050. Neoprene gaskets with push-on joints shall conform to ASTM F477.

Schedule 80 PVC socket type fittings shall conform to ASTM D2467. Schedule 40 PVC fittings shall conform to ASTM D2466. PVC solvent weld cement for socket connections shall meet the requirements of ASTM D2564. Schedule 80 PVC threaded fittings shall conform to ASTM D2464. Fittings for gasketed pipe shall be ductile iron or steel push-on IPS-sized pressure fittings rated for use with the specified class of PVC pipe. Unless otherwise specified, fittings shall be lined and coated in accordance with Section 15061 or Section 15062 as applicable.

B. NONPRESSURE PIPE:

1. GRAVITY SEWER PIPE: PVC material for sewer pipe and fittings shall conform to Class 12454-B, as defined in ASTM D1784. Pipe and fittings shall meet the requirements of ASTM D3034 for SDR 35. Neoprene gaskets with push-on joints shall conform to ASTM F477.

2. DRAIN, WASTE AND VENT PIPE: PVC material for drain waste and vent (DWV) pipe and fittings shall conform to Class 12454-B, ASTM D1784. Pipe and fittings shall conform to ASTM D2665. Unless otherwise specified, connections shall be solvent weld. Connections to traps, closet flanges, and nonplastic pipe shall be with approved adapter type fittings designed for intended use. Solvent weld cement for socket connections shall meet requirements of ASTM D2564.

2.02 CPVC PIPE

CPVC material for pipe and fittings shall conform to ASTM D1784, Class 23447-B. Pipe and fittings shall be in accordance with ASTM F441. Neoprene gaskets with push-on joints shall conform to ASTM F477.

Schedule 80 CPVC socket type fittings shall conform to ASTM F439. Schedule 40 CPVC socket type fittings shall conform to ASTM F438. CPVC solvent weld cement for socket connections shall meet the requirements of ASTM F493. Schedule 80 CPVC threaded type fittings shall conform to ASTM F437.

2.03 PE PIPE

PE pipe shall meet the requirements of ASTM D1248, Type III, Grade P 34, Class C, 100 psi or as specified in Section 15050, whichever is higher. Fittings shall be of the same material,

molded socket fusion for sizes 4 inch diameter and smaller and molded or fabricated butt fusion for sizes 6 inch and larger. Fittings shall be 125 psi or as specified in Section 15050, whichever is higher. Heat fusion welding shall be in conformance with ASTM D2657.

2.04 PP PIPE

A. PRESSURE PIPE:

PP pipe and fittings shall be formulated of polypropylene conforming to ASTM D4101, SDR 11, butt fusion type. Pipe shall be 150 psi rated in all sizes. Heat fusion welding shall be in conformance with manufacturer's recommendation.

B. DRAIN, WASTE AND VENT PIPE:

PP drain, waste and vent (DWV) pipe and fittings shall be made from flame retardant, Schedule 40, polypropylene (PPFR) plastic as defined in ASTM D4101. Pipe and fittings used for buried piping and in concealed locations shall be joined by electrical fusion coils energized by a variable low-voltage power supply to completely fuse the interface between the pipe and socket and form a completely homogenous structure. Unless otherwise specified, mechanical joint fittings may be used under bench or in exposed locations where future disassembly is desired. The mechanical method shall be in conformance with the manufacturer's recommendation.

2.05 PRODUCT DATA

The following information shall be provided in accordance with Section 01300:

1. Manufacturer's certificates of compliance with the specified standards and Contractor's layout drawings.

PART 3--EXECUTION

3.01 INSTALLATION

PVC pipe 3 inches in diameter and smaller shall be joined by means of socket fittings and solvent welding in conformance with ASTM F402. Solvent-cemented joints shall be made in strict compliance with the manufacturer's/supplier's instructions and recommended procedures. Unless otherwise specified, PVC pipe 4 inches in diameter and greater shall be joined by means of gasketed push-on joints and steel or ductile iron push-on or mechanical joint fittings. Fittings shall be lined and coated as specified in Section 15061 or 15062. Unless otherwise specified, PVC and CPVC piping exposed to sunlight shall be painted with coating system L-2 as specified in Section 09900.

Connections to different types of pipe shall be by means of flanges, specified adapters or transition fittings. Where sleeve type couplings are used, both shall be uniformly torqued in accordance with pipe manufacturer's recommendation. Foreign material shall be removed from the pipe interior prior to assembly.

Unless otherwise specified, PE pipe and fittings 4 inch diameter and smaller shall be joined by means of thermal socket fusion and pipe 6 inch and larger by thermal butt fusion. Butt-fusion joining of the pipes and fittings shall be performed with special joining equipment in accordance with procedures recommended by pipe manufacturer. Tensile strength at yield of butt-fusion joints shall not be less than pipe. Flanged adapters shall be provided for connection to valves and where specified.

3.02 TESTING

Testing of plastic piping shall be as specified in Section 15050.

END OF SECTION

SECTION 15066

COPPER PIPING

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies copper piping, tubing, couplings and fittings.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI B16.22	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ANSI B16.26	Cast Copper Alloy Fittings for Flared Copper Tubes
ASTM B32	Solder Metal
ASTM B88	Seamless Copper Water Tube

1.03 SUBMITTALS

Contractor's layout drawings and catalog data demonstrating compliance with this specification and giving full description of the copper piping shall be provided in accordance with Section 01300.

PART 2--PRODUCTS

2.01 COPPER TUBING

Copper tubing shall be seamless copper, conforming to ASTM B88. Unless otherwise specified, copper tubing shall be Type L, drawn, where used in exposed service and Type K, annealed or drawn for buried service.

2.02 COUPLINGS AND FITTINGS FOR COPPER TUBING

Unless otherwise specified, couplings and fittings for copper tubing 1/2 inch and smaller nominal diameter shall be compression type, brass or bronze, capable of holding the full bursting strength of the tubing; shall meet the requirements of ANSI B16.26; and shall be Swagelok, Gyrolok, or equal.

Couplings and fittings for copper tubing larger than 1/2-inch nominal diameter shall be wrought copper or bronze, solder joint pressure fittings and shall conform to ANSI B16.22.

2.03 SOLDER

Solder to be used in copper piping shall be ASTM B32, Alloy Grade Sn95 or Silvabrite 100.

PART 3--EXECUTION

3.01 FABRICATION

A. SOLDER JOINTS:

All pipe and fittings to be jointed with solder shall be free from all burrs and wire brushed or steel wool cleaned. After cleaning, a paste flux shall be evenly and sparingly applied to the surfaces to be joined. Solder shall then be applied and flame passed toward the center of the fitting until the solder disappears. All excess solder shall be removed while it is still plastic. Absolutely no acid flux or acid wipe shall be used in making solder joints.

B. TAKEDOWN COUPLINGS:

Takedown couplings shall be screw union type and shall be provided in accordance with Paragraph 15085-3.03.

C. DIELECTRIC PROTECTION:

Copper tubing or fittings shall not be permitted to come in contact with steel piping, reinforcing steel, or other steel at any location. Electrical checks shall be made to assure no contact is made between copper tubing and steel elements. Wherever electrical contact is demonstrated by such tests, the Contractor shall provide dielectric protection as specified in paragraph 15085-3.05.

3.02 INSTALLATION, CLEANING, DISINFECTION, AND TESTING

The installation, cleaning, disinfection, and testing of copper piping shall be as specified in Section 15050.

END OF SECTION

SECTION 15075

JOINT GASKETS

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies rubber gaskets for push-on compression type joints used with fabricated steel pipe, steel pipe, reinforced concrete pipe, concrete cylinder pipe, and cement mortar lined and coated steel pipe.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM D395	Rubber Property--Compression Set, Test for
ASTM D412	Rubber Properties in Tension, Test for
ASTM D471	Rubber Property--Effect of Liquids, Test for
ASTM D573	Rubber--Deterioration in an Air Oven, Test for
ASTM D1149	Rubber Deterioration--Surface Ozone Cracking in a Chamber (Flat Specimens), Test for
ASTM D2240	Rubber Property--Durometer Hardness, Test for

B. TESTING:

Certified copies of test reports indicating that the gasket material has been tested and that the results of the tests comply with the requirements specified in paragraph 15075-2.02 shall be provided as product data.

PART 2--PRODUCTS

2.01 MATERIALS

Gasket stock shall be a synthetic rubber compound in which the elastomer is neoprene. The compound shall contain no less than 50 percent by volume neoprene and shall be free from factice, reclaimed rubber and other deleterious substances.

2.02 PHYSICAL REQUIREMENTS

The compound shall meet the following physical requirements when tested in accordance with the specified ASTM standards.

A. TENSILE (ASTM D412):

The tensile strength shall be 1500 psi minimum and the ultimate elongation shall be 350 percent minimum

B. HARDNESS (ASTM D2240, TYPE A DUROMETER):

The compound shall have a hardness in the range of 35 to 50 for concrete spigots and 50 to 65 for steel spigots.

C. COMPRESSION SET (ASTM D395):

The compression set shall not exceed 20 percent when compressed for 22 hours at 70 degrees C.

The test specimens shall be circular discs cut from the gaskets. Test specimens shall be 0.500 ($\pm$ 0.005 - 0.025) inches in height. The diameter of the test specimen shall be that of the gasket but not to exceed 1.129 $\pm$ 0.010 inches in diameter.

D. AGING (ASTM D573):

The test specimen deterioration shall be less than 20 percent reduction in tensile strength, 40 percent reduction in ultimate elongation, and 15 points increase in hardness.

E. EFFECT OF LIQUIDS (ASTM D471):

The maximum volume change in oil and in water shall be as follows:

1. Oil: 100 percent in ASTM oil No. 3.
2. Water: 15 percent.

The test specimens shall have a thickness of 0.080 $\pm$0.005 inches and shall be circular discs cut from the gasket.

F. OZONE CRACKING (ASTM D1149):

The test specimen shall be a gasket loop mounted to give at least 20 percent elongation. There shall be no cracking visible at two times magnification of the gasket after 100 hours exposure to 1 mg/l ozone at 40 degrees C.

2.03 PRODUCT DATA

In accordance with Section 01300, the Contractor shall provide certified copies of test reports specified in paragraph 15075-1.02 B.

PART 3--EXECUTION

The gaskets shall be installed in accordance with the manufacturer's recommendations.

END OF SECTION

SECTION 15085

PIPING CONNECTIONS

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies the following methods of connecting metallic piping: flanges, threading, mechanical couplings, equipment connection fittings, dielectric unions, and welding.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI Bl.1	Unified Inch Screw Threads (UN and UNR Thread Form)
ANSI Bl.20.1	Pipe Threads, General Purpose (Inch)
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings
ANSI B16.5	Pipe Flanges and Flanged Fittings
ANSI B18.2.1	Square and Hex Bolts and Screws Inch Series
ANSI B18.2.2	Square and Hex Nuts (Inch Series)
ANSI B31.1	Power Piping
ANSI B31.3	Chemical Plant and Petroleum Refinery Piping
ASME Section IX	Boiler and Pressure Vessel Code; Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators Qualifications
ASTM B98	Copper-Silicon Alloy Rod, Bar and Shapes

Reference	Title
ASTM F37	Standard Test Methods for Sealability of Gasket Materials
ASTM F104	Standard Classification System for Nonmetallic Gasket Materials
ASTM F152	Standard Test Methods for Tension Testing of Nonmetallic Gasket Materials
ASTM F593	Stainless Steel Bolts, Hex Cap Screws, and Studs
AWWA C111	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C206	Field Welding of Steel Water Pipe
AWWA C207	Steel Pipe Flanges for Waterworks Service-Size 4 in. through 144 in.
AWWA C219	Bolted, Sleeve-Type Couplings for Plain-End Pipe
AWWA C550	Protective Epoxy Coatings for Valves and Hydrants
AWWA C606	Grooved and Shouldered Joints
AWWA M11	Steel Pipe-A Guide for Design and Installation
NSF 61	Drinking Water System Components - Health Effects

1.03 SUBMITTALS

In addition to the material listed in the detailed specification, the following submittals shall be provided in accordance with Section 01300:

1. For Equipment Connection Fittings used in pumping applications submit thrust rod stretch calculations in accordance with paragraph 2.01D. and dimensional layout data.

PART 2--PRODUCTS

2.01 FLANGE ASSEMBLIES

A. FLANGES:

1. GENERAL: Flanges shall either be flat flanges or convoluted ring flanges as specified in the following paragraphs.

2. FLAT FLANGES: Cast iron flanges shall be faced in accordance with ANSI B16.1. Where companion flanges are used, the flanges on pipe shall be refaced to be flush with the companion flange face. Class 150 and Class 300 forged steel flanges shall be raised face conforming to ANSI B16.5. Lightweight slip-on flanges shall be plain face conforming to AWWA C207, Class B and ANSI B16.5. Unless otherwise specified, steel flanges shall be ANSI B16.5,

Class 150 or AWWA C207, Class D. Class E AWWA flanges shall be provided where test pressure exceeds 175 psi. Plain faced flanges shall not be bolted to raised face flanges.

B. GASKETS:

Gasket material shall be as specified in paragraph 15085-2.03.

Gaskets for plain faced flanges shall be the full face type. Thickness shall be 1/16 inch for pipe 10 inches and less in diameter and 1/8 inch for pipe 12 inches and larger in diameter. Unless otherwise specified, gaskets for raised face flanges shall match the raised face and shall be 1/16 inch thick for pipe 3-1/2 inches and less in diameter and 1/8 inch thick for pipe 4 inches and larger.

C. BOLTS:

Flange assembly bolts shall be ANSI B18.2.1 standard square or hexagon head bolts with ANSI B18.2.2 standard hexagon nuts. Threads shall be ANSI Bl.1, standard coarse thread series; bolts shall be Class 2A, nuts shall be Class 2B. Bolt length shall conform to ANSI B16.5.

Unless otherwise specified, bolts shall be carbon steel machined bolts with hot pressed hexagon nuts. Bolts for submerged service shall be made of Type 316 stainless steel in conformance with ASTM F593, marking F593F. Nuts for submerged service shall be made of copper-silicon alloy bronze conforming to ASTM B98, alloy C65100, designation H04 or alloy C65500, designation H04. Bolts and nuts for buried service shall be made of noncorrosive high-strength, low-alloy steel having the characteristics specified in ANSI/AWWA C111/A21, regardless of any other protective coating. Where washers are required, they shall be of the same material as the associated bolts.

2.02 MECHANICAL COUPLINGS

A. SLEEVE-TYPE COUPLINGS:

Unless otherwise specified, sleeve-type mechanical pipe couplings shall be Smith-Blair Type 411, Dresser Style 38, or equal, with the stop removed from the middle ring. Reducing couplings shall be Smith-Blair Type 415, Dresser Style 62, or equal. Sleeve-type flanged coupling adapters shall be Smith-Blair Type 913, Dresser Style 128, or equal. Insulating couplings shall be Smith-Blair Type 416, Dresser Style 39, or equal. Flanged adapters shall be Dresser Style 127 or equal.

Bolts for submerged service shall be made of Type 316 stainless steel in conformance with ASTM F593, markingF593F. Nuts for submerged service shall be made of copper-silicon alloy bronze conforming to ASTM B98, alloy C65100, designation H04, or alloy C65500, designation H04. Bolts and nuts for buried service shall be made of noncorrosive high-strength, low-alloy steel having the characteristics specified in ANSI/AWWA C111/A21, regardless of any other protective coating. Where washers are required, they shall be of the same material as the associated bolts.

Gaskets shall be as specified in Paragraph 15085-2.03 and AWWA C111.

B. PLAIN END COUPLINGS:

Plain end pipe couplings for pipe sizes 6 inches and smaller shall be Tyler 6-B No. 500, Victaulic Style 99, or equal for Schedule 80 pipe and Victaulic Style 90, or equal for lighter weight pipe. Plain end couplings for pipe sizes 8 inches and larger shall be Tyler 6-B No. 500, Victaulic Style 99, or equal. Unless otherwise specified, bolts and nuts shall comply with AWWA C606.

Gaskets shall be as specified in Paragraph 15085-2.03 and AWWA C606.

C. NOT USED

D. EQUIPMENT CONNECTION FITTINGS

Equipment connection fittings shall provide both lateral and angular misalignment adjustment between equipment connection flanges and the connection to field piping systems by providing individually adjustable flexible joints at each connection. In addition, equipment connection fittings shall provide full pressure thrust restraint between the field piping connection and equipment connection flanges.

Equipment connection fittings shall consist of two flanged coupling adapters, a plain end section of pipe and thrust restraint rods and associated fittings designed to transmit thrust without transmitting shear to the thrust restraint rods and without compromising provisions for accommodating angular and parallel misalignment. Materials and features shall conform to the requirements established in this paragraph. Standard "dismantling joints" incorporate only one flanged coupling adapter and are not acceptable substitutes. Equipment connection fittings shall be Romac ECF Series, or Baker Coupling Company, Los Angeles or equal, modified as specified to provide the required features.

Equipment connection fittings shall each consist of a single sleeve of plain end piping conforming to the requirements of the specified piping system of sufficient length to span the gap between the connection at the equipment and the connection at the field piping with gasketed flange adapters at each end. Thrust restraint shall be provided by means of all threaded rod spanning between flanges and male rod nuts and female washers that are rounded to provide a ball-joint type self aligning feature. All threaded restraint rod shall project through flange and mating flange coupling adapter bolt holes or through holes in restraint lug plates that extend above the flanges and are secured to the flanges with a minimum of two flange bolts. Where the all threaded rods project through flange bolt holes, ball joint type nut and washer combinations and lock washers shall be provided at each face, each end. Where restraint lug plates are employed, ball joint type nuts and washers shall be provided only on the outside faces of the plates and the nuts shall have a self locking feature that prevents nut movement due to vibration or other operational or environmental causes. Double nutting with non-locking nuts shall not be an acceptable method of providing the self locking feature. Thrust rod diameter and material shall be selected to provide sufficient freedom of movement through all bolt holes to allow unrestricted maximum adjustment of equipment connection fittings to accommodate piping misalignment without transmitting any shear to the thrust rods and also to permit full

development of thrust restraint at all thrust rod tension take-ups. Design of equipment connection fittings shall conform to AWWA C219.

Thrust rods, restraint lug plates, nuts, washers and lock washers shall be Type 316 stainless steel, all selected to develop full rated piping system pressure thrust forces. Equipment connection fittings for pump applications shall have thrust rod number and diameter selected such that thrust rod stretch under piping system operating pressure does not exceed 2 mils. Calculations shall be submitted. Dry film molybdenum di-sulfide anti-galling compound shall be factory applied to ends of thrust rods, covering all threads subject to nut travel and tightening. Gaskets shall be as specified in paragraph 15085-2.03. Flange gaskets shall be full face type. Follower gaskets shall be compression wedge type.

Sleeves shall be carbon steel or as specified for the specific piping system. Pressure rating of flange adapters shall equal or exceed the pressure rating of mating flanges. All metal portions of equipment connection fittings, with the exception of 316 stainless steel components, shall be coated and lined with fusion bonded epoxy conforming to AWWA C550 and NSF 61.

E. DISMANTLING JOINTS

Dismantling joints may be used as takedown couplings in accordance with paragraph 15085-3.03. Dismantling joints shall fully restrained double flange fittings consisting of a flange coupling adapter and flanged spool piece that allows for longitudinal adjustment. Thrust restraint shall be provided by means of all threaded rod spanning between flanges and secured to the flanges with a minimum of two flange bolts. Design of equipment connection fittings shall conform to AWWA C219. Sleeves shall be carbon steel or as specified for the specific piping system. Pressure rating of flange adapters shall equal or exceed the pressure rating of mating flanges. All metal portions of equipment connection fittings, with the exception of 316 stainless steel components, shall be coated and lined with fusion bonded epoxy conforming to AWWA C550 and NSF 61. Dismantling joints shall be Romac DJ-400, Smith Blair 975, or Crane-Viking Johnson Dismantling Joint.

F. SLEEVE BAND COUPLINGS

Sleeve band couplings shall be Victaulic Depend-O-Lock. Unless otherwise noted, couplings for liquid service shall be Model F x F Type 2 fully restrained, shouldered high deflection couplings with standard width band. Couplings shall comply with AWWA C-219. Couplings for use with air systems shall be Airmaster restrained Depend-O-Lock couplings in conformance with AWWA C-606. Sleeve band couplings are acceptable wherever sleeve type couplings are used (paragraph 15085-2.02 A.)

G. FLEXIJOINT

Where specified Flexijoint couplings shall be Flanged Romac Flexijoint couplings. The Flexijoint is a flexible, ductile iron joint that can accommodate expansion, contraction, rotation and bending and is rated at 350 psi working pressure. The joint can accommodate 15 to 20 degree deflection depending on size. Body shall be ductile iron, lock rings Type 410 stainless

steel, and ring gasket, casing, ball and cover shall be EPDM molded watertight construction. All metal portions of Flexijoint coupling including the stainless steel lock rings shall be coated and lined with fusion bonded epoxy conforming to AWWA C550 and NSF 61. For buried installations, install with polyethylene baggy cover in accordance with the manufacturer's instructions.

2.03 GASKETS

Gaskets designated in Section 15050 shall be as follows:

1. EPDM: ethylene-propylene-diene-terpolymer.

2. Neoprene: neoprene.

3. Nitrile: nitrile (Buna N).

4. Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder; ASTM F104 (F712400), 2500 psi (ASTM F152), 0.2 ML/HR LEAKAGE FUEL A (ASTM F37).

5. Compressed gasketing consisting of organic fibers (Kevlar) and SBR binder; ASTM F104 (F712400), 2500 PSI (ASTM F152), 0.1 ml/hr leakage Fuel A (ASTM F37).

6. Gylon gasketing, Garlock Style 3500, 2000 psi (ASTM F152), 0.22 ml/hr Fuel A (ASTM F37).

7. Gylon gasketing, Garlock Style 3510, 2000 psi (ASTM F152), 0.04 ml/hr Fuel A (ASTM F37).

8. Gylon gasketing, Garlock Style 3504, 2000 psi (ASTM F152), 0.12 ml/hr Fuel A (ASTM F37).

9. TFE: noncreeping tetrafluoroethylene (TFE) with insert filler.

10. PTFE bonded EPDM: PTFE bonded to EPDM in full-face gasket having concentric-convex molded rings; Garlock Stress Saver 370 or equal.

11. Styrene Butadiene Rubber (SBR)

2.04 THREAD

Pipe thread dimensions and size limits shall conform to ANSI Bl.20.1.

2.05 DIELECTRIC UNIONS

Dielectric unions shall be EPCO, Capitol Manufacturing, or equal.

2.06 COATINGS

Unless otherwise specified, flange assemblies and mechanical type couplings for buried installation shall be field coated with System M-1 as specified in Section 09900.

2.07 PRODUCT DATA

In accordance with Section 01300, the Contractor shall provide for each welder, a welder qualification certificate indicating the welder is certified for pipe welding in accordance with ASME Boiler and Pressure Vessel, Section IX. Each welder's certificate shall be provided to the Construction Manager prior to that welder working on the job.

PART 3--EXECUTION

3.01 PIPE CUTTING, THREADING AND JOINTING

Pipe cutting, threading and jointing shall conform to the requirements of ANSI B31.1.

3.02 PIPE WELDING

Pipe shall be welded by ASME-certified welders using shielded metal arc, gas shielded arc or submerged arc welding methods. Welds shall be made in accordance with the requirements of ANSI B31.1 for piping Systems 8, 26, and 28 specified in Section 15050. Welds shall be made in accordance with the requirements of ANSI B31.3 for piping System 20 specified in Section 15050.

Welds for piping systems not specified above shall be made in accordance with AWWA C206.

3.03 TAKEDOWN COUPLINGS

Takedown couplings shall be screw unions, flanged or grooved end mechanical coupling type joints and shall be provided as specified. Flanged or grooved end joints shall be employed on pipelines 2-1/2 inches in diameter and larger. Where piping passes through walls, takedown couplings shall be provided within 3 feet of the wall, unless specified otherwise.

A union or flanged connection shall be provided within 2 feet of each threaded end valve.

3.04 FLEXIBILITY

Unless otherwise specified, piping passing from concrete to earth shall be provided with two pipe couplings or flexible joints (or a single Flexijoint) as specified on the buried pipe within 2 feet

of the structure for 2-inch through 6-inch diameter pipe; within 3 feet of the structure for 8-inch through 24-inch diameter pipe; and within one and one-half pipe diameters of the structure for larger pipe. Where required for resistance to pressure, mechanical couplings shall be restrained in accordance with Chapter 13 of AWWA M11, including Tables 13-4, 13-5 and 13-5A, and Figure 13-20.

3.05 DIELECTRIC CONNECTIONS

Where a copper pipe is connected to steel or cast iron pipe, an insulating section of rubber or plastic pipe shall be provided. The insulating section shall have a minimum length of 12 pipe diameters. Dielectric unions as specified in paragraph 15085-2.05 may be used instead of the specified insulating sections. Where copper pipe is supported from hangers, it shall be insulated from the hangers, or copper-plated hangers shall be used.

3.06 EQUIPMENT CONNECTION FITTINGS

Where shown, equipment connection fittings shall be provided between field piping systems and equipment inlet and outlet connections.

END OF SECTION

SECTION 15095

PIPING APPURTENANCES

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE

This section specifies tapping devices and pressure gages.

B. EXCLUSIONS:

Temperature, pressure and flow measuring devices used for instrumentation are specified in Division 17.

1.02 SUBMITTALS

Manufacturer's product data shall be provided in accordance with Section 01300.

PART 2--PRODUCTS

2.01 TAPPING DEVICES

A. SADDLES:

Saddles shall be Ford Style FS202 or equal.

B. CORPORATION STOPS

All components of the corporation stops shall be manufactured of brass, cast in conformance with AWWA C809. Inlet and outlet threads shall conform to AWWA C300 Standards. The corporation stops shall be manufactured by Mueller Corporation or equal.

2.02 NOT USED

2.03 PRESSURE DEVICES

A. GAGE COCKS:

Unless otherwise specified, gage cocks shall be Robertshaw 1303, Ashcroft 1095, or equal. The exposed threads of each gage cock shall be protected by a brass plug.

B. PRESSURE GAGES:

Unless otherwise specified, pressure gage scales shall be selected so that the normal operating pressure falls between 50 and 80 percent of full scale, shall be 4 1/2-inch, 270-degree movement, 1-percent accuracy, full-scale, and suitable for bottom stem mounting. Gages shall have a 316-SS bourdon tube. All gages shall have a 300 series stainless steel case, shatterproof glass, and a 1/2-inch NPT bottom connection. All pressure gages shall have diaphragm seals as specified in 2.03 C.

Pressure gages for air, gas, and low pressure services (0-10 feet) shall be premium grade, heavy-duty bourdon-tube units (bellow type for vacuum) with Delrin bushings and pinion, and stainless steel sector.

Gages on liquid service shall be as noted above, except they shall be provided with an internal pulsation dampening system consisting of either a glycerin fill or a silicone fluid fill. Snubbers or orifices shall not be utilized. Gages shall be Ashcroft General Service Gage Type 1009 or equal.

C. DIAPHRAGM SEALS:

Unless otherwise specified, seals shall be diaphragm type with 1/2-inch flushing connection, Type 316 stainless steel body and Type 316L diaphragm. Fill fluid shall be Silicone DC200 unless otherwise specified. Seal shall be Mansfield and Green Type SG, Ashcroft Type 101, or equal.

D. NOT USED

2.04 NOT USED

2.05 NOT USED

PART 3--EXECUTION

3.01 PIPING AND INSTRUMENT CONNECTION

Unless shown otherwise, piping connections shall be full size of equipment, valve, appurtenance or instrument connection.

3.02 GAGE TAPS

Gage taps shall be provided as shown on the Drawings for each pump, fan, compressor, vacuum pump and blower. Gage taps shall consist of a 1/4-inch gage cock attached by a threaded nipple to the pipeline, duct or equipment.

END OF SECTION

SECTION 15096

PIPE HANGERS AND SUPPORTS

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies hangers and supports for all piping systems specified in Section 15050. This section does not include pipe supports for fire sprinkler systems, pipe anchors, guides or seismic restraints.

B. OPERATING CONDITIONS:

The hangers and supports specified in this section are provided to resist pipe loads occurring primarily in the downward (gravity) direction. For the purpose of pipe hanger and support selection, this section establishes pipe support classifications based on the operating temperatures of the piping contents. Pipe support classifications are as follows:

1. Hot Systems

   A - 1. 120 degrees F to 450 degrees F
   A - 2. 451 degrees F to 750 degrees F
   A - 3. Over 750 degrees F

2. Ambient Systems

   B - 60 degrees F to 119 degrees F

3. Cold Systems

   C - 1. 33 degrees F to 59 degrees F
   C - 2. -20 degrees F to 32 degrees F

C. HANGER AND SUPPORT SELECTION:

The Contractor shall select pipe hangers and supports as specified in the project manual. Selections shall be based upon the pipe support classifications specified in this section, the piping insulation thickness specified in Section 15250, and any special requirements which may be specified in the project manual.

The Contractor shall review the piping layout in relation to the surrounding structure and adjacent piping and equipment before selecting the type of support to be used at each hanger point.

Hangers and supports shall withstand all static and specified dynamic conditions of loading to which the piping and associated equipment may be subjected. As a minimum, consideration shall be given to the following conditions:

1. Weights of pipe, valves, fittings, insulating materials, suspended hanger components, and normal fluid contents.

2. Weight of hydrostatic test fluid or cleaning fluid if normal operating fluid contents are lighter.

3. Reaction forces due to the operation of safety or relief valves

4. Wind, snow or ice loadings on outdoor piping.

Hangers and supports shall be sized to fit the outside diameter of pipe, tubing, or, where specified, the outside diameter of insulation

Where negligible movement occurs at hanger locations, rod hangers shall be used for suspended lines, wherever practical. For piping supported from below, bases, brackets or structural cross members shall be used.

Hangers for the suspension of size 2 1/2 inches and larger pipe and tubing shall be capable of vertical hanger component adjustment under load.

The supporting systems shall provide for and control the free or intended movement of the piping including its movement in relation to that of connected equipment.

Where there is horizontal movement at a suspended type hanger location, hanger components shall be selected to allow for swing. The vertical angle of the hanger rod shall not, at any time, exceed 4 degrees.

There shall be no contact between a pipe and hanger or support component of dissimilar metals. Prevent contact between dissimilar metals when supporting copper tubing by use of copper-plated, rubber, plastic or vinyl coated, or stainless steel hanger and support components.

Unless otherwise specified, existing pipes and supports shall not be used to support new piping.

Unless otherwise specified, pipe support components shall not be attached to pressure vessels.

Stock hanger and support components shall be used wherever practical.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AISC Manual of Steel Construction	American Institute of Steel Construction, Manual of Steel Construction, Allowable Stress Design - 9th Ed.
FEDSPEC WW-H-171e-78	Hangers and Supports, Pipe
MFMA-2-91	Metal Framing Standards Publication
MSS SP-69-91	Pipe Hangers and Supports - Selection and Application
MSS SP-58-93	Pipe Hangers and Supports - Materials, Design and Manufacture

PART 2--PRODUCTS

2.01 ACCEPTABLE PRODUCTS

Standard pipe supports and components shall be manufactured by B-Line, Carpenter & Patterson, Kin-Line, Grinnell, Michigan, Pipe Shields Incorporated, Superstrut, Unistrut, or equal. Pipe support components shall conform to the requirements of MSS SP-69 and FEDSPEC WW-H-171e. Pipe support materials shall conform to the requirements of MSS SP-58. Metal framing system components shall conform to the metal framing manufacturers' Association Standard MFMA-2.

2.02 MATERIALS

A. GENERAL:

Unless otherwise specified, pipe hangers and supports, structural attachments, fittings and accessories shall be hot-dip or mechanically galvanized after fabrication. Nuts, bolts and washers may be zinc-plated except for those subject to moisture or corrosive atmosphere, as specified in paragraph 16000-1.05 B, which shall be type 304 stainless steel.

B. PIPE HANGERS AND SUPPORTS:

1. TYPE 1 - CLEVIS PIPE HANGER: Clevis hangers shall be carbon steel with configuration and components equivalent to MSS and FEDSPEC Type 1.

   a. Steel pipe (insulated) - shall be B-Line B3100, Grinnell Fig. 260, or equal, with insulation shield.

   b. Steel pipe (uninsulated) - shall be B-Line B3100, Grinnell Fig. 260, or equal.

   c. Cast and ductile iron pipe - shall be B-Line B3102, Grinnell Fig. 590, or equal.

   d. Copper pipe (uninsulated) - shall be B-Line B3104 CT, Grinnell Fig. CT-65, or equal.

   e. Copper pipe (insulated) - shall be B-Line B3100, Grinnell Fig. 260, or equal, with insulation shield.

   f. Plastic pipe - shall be B-Line B3100 C, Carpenter & Patterson Fig. 100PVC, or equal.

2. TYPE 2 - "J" PIPE HANGER: Hangers shall be carbon steel with configuration and components equivalent to MSS Type 5.

   a. Steel pipe - shall be B-Line B3690, Grinnell Fig. 67, Michigan model 418, or equal.

   b. Copper and plastic pipe - shall be Michigan model 419, Unistrut J 1205N series, or equal.

3. TYPE 3 - DOUBLE BOLT PIPE CLAMP: Pipe clamp shall be carbon steel, with configuration and components equivalent to MSS and FEDSPEC Type 3.

a. Steel pipe (insulated) - shall be B-Line B3144, Grinnell Fig. 295, or equal, with insulation shield. Insulation shield is optional for hot and ambient systems.

b. Steel pipe (uninsulated) - shall be B-Line B3144, Grinnell Fig. 295, or equal.

c. Copper pipe (insulated only) - shall be B-Line B3144, Grinnell Fig. 295, or equal, with insulation shield.

4. TYPE 4 - ADJUSTABLE ROLLER HANGER: Rollers shall be cast iron, yoke and cross bolt shall be carbon steel. Configuration and components shall be equivalent to MSS Type 43 and FEDSPEC Type 44.

a. Steel pipe (insulated) - shall be B-Line B3110, Grinnell Fig. 181, or equal, with insulation shield.

b. Steel pipe (uninsulated) - shall be B-Line B3110, Grinnell Fig. 181, or equal.

c. Copper pipe (insulated only) - shall be B-Line B3110, Grinnell Fig. 181, or equal, with insulation shield.

d. Plastic pipe - shall be B-Line B3110, Grinnell Fig. 181, or equal.

5. TYPE 5 - SINGLE PIPE ROLL: Rollers and sockets shall be cast iron, cross rod shall be steel. Configuration and components shall be equivalent to MSS Type 41 and FEDSPEC Type 42.

a. Steel pipe (insulated) - shall be B-Line B3114, Grinnell Fig. 171, or equal, with insulation shield.

b. Steel pipe (uninsulated) - shall be B-Line B3114, Grinnell Fig. 171, or equal.

c. Plastic pipe - shall be B-Line B3114, Grinnell Fig. 171, or equal.

6. TYPE 6 - FRAMING CHANNEL PIPE CLAMP: Pipe clamps shall be steel with galvanized finish and material thickness as listed below:

a. Steel pipe (uninsulated) - Pipe size 3/8 inch and 1/2 inch shall be 16 gage; 3/4 inch through 1 1/4 inches shall be 14 gage; 1 1/2 inches through 3 inches shall be 12 gage; 3 1/2 inches through 5 inches shall be 11 gage; 6 and 8 inches shall be 10 gage; Michigan model 431, Powerstrut PS 1100, Unistrut P 1109 series, or equal.

b. Steel pipe (insulated) - Pipe clamp shall be as described in paragraph 15096-2.02 B.6.a with insulation shield.

c. Copper (uninsulated) and plastic pipe - Pipe size 3/8 inch and 1 inch shall be 16 gage; 1-1/4 inches and 1-1/2 inches shall be 14 gage; 2 inches through 3 inches shall be 12 gage; 4 inches shall be 11 gage; clamp shall be copper-plated, plastic coated or lined with dielectric material; Michigan model 432, Powerstrut PS 1200, Unistrut P 2024C and P 2024PC series, or equal.

d. Copper pipe (insulated) - Pipe clamp shall be as described in paragraph 15096-2.02 B.6.a with insulation shield.

7. TYPE 7 - U-BOLT: U-bolts shall be carbon steel with configuration equivalent to MSS and FEDSPEC Type 24.

a. Steel pipe (uninsulated) - shall be Grinnell Fig. 137, B-Line B3188, or equal.

b. Steel pipe (insulated) - shall be Grinnell Fig. 137, B-Line B3188, or equal, with insulation shield.

c. Cast and ductile iron pipe - shall be Grinnell Fig. 137, B-Line B3188, or equal.

d. Copper pipe (uninsulated) - shall be Carpenter & Patterson Fig. 222 CT, B-Line B3501 CT, Grinnell Fig. 137C, or equal.

e. Copper pipe (insulated) - shall be Grinnell Fig. 137, B-Line B3188, or equal, with insulation shield.

f. Plastic pipe - shall be Grinnell Fig. 137C, Michigan model 151, B-Line B3188 C, or equal.

8. TYPE 8 - ADJUSTABLE PIPE ROLL SUPPORT: Rollers and sockets shall be cast iron, cross rod and support rods shall be carbon steel.

a. Steel pipe (insulated) - shall be B-Line B3122, Grinnell Fig. 177, or equal, with insulation shield.

b. Steel pipe (uninsulated) - shall be B-Line B3122, Grinnell Fig. 177, or equal.

c. Copper pipe (insulated only) - shall be B-Line B3122, Grinnell Fig. 177, or equal, with insulation shield.

d. Plastic pipe - shall be B-Line B3122, Grinnell Fig. 177, or equal.

9. TYPE 9 - WELDED PIPE STANCHION: Minimum material thickness shall be standard schedule carbon steel pipe, cut to match contour of the pipe elbow. Use of this support shall be limited to ambient systems only.

10. TYPE 10 - PIPE STANCHION SADDLE: Saddles and yokes shall be carbon steel and comply with MSS Type 37 and FEDSPEC Type 38.

a. Steel pipe (insulated) - shall be Carpenter & Patterson Fig. 125, B-Line B3090, or equal, with insulation shield.

b. Steel pipe (uninsulated) - shall be Carpenter & Patterson Fig. 125, B-Line B3090, or equal.

c. Cast and ductile iron pipe - shall be Carpenter & Patterson Fig. 125, B-Line B3090 NS, or equal.

d. Copper pipe (uninsulated) - shall be Carpenter & Patterson Fig. 125, B-Line B3090, or equal, with insulation shield or lined with dielectric material.

e. Copper pipe (insulated) - shall be Carpenter & Patterson Fig. 125, B-Line B3090, or equal, with insulation shield.

f. Plastic pipe - shall be Carpenter & Patterson Fig. 125, B-Line B3090, or equal.

11. TYPE 11 - OFFSET PIPE CLAMP: Pipe clamp shall be carbon steel with configuration and components as specified and shall be of standard design manufactured by a pipe hanger component manufacturer.

a. Steel pipe (insulated) - shall be B-Line B3148, Grinnell Fig. 103, or equal, with insulation shield.

b. Steel pipe (uninsulated) - shall be B-Line B3148, Grinnell Fig. 103, or equal.

c. Cast and ductile iron pipe - shall be B-Line B3148 NS, Grinnell Fig. 103, or equal.

d. Copper pipe (insulated) - shall be B-Line B3148, Grinnell Fig. 103, or equal, with insulation shield.

e. Copper pipe (uninsulated) - shall be B-Line B3148, Grinnell Fig. 103, or equal, lined with dielectric material.

f. Plastic pipe - shall be B-Line B3148, Grinnell Fig. 103, or equal.

Vertical pipe support applications shall be as specified above except that insulation shields shall not be used for insulated pipe.

12. TYPE 12 - RISER CLAMP: Riser clamp shall be carbon steel with configuration and components equivalent to MSS and FEDSPEC Type 8.

a. Steel pipe (insulated) - shall be B-Line B3373, Grinnell Fig. 261, or equal.

b. Steel pipe (uninsulated) - shall be B-Line B3373, Grinnell Fig. 261, or equal.

c. Cast and ductile iron pipe - shall be B-Line B3373, Grinnell Fig. 261, or equal.

d. Copper pipe (insulated) - shall be B-Line B3373 CT, Grinnell Fig. CT-121, Michigan model 511, or equal.

e. Copper pipe (uninsulated) - shall be B-Line B3373 CT, Grinnell Fig. CT-121, Michigan model 511, or equal.

f. Plastic pipe - shall be B-Line B3373, Grinnell Fig. 261c, or equal.

13. TYPE 13 - FRAMING CHANNEL PIPE STRAP: Pipe strap shall be carbon steel, with configuration equivalent to MSS Type 26.

a. Steel pipe (uninsulated) - shall be Superstrut No. C-708-U, Powerstrut PS 3126, Kin-Line No. 477, or equal.

b. Steel pipe (insulated) - shall be Superstrut No. C-708-U, Powerstrut PS 3126, Kin-Line No. 477, or equal, with insulation shield.

c. Copper pipe (uninsulated) - shall be Superstrut No. C-708-U, Powerstrut PS 3126, Kin-Line No. 477, or equal, with insulation shield or lined with dielectric material.

d. Copper pipe (insulated) - shall be Superstrut No. C-708-U, Powerstrut PS 3126, Kin-Line No. 477, or equal, with insulation shield.

e. Plastic pipe - shall be Superstrut No. C-708-U, Powerstrut PS 3126, Kin-Line No. 477, or equal.

C. RACK AND TRAPEZE SUPPORTS:

1. GENERAL: Unless otherwise specified, trapeze and pipe rack components shall have a minimum steel thickness of 12 gage, with a maximum deflection 1/240 of the span.

2. TYPE 20 - TRAPEZE PIPE SUPPORT: Trapeze pipe support cross members shall be framing channel as specified in paragraph 15096-2.02 E.5. Flat plate fittings shall be 1 5/8-inch square carbon steel of standard design manufactured by framing channel manufacturer, Unistrut P2471, B-Line B202-2, or equal.

3. TYPE 21 - PIPE RACK SUPPORT: Post and cross members shall be framing channel as specified in paragraph 15096-2.02 E.5. Pipe rack fittings shall be carbon steel, of standard design manufactured by framing channel manufacturer. 90-degree fittings shall be gusseted Unistrut P2484, B-Line B844, or equal. Post base fittings shall be as specified in paragraph 15096-2.02 D.5.

D. STRUCTURAL ATTACHMENTS:

1. TYPE A - MALLEABLE IRON CONCRETE INSERT: Concrete inserts shall be malleable iron and comply with MSS and FEDSPEC Type 18. Grinnell Fig. 282, Carpenter & Patterson Fig. 108, or equal.

2. TYPE B - SIDE BEAM BRACKET: Bracket shall be malleable iron and comply with MSS Type 34 and FEDSPEC Type 35. Grinnell Fig. 202, B-Line B3062, or equal.

3. TYPE C - MALLEABLE BEAM CLAMP WITH EXTENSION PIECE: Clamp and extension piece shall be malleable iron, tie rod shall be steel. Beam clamp shall comply with MSS and FEDSPEC Type 30. Grinnell Fig. 218 with Fig. 157 extension piece, B-Line B3054, or equal.

4. TYPE D - STEEL BEAM CLAMP WITH EYE NUT: Beam clamp and eye nut shall be forged steel. Configuration and components shall comply with MSS and FEDSPEC Type 28. Grinnell Fig. 292, Carpenter & Patterson Fig. 297, or equal.

5. TYPE E - FRAMING CHANNEL POST BASE: Post bases shall be carbon steel, of standard design manufactured by framing channel manufacturer. Single channel: Unistrut P2072A, B-Line B280, or equal. Double channel: Unistrut P2073A, B-Line B281, or equal.

6. TYPE F - WELDED BEAM ATTACHMENT: Beam attachment shall be carbon steel and comply with MSS and FEDSPEC Type 22. B-Line B3083, Grinnell Fig. 66, or equal.

7. TYPE G - WELDED STEEL BRACKET: Bracket shall be carbon steel and comply with MSS Type 32 and FEDSPEC Type 33 for medium welded bracket. Heavy welded bracket shall comply with MSS Type 33 and FEDSPEC Type 34.

8. TYPE H - CAST IRON BRACKET: Bracket shall be cast iron, Carpenter & Patterson Fig. 340, or equal.

9. TYPE J - ADJUSTABLE BEAM ATTACHMENT: Beam attachment shall be carbon steel, Carpenter & Patterson Fig. 151, B-Line B3082, or equal.

10. TYPE K - DOUBLE CHANNEL BRACKET: Wall channel shall be single channel framing channel as specified in paragraph 15096-2.02 E.5. Cantilever bracket shall be a carbon steel double framing channel assembly, Unistrut P2542 through P2546, B-Line B297-12 through B297-36, or equal.

11. TYPE L - SINGLE CHANNEL BRACKET: Wall channel shall be single channel framing channel as specified in paragraph 15096-2.02 E.5. Cantilever bracket shall be a carbon steel single framing channel assembly, Unistrut P2231 through P2234, B-Line B198-6, B198-12, B196-18 and B196-24, or equal.

12. TYPE M - WALL MOUNTED CHANNEL: Wall channel shall be single channel framing channel as specified in paragraph 15096-2.02 E.5.

13. TYPE N - PIPE STANCHION FLOOR ATTACHMENT: Baseplate shall be carbon steel with 1/2 inch minimum thickness. Anchor bolt holes shall be 1/16 inch larger than the anchor bolt diameter. The space between the baseplate and the floor shall be filled with nonshrink grout.

E. ACCESSORIES:

1. HANGER RODS: Rods shall be carbon steel, threaded on both ends or continuous threaded and sized as specified.

2. WELDLESS EYE NUT: Eye nut shall be forged steel and shall comply with MSS and FEDSPEC Type 17. Eye nut shall be Grinnell Fig. 290, B-Line B3200, or equal.

3. WELDED EYE ROD: Eye rod shall be carbon steel with eye welded closed. Inside diameter of eye shall accommodate a bolt diameter 1/8 inch larger than the rod diameter. Eye rod shall be Grinnell Fig. 278, B-Line B3211, or equal.

4. TURNBUCKLE: Turnbuckle shall be forged steel and shall comply with MSS and FEDSPEC Type 13. Turnbuckle shall be Grinnell Fig. 230, B-Line B3202, or equal.

5. FRAMING CHANNEL: Framing channel shall be 1 5/8 inches square, roll formed, 12-gage carbon steel. Channel shall have a continuous slot along one side with in-turned

clamping ridges. Single channel: Unistrut P1000, B-Line B22, or equal. Double channel: Unistrut P1001, B-Line B22A, or equal. Triple channel: Unistrut P1004A, B-Line B22X, or equal.

2.03 THERMAL PIPE HANGER SHIELD

Thermal shields shall be provided at hanger, support and guide locations on pipe requiring insulation. The shield shall consist of an insulation layer encircling the entire circumference of the pipe and a steel jacket encircling the insulation layer. The thermal shield shall be the same thickness as the piping system insulation specified in Section 15250. The standard shield shall be used for hot systems and the vapor barrier shield shall be used for cold systems. Stainless steel band clamps shall be used where specified to ensure against slippage between the pipe wall and the thermal shield.

A. STANDARD SHIELD:

1. INSULATION:

a. Hydrous calcium silicate, high density, waterproof
b. Compressive strength: 100 psi average
c. Flexural strength: 75 psi average
d. K factor: 0.38 at 100 degrees F mean
e. Temperature range: 20 degrees F to 500 degrees F

2. STEEL JACKET: Galvanized steel. Gage shall be the manufacturer's standard supplied for the given pipe size.

3. CONNECTION: Shield shall have butt connection to pipe insulation. Steel jacket and insulation shall be flush with end.

B. VAPOR BARRIER SHIELD:

1. INSULATION:

a. Hydrous calcium silicate, high density, waterproof
b. Compressive strength: 100 psi average
c. Flexural strength: 75 psi average
d. K factor: 0.38 at 100 degrees F mean
e. Temperature range: 20 degrees F to 500 degrees F

2. STEEL JACKET: Galvanized steel. Gage shall be the manufacturer's standard supplied for the given pipe size.

3. CONNECTION: Shield shall have butt connection to pipe insulation. Insulation shall extend 1 inch each side of steel jacket for vaportight connection to pipe insulation vapor barrier.

2.04 PRODUCT DATA

Hanger and support locations and components shall be indicated on the piping layout drawings required by paragraph 15050-2.04.

PART 3--EXECUTION

3.01 HANGER AND SUPPORT LOCATIONS

The Contractor shall locate hangers and supports as near as possible to concentrated loads such as valves, flanges, etc. Locate hangers, supports and accessories within the maximum span lengths specified in the project manual to support continuous pipeline runs unaffected by concentrated loads.

At least one hanger or support shall be located within 2 feet from a pipe change in direction.

The Contractor shall locate hangers and supports to ensure that connections to equipment, tanks, etc., are substantially free from loads transmitted by the piping.

Where piping is connected to equipment, a valve, piping assembly, etc. that will require removal for maintenance, the piping shall be supported in such a manner that temporary supports shall not be necessary for this procedure.

Pipe shall not have pockets formed in the span due to sagging of the pipe between supports caused by the weight of the pipe, medium in the pipe, insulation, valves and fittings.

3.02 INSTALLATION

Welded and bolted attachments to the building structural steel shall be in accordance with the requirements of the AISC Manual of Steel Construction. Unless otherwise specified, there shall be no drilling or burning of holes in the building structural steel.

Hanger components shall not be used for purposes other than for which they were designed. They shall not be used for rigging and erection purposes.

The Contractor shall install items to be embedded before concrete is poured. Fasten embedded items securely to prevent movement when concrete is poured.

Embedded anchor bolts shall be used instead of concrete inserts for support installations in areas below water surface or normally subject to submerging.

The Contractor shall install thermal pipe hanger shields on insulated piping at required locations during hanger and support installation. Butt joint connections to pipe insulation shall be made at the time of insulation installation in accordance with the manufacturer's recommendations.

Hanger and support components in contact with plastic pipe shall be free of burrs and sharp edges.

Rollers shall roll freely without binding.

Finished floor beneath Type N structural attachments and framing channel post bases shall be roughed prior to grouting. Grout between base plate and floor shall be free of voids and foreign material.

Baseplates shall be cut and drilled to specified dimensions prior to welding stanchions or other attachments and prior to setting anchor bolts.

Plastic or rubber end caps shall be provided at the exposed ends of all framing channels that are located up to 7 feet above the floor.

3.03 ADJUSTMENTS

The Contractor shall adjust hangers and supports to obtain required pipe slope and elevation. Shims made of material that is compatible with the piping material may be used. Stanchions shall be adjusted prior to grouting their baseplates.

END OF SECTION

SECTION 15110

ECCENTRIC PLUG VALVES

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies eccentric plug valves.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800
ASTM A126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A276	Stainless and Heat-Resisting Steel Bars and Shapes
ASTM A436	Austenitic Gray Iron Castings
ASTM A536	Ductile Iron Castings
AWWA C504	Rubber Seated Butterfly Valves

B. PROOF OF DESIGN TESTS:

The Contractor shall furnish the Construction Manager three certified copies of a report from an independent testing laboratory certifying successful completion of proof-of-design testing

conducted in accordance with AWWA C504, Section 5.2, except that where the word "disc" appears in the standard, it is understood to mean "plug." In lieu of testing the valves at an independent testing laboratory, proof-of-design testing may be performed at the valve manufacturer's laboratory, but must be witnessed by a representative of a qualified independent testing laboratory, and all test reports must be certified by the laboratory representative. Proof-of-design testing shall have been performed on not less than three 6-inch diameter valves, with all three test units demonstrating full compliance with the test standards. Failure to satisfactorily complete the test shall be deemed sufficient evidence to reject all valves of the proposed make or manufacturer's model number.

PART 2--PRODUCTS

2.01 MATERIALS

Materials of construction shall be as follows:

Component	Material
Body	Cast iron, ASTM A126, Class B
Plug	Cast iron, ASTM A126, Class B, or cast iron ASTM A436 (Ni-resist), or ductile iron, ASTM A536
Plug facing	Neoprene or Buna-N
Body seats	
Less than 3 inches	Cast iron, ASTM A126, Class B
3 inches and larger	Stainless steel, ASTM A276, Type 304 or nickel
Packing	Buna V-flex or TFE

Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The Contractor may propose alternative materials for the purpose of providing greater strength or to meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose.

2.02 MANUFACTURE

A. GENERAL:

Valves shall be straight-flow nonlubricated resilient plug type suitable for driptight, bi-directional shutoff at the specified valve design pressure. Port areas for the valve shall be at least 80 percent of the adjacent full pipe area. Valve body seats consisting of nickel for valves 3 inches and larger shall be constructed of a welded-in overlay of not less than 90 percent pure nickel. Upper and lower journal bearings shall be replaceable, sleeve-type, corrosion resistant, and permanently

lubricated. Packing shall be self-adjusting chevron type replaceable without disassembling the valve.

Unless otherwise specified, valves shall, as a minimum, conform to the following pressure ratings:

Size, inches	Design pressure, psig
12 and smaller	175
14 through 36	150
42 through 54	125

B. END CONNECTIONS:

Valves 3 inches and smaller shall have threaded ends. Valve flange drilling for valves larger than 3 inches shall be per ANSI B16.1, Class 125. Grooved-end valves may be provided with grooved-end piping systems.

C. MANUAL OPERATORS:

Unless otherwise specified, valves 4 inches and smaller shall be provided with a lever type manual operator. Valves larger than 4 inches shall be provided with totally enclosed worm gear operators. Where specified, manual operators shall have an adjustable stop. All operator components shall be sized for the valve design pressure in accordance with AWWA C504, Section 4.5. Operators shall comply with applicable portions of Section 15184.

2.03 PRODUCT DATA

The following information shall be provided in accordance with Section 01300:

1. Manufacturer's product data.

2. Proof-of-design test reports specified in paragraph 15110-1.02 B.

PART 3--EXECUTION

Unless otherwise specified, valves shall be provided with the seat downstream away from flow. Valves at tank connections shall be installed with seat away from tank. Valves on pump discharge lines shall be installed with seat adjacent to the pump.

END OF SECTION

SECTION 15118

SPRING-LOADED SWING CHECK VALVES

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies spring-loaded swing check valves.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM A126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A276	Stainless and Heat-Resisting Steel Bars and Shapes
ASTM A536	Ductile Iron Castings
ASTM B148	Aluminum-Bronze Sand Castings
AWWA C508	Swing-Check Valves for Waterworks Service, 2 In. Through 24 In. NPS

1.03 SUBMITTALS

The following information shall be provided in accordance with Section 01300:

A. SHOP DRAWINGS:

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. A check mark shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. *Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.*

2. A copy of the contract document Mechanical Drawing Mxx, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked *"no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.*

3. A copy of the contract document Process and Instrumentation Diagram Drawing P100, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked *"no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.*

4. Limit switch product literature, marked to show model to be provided.

5. Manufacturer's product and catalog data indicating equipment specifications and features including arrangement, dimensions, and weight. Catalog data shall be edited or "arrowhead" to indicate only the models and options to be provided as part of this specification.

PART 2--PRODUCTS

2.01 MANUFACTURERS

The Owner and Construction Manager believe the following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed that named manufacturers' standard equipment or products will comply with the requirements of this Section. Candidate manufacturers include Golden Anderson and APCO, or equal.

2.02 MATERIALS

Materials of construction shall be as follows:

Component	Material
Body, cover	Cast iron, ASTM A126, Class B
Disc	Ductile iron, ASTM A536
Seat rings	Aluminum bronze, ASTM B148 or Stainless steel, ASTM A276, Type 316
Hinge shafts and hinge pins	Stainless steel, ASTM A276, Type 301 or 304
Shaft bushings	Bronze, AWWA C508

Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The Contractor may propose alternative materials for the purpose of providing greater strength or to meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose.

2.03 MANUFACTURE

Disc, disc arm, shaft, keyways, lever and spring shall be capable of closing within .05 seconds of pump stoppage and fluid moving at velocity of 8 feet per second. Spring tension shall be adjustable. The valve design shall permit mounting levers and springs on either side of the valve. The design of the spring attachment shall permit adjustment of closing force by tensioning the spring or replacement with different active length springs.

Valves shall be provided with a clear opening equal to or greater than the connecting piping, with no raised seating surface. Seats shall be threaded onto the body or fitted with an O-ring seal and locked in place with stainless steel screws or pins and shall be replaceable. Shafts shall be provided with stuffing box and packing or O-ring seals at each end. Seals shall be externally replaceable. Minimum shaft diameters shall be as follows:

Valve Inlet Connection Size, inches	Shaft diameter, inches
3	0.75
4	0.825
6	1.0
8	1.75
10	2.0
12	2.5
14	2.75
16	3.25
18	3.5
20	3.75
24	3.75
30	3.75
36	4
42	4.75
48	5.25
54	5.5
60	5.75
66	6

The pivot arm shall be secured to the disc with either twin bolted connections with lockwashers or a pinned nut. In either instance, the connection shall be designed to prevent disc movement relative to the arm. Shaft bearings shall extend the entire length of the shaft other than the section required for the disc arm attachment. Disc and lever arms shall be keyed to the shaft and retained by bushings or pins.

Unless otherwise specified, valves shall, as a minimum, conform to the following pressure ratings:

Size, inches	Working pressure, pressure, psig	Hydrostatic test
2 through 12	175	350
14 through 30	150	300

Check valves wetted parts shall be coated with fusion bonded epoxy.

2.04 LIMIT SWITCH

Provide bracket and NEMA 4X limit switch that operates upon check valve closing. Limit switch shall have one Form C contact, rated 5 amperes, with ½" conduit fitting and tamper resistant enclosure.

2.05 PRODUCT DATA

Manufacturer's catalog information including dimensions, cross-sectional views, details of construction and materials list shall be provided in accordance with Section 01300.

PART 3--EXECUTION

Spring loaded swing check valves shall be installed in accordance with the manufacturer's recommendations. Adjust and demonstrate check valve limit switch operation.

END OF SECTION

SECTION 15151

WASTEWATER AIR RELEASE AND VACUUM RELIEF VALVES

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies air release valves, air and vacuum relief valves, and combination valves for wastewater service.

B. TYPES:

1. GENERAL: Valves furnished under this specification shall be tubular in design with direct acting cylindrical hollow and solid float mechanisms designed to function efficiently in the presence of grease, fibers and particulate material commonly present in municipal and domestic wastewaters and wastewater treatment effluents. The design shall incorporate materials and geometry that provides self-flushing of the valve internals on emptying.

Valve designs that employ float guide brackets, levers, springs and ball type floats are specifically prohibited. Valves furnished under this section shall be fitted with direct vents of flanged for connection to piping connections as indicated. Main venting orifices and outlet connections shall be equal in diameter to the specified pipeline connection.

2. AIR RELEASE VALVES: Wastewater air release valves (ARV) shall have a small venting orifice to vent the accumulation of air and other gases with the line or system under pressure. Size and capacity shall be as specified.

3. AIR AND VACUUM VALVES: Wastewater air and vacuum valves (ARVV) shall have a dual float system with a large venting orifice to permit the release of air as the line is filling or relieve the vacuum as the line is draining or is under negative pressure. As the pipeline approaches the full condition on filling, the large orifices shall be sealed by the primary float and the secondary float shall allow the remaining air to vent at a reduced rate to prevent development of hydraulic transients. Size and capacity shall be as specified.

4. COMBINATION AIR VALVES: Wastewater combination air valves (CARV) shall have operating features of both the air and vacuum valve and the air release valve. Size and minimum capacity under both air release and vacuum relief shall be as specified.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards,

those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM A240	Heat-Resisting Chromium and Chromium Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels

1.03 SCHEDULE

Valve size shall be as shown. Valve performance shall be as listed below.

Valve size, inches	Vent connection [a]	System pressure, psig	Pressure relief capacity, minimum, standard cubic feet/min at 0.75 psi differential[b]	Anti-shock vent capacity, maximum, standard cubic ft/min at 14.5 psi differential[b]	Vacuum relief capacity, minimum standard cubic feet/min at 5 psi differential[b]
2	T		200	42	400
3	T		500	105	1,100
4	F		800	190	1,720
6	F		1,990	377	3,880
8	F		3,190	529	6,900

[a] F= Flange, T = Threaded connection

[b] Capacities shall be documented by an independent testing method acceptable to the Construction Manager and shall be as listed in a report detailing the testing methodology. The report shall be dated not more than two years prior, shall be specific to the model proposed, shall be signed by the test author and shall be notarized as true and correct.

1.04 SUBMITTALS

Submittal material, to be provided in accordance with Section 01300, shall include the following:

1. Catalog information for each size to be furnished.

2. A copy of this specification section and the referencing section and all other applicable specification sections governing the pump, drive and driver, supports and specified appurtenances. The specification copies shall be complete with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

3. Certified performance information produced by an independent testing laboratory acceptable to the Construction Manager, current to within five years from the date of the submittal, specific to the construction details for the model proposed, confirming performance not less than that required by this specification. The test methodology may use mathematical modeling techniques to affirm specific model size performance so long as the test performance for specific size valve(s) has been spot-checked by bench tests of the valve size in question and the results show modeling performance within ± 5 percent of bench test results. The performance confirmation shall be dated, signed by the author of responsible for the test information, notarized as true and correct.

4. Materials of construction

5. Installation requirements

PART 2--PRODUCTS

2.01 ACCEPTABLE PRODUCTS

Wastewater air release valves shall be Vent-Tech SWG, as furnished by International Valve Marketing, or Vent-O-Mat RGX as produced by RF Technologies, Inc.

Alternative manufacturers' products will be considered, provided the following information has been submitted and accepted as proof the proposed substitution provides equal or improved performance over that of the specified product and materials. Any submittal requesting substitution shall include the information specified under paragraph 15151-1.04 and the following:

1. Detailed construction and functional description of operation with bill of materials and detailed graphics showing construction features and step-by-step operation demonstrating compliance with the features and operational characteristics specified in this section.

2. Certified performance (air venting and vacuum venting) curves for each size valve to be provided. Performance curves shall be certified and notarized correct by an independent testing laboratory.

3. Not less than four affidavits of performance signed by general managers or executive officers of the owning agency and notarized. The affidavits of performance shall, as a minimum, document the following:

   a. Side-by-side operation with the specified Vent-Tech or Vent-O-Mat valves in unscreened wastewater service for periods of not less than 6 months.

   b. During the side-by-side periods of operation, the proposed valve and the specified valves shall have been inspected for clogging and function on not less than a weekly basis and shall not have required more maintenance effort than the valves specified in this section.

   c. The affidavits shall contain unreserved acceptance of the proposed valve as a complete equal to the Vent-Tech or Vent-O-Mat valves specified herein.

2.02 MATERIALS

Component	Material
Body and cover	Stainless steel, ASTM A240, Type 316L
Hardware	Stainless Steel, Type 316
Primary and secondary floats	High density polyethylene
Seats	Nitrile or EPDM
Trim and venting orifices	Stainless steel, ASTM A240, Type 316L

Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The Contractor may propose alternative materials for the purpose of providing greater strength or to meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose.

2.03 CONSTRUCTION

A. GENERAL:

All wastewater air release and vacuum valves shall have tubular elongated bodies and shall be specifically designed for operation on wastewater and wastewater applications. Valve bodies shall be certified for not less than twice the system pressure specified in paragraph 15151-1.03 and shall have over pressure relief features to prevent catastrophic rupture of the valve body. The relief feature shall be incorporated into easily replaced components. The valve size shall be the nominal size of the valve inlet and outlet (piping connection) as herein described. All valve clearances shall be designed for unobstructed flow of air through all passages with a net crossectional area at least equal to that of the nominal piping connection. The valve manufacture shall be prepared to document compliance with this requirement in all respects for each component in the valve assembly.

B. BODY:

The valve body shall have a fused glass lining or equivalent finish. The valve body shall, be sized to assure the unobstructed annular space between the valve floats and the inner surface of the valve body exceeds the crossectional area of the valve's inlet and outlet connections. Valved upper and lower flushing ports (1/2 inch minimum) shall be provided. Materials for flushing ports shall be the same as the body.

C. AIR INLET/OUTLET FITTING:

The air inlet/outlet fitting shall have a net opening equal in crossectional area to the valve size and shall be screened with a high efficiency punched screen to prevent ingression of airborne debris. The connection from the air inlet cap chamber to the valve body shall be a smooth toroidial transition, polished to facilitate movement from the cap to the body with minimal energy losses by gradual acceleration to the connection with the valve body air passages. The underside of the fitting shall be finished smooth to effect an air tight seal with the anti-surge floats. The valve shall form an airtight seal with an internal pressure of no more than 3 psig.

D. AIR OUTLET/INLET FITTING:

The air outlet/inlet fitting at the connection to the piping shown shall formed to provide a smooth transition to the valve outlet in a manner equal to that described in paragraph 15151-2.03 C. The connection to the piping system shall have a crossectional area as described in paragraph 15151-2.03 A.

E. FLOATS:

The anti shock float shall have not less than five tubular orifices to evenly distribute pressurized air across the face of the float. Air inlets for the tubular orifices shall be a smooth, rounded transition to reduce shock and discharged moisture as the as the float seats. The main float

shall be tubular in construction, fitted with a centering guide on the upper float cap for contacting and centering on the anti-shock float.

2.04 SPARE VALVES

One spare valve shall be provided for each type and size of valve specified.

2.05 PRODUCT DATA

The following information shall be provided in accordance with Section 01300:

1. Manufacturer's product data.

2. Applicable O&M instructions per Section 01430.

PART 3--EXECUTION

Wastewater air release and vacuum valves shall be installed in accordance with the manufacturer's recommendations. Isolation valves shall be provided below each air valve, as shown on the Contract Drawings.

END OF SECTION

SECTION 15184

MANUAL VALVE AND GATE OPERATORS AND OPERATOR APPURTENANCES

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies manual operators for valves and gates, and operator appurtenances.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AWWA C509	Resilient-Seated Gate Valves for Water Supply Service

1.03 SUBMITTALS

Manufacturer's product data shall be provided in accordance with Section 01300.

PART 2--PRODUCTS

2.01 GENERAL

Except as specified in valve and gate specification sections, manual operators shall be as specified herein. Operators shall be mounted on the valve or gate and provided as a unit. Each valve body or operator shall have cast thereon the word "OPEN," an arrow indicating the direction to open, and flow direction arrows.

2.02 OPERATORS

A. GENERAL:

Manual operators shall have operating torques less than 80 foot-pounds. Unless specified otherwise, each manual operator shall be provided with an operating wheel. Unless specified otherwise, the direction of rotation of the operator shall be counterclockwise for opening.

B. WRENCH NUTS:

Wrench nuts shall comply with Section 4.4.7 of AWWA C509. A minimum of two operating keys, but no less than one key per every ten valves, shall be provided for operation of the wrench nut operated valves.

C. NOT USED

2.03 OPERATOR APPURTENANCES

A. VALVE BOXES:

Valve boxes shall be per MAG Standard Detail 391-1, Type "C".

B. NOT USED

C. NOT USED

PART 3--EXECUTION

3.01 GENERAL

Installation shall be as specified herein. Valve operators shall be located so that they are readily accessible for operation and maintenance. Valve operators shall be mounted for unobstructed access, but mounting shall not obstruct walkways. Valve operators shall not be mounted where shock or vibration will impair their operation. Support systems shall not be attached to handrails, process piping, or mechanical equipment.

3.02 OPERATORS

A. GENERAL:

Valves and gates shall be provided with manual operators, unless specified otherwise. Where possible, manual operators shall be located between 48 inches and 60 inches above the floor or a permanent work platform.

B. WRENCH NUTS:

Wrench nuts shall be provided on buried valves, on valves which are to be operated through floor boxes, and where specified. Extended wrench nuts shall be provided if necessary per MAG Standard Detail 391-2.

C. NOT USED

3.03 OPERATOR APPURTENANCES

A. VALVE BOXES:

Valve boxes shall be installed per MAG Standard Detail 391-1.

B. NOT USED

END OF SECTION

SECTION 16000

GENERAL REQUIREMENTS FOR ELECTRICAL WORK

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies general requirements for electrical work for the Sweetwater Lift Station. Work includes replacement of all electrical and control equipment for a sewage pumping station. Demolished, salvaged, and reused equipment: Spec. 01046. Work shall be as specified, and per the IBC, NECA-1, and NFPA 70.

1. Detailed requirements for specific electrical items are specified in other sections but are subject to the general requirements of this section. The electrical drawings and schedules included in this project manual are functional in nature and do not specify exact locations of equipment or equipment terminations.

2. Anchorage, supports, and restraints for floor mounted motor control center requires a Contractor provided structural engineering design and installation per Section 01900 requirements. Submit the anchorage, supports, and restraints design document that is sealed by a Registered Structural Engineer in Arizona.

3. Provide electrical enclosure layout drawings based on equipment submittals prior to conduit placement.

4. Test submittals, planning, and testing of all equipment and systems shall be provided per Sections 01660, 16030, and 17030.

5. Provide requirements of Salt River Project (SRP) electric utility service.

B. DEFINITIONS:

1. ELEMENTARY OR SCHEMATIC DIAGRAM: A schematic (elementary) diagram shows, by means of graphic symbols, the electrical connections and functions of a specific circuit arrangement. The schematic diagram facilitates tracing the circuit and its functions without regard to the actual physical size, shape, or location of the component devices or parts.

2. ONE-LINE DIAGRAM: A one-line diagram shows by means of single lines and graphical symbols the course of an electrical circuit or system of circuits and the components, devices or parts used therein. Physical relationships are usually disregarded.

3. WIRING DIAGRAM OR CONNECTION SYSTEM: A wiring or connection diagram includes all of the devices in a system and shows their physical relationship to each other including terminals and interconnecting wiring in an assembly. This diagram shall be (a) in a form showing interconnecting wiring only by terminal designation (wireless diagram), or (b) a panel layout diagram showing the physical location of devices plus the elementary diagram.

4. ARRANGEMENT, LAYOUT, OR OUTLINE DRAWINGS: An arrangement, layout, or outline drawing is one which shows the physical space and mounting requirements of a piece of equipment. It may also indicate ventilation requirements and space provided for connections or the location to which connections are to be made.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
NECA-1	National Electrical Contractors Association – Standard Practices for Good Workmanship in Electrical Contracting
NFPA	National Fire Protection Association
NFPA-70	National Electrical Code (NEC)
NFPA-70E	National Electrical Safety Code (NESC)
ACI 318	Building Code Requirements for Structural Concrete

B. IDENTIFICATION OF LISTED PRODUCTS:

Electrical equipment and materials shall be listed for the purpose for which they are to be used, by an independent testing laboratory. Three such organizations are Underwriters Laboratories

(UL), Canadian Standards Association (CSA), and Electrical Testing Laboratories (ETL). Independent testing laboratory shall be acceptable to the inspection authority having jurisdiction.

When a product is not available with a testing laboratory listing for the purpose for which it is to serve, the product may be required by the inspection authority, to undergo inspection at the manufacturer's place of assembly. All costs and expenses incurred for such inspections shall be included in the original contract price.

C. REGULATORY REQUIREMENTS:

1. Obtain all permits from the Authority Having Jurisdiction and pay fees required.

2. Provide materials, equipment, and construction in accordance with NFPA-70, NFPA-70E, NFPA-820, IBC, applicable state and local codes, Owner adopted codes, and Owner code amendments.

3. Request inspections from the Authority Having Jurisdiction.

1.03 SUBMITTALS

The following submittals shall be provided in accordance with Section 01300:

A. SHOP DRAWINGS:

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation.

   The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications.

   Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

2. Catalog cuts of equipment, devices, and materials requested by the individual specification sections. Catalog information shall include technical specifications and application information, including ratings, range, weight, accuracy, etc. Catalog cuts shall be edited to show only the items, model numbers, and information which apply.

   Catalog cuts shall be assembled in a folder. Each folder shall contain a cover sheet, indexed by item, and cross-referenced to the appropriate specification paragraph.

3. Safety disconnect switch list including legend with equipment tag, equipment description, and power feeder circuit source and location information.

B. STRUCTURAL ANCHORAGE AND BRACING REQUIREMENTS:

The following submittal shall be provided, in accordance with paragraph 2.06 and including the submittal requirements of Section 01900.

1. A copy of this specification section, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. A check mark shall denote full compliance with a paragraph as a whole.

   If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation.

   The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications.

   Failure to include a copy of the marked up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

1.04 DRAWINGS

Where the Contractor is required to provide information on drawings as part of the specified work, such drawings shall be prepared on drafting media complete with borders and title blocks clearly identifying project name, equipment and the scope of the drawing.

Drawing quality and size of presentation shall be such as to permit 50 percent reduction of such drawings for insertion in operation and maintenance manuals.

1.05 PROJECT/SITE CONDITIONS

A. GENERAL:

Unless otherwise specified, equipment and materials shall be sized and derated for the ambient conditions specified in Section 01800, but not less than an ambient temperature of 50 degrees C at an elevation ranging from sea level to 1,220 feet without exceeding the manufacturer's stated tolerances.

B. CORROSIVE AREAS:

The following areas are designated as corrosive:

a. Wetwell and perimeter.

b. Existing manhole and perimeter.

c. Outdoor areas.

C. HAZARDOUS (CLASSIFIED) AREAS:

The following areas are designated as hazardous (classified) as shown on Drawing E101, in accordance with the NEC:

a. Wetwell and perimeter

b. Existing manhole and perimeter.

D. SEISMIC:

Electrical equipment, supports, and anchorage shall be designed and installed in accordance with the seismic design requirements specified in Section 01900.

1.06 STORAGE OF MATERIALS AND EQUIPMENT

Materials and equipment shall be stored as specified in paragraph 01605-3.0 E. Equipment and materials to be located indoors shall be stored indoors and sealed with plastic film wrap.

1.07 ELECTRICAL NUMBERING SYSTEMS

A. RACEWAY NUMBERS:

Raceways shall be tagged at all terminations. Contractor shall assign raceway numbers in accordance with the following system where raceway numbers have not been assigned:

Raceway Prefix	Type of Function
C	Control or power - 120V or less
H	Power above 600V
N	Pneumatic tubing
P	Power 208V to 600V
S	Signal - data communication or instrumentation
X	Spare

Prefixes shall be followed by a 4-digit number. Add a letter suffix to distinguish the raceways where more than one raceway is routed to a particular piece of equipment. Example:

Raceway number = P3109A where:
- P = conduit contains power
- 3109 = unique 4-digit number
- A = letter to distinguish raceways to same equipment

B. CONDUCTOR NUMBERS:

Conductors shall be identified with numbers at both ends. Conductor tag numbers shall consist of the equipment number followed by a dash followed by the conductor number specified on the control diagram. Example:

Equipment Tag number = 1900 - L1 where:
- 1900 = cable number
- L1 = conductor number

Conductors in parallel or in series between equipment shall have the same conductor number. Neutral conductors shall have the same conductor number. Wherever possible, the conductor number shall be the same as the equipment terminal to which it connects.

Where factory-wired equipment has terminal numbers different than the conductor numbers shown on the control diagrams:

1. Both shall be shown on the interconnection diagram

2. Include a copy of the interconnection diagram inside of the equipment cabinet.

PART 2--PRODUCTS

2.01 EQUIPMENT AND MATERIALS

A. GENERAL:

Equipment and materials shall be new and free from defects. All material and equipment of the same or a similar type shall be of the same manufacturer throughout the work. Standard production materials shall be used wherever possible.

B. EQUIPMENT FINISH:

Unless otherwise specified, electrical equipment shall be painted by the manufacturer as specified in Section 09900 - Coating Systems.

2.02 WIRE MARKERS

Each power and control conductor shall be identified at each terminal to which it is connected. Conductors size No. 10 AWG or smaller shall have identification sleeves. Conductors No. 8 AWG and larger shall use cable markers of the locking tab type. Tabs shall be white plastic with conductor identification number permanently embossed.

Conductors shall be identified in accordance with paragraph 16000-1.07 B. Adhesive strips are not acceptable.

The letters and numbers that identify each wire shall be machine printed on sleeves with permanent black ink with figures 1/8 inch high. Sleeves shall be yellow or white tubing and sized to fit the conductor insulation. Shrink the sleeves with hot air after installation to fit the conductor.

Conductor and Wire Marker Manufacture:

1. TMS Thermofit Marker System by Raychem Co
2. Sleeve style wire marking system by W. H. Brady Co.
3. or equal.

2.03 RACEWAY MARKERS

Raceway markers tags shall be:

1. Solid aluminum with 0.036-inch minimum thickness.
2. Raceway number stamped in 3/16-inch minimum height characters
3. Attached to the raceway with 316 stainless steel wire.

2.04 NAMEPLATES

Nameplates shall be made from laminated phenolic plastic.

1. Nominal size: 3/4 inch high by 2 inches long.
2. Black backgrounds with 3/16-inch white letters.
3. Fastened using self-tapping stainless steel screws.

Abbreviations shall be submitted to the Construction Manager prior to manufacture because of space limitations. Nameplate adhesives will not be permitted on the outside of enclosures.

2.05 TERMINAL BLOCKS

Unless otherwise specified, terminal blocks shall be panhead strap screw type. Terminals shall be provided with integral marking strips that permanently identify with the connecting wire numbers as shown on the drawings:

1. Terminal blocks for P-circuits (power 208-600 volts)

    a. Rated not less than the conductor current rating

    b. Rated less than 600 volts AC.

2. Terminal blocks for C-circuits and S-circuits:

    a. Rated not less than 20 amperes

    b. Rated less than 600 volts AC.

3. Terminals shall be tin-plated.

4. Insulating material shall be nylon.

2.06 STRUCTURAL ANCHORAGE AND BRACING REQUIREMENTS DESIGN

A. BRACING SYSTEM DESIGN:

The design shall per the requirements of Section 01900 for the following:

1. Equipment: Refer to Division 16 and 17 Sections for applicable equipment.

B. DESIGN DATA:

The Contractor shall provide the following to the Bracing System Registered Structural Engineer per paragraph 1.01 A:

1. Copy of all Specifications including addenda updates.

2. Division 16 Manufacturer's equipment Structural Bracing submittals.

C. ONSITE DATA:

The Bracing System Designer shall provide one man-day onsite reviewing Contractor provided design data and site conditions.

2.07. SAFETY DISCONNECT SWITCHES

Heavy duty fused and non-fused disconnect switches with current range of 30 to 600 amperes shall be provided as shown on the drawings with the enclosure type matching the area rating, NEMA 4 minimum. Provide lock-off provision for a hasp padlock. Provide visible knife blades through a cover viewing window. Provide shielded or insulated line terminals with quick-make / quick-break switch operator. Provide internal barrier kit for additional personnel barrier from accidental contacts with live parts. Provide a legend plate with equipment tag, equipment description, and power feeder circuit source and location identification.

Disconnects shall include one auxiliary contact that operates with the power switch blades. The auxiliary contact shall be wired as shown on the drawings for remote status monitoring of the disconnect position where shown or for disconnecting motor space heater where shown.

Fuse clips shall be Class R rejection type and sized for UL Class R, one-time, time-delay fuses. Fuse assembly shall have a minimum short circuit capacity of 100,000 amps symmetrical. Provide fuses as shown and one set of spare fuses with each switch.

2.08 PRODUCT DATA

The following information and product data specified under individual specification sections shall be provided in accordance with Section 01300.

1. Applicable operation and maintenance information on an item-by-item basis in accordance with Section 01730. Operation and maintenance information shall be provided at the time of equipment, device, or material site delivery, or at a certain stage of project completion as required by Section 01730, whichever is the earlier. Full-size drawings shall be reduced to 11 x 17 inches.

2. Test results for motors and electrical systems on the forms specified in Section 16030. A file of the original test results shall be maintained by the Contractor. Prior to acceptance of work, the resulting file shall be provided to the Construction Manager.

3. Description of functional checkout procedures specified under paragraph 16000-3.02 C shall be provided 30 days prior to performing functional checkout tests.

4. Record documents specified in Section 01720 and paragraph 16000-3.03.

PART 3--EXECUTION

3.01 GENERAL

A. CONSTRUCTION:

The work under Division 16 shall be performed in accordance with these specifications.

Refer to the National Electrical Contractors Association's (NECA) National Electrical Installation Standards (NEIS) for Standard Practices for Good Workmanship in Electrical Contracting (NECA-1) as a minimum baseline of quality and workmanship for installing electrical products and systems that defines what is meant by "neat and workmanlike" as required by the National Electrical Code Section 110-12. Specified requirements supersede NECA practices.

Electrical layout drawings are diagrammatic, unless otherwise detailed or dimensioned. The Contractor shall coordinate the location of electrical material or equipment with the work.

Major electrical openings may compromise the structural integrity of the slab and wall elements. Major electrical openings are defined as openings or penetrations greater than two times the wall thickness in any dimension, and include duct bank transitions into a building through structural elements. Major electrical openings shall be constructed according to standard details on the drawings, up to an opening dimension of three feet. For opening dimensions greater than three feet, construct walls and slabs as specifically detailed on the drawings for that case. Major electrical openings proposed by the Contractor shall be submitted to the Structural Engineer of Record for the project for review.

Minor changes in location of electrical material or equipment made prior to installation shall be made at no cost to the Owner.

B. STRUCTURAL ANCHORAGE AND BRACING REQUIREMENTS:

All provided equipment and raceways shall be anchored, supported, and restrained per the Bracing System Design specified in paragraph 16000-2.05 and Section 01900. Copies of the Structural Anchoring and Bracing Requirements Submittal shall be onsite during construction and inspection.

C. CONDUITS IN CONCRETE CONSTRUCTION:

Conduits for power, control and instrumentation may be embedded in and pass through concrete construction subject to the limitations in this paragraph. Where concrete strength or serviceability requirements prevent the direct embedment of conduit, provide adequate support, bracing, and serviceability details:

1. Concrete strength shall not be impaired significantly by the embedment of conduits in or through structural sections.

2. Conduit layout shall conform to the requirements of ACI 318, Sections 3.3 – Aggregates and 6.3 – Conduits and Pipes Embedded in Concrete.

3. Conduits shall be treated similarly to reinforcing steel for purposes of clearance. In general, code sections require conduit spacing the greater of:

   a. 1.33 times the maximum concrete aggregate size, clear

   b. Three diameters center to center

   Alternate spacing and layout shall be as reviewed and accepted by the Engineer.

4. Conduit and raceway penetrations through walls and slabs where:

   a. one side is a conditioned or an occupied space and the other side not, or

   b. one side has liquid or groundwater contact and the other not,

   shall be detailed and constructed to prevent liquid and moisture penetration through the wall or slab section for each conduit.

D. HOUSEKEEPING:

Electrical equipment shall be protected from dust, water and damage. Motor control centers, switchgear, and buses shall be wiped free of dust and dirt, kept dry, and shall be vacuumed on the inside within 30 days of acceptance of the work.

Before final acceptance, the Contractor shall touch up any scratches on equipment as specified in paragraph 09900-3.03 H.

Electrical equipment temporarily exposed to weather, debris, liquids, or damage during construction shall be protected as specified in paragraph 01605-3.0 F.

E. ELECTRICAL EQUIPMENT LABELING

Electrical equipment shall have field marked signs and labeling to warn qualified persons of the potential electric arc flash hazards per NEC Article 110.16 Flash Protection.

Electrical equipment shall have NFPA 70E labels installed stating the results of the Arc Flash analysis specified in Section 16431 Short Circuit and Protective Device Coordination Study Report.

Electrical distribution equipment and utilization equipment shall be field labels to identify the power source and the load as specified. Refer to NEC Article 110.22 for Identification of Disconnecting Means installation criteria. Specific information is required such as the equipment tag number and equipment description of both the power source and the load equipment.

F. MOTOR CONNECTIONS

Verify that the motors are purchased with the correct size motor termination boxes for the circuit content specified as shown on the power single line diagrams or submit custom fabrication drawing indicating proposed motor termination box material, size, gasket, termination kit, grounding terminal, motor lead connection method, and motor terminal box connection/support system. Verify the motor termination box location prior to raceway rough-in.

G. CONDUCTOR INSTALLATION

An enclosure containing disconnecting means, overcurrent devices, or electrical equipment shall not be used as a wireway or raceway for conductors not terminating within the enclosure. Provide wireways, raceways, termination boxes, or junction boxes external to the enclosure for the other conductors.

3.02 TESTING

A. GENERAL:

Prior to energizing the electrical circuits, insulation resistance measurements tests shall be performed using a 1000-volt megohmmeter to verify the conductor is acceptable for use on the project. The test measurements shall be recorded on the specified forms and provided in accordance with paragraph 16000-1.03.

B. INSULATION RESISTANCE MEASUREMENTS:

1. GENERAL: Insulation resistance measurements shall be made on conductors and energized parts of electrical equipment. Minimum acceptable values of insulation resistance shall be in accordance with the applicable ICEA, NEMA or ANSI standards for the equipment or material being tested, unless otherwise specified. The ambient temperature at which insulation resistance is measured shall be recorded on the test form.

Insulation resistance measurements shall be recorded in a format similar to Form 16000-A, contained in Section 01999. Insulation with resistance of less than 10 megohms is not acceptable.

2. CONDUCTOR AND CABLE TESTS: The phase-to-ground insulation resistance shall be measured for all circuits rated 120 volts and above except lighting circuits. Measurements may be made with motors and other equipment connected. Solid state equipment shall be disconnected, unless the equipment is normally tested by the manufacturer at voltages in excess of 1000 volts DC.

3. MOTOR TESTS: The Installed Motor Test Form, 16000-B, specified in Section 01999, shall be completed for each motor after installation.

Motors shall have their insulation resistance measured before they are connected. Motors 50 HP and larger shall have their insulation resistance measured at the time of delivery as well as when they are connected. Insulation resistance values less than 10 megohms are not acceptable.

C. PRE-FUNCTIONAL TEST CHECKOUT:

Functional testing shall be performed in accordance with the requirements of Section 16030. Prior to functional testing, all protective devices shall be adjusted and made operative.

1. Submit a description of the proposed functional test procedures prior to the performance of functional checkout.

2. Prior to energization of equipment, perform a functional checkout of the control circuit. Checkout:

   a. Energizing each control circuit.
   b. Operating each control device, alarm device, or monitoring device.
   c. Operate each interlock to verify that the specified action occurs.

Verify motors are connected to rotate in the correct direction. Verification may be accomplished by momentarily energizing the motor, provided the Contractor confirms that neither the motor nor the driven equipment will be damaged by reverse operation or momentary energization.

3.03 RECORD DOCUMENTS

Contract documents shall be maintained and annotated by the Contractor during construction, including the record drawings specified in Section 01720.

END OF SECTION

SECTION 16030

ELECTRICAL ACCEPTANCE TESTING

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

The electrical equipment and conductors to be tested are specified herein and shown on the electrical drawings of the Contract Documents.

The Contractor shall retain an independent InterNational Electrical Testing Association (NETA) member Engineering and Testing Firm (Testing Firm) for specified on-site acceptance testing of the project electrical power distribution system and utilization equipment covered by this contract.

The Testing Firm shall be responsible for the Short Circuit and Protective Device Coordination Report as specified in Section 16431. The Testing Firm shall verify the protective device settings are implemented in accordance with Section 16431. The Testing Firm work includes the ARC-Fault equipment labeling work as specified in Section 16431.

Tests performed by the Testing Firm shall be witnessed by the Owner's Representative. Provide the Construction Manager 30-day advanced notice for Testing Firm tests. Insulation tests by the Contractor typically will not be witnessed. Critical equipment witness testing may be requested by the Construction Manager.

The manufacturer of the electrical equipment supplied for the project shall complete their on-site factory inspection, testing, and setup prior to the Testing Firm's Acceptance Testing and subsequent Protective Device setting verification work. The power monitors shall be set up by the factory representatives and power monitor readings and settings verified by the Testing Firm. Manufacturer work is specified in the respective equipment sections.

The Installation Contractor shall test motors, conductors, and equipment as specified and shown. Contractor shall provide the labor, tools, material, including quality power sources required by the Testing Firm equipment, and other services necessary to provide specified tests and retesting.

Submit proposed electrical test procedures for tests to be performed by the Installing Contractor, other than insulation resistance testing, and proposed test procedures for tests to be performed by the Testing Firm.

1.02 QUALITY ASSURANCE

A. REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI/NETA ATS	International Electrical Testing Association (NETA) - Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

B. TESTING FIRM

The Testing Firm and their proposed project team shall possess the following minimum qualifications:

1. Testing Firm shall be an independent testing organization providing unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems to be evaluated.

2. Testing Firm shall be regularly engaged in the testing of electrical equipment, devices, installations, and systems.

3. Testing Firm shall be a "NETA Accredited Company" of the InterNational Electrical Testing Association (NETA providing testing in accordance with ANSI/NETA ATS published specifications or the pre-approved firms that use the NETA methods and published testing specifications.

4. If firm's own published testing specifications are proposed, then submit a copy to the Engineer for acceptance and submit the qualifications of the testing staff.

5. Testing Firm's lead technical person shall be currently certified by NETA or the National Institute for Certification in Engineering Technologies (NICET) in electrical power distribution systems testing. Submit proof of technical training and certification for performing testing work.

6. Testing Firm's technicians shall be regularly employed, qualified testing staff.

7. The following are pre-qualified Testing Firms:

   a. Emerson (Electro-Test Inc.)

   b. Power Systems Testing Co

   c. Southwest Energy Systems

   d. Eaton Electrical Service and Systems

8. The Engineering and Study Firm may be Brown and Caldwell Engineers.

C. TESTING FIRM QUALIFICATIONS

For any Testing Firm not pre-qualified, the Contractor shall receive Construction Manager approval of the proposed Testing Firm, their proposed project team, and their test procedures prior to the Pre-Test Submittals.

1. Project Team: Identify lead technical person and testing staff and provide documentation of training and experience demonstrating compliance with the qualifications specified.

2. Testing Firm: Provide reference names and current phone numbers of the Owner, Contractor, Engineer, or Construction Manager that has knowledge of the Firm's work:

   a. Three projects for Owner completed within the past four years, or

   b. Three projects for Brown and Caldwell completed within the past four years, or

c. Provide references for five recent projects that were completed within the last four years. Provide a description of the scope of the referenced project.

3. For Testing Firm's experience to be judged acceptable, the Contractor shall demonstrate that the proposed Testing Firm's reference projects are of similar scope and size to this project, and in performing these projects the following has been achieved:

   a. Testing Firm's work did not delay the projects or adversely impact the progress of the Contractor's work or the Owner's project.

   b. Specified requirements were achieved.

   c. Work was performed in accordance with ANSI/NETA ATS, MTS, or other Engineer accepted testing criteria.

   d. Submittals approved with two or fewer re-submittals after the initial submittal.

   e. No warranty claims related to the Testing Firm's work.

4. Provide documentation demonstrating NETA Accreditation and compliance with the qualification specified.

1.03 SUBMITTALS

Contractor shall submit the following information in accordance with specification Section 01300:

A. TESTING FIRM QUALIFICATIONS:

For any Testing Firm not pre-qualified per paragraph 1.02 B, submit qualifications per paragraph 1.02 C.

B. PRE-TEST SUBMITTALS:

1. Description or samples of specified test procedures.

2. Sample test report forms for the specified tests.

3. Preliminary Schedule listing equipment to be tested.

4. Notification form for the work scheduled.

5. Pre-Functional test procedures and testing schedule.

6. Functional test procedures and testing schedule.

C. POST-TEST SUBMITTALS:

1. Contractor Completed Section 01999-Test Records:

a. Wire and Cable Resistance Test Data Form: 16000-A

b. Installed Motor Test Form: 16000-B

2. Testing Firm Reports specified in Part 3 of this Section.

PART 2--PRODUCTS

2.01 TESTING EQUIPMENT AND INSTRUMENTS

The test equipment, instruments and devices used for testing shall be calibrated to test equipment standards with references traceable to the National Institute of Standards and Technology.

The test equipment, instruments and devices shall have current calibration stickers indicating date of calibration, deviation from standard, name of calibration laboratory and technician, and date of next recalibration.

PART 3--EXECUTION

3.01 GENERAL

The Contractor shall submit a schedule for the Testing Firm work and notify the Construction Manager 30 days prior to commencement of any witnessed testing.

The required tests, including correction of defects where found, and subsequent retesting, shall be completed prior to energizing electrical distribution system, utilization systems, and conductors and completed prior to functional testing. The installation of the protective device, breaker, and relay settings shall be completed and verified.

3.02 INSTALLATION CONTRACTOR TESTING

A. GENERAL:

Submit all completed test report forms in a 3-ring binder type notebook at the project Substantial Completion date.

B. INSULATION RESISTANCE MEASUREMENTS:

1. TESTS: Insulation resistance measurements shall be made on conductors and electrical equipment that will carry current. Where not specified, the minimum acceptable values of insulation resistance shall be in accordance with the applicable NETA-ATS, ICEA, NEMA, or ANSI standards for the equipment or material being tested.

The ambient temperature at which insulation resistance is measured shall be recorded on the test form. A megohmmeter shall be used for insulation resistance measurements.

Refer to specification Section 01999-Reference Forms for the test forms required to document the testing performed by the Installing Contractor.

2. CONDUCTOR AND CABLE TESTS: The phase-to-ground insulation resistance shall be measured for circuits 120 volts and above except lighting circuits. Measurements may be made with motors and other load equipment connected. Insulation resistance measurements shall be recorded on Form 16000-A contained in Section 01999, and submitted. Insulation with resistance of less than 100 megohms is not acceptable.

3. MOTOR TESTS: The Installed Motor Test Form, 16000-B, contained in Section 01999, shall be completed for each motor after installation and submitted. All motors shall have their insulation resistance measured before they are connected.

Motors 50 HP and larger shall have their insulation resistance measured at the time of delivery and when they are connected. Insulation resistance values less than 50 megohms are not acceptable.

Verify that motors are connected to rotate in the correct direction with the load disconnected. Verification may be accomplished by momentarily energizing the motor, provided the Contractor confirms that neither the motor nor the driven equipment will be damaged by reverse operation.

Motor running current shall be measured on each phase with the motor operating under load. Current imbalance shall be less than 5-percent difference between phases.

C. POWER DISTRIBUTION EQUIPMENT:

Transformers, panelboards, and other power distribution equipment shall have their insulation resistance measured phase-to-phase and phase-to-ground. Insulation resistance values less than 10 megohms are not acceptable.

D. POWER UTILIZATION EQUIPMENT:

Test receptacles and power outlets using a device to verify polarity, grounding, and the correct wiring connections.

E. SIGNAL AND DATA CABLE TESTS:

Signal conductors and shield drain shall be tested for insulation resistance with the other conductors in the cable grounded. Each shield drain conductor shall be tested for continuity. Insulation resistance measurements shall be recorded on Form 17000-A contained in Section 01999, and submitted.

Instruments used for continuity measurements shall have a resolution of 0.1 ohms and an accuracy of better than 0.1 percent of reading plus 0.3 ohms. A 500-volt or 1000-volt meg-ohmmeter shall be used for insulation resistance measurements as appropriate.

F. PRE-FUNCTIONAL CHECKOUT:

Prior to energizing equipment, the Contractor shall perform a pre-functional checkout of the power and the control circuit. Protective devices shall be installed and available for service and calibrated or adjusted with specified setpoints installed. Contractor selected initial setpoints shall be installed and recorded, when specified setpoints are not required from the manufacturer or the Engineer.

Contractor shall submit a description of proposed test and checkout procedures conforming to the following requirements, including a schedule for conducting these procedures, not less than 30 days prior to the performance of pre-functional testing

Pre-functional checkout shall consist of energizing each control circuit and operating each control device, protective device, monitoring or alarm device, and each interlock and verify the specified action or response occurs. Coordinate testing with the requirements specified in Section 01660 – Equipment and System Performance and Operational Testing.

G. FUNCTIONAL TESTING:

Contractor shall submit a description of proposed functional test and checkout procedures conforming to the following requirements, including a schedule for conducting these procedures, not less than 30 days prior to the performance of functional testing.

Prior to functional testing, all protective devices shall be adjusted and made operative. Prior to energization of associated equipment, perform a functional checkout of all electrical and instrumentation control circuits as specified in the following and in Division 17. Checkout shall consist of energizing each control circuit and operating each control, alarm, safety device, and each interlock, in turn, to verify that the specified action occurs.

Record and submit data sheets as specified. Coordinate testing with the requirements specified in Section 01660 – Equipment and System Performance and Operational Testing.

3.03 TESTING FIRM ACCEPTANCE TESTING REQUIREMENTS

A. ACCEPTANCE TEST REPORTS:

The Contractor shall maintain a written record of all inspection and test results and, upon completion of the project, shall assemble and certify a final test report

A copy of the preliminary test results shall be provided to the Construction Manager at the end of each day of testing.

Furnish two copies of the complete acceptance testing final report to the Construction Manager at Substantial Completion of the project.

B. ACCEPTANCE TEST DOCUMENTATION

The Contractor shall submit test documentation forms and a detailed description of the proposed inspection and test procedures to be performed by the Testing Firm. Testing shall not commence until the Construction Manager has approved the proposed forms and procedures.

The description shall identify the test equipment required for each specified test to be performed. Test report forms shall include the following information:

1. Electrical equipment description.
2. Electrical equipment identification number.
3. Electrical equipment nameplate data.
4. Electrical equipment settings.
5. Time and date of test.
6. Ambient conditions at time of test.
7. Inspection checklist and results.

8. Test results.

9. Test equipment used with manufacture, model number, and calibration date.

10. Remarks about test procedures, results, and suggestions.

11. Name and signature of testing personnel.

12. Name and signature of test witness.

C. ACCEPTANCE TESTING FIRM TESTS:

Acceptance testing procedures and test results shall be as specified in ANSI/NETA ATS. The following types of equipment and systems shall be inspected and tested by the Testing Firm. Acceptance testing work shall not be limited to equipment shown on the drawings. Refer to Division 16 specification for the electrical equipment specified.

Refer to the electrical drawings for location and identification of the electrical distribution system equipment, utilization equipment, and electrical conductors, included but not limited to:

1. Service Entrance Section

2. Motor Control Center

3. Circuit Breakers, Low-Voltage, 225A frame and larger.

4. Instrument Transformers.

5. Metering, include non-utility power metering equipment.

6. Grounding Systems include installed grounding systems and existing grounding systems that are being utilized.

7. Ground Fault Protection Systems.

8. Surge Protection Devices, include lightning arresters.

9. Engine Generator.

10. Automatic Transfer Switch.

3.04 ACCEPTANCE TEST VALUES

Minimum acceptable test values shall be as specified in ANSI/NETA ATS. Where acceptance test values are not specified, the equipment manufacturer's recommended test values shall be used. Where acceptance test values are not specified and the equipment manufacturers recommended test values are not available, request acceptance test values from the Construction Manager.

3.05 ACCEPTANCE TEST FINAL REPORT

Test report shall be assembled as described in ANSI/NETA ATS. Test results shall be organized by electrical distribution system equipment, project utilization equipment, and electrical conductors with individual tab dividers with labels to identify each group of items and cross-referenced to the Contract Documents. The equipment description, equipment number, and equipment tag number shall be used as shown on the drawings or listed in specifications.

Final Test Reports that are illogically assembled, labeled, and organized shall be returned for rework at no cost to the Owner and resubmitted in an acceptable format.

Deficiencies and non-compliant test results found during acceptance testing shall be identified in the test report and cover letter. The Testing Firm shall certify in the final test report that all deficiencies and non-compliant test results listed have been "corrected" and shall include a description of the resolution for each problem listed.

3.06 PROTECTIVE DEVICE FIELD SETTINGS

The Testing Firm shall verify, and certify in the acceptance test final report, that the protective device coordination study settings for new and existing equipment based on the Short Circuit and Protective Device Coordination Report specified in Section 16431 have been implemented and recorded on the Testing Firm's Data Sheets.

3.07 ARC FLASH STUDY RESULTS

The Testing Firm shall provide and install labels on the project electrical equipment for personnel protective clothing requirements as specified in Section 16431.

END OF SECTION

SECTION 16110

RACEWAYS, BOXES, AND SUPPORTS

PART 1--GENERAL

1.01 SCOPE

This section covers the furnishing and installation of electrical conduits, wireways, pull boxes, manholes, handholes, cable trays, fittings and supports. Raceways shall be provided for lighting, receptacles, power, control, instrumentation, signaling and grounding systems.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI C80.1	Rigid Steel Conduit-Zinc Coated
ANSI C80.3	Electrical Metallic Tubing-Zinc Coated
ASTM F512	Smooth-Wall Polyvinylchloride Conduit and Fittings for Underground Installation
FEDSPEC WW-C-581E	Conduit, Metal, Rigid and Intermediate; and Coupling, Elbow, and Nipple, Electrical Conduit; Zinc Coated
FEDSPEC W-C-1094A	Conduit and Conduit Fittings, Plastic, Rigid
JIC EMP-1	Electrical Standards for Mass Production Equipment
NEMA ICS 6	Industrial Control and Systems Enclosures
NEMA TC2	Electrical Plastic Tubing (EPT) and Conduit (EPC 40 and EPC 80)

NEMA TC6	PVC and ABS Plastic Utilities Duct for Underground Installation
NEMA VE1	Cable Tray Systems
NEMA 250	Enclosures for Electrical Equipment (1000 volts maximum)
NFPA 70	National Electrical Code (NEC)
NFPA 79	Electrical Standards for Industrial Machinery
IBC	International Building Code
UL 1	Flexible Metal Electrical Conduit
UL 6	Rigid Metal Electrical Conduit
UL 360	Liquid Tight Flexible Electrical Conduit
UL 514	Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers
UL 651	Rigid Nonmetal Electrical Conduit
UL 797	Electrical Metallic Tubing
UL 870	Wireways, Auxiliary Gutters, and Associated Fittings
UL 884	Underfloor Raceways and Fittings
UL 886	Outlet Boxes and Fittings for Hazardous (Classified) Locations

1.03 SUBMITTALS

The following information shall be provided in accordance with Section 01300:

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.

   A check mark shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. *Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.*

2. Manufacturer's descriptive literature for materials.

3. Certification that Contractor has been trained to work on PVC-coated conduit systems.

PART 2--PRODUCTS

2.01 RACEWAYS AND FITTINGS

General requirements for raceway materials specified in this section are listed in the RACESPECS sheets at the end of this section. The type of raceways and raceway fittings to be used for any given area and application shall conform to the requirements in this section.

2.02 BOXES, GUTTERS, TERMINAL CABINETS, MANHOLES, AND HANDHOLES

Provide Type 316L (low carbon), 317, or Type 316 stainless products where specified. Enclosure constructed of mild sheet steel shall be hot-dipped galvanized after fabrication. Hinges shall be continuous type and for NEMA-4X cabinets hinges shall be stainless steel.

Table A specifies the electrical enclosure material and rating for the location and application.

Table A

Location	Electrical Enclosure Material and NEMA Rating
Outdoor: Corrosive Area	NEMA 4X: Stainless Steel
Hazardous Area	NEMA 7: Galvanized Malleable Iron or Aluminum, corrosion resistant coatings

A. PULL BOXES AND WIRING GUTTERS:

Indoor boxes and enclosures larger than FD boxes shall be constructed of sheet steel and galvanized after fabrication. Outdoor boxes and enclosures shall be provided with neoprene gaskets on the hinged doors or removable covers. Box and gutter sizes, metal thickness, and grounding shall comply with the National Electrical Code. Bolt-on junction box covers 3 feet square or larger, or heavier than 25 pounds, shall have a rigid handle. Covers larger than 3 x 4 feet shall be split.

B. TERMINAL CABINETS:

Terminal cabinets shall be provided with adjustable terminal strip mounting, back-panels for equipment mounting, print pockets in the doors, continuous door hinges, and three-point lockable latches. Terminal cabinets located indoors shall be NEMA 12. Terminal cabinets located outdoors and in corrosive areas shall be modified NEMA 4X with stainless steel door

hinge, three-point latch, and filtered ventilation, if required. Terminal block shall conform to Section 16000.

C. NOT USED

D. HANDHOLES:

Handholes shall be precast concrete with checker plate, galvanized, traffic covers designed for H 20 loading. Handholes shall be provided with precast solid concrete slab bottoms with sumps. Handholes shall be constructed of 3000 psi reinforced concrete. Handhole cover shall be engraved "ELECTRICAL" or "SIGNAL" as applicable.

Dimensions shall be as specified on the drawings. Handhole walls shall be provided with boxouts, as specified for manholes.

E. MANHOLE AND HANDHOLE CABLE SUPPORTS:

Provide heavy-duty, non-metal cable racks for support of conductors. Racks shall be UL listed glass-reinforced nylon consisting of slotted wall brackets for support arms designed for a minimum of a 400-pound load. Each support bracket shall from the top to the bottom and the arms shall be adjustable and installed on 24-inch centers. Use ½-inch stainless steel bolts, hardware, inserts, and fasteners. Cables supports, clamps or racks shall be provided to support the cable at minimum 2 foot intervals. Concrete inserts shall be embedded on 24-inch centers in walls and ceiling.

Cable Support Products or equal:

1. Underground Devices Incorporated Type RA arms with CR36 support brackets.

2. Unistrut Power-Rack F20N-STA33 Stanchions with F20N-ARM14 Arms.

F. GROUND BUS:

Provide a ground bus in concrete manholes, handholes, and electrical pullboxes with dimension of 3-foot width x 3-foot length x 3-foot depth and larger. Provide a NEMA threaded 4-hole grounding plate for connecting two to four-1-hole ground connectors that enter the enclosure from two to four duct banks. Products: Burndy, T&B, or equal.

2.03 RACEWAY SUPPORTS

A. CONDUIT SUPPORTS:

Framing channel with end caps and straps shall be provided to support groups of conduit. Individual conduit supports shall be one-hole pipe straps used with clamp backs and nesting backs where required. Material as specified herein.

Conduit supports for PVC coated rigid steel and PVC conduit systems shall be one-hole PVC coated rigid steel clamps or oversized stainless steel clamps.

B. CEILING HANGERS:

Ceiling hangers shall be adjustable steel rod hangers and fittings. Provide J-Type conduit support for single conduit. Straps or hangers of plumber's perforated tape are not acceptable. Unless otherwise shown, hanger rods shall meet ASTM A193 and be sized as 3/8-inch up to 2-inch conduit and shall be 1/2 inch all-thread rod over 2-inch conduit. Material as specified herein.

C. SUSPENDED RACEWAY SUPPORTS AND RACKS:

Suspended raceway supports shall consist of concrete inserts, steel rod hangers, and jamb nuts supporting framing channel or lay-in pipe hangers as required. Framing channel shall be a minimum of 12-gauge. Material as specified herein.

Hanger rods shall be 1/2-inch diameter all-thread rod and shall meet ASTM A193. Suspended raceway supports and racks shall be braced for seismic forces as specified in Section 16000.

D. MATERIALS:

Table B specifies the type of raceway supports required for each location and application.

Table B

Location	Framing Channel	Threaded Rod, Hardware, & Fittings
Outdoor, Corrosive Area (general)	Stainless Steel	Stainless Steel

2.04 CONCRETE ENCASED DUCT BANKS

Concrete used for duct banks shall be Class E with red color added and a minimum 28-day compressive strength of 2,000 psi as specified in the Cast-in-Place Concrete Section 03300.

2.05 UNDERGROUND MARKING TAPE

Underground detectable marking tape shall be for early warning protection of digging around direct buried cables, conduits, and concrete duct banks. Tape shall be OSHA approved.

Marking tape example: Low density polyethylene plastic, nominally 6 inches wide and 4 mil thickness with metallic lined tape with red polyethylene film on top and clear polyethylene film on the bottom. Tape shall be imprinted with a warning continuously along the length similar to: "CAUTION - STOP DIGGING - BURIED ELECTRIC LINE BELOW."

Tape Products: Brady "Identoline"; Services and Materials "Buried Underground Tape"; Somerset (Thomas & Betts) "Protect-A-Line"; or equal.

2.06 NAMEPLATES

Nameplates shall be provided for boxes in accordance with the requirements of Section 16000. Nameplate wording shall be as shown on the drawings. Provide the functional description of the device on the nameplate, where wording is not specified

2.07 NOT USED

2.08 RACEWAY IDENTIFICATION

Raceway number tags shall conform to the requirements of raceway markers, Section 16000.

2.09 ELECTRICAL SEALANT

Electrical sealant putty shall be non-hardening, non-oxidizing, non-corrosive, non-poisonous, and non-injurious to human skin with service temperature range of 30 to 200 degrees Fahrenheit. Product shall be used to seal against the entrance of water.

2.10 HAZARDOUS AREA AND CORROSIVE AREA CONDUIT SEALS

Sealing compound shall be non-hardening type for corrosive areas. Seal fittings for conduit systems in hazardous atmosphere locations shall be hot-dip galvanized cast ferrous alloy or aluminum alloy. Seal fittings shall be 40-percent fill type.

Sealing compound shall be hard type installed in UL listed for explosion-proof sealing fittings after the conductors are installed, tested, and accepted.

Provide PVC-coated seal fittings used for PVC-coated conduit with 40-mil factory coating. Seal fitting and sealing compound manufacture: Appleton, Crouse-Hinds, or equal.

2.11 PULLING LINE

Pulling line shall be polyethylene type, mildew and rot resistant with minimum of 200-pound tensile strength and minimum 1/4-inch diameter. Install in all "future" raceways. Manufacture: Greenlee, Ideal, or equal.

2.12 CONDUIT THREAD LUBRICANT

Thread lubricant shall be conductive with anti-seize and anti-corrosion properties, compatible with steel and aluminum conduit materials. Manufacture: T&B CP8 KOPR-Shield; Robroy Threadcompound; or equal.

PART 3--EXECUTION

3.01 GENERAL

Table C specifies the type of raceway required for each location and application by RACESPEC sheet. Unscheduled conduit shall be galvanized, rigid steel, RACESPEC type GRS.

Table C

Location	Application/Condition	RACESPEC
Outdoor	Exposed (WWTP)	PGRS
Concealed	Power circuits embedded in concrete structure or beneath slab-on-grade	PVC4
Concealed	Instrumentation, communications and data signals encased in concrete, duct bank	PVC4
Underground	Power circuits encased in concrete, duct bank	PVC4
Underground	Instrumentation, communications and data signals directly buried	PVC4
Nonhazardous	Final connection to equipment and light fixtures	LFS
Hazardous corrosive	Exposed	PGRS

3.02 CONDUIT

A. GENERAL:

The conduit systems, installation, and hazardous location fittings are specified herein.

B. INDOOR AND OUTDOOR CONDUIT SYSTEMS:

In general, Contractor shall be responsible for determining conduit routing that conforms to the specified installation requirements:

1. Conduits for lighting and outlets: exposed.
2. Conduits for process equipment: concealed
3. Conduit inside structures: concealed
4. Conduit concealed inside water chambers slabs and walls

Conduit installation shall conform to the requirements of the RACESPEC sheets and the following specified installation requirements:

1. Exposed conduit: Install parallel or perpendicular to structural members and surfaces. Install conduit horizontally and allow minimum headroom of 7 feet.

2. Route two or more exposed conduits in the same general routing parallel with symmetrical bends.

3. Space exposed conduit installed on supports not more than 10 feet apart. Space multiple conduits in parallel and use framing channel.

4. Comply with the requirements of Section 16000 and herein, where conduits are suspended from the ceiling.

5. Secure conduit rack supports to concrete walls and ceilings with cast-in-place anchors or framing channel concrete inserts.

6. Install conduits at least 6 inches from high temperature piping, ducts, and flues with temperatures higher than 90 degree C.

7. Install conduits between the reinforcing steel in walls or slabs that have reinforcing in both faces.

8. Place conduits under the reinforcement in slabs with only a single layer of reinforcing steel. Separation between conduits, conduits and reinforcement, and conduits and surfaces of concrete shall be maintained in accordance with UBC.

9. Route conduit clear of structural openings and indicated future openings.

10. Provide conduits with flashed and watertight seals routed through roofs or metal walls.

11. Grout conduits into openings cut into concrete and masonry structures.

12. Cap conduits or plug flush conduits during construction to prevent entrance of dirt, trash, and water. Cap or plug empty conduits designated as "future", "spare", or "empty" and include a pulling line accessible at both ends. Use anti-seize compound on cap and plug threads prior to installation.

13. Determine concealed conduit stubup locations from the manufacturer's shop drawings. Terminate concealed conduit for future use in specified equipment.

14. Install conduit flush with structural surfaces with galvanized couplings and plugs. Caps and plugs shall match the conduit system.

15. Provide concealed portions of conduits for future equipment where the drawings indicate future equipment. Match the existing installation for duplicate equipment.

16. Terminate conduits that enter enclosures with fittings that match the NEMA rating of the enclosure.

17. Underground metallic or nonmetallic conduit that turn out of concrete, masonry or earth: Install a 90-degree elbow of PVC-coated rigid steel conduit before emergence above ground.

18. Provide O-Z Gedney "Type DX" or Crouse-Hinds "Type XD" bonded, weathertight expansion and deflection fitting for the conduit size where conduit across structural joints that allows structural movement.

C. UNDERGROUND CONDUIT SYSTEM:

Excavation, backfilling, and concrete work shall conform to respective sections of these specifications. Underground conduit shall conform to the following requirements:

1. Underground conduits shall be reinforced concrete encased that are not shown otherwise on the drawings.

2. Concrete encased conduit shall have minimum concrete thicknesses of 2 inches between conduits, 1 inch between conduit and reinforcing, and 3 inches between reinforcing and earth, unless shown otherwise in an electrical detail.

3. Concrete encasement on exposed outdoor conduit risers shall continue to 3 inches above grade, with top crowned and edges chamfered.

4. Underground conduit bend radius shall be not less than 2 feet minimum at vertical risers and shall be not less than 3 feet elsewhere.

5. Where conduit and concrete encasement are terminated underground, the conduit and reinforcing shall both extend at least 2 feet past the concrete. Conduits shall be capped and threads protected. Steel surfaces shall be given two coats of epoxy paint.

6. Underground conduits and conduit banks shall have 2 feet minimum earth cover unless otherwise shown.

7. Underground conduit banks through building walls shall be cast-in-place or installed with concrete into boxouts with waterstops on all sides of the boxout. Water-stops shall be as specified in the Cast-in-Place Concrete section. Extend the horizontal reinforcement from the duct bank into the boxout terminating with J-hook bends.

8. Conduits not encased in concrete and passing through walls with one side in contact with earth shall be sealed watertight with special rubber gasketed sleeve and joint assemblies or with sleeves and modular rubber sealing elements.

9. Thoroughly swab conduits and raceways on the inside, immediately upon completion of pouring concrete.

10. Label raceways in accordance with Section 16000.

11. After the concrete has set and before backfilling, pull a mandrel through each conduit. The mandrel shall have a diameter equal to the nominal conduit inside diameter minus 1/2 inch and shall not be less than 4 inches long.

12. If the mandrel showed signs of protrusions on the inside of the conduit, the conduit shall be repaired or replaced.

13. Provide manufactured plastic conduit spacers anchored to prevent movement during the concrete pour. Manufacture: Carlon, PW Pipe, Underground Devices, or equal.

14. Form the concrete pour ten feet from the wall, manhole, or handhole and form to allow for future conduit entry.

15. Backfill duct banks with clean fill compacted to 90-percent in 6-inch lifts after concrete has cured. Refer to Section 03300 for concrete requirements including minimum 7 days of cure time prior to backfill over duct banks.

16. Allow and provide for two offsets per conduit and raceway for each 100-linear feet to account for unexpected field conditions including for excavation and backfill limited to three feet of extra width and/or depth. Include these specified provisions in the bid price.

17. Provide PVC threaded adapter with female threads where PVC conduit is joined to steel conduit. Procedure:

a. Before assembly: Double coat steel conduit with Red-Robroy, Green-Permacote, Blue-Ocal or equal product.

b. After assembly: Seal with 65-mil thick, 2-inch wide mastic sealing tape to ½-inch beyond threads. Procucts: 3M Scotch 2228; Plymouth 02625; or equal.

c. Cover with 20-mil corrosion protection tape applied in ½-lap layers to 2-inch beyond threads. Products: 3M Scotchwrap 51; Plymouth Plywrap 12; or equal.

18. Where reinforced concrete duct banks enter the side of a building, manhole, or handhole and the reinforcement cannot be brought into a window and be terminated, then drill the structure and embed the reinforcement in epoxy to minimum of 3-inches depth.

19. Provide PVC conduit with bell ends where duct banks terminated at walls, manholes, or handholes. Install bell ends flush with finished concrete.

20. Provide PVC conduit with bell ends where conduit rise below grade into a floor mounted electrical panel, electrical cabinet, MCC, switchboard, or switchgear.

21. Separate power conduits from signal conduit within the same ductbank by 12" or greater separation, as shown. Refer to the drawings or schedules for signal to be installed in metal conduits instead of PVC ducts.

22. Separate high voltage ductbanks from low voltage ductbanks, as shown.

23. Provide wireways for transition from underslab conduits rising into wall-mounted panels where the number of conduits exceed the NEC allowable panel space in the bottom of the panel. Provide conduit sleeves or fitting for panel transition. Continuous thread or all-thread is prohibited.

D. NOT USED

E. CONDUIT SEAL-OFF FITTINGS:

Conduits passing:

1. Between Class I, Division 1 area and Class I, Division 2 area; provide sealing fittings located at the boundary in accordance with NEC Article-500.

2. From hazardous or corrosive area into a non-hazardous or non-corrosive area.

Install the seal-off material in the conduit seal-off fittings after inspection.

F. CONDUIT AND INNERDUCT SEALING MATERIAL:

Provide HYDRA-SEAL® Handi-Polyurethane-Foam or equal product to seal conduits and inner ducts.

Sealing product required features:

1. Compatible with common cable jacket materials.

2. ASTM E-84 flame spread requirements and UL Classified.

3. Pre-pressurized, portable, one-component closed-cell foam sealing system.

4. Dries tack-free within 15 minutes and cures within 24 hours.

5. Reacts with applied moisture or with ambient humidity.

6. Remove over-spray with acetone and remove cured foam mechanically

Application Criteria:

1. Apply in ambient temperatures between 60° to 100° F.

2. Apply bead onto clean surface.

3.03 MANHOLES AND HANDHOLES

Unless otherwise specified, manhole and handhole installation shall be as follows:

1. Manholes, handholes, and pull boxes shall be set on a minimum of 6 inches of crushed rock on top of undisturbed or compacted earth.

2. Manholes and handholes shall be set plumb so that water shall drain to the sump.

3. Manhole covers shall be 36-inches in diameter and set at 2 inches above finish grade with surrounding pavement sloping away from the manhole cover.

4. Metallic hardware inside manholes and handholes shall be bonded to the ground plate or ground bus using bolted connections, bonding jumpers and grounding bushings.

3.04 NOT USED

3.05 RACEWAY NUMBERING

Each new and reused conduit shall be provided with a number tag at each end and in each manhole, handhole, or pull box. Cable trays shall be identified by stencils at intervals not exceeding 50 feet, at intersections, and at each end to identify power cable tray voltage, control cable tray, or instrument cable tray.

3.06 RACEWAY SCHEDULE

A. NOT USED

B. UNSCHEDULED RACEWAY:

Unscheduled lighting and receptacle raceways shall be sized by the Contractor in accordance with the NEC. Minimum size shall be 3/4 inch for exposed and 1 inch for embedded raceway.

The number and size of communication, paging, fire alarm, and security raceways shall be as required for the particular equipment provided subject to the minimum sizes specified herein.

C. SCHEDULED RACEWAY:

The size and type of raceway shall be as specified on the single line drawings.

3.07 RACESPEC SHEETS

The following RACESPECS are included in this section:

3.07 RACEWAY SPECIFICATION SHEETS (RACESPEC)

Raceway Identification:	GRS
Description:	Galvanized Rigid Steel Conduit (GRS)
Compliance:	ANSI and UL
Finish:	Hot-dip galvanized after fabrication, inside and outside. Smooth finished surfaces.
Manufacturers:	Allied Tube and Conduit Corp., Wheatland Tube Co., or equal.
Minimum size:	Unless otherwise specified, 3/4 inch for exposed, 1 inch for embedded, encased, or otherwise inaccessible.
Fittings:	
Locknuts, Rings, Hubs:	Hot-dip galvanized insulated throat with bonding locknut or ring. The hubs shall utilize a neoprene "O" ring and provide a watertight connection. O-Z Gedney, CHM-XXT, or equal
Unions:	Electro-galvanized ferrous alloy type Appleton UNF or UNY, Crouse-Hinds UNF or UNY, or equal. Threadless fittings are not acceptable.
Conduit Bodies:	Oversized conduit bodies: Ferrous alloy type with screw taps for fastening covers to match the conduit system. Gaskets shall be made of neoprene.
Boxes:	
Indoor:	Type FD cast ferrous for all device boxes and for junction boxes less than 6 inches square.
Outdoor:	Type FD cast ferrous for all device boxes and for junction boxes less than 6 inches square.

3.07 RACEWAY SPECIFICATION SHEETS (RACESPEC)

Raceway Identification:	GRS (continued)
Corrosive:	NEMA 4X stainless steel or nonmetallic, as specified.
Hazardous:	NEMA Class 7 cast ferrous.
Elbows:	
(3/4" thru 1-1/2")	Factory fabricated or field bent.
(2" thru 6")	Factory fabricated only.
Conduit Bodies (Oversized):	
(3/4" thru 4")	Malleable iron, hot-dip galvanized, unless otherwise noted. Neoprene gaskets for all access plates. Tapered threads for conduit entrances.
(5" and 6")	Electro-galvanized iron or cast iron box.
Expansion Fittings:	Expansion fittings in embedded runs shall be watertight with an internal bonding jumper. The expansion material shall be neoprene allowing for 3/4-inch movement in any direction.
Manufacturers:	Appleton, Crouse-Hinds, Hubbell, O. Z. Gedney, or equal.
Installation:	Rigid steel conduit shall be made up tight and with conductive thread compound. Joints shall be made with standard couplings or threaded unions. Steel conduit shall be supported away from the structures using hot-dip galvanized malleable iron straps with nesting backs or framing channel. Conduit entering boxes shall be terminated with a threaded hub with a grounding bushing. Exposed male threads on rigid steel conduit shall be coated with zinc-rich paint.

3.07 RACEWAY SPECIFICATION SHEETS (RACESPEC)

Raceway Identification:	LFS
Description:	Liquidtight Flexible Steel Conduit
Application:	Final connection to equipment subject to vibration or adjustment.
Compliance:	UL 360
Construction:	Spirally wound galvanized steel strip with successive convolutions securely interlocked and jacketed with liquidtight plastic cover.
Minimum size:	3/4 inch
Fittings:	Cadmium-plated malleable iron body and gland nut with cast-in lug, brass grounding ferrule threaded to engage conduit spiral. O-ring seals around the conduit and box connection and insulated throat. Provide forty-five and ninety degree fittings where applicable. Provide PVC coated flexible conduit and fittings where the conduit system is PVC coated.
Installation:	Length of flexible liquidtight conduit shall not exceed 15 times the trade diameter of the conduit and not exceed 36 inches in length. Use conductive thread compound.

3.07 RACEWAY SPECIFICATION SHEETS (RACESPEC)

Raceway Identification:	PGRS
Description:	Rigid Steel Conduit, Corrosion-Resistant, Polyvinyl Chloride (PVC) Coated. Provide factory made and coated elbows.
Compliance:	ANSI, ETL and UL. The PVC coated rigid galvanized steel conduit shall be stamped with the ETL Verification Mark "ETL Verified to PVC-001".
Finish:	PGRS shall be hot-dip galvanized rigid steel conduit as specified in 16110-3.03 GRS, with a PVC Coating. The PVC coating shall be gray, minimum 40 mils thick, bonded to the outside and continuous over the entire length of the conduit except at the threads, and be free of blisters, bubbles, or pinholes. Thread protectors shall be used on the exposed threads of the PVC coated conduit. A 2-mil coat of urethane enamel coating shall be bonded to the inside. Coating shall be free of pinholes. Bond strength shall exceed the tensile strength of the PVC coat.
Minimum size:	3/4 inch
Fittings:	Similarly coated to the same thickness as the conduit and provided with Type 316 stainless steel hardware. Conduit and fittings shall be manufactured by the same company Conduit and fittings shall be coated by the same company. Male threads on elbows and nipples, and female threads on fittings or conduit couplings shall be protected by application of urethane coating.
Covers:	PVC coated covers shall have V-groove seal and stainless steel hardware.
Hubs:	Hubs for connection of conduit to junction, device, or terminal boxes shall be threaded cast ferrous alloy. Hubs shall have the same PVC coating as the conduit and insulating grounding bushings. Hubs shall utilize a neoprene "O" ring and shall provide a watertight connection.

3.07 RACEWAY SPECIFICATION SHEETS (RACESPEC)

Raceway Identification:	PGRS (continued)
Boxes:	
Nonhazardous:	NEMA Class 4X stainless steel or nonmetallic.
Hazardous:	NEMA Class 7 cast ferrous.
Manufacturers:	PVC coated conduit that bears the ETL Verified PVC-001 label by Robroy Industries, Plasti-Bond, Perma-Cote, KorKap or equal.
Installation:	Plastic coated conduit shall be made up tight, threaded, and installed using tools approved by the PVC-coated conduit manufacturer. Exposed conduit threads shall be covered by a plastic overlap coated and sealed per manufacturer's recommendations. Pipe wrenches and channel locks shall not be used for tightening plastic coated conduits. Damaged areas shall be patched, using manufacturer's recommended material. The area to be patched shall be built up to the full thickness of the coating. Painted fittings are not acceptable. PVC coated conduit shall be supported away from the structure using PVC coated conduit wall hangers or PVC coated conduit mounting hardware. Damaged work shall be replaced
Training:	Installers shall be trained and certified in the proper installation techniques provided by the PVC-coated conduit system manufacture. Proof of certification shall be provided under paragraph 16110-1.03.

3.07 RACEWAY SPECIFICATION SHEETS (RACESPEC)

Raceway Identification:	PVC4
Description:	Rigid Nonmetallic Conduit.
Application:	Heavy wall thickness for direct bury, concrete encasement or surface mounting where not subject to physical damage.
Compliance:	NEMA TC2, UL 651
Construction:	Schedule 40, high-impact, polyvinylchloride (PVC)
Minimum size:	3/4 inch exposed; 1 inch embedded or encased
Fittings:	PVC solvent weld type
Boxes:	
Indoor:	NEMA Class 4, nonmetallic
Outdoor and corrosive:	NEMA Class 4X, nonmetallic
Installation:	PVC conduit entering fiberglass boxes or cabinets shall be secured by threaded bushings on the interior of the box and shall be terminated with a threaded male terminal adapter having a neoprene O ring. Joints shall be made with standard PVC couplings. PVC conduit shall have bell ends where terminated at walls and boxes.

3.07 RACEWAY SPECIFICATION SHEETS (RACESPEC)

Raceway Identification:	WW
Description:	Wireway and Auxiliary Gutter: Match the conduit or raceway system specified and shown on the drawings. Minimum: Flanged, oiltight type with hinged covers
Application:	As shown on the drawings.
Compliance:	JIC EMP-1
Sizes as shown:	4 inch by 4 inch, 6 inch by 6 inch, 8 inch by 8 inch
Finish:	Hot-dip galvanized after fabrication, inside and outside. Smooth finished surfaces.
Indoor non-corrosive area:	NEMA-1, NEMA-12, NEMA-4 or as shown on the drawings.
Outdoor and corrosive area:	NEMA-3R, NEMA-4X or as shown on the drawings.

3.07 RACEWAY SPECIFICATION SHEETS (RACESPEC)

Raceway Identification:	XPFS
Description:	Explosion-proof Flexible Steel Conduit
Application:	XPFS Conduit coupling shall be used for final connections to motors and other equipment subject to vibration or adjustment in Class I Division 1 hazardous areas and shall be watertight.
Size:	1/2 inch – 4-inch
Length:	4-inch – 36-inch

END OF SECTION

SECTION 16120

600 VOLT CONDUCTORS, WIRE, AND CABLE

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies stranded copper cables, conductors, and wire rated 600 volts insulation used for power; lighting, analog, digital, or pulse signals and control circuits.

1.02 REFERENCES

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

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

Reference	Title
ASTM B3	Soft or Annealed Copper Wire
ASTM B8	Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B33	Tinned Soft or Annealed Copper Wire for Electrical Purposes
ICEA S-68-516	Ethylene-Propylene-Rubber-Insulated Wire
NEMA WC7	Cross-Linked-Thermosetting Insulated Wire and Cable for the Transmission and Distribution of Electric Energy
NFPA 70	National Electric Code (NEC)
UL 44	Rubber-Insulated Wires and Cables
UL 83	Thermoplastic-Insulated Wires and Cables

1.03 SUBMITTALS

The following information shall be provided in accordance with Section 01300.

1. Submittals specified in Section 16000.

2. Complete catalog cuts for all conductors, wire, and cable.

PART 2--PRODUCTS

2.01 GENERAL

A. UNSCHEDULED CONDUCTORS AND CABLES:

Where not specified on the Drawings, conductors and cables shall be sized in accordance with the National Electrical Code for the particular equipment served with the minimum size as specified herein.

Unscheduled conductor with insulation shall be provided in accordance with the following:

1. CABLESPEC "MEPR/CPE" multi-conductor power and control cable

2. CABLESPEC "XHHW" for single conductors

3. CABLESPEC "THWN" for indoor lighting and receptacles

B. CABLE SPECIFICATION SHEETS (CABLESPEC):

General requirements for conductors and cables specified in this Section are listed on CABLESPEC sheets in paragraph 16120-3.06.

2.02 COLOR CODING

A. CONTROL CONDUCTORS:

Single-conductor control conductors shall have the following colors for the indicated voltage:

Control Conductor	120V
Power (AC)	Black
Control (AC)	Red
Neutral	White

Ground	Green
Foreign Voltage (DC)	Blue
Foreign Voltage (AC)	Yellow
Power (DC)	Blue
Control (DC)	Blue

B. POWER CONDUCTORS:

Power conductors shall have the following colors for the indicated voltage:

Power Conductor	480V	208/120V
Phase A	Brown	Black
Phase B	Orange	Red
Phase C	Yellow	Blue
Ground	Green	Green
Neutral	Gray	White

Cables may be black with colored 3/4-inch vinyl plastic tape applied at each cable termination. Tape shall be wrapped with 25 percent overlay to provide 3 inches minimum coverage.

C. SIGNAL CONDUCTORS:

Signal cable conductors shall be color coded black and white for pairs or black, white, and red for triads. Each conductor and each group of conductors shall be numbered.

2.03 POWER AND CONTROL CONDUCTORS AND CABLE, 600 VOLT

A. SINGLE CONDUCTOR:

Provide stranded conductors for all cable or wires. Provide minimum conductor size of 12 AWG for power and lighting circuits and minimum conductor size of 14 AWG for control circuits.

B. MULTICONDUCTOR CABLE:

Provide multiconductor power cable and multiconductor control cable where identified on the drawings. Provide stranded conductors for all cable or wires.

2.04 SIGNAL CABLES

A. GENERAL:

Factory cable between manufactured instrument system components shall be provided in compliance with the instrument manufacturer's recommendations.

Signal cable shall be provided for instrument signal transmission. Single instrument cable (SIC) and multiple-circuit instrument cable (MIC) shall be provided in accordance with the following examples:

CABLESPEC "SIC":
Cable designation: 1PR#18S shielded twisted pair (STP)
Cable designation: 1TR#18S triad (STT)

CABLESPEC "MIC":
Cable designation example: 4PR#18S with individual shields for each of the four pair and an overall shield and jacket for the multiconductor instrument cable.

2.05 PORTABLE CORD

Portable cord shall be provided in accordance with CABLESPEC "CORD," unless otherwise specified. Cords shall contain an equipment grounding conductor.

2.06 SPLICING AND TERMINATING MATERIALS

Connectors shall be tool applied compression type of correct size and UL listed for the specific application. Connectors shall be tin-plated high conductivity copper. Wire nuts for a splice is prohibited.

Signal and control conductors shall be connected to terminal blocks and field devices and instruments shall be terminated with conductor terminals as specified in paragraph 16000-2.02.

Connectors for wire sizes No. 8 AWG and larger shall be compression tool installed one-hole lugs up to size No. 3/0 AWG, and two-hole or four-hole lugs for size No. 4/0 and larger. Mechanical clamp, dimple, screw-type connectors are not acceptable. In-line splices and taps shall be used only by written consent of the Construction Manager.

Power conductor splices shall be compression type, made with a compression tool die approved for the purpose, as made by Thomas and Betts Corp., or equal. Splices shall be covered with electrical products designed for the application, insulated, and covered with a heat-shrinkable sleeve or boot, as specified elsewhere.

Motor connection kits shall consist of heat-shrinkable, polymeric insulating material over the connection area and high dielectric strength mastic to seal the ends against ingress of

moisture and contamination. Motor connections may use the Tyco Electronics removable boot product line.

Motor connection kits shall accommodate a range of cable sizes for both in-line and stub-type configurations. Connection kits shall be independent of cable manufacturer's tolerances. Refer to the electric motor specification Section 11060.

2.07 CORD GRIPS

Cord grips shall be provided where indicated on the Drawings to attach flexible cord to equipment enclosures. Cord grips shall consist of a threaded aluminum body and compression nut with a neoprene bushing and stainless steel wire mesh for strain relief. Cord grip shall provide a watertight seal at enclosure interface and sized to accommodate the flexible cord.

PART 3--EXECUTION

3.01 GENERAL

Conductors shall be identified at each connection terminal and at splice points. The identification marking system shall comply with Section 16000.

Pulling wire and cable into conduit or trays shall be completed without damaging or putting undue stress on the insulation or jacket. Manufacture recommended and UL Listed pulling compounds are acceptable lubricants for pulling wire and cable. Grease is not acceptable.

Raceway construction shall be complete, cleaned, and protected from the weather before cable is installed. Where wire or cable exits a raceway, a wire or cable support shall be provided.

Provide tin-plated bus bar. Scratch-brush the contact areas and tin plate the connection where flat bus bar connections are made with un-plated bar. Bolts shall be torqued to the bus manufacturer's recommendations.

3.02 600 VOLT CONDUCTOR AND CABLE

Conductors in panels and electrical equipment shall be bundled and laced at intervals not greater than 6 inches, spread into trees and connected to their respective terminals. Lacing shall be made up with plastic cable ties. Cable ties shall be tensioned and cut off by using a tool specifically designed for the purpose such as a Panduit GS2B. Other methods of cutting cable ties are unacceptable.

Conductors crossing hinges shall be bundled into groups not exceeding 10 to 15 conductors and protected using nylon spiral flexible covers to protect conductors. Provide oversized plastic panel wiring duct within panels and panelboards.

Slack shall be provided in junction and pull boxes, handholes and manholes. Slack shall be sufficient to allow cables or conductors to be routed along the walls. Amount of slack shall be equal to largest dimension of the enclosure. Provide dedicated electrical wireways and insulated cable holders mounted on unistrut in manholes and handholes.

Raceway fill limitations shall be as defined by NEC and the following:

1. Lighting and receptacle circuits may be in the same conduit in accordance with de-rating requirements of the NEC. Lighting and receptacle circuits shall not be in conduits with power or control conductors. Signal conductors shall be in separate conduits from power conductors. Motor feeder circuits shall be in separate conduits including small fan circuit unless combination fan-light fixture.

2. Power conductors derived from uninterruptible power supply systems shall not be installed in raceways with conductors of other systems. Install in separate raceways.

3. Slices and terminations are subject to inspection by the Construction Manager prior to and after insulating.

4. Motor terminations at 460-volt motors shall be made by bolt-connecting the lugged connectors.

5. In-line splices and tees, where approved by the Construction Manager, shall be made with tubular compression connectors and insulated as specified for motor terminations. Splices and tees in underground handholes or pull boxes shall be insulated using Scotch-cast epoxy resin or Raychem splicing kits.

6. Terminations at solenoid valves, 120 volt motors, and other devices furnished with pigtail leads shall be made using self-insulating tubular compression connectors within the termination box.

7. Terminations at valve and gate motor actuators shall be made directly into the actuator where possible. Power termination shall be made in the actuator power disconnect. Control and signal cable may be routed to a termination box near the actuator on 20-ampere rated terminal strips with label identification for the control and signal conductors. Single wire control conductors and analog cable (SIC or MIC) then installed in flexible conduit to the actuator control and signal termination compartments.

3.03 SIGNAL CABLE

Provide terminal blocks at instrument cable junctions within dedicated terminal boxes provided by the installer. Signal circuits shall be run without splices between instruments, terminal boxes, or panels.

Circuits shall not be made using conductors from different pairs or triads. Triads shall be used wherever 3-wire circuits are required.

Shields are not acceptable as a signal path, except for circuits operating at radio frequencies utilizing coaxial cables. Common ground return conductors for two or more circuits are not acceptable.

Shields shall be bonded to the signal ground bus at the control panel only and isolated from ground at the field instrument or analyzer and at other locations. Shields or drain wires for spare circuits shall not be grounded at either end of the cable run. Terminals shall be provided for running signal leads and shield drain wires through junction boxes.

Spare circuits and the shield drain wire shall be terminated on terminal blocks at both ends of the cable run and be electrically continuous through terminal boxes.

Where instrument cable splicing is required, provide an instrument stand with terminal box rated for the area and environment and mounted approximately 3 feet above grade for instrument cable splices with the circuits and individual conductors provided with label as specified in Section 16000.

Cable for paging, security, voice communication, and telephone systems shall be installed and terminated in compliance with the manufacturers and the Utilities recommendations.

3.04 PORTABLE CORD

Portable power cords feeding permanent equipment, such as pendant cords feeding motors for pumps, cranes, hoists, and portable items shall have a wire mesh cord grip of flexible stainless steel wire to relieve the tension from the cable termination. Connection of portable cords to permanent wiring shall be accomplished with dedicated boxes and terminals blocks.

3.05 TESTING

The Contractor shall test conductors, wire, and cable in accordance with Section 16030.

3.06 CABLE SPECIFICATION SHEETS (CABLESPEC)

A. GENERAL:

Conductor, wire, and cable types for different locations, service conditions and raceway systems are specified on individual cable specification sheets. Scheduled and unscheduled conductors, wires, and cables shall be installed in accordance with the CABLESPEC SHEETS.

B. CABLESPEC SHEETS:

The following CABLESPEC sheets are included in this section:

Type	Volt	Product	Purpose
COAX	300	ANDREW LDF4-50A HELIAX, ½"	900 MHZ RADIO COMMUNICATION
SIC	600	P-OS: 1-PR#18SH or 1-TR#18SH	CABLE TRAY RATED INSTRUMENT CABLE
THWN	600	PVC INSULATED WITH NYLON JACKET BUILDING GRADE CONDUCTOR	LIGHTS & RECEPTACLES
XHHW	600	XLP INSULATED INDUSTRIAL GRADE CONDUCTOR	POWER, CONTROL
MEPR / XLP	600	MULTICONDUCTOR RUBBER INSULATED CABLE WITH JACKET EXAMPLES: CONTROL CABLE: 19/C #14	CABLE TRAY RATED POWER & CONTROL
CORD	600	HEAVY DUTY CABLE: SJOOW	PORTABLE ITEMS

3.06 CABLE SPECIFICATION SHEET--CABLESPEC

Cable System Identification:	SIC
Description:	Single twisted, shielded pair or triad, 18 AWG, instrumentation and signal cable; UL listed; Cable Tray rated
Voltage:	600 volts
Conductor Material:	Bare annealed copper; stranded per ASTM B8
Insulation:	15 mil, Polyvinyl Chloride (PVC) with 4 mil nylon, 90 degree C temperature rated Color Code per ICEA Method-1: Pairs- Black and White with one conductor in each pair printed alpha-numerically for identification
Lay:	Twisted on a 2-inch lay
Shield:	100 percent, 1.35 mil aluminum-Mylar tape with a 7-strand tinned copper drain wire
Jacket:	45 mil Polyvinyl Chloride (PVC)
Flame Resistance:	UL 1277
Manufacturer(s):	Okonite, Okoseal-N Type P-OS (Pair(s) Overall Shield) and Type TOS (Triad(s) Overall Shield); or Cooper Industries-Belden equal; or General Cable equal
Execution:	
Use:	Analog signal cable and RTD device Triad extension cable.
Installation:	Install in accordance with paragraph 16120-3.03.
Testing:	Test in accordance with paragraph 16120-3.05.

3.06 CABLE SPECIFICATION SHEET--CABLESPEC

Cable System Identification:	THWN
Description:	Single conductor lighting and receptacle type; Indoor branch circuit conductor.
Voltage:	600 volts
Conductor Material:	Bare annealed copper; stranded per ASTM B8
Insulation:	THWN/THHN, 90 degree C dry, 75 degree C wet, Polyvinyl Chloride (PVC) per UL 83.
Jacket:	Nylon
Flame Resistance:	UL 83
Manufacturer(s):	Okonite, Okoseal-N, series 116-67-XXXX; or equal.
Uses Permitted:	Lighting, receptacle and appliance circuits
Execution;	
Installation:	Install in accordance with paragraph 16120-3.02.
Testing:	Test in accordance with paragraph 16000-3.02 and Section 16030.

3.06 CABLE SPECIFICATION SHEET--CABLESPEC

Cable System Identification:	XHHW
Description:	Industrial grade single conductor Sizes: 14 AWG through 750 kcmil as shown
Voltage:	600 volts
Conductor Material:	Bare annealed copper; stranded per ASTM B8
Insulation:	NEC Type XHHW-2; 90 degree C dry and C wet; Cross-Linked Polyethylene (XLP) per ICEA S-66-524 and UL-44; Color in sizes 14, 12 and 10 AWG: Black, Green, Yellow, White, Orange, Brown, Red, Blue
Jacket:	None
Flame Resistance:	UL 83
Manufacturer(s):	Okonite, X-Olene; Cablec, Durasheath XLP; or equal.
Uses Permitted:	Power and control circuits.
Execution:	
Installation:	Install in accordance with paragraph 16120-3.02.
Testing:	Test in accordance with paragraph 16000-3.02 and Section 16030.

3.06 CABLE SPECIFICATION SHEET--CABLESPEC

Cable System Identification:	MEPR / CPE
Description:	Multiconductor Power Cable and Multiconductor Control Cable:14 AWG stranded conductors; Cable tray rated.
Power Cable:	Insulated green grounding conductor sized per the NEC.
Ground Conductor Size:	Multiple sets of multiconductor power cable: Oversize the grounding conductor per NEC 250.
Control Cable Type:	ICEA Method 1, E-2, without white neutral conductor or green ground conductor
Control Cable Identification:	Conductors color coded per ICEA and conductors numbered
Voltage:	600 volts
Conductor Material:	Bare annealed copper; stranded per ASTM B8, coated per ASTM B33
Insulation:	XIIHW, 90 degree C dry, 75 degree C wet, cross-linked polyethylene (XLP) per ICEA 2-68-516 and UL 1581.
Jacket:	Cross-linked Polyethylene (XLP)
Flame Resistance:	IEEE 383
Manufacturer(s):	Okonite, X-Olene-Okoseal type TC; Cablec, Durasheath EP; or equal.
Execution:	
Installation.	Install in accordance with paragraph 16120-3.02.
Testing:	Test in accordance with paragraph 16000-3.02 and Section 16030.

3.06 CABLE SPECIFICATION SHEET--CABLESPEC

Cable System Identification:	CORD
Description:	Industrial Grade Flexible Portable Cord: Synthetic Rubber Insulation with Oil-Resistant Thermoset Jacket construction: Type SOOW for 600 Volt circuits; Type SJOOW for 300 Volt circuits
Voltage:	600 V RMS where shown or where unspecified: Type SOOW
Conductor Material:	Flexible rope stranded annealed copper per ASTM B189 and B33.
Insulation:	Insulation: Ethylene propylene (EPR) per ICEA S-68-516 and rated for continuous operation at 90 degrees C. Green used for ground only Color: 2/C Black and White; 3/C Black, White, and Green; 4/C Black, White, Red and Green; 5/C Black, White, Red, Green, and Orange
Jacket:	Heavy-duty Neoprene per ICEA S-68-516. Color: Black
Manufacturer(s):	Okonite: Okocord; American Insulated Wire Cord equal; or Engineer accepted equal.
Execution:	
Installation:	Install in accordance with paragraph 16120-3.02.
Testing:	Test in accordance with paragraph 16120-3.05.

END OF SECTION

SECTION 16140

WIRING DEVICES

PART 1--GENERAL

1.01 DESCRIPTION

This Section specifies wiring devices consisting of receptacles, plugs, switches and appurtenances.

1.02 REFERENCES

This Section contains references to the following documents. They are a part of this Section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this Section as if referenced directly. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
NEMA 250	Enclosures for Electrical Equipment (1000 volts maximum)
NEMA WD-1	General Requirements for Wiring Devices
NFPA 70	National Electrical Code (NEC)

PART 2--PRODUCTS

2.01 GENERAL

Wiring devices shall be UL approved for the current and voltage specified and shall comply with NEMA WD-1. Devices shall contain provisions for back wiring and side wiring with captive binding screws.

Provide devices colored to conform to manufacturer's or industry standard for special use such as orange for isolated ground receptacles, blue for surge suppression receptacles, and red for emergency power receptacles. Unless shown otherwise on the Drawings or Schedules, normal use devices shall be brown, except those located in finished areas shall be ivory.

2.02 RECEPTACLES AND PLUGS

A. GENERAL:

Receptacles shall be grounding type.

B. 120V RECEPTACLES:

1. INDOOR, CLEAN AREAS: Unless shown otherwise on the Drawings or Schedules, receptacles shall be duplex 20 amp, NEMA 5-20R, and shall accept NEMA 5-15P and 5-20P plugs. Where the manufacturer of cord connected equipment requires and isolated ground, a receptacle with isolated ground shall be provided.

Manufactures: Hubbell 5362, 5362-AI or equal.

2. OUTDOOR, PROCESS OR CORROSIVE AREAS: Receptacle shall be duplex, 20 ampere, NEMA 5-20R, and shall accept NEMA 5-15P and 5-20P plugs. Receptacle and plug shall be corrosion resistant, marine duty with yellow polycarbonate weatherproof lift covers.

Manufacturers: Hubbell 53CM62/53CM21, 15W33W/O BOX, or equal.

C. NOT USED

D. PLUG CAPS:

Male plug caps for 120 volt and 250 volt receptacles shall be of the cord grip armored type with heavy phenolic housing, of the same manufacture as the receptacle. Plug caps shall be rated 15 amps. One plug cap shall be provided for every four receptacles furnished, with a minimum of two plug caps being provided. Plug caps shall be delivered to the Construction Manager.

E. THREE PHASE RECEPTACLES AND PLUGS:

Receptacles shall be suitable for 480 volt, 3-phase, 4-wire service, with ampere ratings as specified. Receptacles and plugs shall be designed so that the grounding pole is permanently connected to the housing. The grounding pole shall make contact before the line poles are engaged when the plug is connected to the receptacle housing. The plug sleeve shall also make contact with the receptacle housing before the line and load poles make contact. Receptacles shall be provided complete with cast back box, angle adapter, gaskets, and a gasketed screw-type, weathertight cap with chain fastener. Each receptacle shall be provided with one plug.

Manufactures: Crouse-Hinds "Arktite," Appleton "Powertite," or equal.

F. RECEPTACLES FOR HAZARDOUS AREAS:

Receptacles for use in hazardous areas shall be rated in accordance with NEC for the area in which they are to be located and shall be factory sealed. Receptacles shall be designed so the plug must be inserted and turned before load is energized. Receptacles shall be provided with mounting box, sealing chamber, and compatible plug. Voltage and current ratings shall be as 120 Vac, 20-ampere.

Manufactures: Appleton "U-Line," Crouse-Hinds "Ark-Gard 2," or equal.

2.03 SWITCHES

A. GENERAL PURPOSE (INDOOR, CLEAN AREAS):

General purpose switches shall be quiet AC type, specification grade, back and side wired, and shall be provided in accordance with rated capacities as required or as indicated on Drawings or Schedules. Switches shall match receptacles in color.

Manufactures: General Electric, Hubbell, or Construction Manager accepted substitute, as follows:

	15A, 120-277V		20A, 120-277V	
	G.E. Co.	Hubbell	G.E. Co.	Hubbell
Single:	PS 15AC1	HBL1201	PS 20AC1	HBL1221
Three-way:	PS 15AC3	HBL1203	PS 20AC3	HBL1223
Four-way:	PS 15AC4	HBL1204	PS 20AC4	HBL1224
SPST momentary:	# 7842	--	--	--
Three position center off momentary:	# 1250	HBL1556	--	HBL1557

B. SWITCHES FOR HAZARDOUS AREAS:

Switches for control of lighting and small single-phase power loads in hazardous areas shall consist of a factory assembled and sealed combination general purpose type switch in an explosion-proof housing. The switch shall be rated in accordance with NEC for the area in which it is to be installed. The external operating mechanism shall consist of a wing-type handle having the "ON" and "OFF" positions visible from the front.

Manufactures: Crouse-Hinds EDSC Type, Appleton EDSC Type, or equal.

C. SWITCHES FOR OUTDOOR AND CORROSIVE AREAS:

Switches shall be 20-ampere with weatherproof/ corrosion resistant neoprene plate. Switches shall be mounted in "FS" type copper-free aluminum or PVC mounting boxes.

Manufactures: Hubbell or Arrow-Hart as follows:

	Hubbell with 17CM50 plate	Arrow-Hart with 2881 plate
Single pole	1281	2991
Double pole	1282	2992
3-way	1283	2993
4-way	1284	2994

2.04 DEVICE PLATES

Device plates shall be provided with switches. In non-corrosive indoor areas, receptacle device plates shall be made of sheet steel, zinc electroplated with chrome finish as manufactured by Crouse-Hinds, Appleton, or equal.

Device plates in corrosive or outdoor areas shall be corrosion-resistant/marine-duty type. Device plates for explosion-proof equipment shall be factory provided with the equipment.

Device plates shall be provided with engraved laminated phenolic nameplates with 1/8-inch white characters on black background.

Nameplates for switches shall identify panel and circuit number and area served. Nameplates for receptacles shall identify circuit and voltage if other than 120 volts, single phase.

2.05 PLUG STRIPS

Plug strips shall be manufactured of sheet steel with the receptacles mounted on the front cover. The front cover shall be removable.

Plug strips for office and laboratory areas shall have single 3 wire, 20 ampere grounding type receptacles mounted along the strip on a single circuit.

Plug strips for work benches in shop and laboratory areas shall have 3 wire, 20 ampere grounding type duplex receptacles mounted along the strip on the circuits specified. Sufficient space shall be provided behind the receptacles for ten No. 12 AWG conductors in accordance with the NEC space rules.

Manufacture of plug strips: Plugmold, or equal.

2.06 PRODUCT DATA

In accordance with Section 01300, the Contractor shall provide catalog cuts for all materials provided under this section.

PART 3--EXECUTION

Boxes shall be independently supported by galvanized brackets, expansion bolts, toggle bolts, or machine or wood screws as appropriate. Wooden plugs inserted in masonry or concrete shall not be used as a base to secure boxes, nor shall welding or brazing be used for attachment.

Receptacles and switches installed in sheet steel boxes shall be flush mounted. Flush mounted receptacles shall be located 18 inches above the floor unless otherwise indicated. Switch boxes shall be mounted 48 inches above the floor. Receptacles installed in cast device boxes shall be located 48 inches above the floor.

Wiring devices shall be tested for correct connections.

END OF SECTION

SECTION 16175

MISCELLANEOUS ELECTRICAL DEVICES

PART 1--GENERAL

1.01 DESCRIPTION

The vendor, manufacturer, and custom control panels shall provide enclosures, selector switches, pushbuttons, indicators, terminal strips, surge devices, nameplates, testing procedures, wiring method, wiring color coding, wire labeling, separation between power, controls, and instruments, hardwired logic relays or PLC logic products as specified herein and in Section 16176 and 17110.

A. This section specifies electrical control and monitoring devices:

1. Control Devices:

a. Pushbuttons

b. Selector Switches

c. Indicating Lights

d. Control Station Enclosures

2. Control Relays:

a. Load-Switching

b. Logic Level Switching

B. This section specifies power devices:

1. Field Instrument and Field Analyzer: Key-Switch in control station with surge devices

2. Elapsed Time Indicators

3. Current transformers and transducers

4. Intrusion Switches and Override Key Switches

C. Request clarification where conflicts occur with this section and other sections in Divisions 11, 15, 16 and 17.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid or on the effective date of the Agreement if there were no Bids. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
NEMA 250	Enclosures for Electrical Equipment (1000 volts maximum)
NEMA ICS-1	General Standards For Industrial Controls and Systems
NEMA ICS-2	Industrial Control Devices, Controllers, and Assemblies
NEMA KS 1	Enclosed Switches

1.03 SUBMITTALS

The following submittals shall be provided in accordance with Section 01300 and Section 16176:

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.

   Check marks shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation.

   The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications.

   Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements,

with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

2. Product literature including performance specifications; dimensions; and connections, marked to show products to be provided.

PART 2--PRODUCTS

2.01 CONTROL DEVICES

A. PUSHBUTTONS:

Pushbuttons shall be flush head, heavy-duty, with NEMA rating to match enclosure type. Operators shall be green for start function, red for stop functions, and black for all other functions. The escutcheon legend shall be as specified on the drawings.

1. UL Listed.

2. Dielectric Strength: 1300 Volts for one minute for Logic Reed contacts, 2200 Volts for one minute for other contacts.

3. 30.5mm mounting hole.

4. Temperature operating range –10 degree C. to +55 degree C.

5. Momentary contact type

6. When switching circuits are monitored by programmable controllers or other solid state circuits, furnish hermetically-sealed, logic-reed type contacts rated not less than 0.15 amperes at 150 Vac and 0.06 amperes at 30 Vdc.

7. When switching circuits are not monitored by programmable controllers or other solid state circuits, furnish contacts with NEMA Utilization Category rating A600 rated not less than 10 amperes continuous and 6 amperes break at 120 Vac.

Manufacturer: Allen-Bradley 800T/800H series or equal.

B. SELECTOR SWITCHES:

Selector switches shall be heavy-duty with NEMA rating to match enclosure type. Selector switches shall have maintained position contacts. Switches shall be provided with contact blocks and number of positions as required performing the specified or indicated operations.

The escutcheon legend shall be as specified on the drawings. Provide:

1. UL Listed.

2. Dielectric Strength: 1300 Volts for one minute for Logic Reed contacts, 2200 Volts for one minute for other contacts.

3. 30.5mm mounting hole.

4. Temperature operating range –10 degree C. to +55 degree C.

5. Standard knob operator (not lever type nor wing lever type)

6. Number of positions and contact configuration as shown on Drawings.

7. When switching circuits are monitored by programmable controllers or other solid state circuits, furnish hermetically-sealed, logic-reed type contacts rated not less than 0.15 amperes at 150 Vac and 0.06 amperes at 30 Vdc.

8. When switching circuits are not monitored by programmable controllers or other solid state circuits, furnish contacts with NEMA Utilization Category rating A600 rated not less than 10 amperes continuous and 6 amperes break at 120 Vac.

Manufacturer: Allen-Bradley 800T/800H series or equal.

Field instruments and field analyzers specified in Section 17200 – Instrument Index shall have a lock-out style selector switch for locking on or locking off the 120Vac power source. The selector switch shall use a control station in NEMA-12, 4, 4X, or 7 as required by the area classification. Provide O-Z/Gedney Class 441 with two position key-operated maintained contact switch. Provide surge protection device that matches the enclosure type of the power disconnect type control station, field instrument, or field analyzer: Telematic TP48 transmitter surge protection device or equal.

C. INDICATING LIGHTS:

Red, amber, green, and blue indicating lights shall be heavy-duty full voltage 120Vac or 24Vdc push-to-test LED type with NEMA rating to match enclosure type for installation in a 30.5mm hole. Furnish with 28 chip high visibility LED. The escutcheon and lens color shall be as shown on Drawings or scheduled.

White indicating lights shall be as above, incandescent type lamp.

Manufacturer:

1. Allen-Bradley 800H-QRTH10 series or equal for 120Vac applications with colors other than white.

2. Allen-Bradley 800HQRTH24 series or equal for 24Vdc applications with colors other than white.

3. Allen-Bradley 800H-QRT10 series or equal for 120Vac applications with white.

4. Allen-Bradley 800H-QRT24 series or equal for 24Vdc applications with white.

Indicating Light Lens Color:

Lens Color	Typical Function	Example
Red	Danger, running	Equipment operating, motor running, valve open, power voltage applied, cycle in automatic
Amber	Fault condition, attention	Equipment failure, status abnormal
Green	Ready condition	End of cycle; unit or head returned; motors stopped; motion stopped; contactors open, valve closed
White or Clear	Normal condition	Normal pressure of air, water, lubrication, control power on, status okay
Blue	Advisory	Control mode not in automatic

D. CONTROL STATION ENCLOSURES:

1. Enclosures locations and ratings:

   a. Indoors: NEMA 12

   b. Outdoors and Corrosive areas: NEMA 4X stainless steel.

   c. Hazardous Areas: NEMA-7, corrosion resistant.

E. CONTROL POWER TRANSFORMERS:

1. Sized for the panel devices and products.

2. Dual primary and single secondary fusing.

2.02 CONTROL RELAYS

A. LOAD-SWITCHING CONTROL RELAYS:

Control relays used for switching loads such as solenoids, actuators, contactors, motor starter coils, remote interlocking, etc. shall be heavy-duty machine tool type.

Contacts shall be 4-pole and be field interchangeable to either normally-open or normally-closed. Relay shall be capable of accepting a 4-pole adder.

AC relays shall have NEMA A600 contact ratings and electrical clearances for 600 volts. DC relays shall have NEMA P300 contact ratings and electrical clearances for 250 volts.

Manufacturer: Allen Bradley Bulletin-700, Square D Class 8501, or equal.

B. LOGIC LEVEL SWITCHING CONTROL RELAYS:

Control relays for signal circuits shall have a minimum of three SPDT, gold-flashed, fine silver contacts rated 3-ampere resistive at 120V AC or 28Vdc.

Control relays shall be plug-in type with heavy-duty, barrier-protected screw terminal sockets and clear polycarbonate dust cover with clip fastener.

AC models shall have neon lamp indicator wired in parallel with coil. DC models shall have LED lamp indicator wired in parallel with coil.

Manufacturer: Potter Blumfield series KUP; Schrack Series RA; or equal

C. TIMERS:

1. Multi-function, micro-controller based, socket mounted timing relay.

2. Single functions:

    a. Delay on Make
    b. Delay on Break
    c. Recycle (on time first, equal recycle delays)
    d. Single shot
    e. Interval
    f. Trailing edge single shot
    g. Inverted single shot
    h. Inverted delay on break
    i. Accumulative delay on make
    j. Re-triggerable single shot

3. Dual functions:

   a. Delay on make/delay on break
   b. Delay on make/recycle (on time first, equal recycle delays.)
   c. Delay on make/interval
   d. Delay on make/single shot
   e. Interval/recycle (on time first, equal recycle delays)
   f. Delay on break/recycle (on time first, equal recycle delays)
   g. Single shot/recycle (on time first, equal recycle delays)
   h. Recycle – both times adjustable (on time first)
   i. Recycle – both times adjustable (off time first)
   j. Interval/delay on make
   k. Accumulative delay on make/interval

4. Time delay range, switch selectable:

   a. Single function 0.1 second to 1,705 hours in 8 ranges.
   b. Dual function 0.1 second to 3,100 minutes in 8 ranges.
   c. Setting accuracy +/- 1 percent or 50 milliseconds, whichever is greater.
   d. Repeat accuracy +/- 0.1 percent or 16 milliseconds, whichever is greater.

5. Output:

   a. Two Form-C electromechanical isolated contacts rated 10-amperes resistive at 240Vac
   b. Rated 1/3-horsepower at 120 or 240Vac
   c. Double-pole double-throw: DPDT.
   d. Mechanical life: 10,000,000 operations
   e. Electrical life: 1,000,000 operations at full load.

6. Mounting: Magnal Plug 11-pin socket

7. Environment: -20 to +65 degree C.

8. Manufacture:

   a. ABB / SSAC's multifunction type TRDU time delay relay with dip-switch function setting with 12Vdc, 24Vac, 120Vac, 240Vac inputs as required or indicated or equal.

2.03 NOT USED

2.04 NOT USED

2.05 NOT USED

2.06 ELAPSED TIME INDICATORS

Elapsed time indicators shall be panel mounted, non-resettable, 5.5-digit, hour indicator, rated 120Vac, 60-Hertz.

2.07 CURRENT TRANSFORMERS AND TRANSDUCERS

Provide monitoring current transformers with 600Vac insulation and primary ampere rating as indicated with 5-ampere output.

Provide AC current transducer for any one of the phase conductors of the power circuit to be installed through onboard toroid. Provide a loop-powered transducer with input rated from 0 to 50-ampere with 4-20madc analog output scaled for the primary current of the current transformer. Provide zero and span adjustments.

Manufacturer: ABB AC current transducer TCSA Series Loop Powered and mounting accessories, or equal.

Provide a DIN rail or back plate mounted AC current transducer that is a loop-powered transducer with input rated from 0 to 5-ampere and with 4-20madc analog output scaled for the primary current of the current transformer.

Manufacturer: ABB AC current transducer DCSA Series Loop Powered and mounting accessories, or equal.

2.08 TERMINAL STRIPS, BLOCKS, AND DEVICES

A. Power Wiring: Provide back plate mounted terminal strips rated at 600 Vac.

B. Control Wiring: Provide a DIN rail with spring powered contact rated at 300 Vac 24 ampere with pluggable terminals.

C. Terminal identification standard to the product provided.

D. Manufacturer:

1. Standard: Allen Bradley or equal.

2. Standard: DIN rail: Phoenix Contact or Weidmuller Z-Series.

2.09 INTRUSION DEVICES

The intrusion switch shall be wide-gap industrial grade magnetic door switch with maximum gap 2.5 inches between the sensing elements. The magnet element shall be mounted on the moving part of the door. The sensor switch shall close when the door is closed. The sensor

switch shall open when the door is opened. Provide with appropriate mounting bracket for the entrance doors.

Manufacturer: George Risk Industries - Series 4400 (800-445-5218), http://www.grisk.com/security_products.htm or equal.

Exterior gate and door intrusion switches to be Allen-Bradley or equal, NEMA 4X.

Hatch intrusion switches to be Allen-Bradley or equal, NEMA 7.

2.10 NOT USED

2.11 NOT USED

2.12 NAMEPLATES

Nameplates for all control stations, relays, timers, motor contactors and disconnect switches shall be provided in accordance with the requirements of Sections 16000 and 16176.

2.13 PRODUCT DATA

Operation and maintenance data as specified in Section 01730 including approved submittal manufacturer's catalog data, as-built drawings, and instructions for all configurable or programmable components.

PART 3--EXECUTION

Control stations, contactors and safety disconnect switches shall be mounted 48 inches above the floor, ground, or slab to center of device.

Miscellaneous electrical devices shall be tested in accordance with Section 16000 and Section 16030.

END OF SECTION

SECTION 16231

OUTDOOR STANDBY
DIESEL-ENGINE GENERATOR

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This Section specifies the requirements for providing, factory testing, and on-site acceptance testing of complete and operable standby diesel engine driven generating system (GenSet) with an outdoor metal enclosure, ballistic resistant secondary contained belly tank fuel storage container, and the devices and equipment required for the system operation.

The generation system shall include the following:

1. Digital control, monitoring, and display system
2. Cooling system
3. Belly tank
4. Exhaust silencer: mounted inside the enclosure
5. Noise dampening mounting system
6. Sound attenuated level 2 outdoor enclosure accessories
7. Accessories: including batteries, battery charger, and coolant heater
8. Control system testing
9. Testing with load bank

B. OPERATING REQUIREMENTS:

The electric power generating system shall have ratings as indicated with 0.80 power factor, 480 volts, WYE connected generator, three-phase, four-wire, 60-Hertz, 1800 rpm and rated for Standby operation per NEC Article-701.

C. GENERATOR SET SCHEDULE:

Tag No.	Description / Location	Enclosure
W_55SLS-GEN-1781	Standby Generator/ Next to MCC	Outdoor

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI C57.13	Requirements for Instrument Transformers
IEC 34-5	Rotating Electrical Machines - Part 5: Degrees of Protection by Enclosures for Rotating Machinery
IEC 60529	Guidelines for Panel Testing
ISO	International Organization for Standardization
MG1	Motors and Generators
NEMA MG1	National Electrical Manufacturers Association Standards Publication MG-1
NEMA SG31	Low Voltage Power Circuit Breakers
NEMA SG51	Power Switchgear Assemblies
NFPA 37	National Fire Protection Association Standard 37, Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines
NFPA 70	National Electrical Code (NEC)
NFPA 110	Emergency and Standby Power Systems
OSHA	Occupational Safety and Health Act
SAE J 1349	Society of Automotive Engineers Engine Power Test Code
UL	Underwriters Laboratories Inc.

Reference	Title
UL 142	Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids

B. UNIT RESPONSIBILITY:

The Contractor shall assign unit responsibility, as specified in Section 11000, to the manufacturer of the GenSet provided under this section. This manufacturer is the unit responsibility manufacturer and has unit responsibility, as specified in Section 11000, for the GenSet equipment assembly specified in this section. A completed, signed, and notarized Certificate of Unit Responsibility (Form 11000-C, Section 01999) shall be provided.

C. DESIGN REQUIREMENTS:

1. ENGINE:

a. RATING: Engine brake horsepower shall be sufficient to deliver full rated GenSet kW/kVA when operated at rated rpm and equipped with all engine-mounted parasitic and external loads such as radiator fans, fuel pumps, and cooling water pumps.

b. FUEL: Diesel engines shall be able to deliver rated power when operating on low-sulfur No. 2 diesel fuel having 35 degree API (16°C, 60°F) specific gravity.

c. FUEL CONSUMPTION: Diesel fuel rates shall be based on fuel having a low heating value (LHV) of 42,780 kJ/kg (18,390 Btu/lb) when used at 29°C (85°F) and weighing 838.9 g/l (7.001 lb. / U.S. gal).

2. GENERATOR:

a. MOTOR STARTING: Constant speed controllers as indicated.

b. GENERATOR PERFORMANCE: Voltage dip for motor starting shall not exceed 25% for any individual load step.

3. GENSET START TIME AND LOAD ACCEPTANCE: Engines shall start, achieve rated voltage and frequency, and be capable of accepting load within 10 seconds.

D. NOISE REQUIREMENTS AND CONTROL:

GenSet enclosure sound pressure level when GenSet is fully loaded shall be not greater than Level 2: 72 dBA at 7 meters (23 feet) from enclosure.

E. MANUFACTURER'S QUALIFICATIONS AND WARRANTY:

The complete power generation system shall be the product of one manufacturer who has been regularly engaged in the production of complete generating systems for at least twenty-five years.

The supplier shall be the engine-generating system manufacturer's authorized local representative that shall provide installation assistance, start-up services, and Owner's staff training. The supplier shall have 24-hour service availability with factory-trained technicians qualified to perform trouble-shooting, repairs on the system, and warranty compliance services.

The GenSet supplier shall provide the following warranty that includes battery warranty:

Two year parts and labor with travel time included.

F. MANUFACTURER FACTORY TESTING:

1. FUNCTIONAL TESTS: Functional testing of the complete power generation system final assembly shall be performed at the GenSet manufacturer's factory to assure proper system operation.

GenSet shall be load tested after the assembly is installed into the enclosure and operate continuously without stoppage for a period of 8 hours.

GenSet shall operate for one hour at ½, ¾, and full load, at 0.8 power factor or greater. Restart the test, if stopped for any reason.

2. PROTOTYPE TEST: The GenSet manufacturer shall certify that engine, generator, and controls have been tested as complete systems in accordance with NFPA 110 of representative engineering models (not on equipment sold).

G. SHIPMENT, HANDLING, AND STORAGE:

The equipment shall be protected during shipment, handling, and storage per Section 01605.

1.03 ENVIRONMENTAL CONDITIONS

A. GENERAL:

The GenSet manufacturer shall verify that the diesel engine is correctly sized and is capable of driving the generator with all accessories in place and operating, at the generator's kW rating after derating for the range of temperatures expected in service and the project site altitude.

B. SEISMIC:

Equipment and supports shall be braced per Section 01900.

C. SITE CONDITIONS:

The site conditions are as specified in Section 01800.

1.04 SUBMITTALS

The following submittals shall be provided in accordance with the requirements of Section 01300.

A. SHOP DRAWINGS:

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. A check mark shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. *Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration*

2. Completed Certificate of Unit Responsibility attesting that the Contractor has assigned, and that the manufacturer accepts, unit responsibility in accordance with the requirements of this Section and paragraph 11000-1.02 C. *No other submittal material will be reviewed until the certificate has been received and found to be in conformance with these requirements*

3. A copy of the contract document electrical drawings E4, E10, E11, and E101, with addendum updates included, marked to show deviations. If no changes are required, the drawing or drawings shall be marked "no changes required". *Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.*

4. A copy of the contract document process and instrumentation diagram P200 with addendum updates included, marked to show deviations. If no changes are required, the drawing or drawings shall be marked "no changes required". *Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.*

5. Manufacturer and manufacturer's type designation.

6. Manufacturer's catalog and/or other data confirming conformance to specific design, material and equipment requirements including:

a. ENGINE:

1) Type, aspiration, compression ratio, and combustion cycle
2) Bore, stroke, displacement, and number of cylinders
3) Rotational speed, RPM
4) Engine lubricating oil capacity
5) Engine coolant capacity without radiator
6) Engine coolant capacity with radiator
7) Coolant pump external resistance (maximum)
8) Coolant pump flow at maximum external resistance
9) Exhaust back-pressure (maximum allowable pressure)
10) Combustion air inlet flow rate
11) Exhaust gas, flow rate, stack temperature
12) Exhaust system back pressure (maximum)
13) Heat rejection to:
    a. coolant
    b. aftercooler
    c. lube oil
    d. exhaust
    e. atmosphere
14) Fuel Consumption:
    a. 50% load
    b. 75% load
    c. 100% load
15) Fuel supply system including belly tank

b. GENERATOR:

1) Model
2) Frame
3) Voltage
4) kW
5) Power Factor
6) Frequency
7) Insulation class
8) Number of leads
9) Weight, total
10) Weight, rotor

c. EFFICIENCY AT RATED VOLTAGE:

1) Efficiency at 0.8 power factor for 50% load.
2) Efficiency at 0.8 power factor for 75% load.
3) Efficiency at 0.8 power factor for 100% load.

c. RADIATOR:

1) Model
2) Type
3) Heat Rejection: BTU/Hour
4) Fan drive ratio
5) Coolant capacity, radiator
6) Coolant capacity, radiator and engine

e. GENSET WITH ENCLOSURE DIMENSIONS:

1) Dimensions: Length, width, height
2) Weight: dry and wet
3) Vibration isolators

f. POWER RATING: Nominal full capacity standby kW at 0.8 power factor and corresponding kVA rating

7. not used.

8. Drawings:

a. General dimensions drawings showing overall GenSet measurements, mounting location, and interconnection points for load leads, fuel, exhaust, cooling and drain lines.

b. General dimension drawings for fuel supply and storage system including interconnection points, fuel and drain lines, and level and leak detection equipment, terminal-boxes and panels.

9. Wiring diagrams, schematics and control panel outline drawings published by the manufacturer in Joint Industrial Council (JIC) format for controls and switchgear showing interconnected points and logic diagrams for use by contractor and owner.

B. STRUCTURAL BRACING AND ANCHORAGE:

Provide submittal separately from and after review of the Shop Drawings submittal. Provide the following per the requirements of Section 01900 and paragraph 16231-2.02 H.

1. A copy of this specification section and a copy of specification section 01900 and Drawings S1 and S2, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. A check mark shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation.

   The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. *Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration*

2. Manufacturer's written certification confirming that the equipment bracing complies with the specified requirements.

3. Manufacturer's scaled drawings for the equipment showing internal assembly bracing.

4. Weight for each complete equipment assembly.

5. Manufacturer's recommended anchorage requirements in accordance with the specified requirements, if available from the Manufacturer.

C. FINAL STRUCTURAL BRACING CERTIFICATION:

Provide the final reviewed complete Structural Bracing submittal including review comments for review by the Owner's Authority Having Jurisdiction.

PART 2--PRODUCTS

2.01 MANUFACTURERS

The Owner and Construction Manager believe the following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed that named manufacturers' standard equipment or products will comply with the requirements of this Section. Candidate manufacturers include Cummins Onan, or equal.

2.02 ENGINE EQUIPMENT

A. GENERAL:

The engine shall be a single stationary, liquid cooled, 1800 rpm, four-cycle design, direct injection engine with forged steel crankshaft and connecting rods. Systems with dual engine-generators in one enclosure will not be permitted.

The engine cylinder block shall be cast iron with replaceable wet liners with four valves per cylinder. Provide 6, 12, or 16 cylinders engine with turbocharger and after-cool, as required by the GenSet manufacturer.

The GenSet engine shall not be manufactured with any Class I ozone depleting substances (ODS) as defined by Federal Register Vol. 57 No. 86. The GenSet shall be pre-certified EPA Tier-1 emission requirements.

B. STRUCTURAL STEEL FRAME:

The generator, radiator, and engine shall be securely mounted on a heavy welded steel frame structure frame that is stiffened and cross-braced to provide a rigid mounting base.

C. ENGINE EQUIPMENT:

The engine shall be equipped with manufacturers standard air filters, fuel filters, pressure gauges, lubricating oil cooler, filters, and pressure gauge, water pump and temperature gauge, service hour meter, flywheel, and flywheel housing when applicable.

D. ENGINE FUEL SYSTEM:

1. FUEL/WATER SEPARATOR: A fuel/water separator shall be provided to protect the fuel system from water damage.

2. FUEL LINES: Flexible fuel lines between engine and fuel supply shall be provided to isolate vibration.

3. FUEL SYSTEM MAINTENANCE: The fuel transfer pump, injection pumps, rack and pinion assembly, and timing mechanism shall be maintenance and adjustment free for the life of the equipment. The fuel filter shall not require changing more frequently than once per year or every 250 hours. Provide a fuel filter with spill containment and catch pan for about three gallons of fuel.

E. GOVERNOR:

1. GENERAL: The engine governor shall control engine speed and transient load response. The governor shall be selected, installed, and tested by the GenSet manufacturer.

2. SPEED CONTROL: The engine governor shall be an electronic speed-control actuator. Speed droop shall be 0 (isochronous) from no load to full rated load.

3. FREQUENCY REGULATION: The steady state frequency regulation shall be within 0.25%. Speed shall be sensed by a magnetic pickup off the engine flywheel ring gear.

4. REMOTE SPEED CONTROL: A provision for remote speed adjustment shall be provided.

5. ACTUATOR: The forward acting actuator shall move to the minimum fuel position in the event of a DC power loss.

F. COOLING SYSTEM:

1. GENERAL: The engine jacket water cooling system shall be a closed circuit design with provision for filling, expansion, and de-aeration.

The cooling pump shall be driven by the engine. Auxiliary coolant pumps required for heat exchangers or separate circuit after-cooling shall be engine driven.

The cooling system shall tolerate at least 172 kPa (25 psi) static head. Coolant temperature shall be internally regulated to disconnect external cooling systems until operating temperature is achieved.

2. ENGINE MOUNTED RADIATOR: Heat rejected to the engine jacket water shall be discharged to the atmosphere through a close-coupled radiator.

3. COOLANT: The unit shall have an antifreeze / coolant mixture. The radiator shall cool the jacket water while the engine is operating at full site capability and 0.062 kPa (0.25 inch water column) external air restrictions.

Additional restriction affecting airflow shall not limit the radiator's capability to adequately cool at maximum site temperature. Provide air flow to meet ambient conditions at specified ratings at 100% rated connected load.

4. FAN AND BELT GUARDING: The fan, fan drive, and fan belts shall be covered with 14 gauge punched steel mesh guarding for personnel protection. The guarding shall conform to IEC 34-5, ISO and OSHA standards.

5. RADIATOR FAN: The radiator-cooling fan shall be a propeller type driven from the engine with the air drawn from the engine side and exhausted through the radiator core.

6. INLET AIR SYSTEM: The engine air cleaner shall be engine mounted with maintenance access. The maximum restriction to the combustion air inlet shall not exceed engine manufacturer requirements where external ducting provided.

G. EXHAUST SYSTEM:

1. GENERAL: The engine exhaust system shall discharge combustion gases safely and without leakage with minimum restriction. The critical sound silencer shall be designed for minimum restriction without excessive back-pressure.

Engine exhaust piping shall be Schedule 40 carbon steel type 321 or 316 with long radius 90 degree bends. Piping shall be installed with 9 inch minimum clearance from combustible material or incorporate appropriate insulation and shielding, as appropriate for personnel safety. Provide a stainless steel flexible connection between the engine and exhaust piping.

Exhaust piping shall be supported and anchored to prevent weight or thermal growth being transferred to the engine. Flexible expansion fittings provided to accommodate thermal growth. Support dampers and spring isolators provided to isolate vibration.

Long runs of exhaust piping shall be pitched away from the engine and water traps installed at the lowest point. Provide a 1-inch diameter capped sample port for emissions testing. Provide ports 90-degrees apart on a straight section of exhaust piping.

Exhaust stacks shall be extended to avoid fumes and odors inside enclosure and installed to minimize noise.

2. SILENCER-CRITICAL: The silencer shall be residential quality.

H. STRUCTURAL BRACING:

Generator assembly shall be braced by the Manufacturer per the seismic requirements of Section 01900. Submit bracing information.

2.03 THERMAL INSULATION WRAP

A. GENERAL:

Provide thermal insulation wrap or other acceptable method for insulating the hot surfaces on generator engines for personnel and structure safety.

B. SURFACES:

Hot surfaces within the enclosure to protect personnel and structure as recommended by the manufacturer.

C. EXECUTION:

Provide thermal insulation blanket or metal guard that is easily removed without damaging the blanket during maintenance or repair of the engine.

Stainless steel removable lacing shall be provided. The use of "hot rings" for binding edges or securing blankets is unacceptable.

2.04 GENERATOR SYSTEM

A. GENERATOR:

The generator shall be synchronous, four pole, revolving field, pre-lubricated bearing, air cooled by a direct drive centrifugal blower fan, and directly coupled to the engine with flexible drive discs.

The armature shall have skewed laminations of insulated electrical grade steel, two-thirds pitch windings. The rotor shall have amortissuer damper windings of layer-wound, mechanically-wedged winding construction. The rotor shall be dynamically balanced.

Insulation system components shall meet NEMA MG1 temperature limits for a Class H insulation system. Actual temperature rise measured by resistance method shall not exceed 125 degrees Centigrade to provide additional allowance for internal hot spots.

The generator insulation systems shall be suitably impregnated for operation in severe environments for resistance to sand and other air-born contaminants.

B. EXCITER:

A permanent magnet generator (PMG) shall provide excitation power to the automatic voltage regulator for immunity from voltage distortion caused by non-linear loads on the generator.

The PMG shall sustain field excitation power for optimum motor starting and shall sustain short circuit current for selective operation and coordination of system overcurrent devices.

The PMG exciter insulation systems shall be suitably impregnated for operation in severe environments for resistance to sand and other air-born contaminants.

C. VOLTAGE REGULATOR:

The automatic voltage regulator shall be temperature compensated, digitally controlled pulse width modulated solid-state design, and include over-voltage and over-current protection functions.

Over-voltage protection shall sense generator output voltage, In the event of regulator failure or loss of reference, the regulator shall shut down its output on a sustained over-voltage of one-second duration.

Over-excitation protection shall sense regulator output and shut down its output if overload exceeds ten seconds duration. Both over-voltage and over-excitation protection shall be latched, requiring the generator to be stopped for reset.

Generator output voltage shall be maintained within 1% of rated value for any load variation between no load and full load and drift no more than within 0.5% of rated value at constant temperature.

D. CIRCUIT BREAKER:

The generator mounted circuit breaker shall be mounted and connected in a guarded drip proof freestanding enclosure meeting, IEC 144 requirements and provided with adequate space for customer power cable lug connections. Cable lugs by supplier, refer to the electrical drawings for circuit conductor sizes and numbers.

Provide the following:

1. Molded case circuit breaker rated for 100% current, 3-pole, single-throw, stationary-mounted with manual operating handle, overload and short circuit trips, complete with cable lugs.

2. Circuit breaker shall be UL labeled and rated for 600-volt circuits and provided with a solid state over-current trip device.

3. Not used.

4. Three current transformers with 5-ampere secondary windings for the ammeter display, as needed.

5. National Electrical Code required working access space around the Circuit Breaker enclosure.

2.05 ENGINE-GENERATOR SYSTEMS

A. ENGINE STARTING SYSTEM:

The engine starting system shall include 24 Vdc starting motor(s), starter relay, and automatic reset circuit breaker to protect against butt engagement.

Required cables furnished and sized for power feeder circuit requirements and capable of starting the specified engine within 10 seconds at the elevation and ambient environmental conditions specified herein.

B. WATER JACKET HEATER:

Jacket water heater(s) shall be provided to maintain coolant temperature of 32°C (90°F) while the engine not running. Heaters shall accept 240 Vac single phase power and include thermostatic controls.

C. BATTERIES:

Batteries for GenSet starting and control shall be selected and supplied by the GenSet manufacturer. Battery warranty shall be the responsibility of the GenSet manufacturer. Batteries shall be protected from engine fuel leaks.

Batteries shall be maintenance free SLI lead acid type with through-partition connectors and mounted near the starting motor. Batteries shall be mounted on a corrosion resistant or coated steel battery rack close to the starting motor as practical and allow personnel access for inspection and maintenance.

Starting batteries shall be rated 24 Vdc that includes the sizing requirements to allow for engine oil viscosity, ambient starting temperature, project elevation, and accessories.

D. ALTERNATOR:

An engine-mounted belt-driven battery charging alternator shall be installed with an automatic voltage regulator. Alternator and regulator suitable for the application with a rating of 24 Vdc output.

E. BATTERY CHARGER:

A dual rate 10-ampere battery charger shall be provided that shall accept 120 Vac single phase input to provide 24 Vdc output.

The battery charger shall be fused on the AC input and DC output, and incorporate current limiting circuitry to avoid the need for a crank disconnect relay. The charger shall be rated for operation at plus 50°C ambient. Charger voltage regulator shall be temperature compensated.

A voltage power switch shall be mounted on the face of the charger and shielded from accidental switching. The charger shall include an AC ammeter and voltmeter, a failure malfunction alarm switch, and be housed in an enclosure suitable for mounting inside the outdoor enclosure.

2.06 FUEL STORAGE SYSTEM

Provide 24 hour rated belly fuel tank, fuel level indication, and diesel fuel flowmeter indicating flow rate and flow total. Tank shall have UL142 secondary containment with leak detector.

Provide low fuel alarm to generator controller.

2.07 OUTDOOR ENCLOSURE

A. GENERAL:

The acoustical enclosure shall house the engine generator and the auxiliary equipment required for the electric power generating system. The enclosure shall be a weather-protected sound attenuated enclosure complete with fire extinguisher and the following modification and features:

B. SOUND ATTENUATION ENCLOSURE:

The acoustical enclosure shall be constructed of 14-gauge minimum galvanized steel modular panel construction with 4-inch acoustic insulation and perforated liner. The enclosure shall be designed for a minimum wind load of 100-mph, roof load of 50-pounds per square foot, and floor load of 200-pounds per square foot if equipped with a floor.

Galvanized perimeter frame structure bracing shall allow the enclosure to be removed as a unit without disassembly. Provide crane lifting eyes where required to move enclosure. Provide peaked roof for rain run-off.

Provide fixed vane weather-proof acoustic intake louvers with hinged access and sized per the engine's cooling and combustion airflow requirements.

Provide NEC required 3-1/2 foot clear workspace in front of the generator circuit breaker and generator control panel.

C. DOORS:

Enclosure shall contain four personnel outside entrance double-gasketed doors for entering the engine/generator compartment. Doors shall be fabricated from 14-gauge galvaneal with heavy duty continuous stainless steel piano hinge with stainless steel fasteners and pins.

Outside door latch mechanism shall be flush mounted and lockable. No hardware shall protrude beyond the perimeter of the enclosure to facilitate normal handling and shipping aboard container ships or by highway semi-tractor trailer.

D. SURFACE PREPARATION AND PAINTING:

Surface preparation and painting for the enclosure by the container manufacture shall be as follows:

1. Steel sheeting shall be galvanized steel.

2. Steel components shall be force dried and painted with a two-part epoxy primer and high gloss finish polyurethane topcoat.

3. Caulk open seams with a sealant to prevent rust seepage after painting.

E. EXTERIOR COLOR:

The enclosure exterior shall be manufacturer standard finish, suitable for field applied coating.

F. NOT USED

G. NOT USED

H. NOT USED

I. ELECTRICAL CONNECTIONS:

The generator main circuit breaker shall be housed in a NEMA-12 gasketed metal enclosure installed within the enclosure. Provide a NEMA-12 gasketed terminal box for control and instrumentation wiring, separated from power connections, and show terminal box location in the submittal documentation.

J. VENTILATION:

Hinge the fixed vane intake louvers for access and size per the engine's cooling and combustion airflow requirements. Separate the intake louver from the exhaust louver.

Orient each louver to minimize superheating of the intake air. Use air directional acoustic barrier plates to mitigate sound escaping from the enclosure while not impeding airflow necessary for combustion and cooling. Install water separator to catch and drain of standing water on the louvers.

A sound insulated baffle shall be installed six inches below the opening of the fan and shall extend twelve inches beyond the fan opening.

K. SOUND ATTENUATION:

The enclosure shall be sound attenuated with composite sandwich construction of perforated metal enclosure either non-flammable mineral fiber or fiberglass. The interior wall surface shall be 20-gauge perforated aluminum metal construction.

2.08 CONTROLS

A. ENGINE-GENERATOR CONTROL PANEL:

The control panel shall be designed and built by the engine-generator manufacturer and mounted near the generator with vibration dampening mounting devices.

Provide a 100 percent solid state microprocessor based control circuitry, sealed dust tight, watertight modular components, and digital instrumentation. Provide IEC-IP52 or NEMA 12 enclosure ratings. Comply with IEC 60529 or NEMA standards for enclosure protection. Label the control panel with ISO symbols.

Display critical parameters such as operating hours, engine RPM, battery DC volts, oil pressure, jacket water temperature, including the specified engine and electrical parameters.

B. ENGINE MONITORING DEVICES:

Engine monitoring signals provided by engine mounted lubricating oil pressure and coolant temperature transducers shall communicated over a serial data link through a Data Sending Unit (DSU) to the control panel receiving module. The safety logic shall shut the engine down if the serial data link is lost.

C. CONTROL FUNCTIONS:

Provide control panel front mounted devices such as generator voltage control device, ammeter/voltmeter phase selector switch, control selector switches, and pushbuttons. Provide control and monitor devices identified and labeled with ISO symbols.

Provide start-stop logic for cycle cranking and cool down operation and red-mushroom head emergency-stop maintained pushbutton.

D. CONTROL WIRING:

GenSet control wiring: Number 16 AWG stranded wire and control panel ground wire Number 12 AWG with green and yellow striped insulation rated. Conductors shall be rated 90°C 600 Vac insulation with UL or CSA listing.

Provide wire identification on the conductor 6-inches from the terminal and protect wire from sharp bends and metal edges.

Provide four sets of Form-C dry contacts rated at 2 amps for remote customer alarming:

1. Run status
2. Trouble (pre-alarm) Alarm
3. Shutdown Alarm
4. Low Fuel Alarm

E. ALARM AND SHUTDOWN CONDITIONS:

Indicate the following alarm and shutdown conditions and provide a RESET device to clear fault:

1. Low oil pressure: pre-alarm
2. High engine temperature: pre-alarm
3. Low engine temperature: pre-alarm
4. Low fuel: pre-alarm
5. Low battery DC voltage: pre-alarm
6. Generator output circuit breaker (trip or off): alarm
7. Generator overload: alarm
8. Low oil pressure: shutdown

9. High engine temperature: shutdown
10. Low coolant level: shutdown
11. Over-crank: shutdown
12. Over-speed: shutdown
13. Over-voltage: shutdown
14. Under-voltage: shutdown
15. Under-frequency: shutdown
16. High battery voltage alarm
17. Low battery voltage alarm
18. Normal battery voltage indication
19. Battery charger malfunction alarm
20. Spare (2): alarm and shutdown

F. METERING:

Provide digital metering with 0.5% accuracy.

Provide true RMS indication that includes the total harmonic voltage and current content:

1. Voltmeter
2. Ammeter
3. Frequency meter
4. Phase select switch
5. Running time

G. ALARM MODULE:

Provide integral digital alarm annunciator for indication and audible alarm per NFPA 110 on the engine-generator control panel. Provide lamp test switches, alarm horn silence-button, and first-out alarm detection.

2.09 PRODUCT DATA

The following information shall be provided:

1. Certified factory test results.

2. Operation and maintenance information as specified in 01730. In addition the following:

   a. Operating instructions with description and illustration of engine and generator controls and monitors.

   b. Manuals that illustrate and list assemblies, subassemblies and components, except the standard fastening hardware.

c. Preventative maintenance instructions for daily, weekly, monthly, biannual, and annual maintenance requirements. Include a lubrication chart for all components.

d. Routine test procedures for electronic and electrical circuits including the generator.

e. Troubleshooting chart covering the complete GenSet with a description of trouble, probable cause, and suggested remedy.

f. Recommended spare parts list showing consumables anticipated during routine maintenance and test.

g. Wiring diagrams and schematics showing function of electrical components.

h. Complete final submittals including Record As-Built drawings.

i. Manuals and books described above shall be contained in rigid plastic pouches.

j. Warranty verification statements published by manufacturer.

k. Location and description of supplier's parts and service facility including parts inventory and number of qualified GenSet service personnel.

l. Installation requirements showing clearances required for maintenance purposes: Access to main breaker, oil fill line, fuel fill line, etc.

3. Training certification Form 11000-B specified in paragraph 16231-3.03.

4. Field test reports as specified.

PART 3--EXECUTION

3.01 INSTALLATION

A. GENERAL:

The GenSet shall be installed and connected in accordance with manufacturer's recommendations and the installation shall be certified on Form 11000-A as specified in Section 01999.

Verify the equipment pad is sized for the GenSet size per submittal information, level, with ground pad installed.

B. SIGNS:

Provide NEMA MG1-22.61 GenSet nameplate. Provide laminated equipment, device, and panel nameplates per specification Section 16000.

C. CONDUIT TRANSITIONS AT SLAB:

Connection from underground conduits to GenSet equipment shall transition via PVC coated flexible steel conduits. Loose or open cabling will not be permitted.

D. NOT USED

E. EXTERIOR COLOR:

The enclosure exterior shall be manufacturer standard finish, suitable for Contractor applied coatings per Section 09900.

3.02 FIELD INSPECTION AND TESTING

A. PRE-DELIVERY INSPECTION:

Provide a pre-delivery inspection performed by the system manufacturers' local dealer at the dealer's facility to insure no damage occurred in transit. Verify GenSet components, controls, and electrical equipment is included as specified herein. Verify the NEC work access to electrical power equipment and control equipment is provided as specified.

B. PRE-DELIVERY SUPPLIER FACILITY TESTING:

Prior to delivery of the GenSet to the project site, test the GenSet to verify it is free of defects, starts automatically, and carry full load. Test shall be performed at the facility of the system manufacturer's authorized supplier.

The testing shall be done on dry type, resistive load banks capable of precise incremental loading. Salt water brine tanks or load banks requiring water as a source of cooling will not be allowed.

Provide separate test grade instrumentation to monitor the GenSet using the load bank. The GenSet monitoring instruments shall be read and compared to the amperage and voltage on each phase. Both readings shall be recorded and compared in the test report.

C. PRE-DELIVERY TESTING PROCEDURE:

Provide a pre-delivery test and operation that includes setup, test, and operation performed by factory trained technicians with test equipment, facilities, and consumables provided by the supplier.

Construction Manager shall be scheduled to witness all tests. The test shall be performed on the complete fabricated GenSet within sound attenuated enclosure.

1. Check electrical, exhaust, fuel and water connections for proper size, continuity and tightness of fittings.

2. Check fluids for appropriate levels and jacket water heater operation.

3. Correct defects during the test at no additional cost to the Owner prior to shipment to the job site.

4. Connect a 100 percent rated resistance load bank equivalent to the nameplate rating at unity power factor.

5. The GenSet shall be run for proper engine break-in, then 100 percent for 1 hour, or similar manufacturer recommended test operation sequence.

6. Not used.

7. Maintain test records at intervals to record water temperature, fuel pressure, oil pressure, ambient air temperature, voltage, amperage, frequency, kilowatts and power factor.

8. Test safety devices using methods recommended by the manufacturer.

9. Test results shall be documented and submitted for approval.

10. Setup the control system to allow engine to cool before shutdown.

D. ON SITE POST-INSTALLATION TESTING:

Following installation, the following tests shall be performed by the system manufacturer's qualified representative in the presence of the Owner's representative.

Pre-start Checks:

1. Oil level

2. Water level

3. Fuel level

4. Battery connection and charge condition

5. Engine to control interconnects

6. GenSet intake/exhaust obstructions

7. Removal of all packing materials

E. FIELD TESTS:

The GenSet field test shall be performed by factory trained technicians at the project site with test equipment, facilities, and consumables including fuel and lubricants provided by the supplier. Provide a full tank of diesel fuel when the testing is completed and the GenSet is available for operation.

Owner's representatives shall witness the field tests. Contractor shall provide to the Construction Manager written notice of the date field testing will commence a minimum of two weeks prior to that date.

The following field tests shall be conducted:

1. Check electrical exhaust, fuel and water connections for proper size, continuity and tightness of fittings.

2. Check fluids for appropriate levels and jacket water heater operation.

3. Start-up engine and make initial start-up check of operational equipment.

4. Upon completion of initial start-up and system checkout, schedule the witnessed field test to demonstrate load carrying capability, stability, voltage and frequency.

5. Operate the GenSet for 1-hour for proper engine break-in and record water temperature, fuel pressure, oil pressure, ambient air temperature, voltage, amperage, frequency, kilowatts, and power factor.

6. Operate a minimum of 4-hours under full load with consumables necessary for testing furnished by the manufacturer.

7. Return to normal power source and test the ATS transfer from normal power to standby power and the ATS monitoring functions by simulating the loss of normal power source.

8. Test the ATS initiated "GenSet Start" condition with the load bank.

9. Run the generator for test duration; monitor the oil and water temperatures and record readings every fifteen minutes.

10. Test the GenSet safety devices using methods recommended by the manufacturer.

11. Setup the unloaded run at the conclusion of the test and the retransfer to normal power to allow engine to cool before engine shutdown.

12. Notify the Owner's representative of problems and the mitigation plan.

13. Submit the formal Test Results Report for approval.

3.03 TRAINING

The Contractor shall contract with the GenSet manufacturer to provide 4-hours of training. Arrange and schedule the training with the Owner.

Training shall include the requirements of Section 01664 and the following:

1. Diesel Engine theory
2. AC Generator theory
3. Operational information for the specific equipment provided.
4. Operation of the equipment in automatic and manual modes.
5. Troubleshooting.
6. Routine maintenance.

Training shall be certified on Form 11000-B as specified in Section 01999.

END OF SECTION

SECTION 16431

ARC FLASH ANALYSIS, SHORT CIRCUIT STUDY, AND PROTECTIVE DEVICE COORDINATION REPORT

PART 1--GENERAL

1.01 DESCRIPTION

A. GENERAL:

This section specifies that the Contractor subcontract an independent full member NETA Engineering and Study Firm / Testing Firm to prepare:

1. Electrical equipment short circuit study (SCS).

2. Protective device coordination study (PDCS) report.

3. Arc flash analysis (AFA) and labeling for.

The Testing Firm shall be as described in Section 16030 and shall also be responsible for the electrical testing described therein.

B. SCOPE:

The Short Circuit and Protective Device Coordination Report shall include analysis including Utility Company equipment that affect the installed equipment's short circuit ratings, protective device ratings and protective device settings.

Report shall also include analysis of the equipment's short circuit ratings, protective device ratings and protective device settings affected by the installed equipment.

Report shall include the results of the arc flash hazard analysis study for energized electrical equipment in accordance with the methods outlined in IEEE Standard 1584 and stated hereinafter.

Work shall include the fabrication of signs with the arc flash hazard study results and the installation of the signs on the equipment in accordance with NFPA 70E Table 3-3.9.3 that includes the personnel protective equipment (PPE) risk category, the energy available, and the clothing recommendation.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
IEEE 141	Recommended Practice for Electric Power Distribution for Industrial Plants
IEEE 242	Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
NETA ATS	Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems, 1999

B. SCHEDULE:

The report shall be completed, submitted to the Construction Manager for acceptance and reworked to include the Construction Manager comments and corrections, as required. The report shall be approved by the Construction Manager prior to purchase and fabrication of electrical equipment including switchgear.

A copy of the Construction Manager accepted report shall be sent by the Contractor to all affected manufacturers prior to fabrication.

1.03 SUBMITTALS

The report specified in this Section shall be provided in accordance with Section 01300.

PART 2--PRODUCTS

2.01 REPORT

The product shall be a certified report summarizing the short circuit and coordination study and conclusions or recommendations which may affect the integrity of the electric power distribution system. As a minimum, the report shall include the following:

1. The equipment manufacturer's information used to prepare the study.

2. Power Utility Company system information applicable to the project.

3. Short circuit calculations listing short circuit levels at each bus. Provide a sketch of the bus and use both the project term and the bus-code-name to identify the bus, branches, sources, loads. Base the system on the Project One-Line diagram.

4. Coordination study time-current curves including the instrument transformer ratios, model numbers of the protective relays, and the relay settings associated with each breaker.

5. Comparison of short circuit duties of each bus to the interrupting capacity of the equipment protecting that bus.

6. Data used as input to the report that includes cable impedances, source impedances, equipment ratings for the equipment being purchased for the project, etc.

7. Assumptions made during the study.

PART 3--EXECUTION

3.01 GENERAL

Provide a short circuit and coordination study on the electrical power distribution system as specified and as described in Section 6.1 of NETA ATS. The studies shall be performed in accordance with IEEE Standards 141 and 242 and shall utilize the ANSI method of short circuit analysis in accordance with ANSI C37.010.

The studies shall be performed using actual equipment data for both existing and new equipment. The coordination study shall use the data from the same manufacturer of protective relay devices as being provided by the switchgear manufacturer.

For new equipment, the Contractor shall provide copies of final reviewed equipment submittals upon request by the Study Firm.

3.02 QUALIFICATIONS

The short circuit and coordination report shall be performed by the Testing Firm as described in Section 16030. The studies shall be signed by the professional electrical engineer responsible for the studies and registered to practice engineering in the state in which the project is located.

3.03 SHORT CIRCUIT STUDY

The Contractor shall be responsible to obtain and verify all data needed to perform the study. As a minimum, the short circuit study shall include the following:

A. ONE-LINE DIAGRAM

1. Location and function of each protective device in the system, such as relays, direct-acting trips, fuses, etc.

2. Type designation, current rating, range or adjustment, manufacturer's style and catalog number for all protective devices.

3. Power, voltage ratings, impedance, primary and secondary connections of all transformers.

4. Type, manufacturer, and ratio of all instrument transformers energizing each relay.

5. Nameplate ratings of all motors and generators with their subtransient reactances. Transient reactances of synchronous motors and generators and synchronous reactances of all generators.

6. Sources of short circuit currents such as utility ties, generators, synchronous motors, and induction motors.

7. Significant circuit elements such as transformers, cables, breakers, fuses, reactors, etc.

8. Emergency as well as normal switching conditions, as applicable.

9. The time-current setting of existing adjustable relays and direct-acting trips, as applicable.

B. IMPEDANCE DIAGRAM

1. Available MVA, voltage, and impedance from the power utility company.

2. Local generated capacity impedance.

3. Bus impedance.

4. Transformer and/or reactor impedances.

5. Cable impedances.

6. Equipment impedances.

7. System voltages.

8. Grounding scheme for the project: resistance grounding, solid grounding, or no grounding.

C. CALCULATIONS

1. Determine the paths and situations where short circuit currents are the greatest.

2. Study shall address bolted faults and calculate the 3-phase and line-to-ground short circuits of each case.

3. Calculate the maximum fault currents.

3.04 ARC FLASH ANALYSIS

The Contractor shall be responsible to obtain and verify all data needed to perform the study. The arc flash analysis study shall include the following IEEE Standard 1584 nine step analysis process:

1. Collect system and installation data.

2. Determine modes of operation.

3. Determine bolted fault current.

4. Determine arc fault current.

5. Determine protective device characteristic and arc fault duration.

6. Document system voltages and equipment class.

7. Select working distances.

8. Calculate incident energy.

9. Calculate the arc flash protection boundary.

3.05 PROTECTIVE DEVICE COORDINATION STUDY

As a minimum, the coordination study for the power distribution system shall include the following on 5-cycle, log-log graph paper:

1. Time-current for each protective relay or fuse showing graphically that the settings will provide protection and selectivity within industry standards. Each curve shall be identified, and the tap and time dial settings shall be specified.

2. Time-current curves for each device shall be positioned to provide for maximum selectivity to minimize system disturbances during fault clearing. Where selectivity cannot be achieved, the Construction Manager shall be notified as to the cause.

3. Time-current curves and points for cable and equipment damage.

4. Circuit interrupting device operating and interrupting times.

5. Indicate maximum fault values on the graph.

6. Sketch of bus and breaker arrangement.

3.06 IMPLEMENTING PDCS SETTINGS AND ARC FLASH SIGN INSTALLATION

The Testing Firm shall implement the protective device coordination study settings on new and existing equipment as required in Section 16030, based on the Engineers accepted Protective Device Coordination Report specified herein and submit a final amended report of the Record As-Built electrical equipment protective device settings subsequent to start-up and testing.

The Testing Firm shall work with the Contractor and the Study Firm for implementing the Arc Flash Hazard sign installation requirements for electrical equipment as specified in NEC Article 110.16 Flash Protection and NFPA 70E.

END OF SECTION

SECTION 16450

GROUNDING SYSTEM

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies the system for grounding electrical distribution and utilization equipment, including but not limited to cabinets, motor frames, manholes, instrumentation, metal surfaces of process/mechanical equipment that contain energized electrical components, metal structures and buildings, outdoor metal enclosures, fences and gates.

The Equipment Grounding Conductor shall ground or bond equipment, structures, or equipment frames to the Grounding Electrode System as defined in the National Electrical Code Article 250 and addressed herein.

The minimum size of the Equipment Grounding Conductors installed with the circuit conductors shall be per the National Electrical Code Table 250.122. The circuit grounding conductor size routed with a feeder or branch circuit conductors is as shown on the drawings.

1.02 REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
IEEE 81	Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
IEEE Std 81.2-1991	Guide to Measurement of Impedance and Safety Characteristics of Large, Extended or Interconnected Grounding Systems

Reference	Title
NETA - ATS	InterNational Electrical Testing Association Inc. - Acceptance Testing Specifications
NFPA 70	National Electric Code (NEC) Article 250

1.03 SUBMITTALS:

The following information shall be submitted for review in accordance with Section 01300:

A. PRODUCT LITERATURE:

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. A check mark shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. *Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.*

2. Marked product literature for ground rods, test wells, and equipment ground plate.

PART 2-- PRODUCTS

2.01 GROUND CONDUCTORS

The System Ground Conductor shall be soft-drawn, bare annealed copper, concentric stranded, as specified. The minimum sizes shall be as follows, where American Wire Gage (AWG) conductor sizes are not shown or specified:

480V switchboards	2/0 or 4/0 AWG
Large motors 250 hp & >	2/0 or 4/0 AWG
Lighting & Power panels	2 AWG

Exposed metal cabinets	2 AWG
Electrical equipment	2 AWG
Buildings and enclosure	2 AWG
Fences and gates	2 AWG
Motors 25 hp to 250 hp	2 AWG
Motors 1 hp to 25 hp	6 AWG

2.02 GROUND RODS

Ground rods shall be copper covered steel, 3/4-inch diameter and 10-feet long. Rods shall have threaded type removable caps so that extension rods of same diameter and length may be added where necessary.

2.03 COMPRESSION CONNECTORS

Compression connections shall be irreversible, cast copper as manufactured by Thomas and Betts, or equal.

2.04 BOLTED CONNECTORS

Bolted connectors shall be Burndy, O. Z. Gedney, or equal.

2.05 WELDED CONNECTORS

Exothermic welding products shall be Erico's Cadweld Plus system with a remotely operated battery powered electronic ignition device and moisture resistant weld metal cup for the required mold, or equal.

2.06 TEST WELLS

Provide concrete test well with cover and connect the ground grid extension using a removable connector.

2.07 EQUIPMENT GROUND BARS

Copper equipment ground bars shall be Erico Eritech EGB Series or equal, sized as required for the installation.

2.08 EQUIPMENT GROUND PLATE

Equipment ground plate shall be two-hole copper flush mounted grounding plate, Erico Cadweld, Burndy YGF Series, or equal.

2.09 PRODUCT DATA

Ground resistance readings specified in paragraph 16450-3.05 shall be provided in accordance with Section 01300.

PART 3--EXECUTION

3.01 GENERAL

Grounding system shall be provided in compliance with the NFPA 70 National Electrical Code (NEC). Grounding conductor shall not be used as a system neutral.

Embedded and buried ground connections shall be made by compression connectors utilizing diamond or hexagon dies and a hand compression tool for wire sizes 2 AWG and smaller and a hydraulic pump and compression head for wire sizes 2/0 AWG and larger. Alternate method allowed: exothermic welding using a remote igniter device.

Tools and dies shall be approved for this purpose; dimple compressions are not acceptable. Compression connections shall be prepared in accordance with the manufacturer's instructions. Compression-type lugs shall be used in accordance with manufacturer's recommendations. Exposed ground connections to equipment shall be made by bolted clamps unless otherwise specified. No solder material shall be used in any part of the ground circuits.

Embedded ground conductors and fittings shall be securely attached to concrete reinforcing steel with tie wires and prevented from displacement during concrete placement.

Notify the Construction Manager two hours prior to backfilling, as each part of the grounding system installed below finished grade is complete and ready for inspection. Non-compliance shall effect the payment schedule for this work.

Grounding conductors extended beyond concrete surfaces for equipment connection shall be extended a sufficient length to reach the final connection point without splicing. Provide grounding fittings, pads, or plates as shown in the electrical details. Minimum grounding conductor extension shall be 3-feet.

Grounding conductors which project from a concrete surface shall be located as close as possible to a corner of the equipment pad, protected by rigid conduit bonded to the grounding conductors, or terminated in a flush grounding plate.

Exposed grounding conductors shall be supported by noncorrosive metallic hardware at 4-foot intervals or less. Grounding conductors for shown and future equipment shall be terminated using a equipment grounding plate.

Ground conductors entering electrical enclosures shall be bonded to a single ground bus or terminal strip in the enclosure and to metallic raceways within or terminating at the enclosure.

Direct ground connections to enclosure chassis or back plate are not acceptable. Prior to making ground connections or bonds, the metal surface at the point of connection shall be cleaned.

Lightning arresters shall be directly connected to the ground grid system using lightning industry braided copper conductors, sized as specified.

Metallic sheaths or shields of shielded power cable shall be terminated by a copper ground bus provided with cable connection for connection to the grounding system.

3.02 RACEWAY GROUND

All service, feeder and branch circuit raceways shall contain a green insulated ground conductor sized per applicable NFPA 70 National Electrical Code (NEC) tables:

1. T250.66 - Grounding Electrode Conductor for Alternating-Current Systems or

2. T250.122 - Minimum Size Equipment Grounding Conductors for Grounding Raceways and Equipment.

Metallic conduits terminating at concentric knock-outs or reducing washers shall be bonded using insulated grounding bushings. Grounding bushings shall be connected to the grounding system using conductors sized in compliance with NEC.

Cable trays shall have 2/0 or 4/0 bare copper ground conductor run on the outside of each tray or tray group of tiered cable tray. Conductor shall be connected to each section or fitting using an approved ground-clamp and supported at 5 foot intervals.

3.03 EQUIPMENT AND ENCLOSURE BONDING

Electrical distribution and utilization equipment enclosure ground bus, motor frames, manholes, metal structures and buildings, outdoor metal enclosures, fences and gates shall be bonded to the grounding system with conductor sizes as specified.

Connect the conductor to the metal enclosure using a UL listed connector, where the enclosure does not contain an internal ground bus

Non-electrical equipment with metallic enclosures, that are located outdoor and without a cover or a shade, shall be connected to the grounding system.

3.04 ISOLATED GROUNDING

An isolated ground system shall be installed where required by an equipment manufacturer. The isolated ground conductor shall have green insulation with a yellow stripe and shall be run in the same raceway as the power and neutral conductors. The isolated ground bus shall be kept isolated from neutral and grounding buses.

Where specifically directed by the Engineer and required by an equipment manufacturer, the Contractor shall provide an additional isolated ground conductor from the service or separately derived system to an isolated ground bus bar at each associated distribution point.

3.05 SERVICE AND SEPARATELY DERIVED SYSTEM BONDING

A neutral bonding jumper shall be installed in only one location for each service or separately derived system. The bonding jumper shall be located at the service source or the first immediate distribution point downstream from the source. The neutral and ground buses shall be kept isolated from each other accept where the bonding jumper is installed.

3.06 GROUNDING SYSTEM TESTS

The Contractor shall test the facility grounding system and the building grounding system to determine the ground resistance. The grounding test shall be IEEE Standard 81 using the NETA Fall-of-Potential procedure. A plot of ground resistance readings for each isolated ground rod, ground mat, or ground bus shall be submitted on 8-1/2 x 11 inch size graph paper. Point-to-point resistance measurements are not acceptable.

The current reference rod shall be driven at least 100 feet from the ground rod or grid under test or as recommended by IEEE Standard 81. The measurements shall be made at 10-foot intervals beginning 25 feet from the test electrode and ending 75 feet from it, in direct line between the ground rod or center of grid and the current reference electrode.

A grounding system that shows greater than 2 ohm resistance for the flat portion of the plotted data shall be considered inadequately grounded.

The Contractor shall add additional parallel connected ground rods and/or deeper driven rods until the ground resistance measurements meet the 2 ohm requirement. Additional ground rods will be paid for as extra work where the required numbers exceed that specified when authorized and approved by the Construction Manager.

Use of salts, water, or compounds to attain the specified ground resistance is not acceptable.

END OF SECTION

SECTION 16500

LUMINAIRES

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies luminaries (lighting fixtures) features and installation.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
NFPA 70	National Electrical Code (NEC)

B WARRANTY

1. NOT USED

2. FLUORESCENT BALLASTS WARRANTY:

Manufacturer's standard form in which ballast manufacturer agrees to repair or replace ballasts that fail in materials or workmanship within specified warranty period for Electronic or Electromagnetic Ballasts: Two years from date of Substantial Completion.

3. T5 AND T8 FLUORESCENT LAMPS WARRANTY:

Manufacturer's standard form, made out to Owner, and signed by lamp manufacturer agreeing to replace lamps that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period: Two years from date of Substantial Completion.

1.03 SUBMITTALS

The following information shall be submitted in accordance with Section 01300:

A. SHOP DRAWINGS:

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.

   A check mark shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation.

   The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. *Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.*

2. A copy of the contract document electrical drawings E10, E11, and E101, with addendum updates included, marked to show deviations. If no changes are required, the drawing or drawings shall be marked "no changes required". *Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.*

3. Catalog information describing fixture make, materials, and dimensions.

4. Manufacturers' warranties as specified in paragraph 1.02.

PART 2--PRODUCTS

2.01 LIGHTING MATERIALS

Lighting materials, including luminaries, lamps, accessories, and hardware, shall conform to the detailed requirements specified on the drawings.

2.02 INTERIOR LUMINAIRES AND COMPONENTS

A. NOT USED

B. Incandescent, Fluorescent and HID Fixtures: Comply with UL 1598.

C. Sheet Metal Components: Steel, unless otherwise indicated. Formed and supported to prevent warping and sagging.

D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

E. Diffusers, Covers, and Globes:

1. Acrylic Lighting Diffusers and Other Products: Provide 100 percent virgin acrylic plastic with high resistance to yellowing and physical changes due to aging, exposure to heat and UV radiation.

   a. Lens Thickness: At least 0.125 inch minimum.
   b. UV stabilized.

2. Glass Lighting Diffusers and Other Products: Provide annealed crystal glass, unless otherwise indicated.

2.03 EXTERIOR LUMINAIRES

Complying with UL 1598 and listed for installation in wet locations.

A. SHEET METAL COMPONENTS:

Corrosion-resistant aluminum, unless otherwise indicated. Formed and supported to prevent warping and sagging.

B. HOUSINGS:

Housings shall not warp, sag, or deform in use and shall be rigidly formed, weather- and light-tight enclosures. Provide filter/breather for enclosed luminaries.

C. DOORS, FRAMES, AND INTERNAL ACCESS:

Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Removable doors for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

D. EXPOSED HARDWARE MATERIAL: Stainless steel.

E. PLASTIC PARTS:

High resistance to yellowing and physical changes due to aging, exposure to heat, and UV radiation.

F. LENSES AND REFRACTORS GASKETS:

Provide heat-resistant and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminary doors.

2.04 FLUORESCENT ELECTRONIC BALLASTS

Ballasts for F32T8 lamps shall be:

1. High frequency solid state electronic.
2. Instant start, parallel operation.
3. Minimum starting temperature: 50 F.
4. Minimum 0.87 ballast factor.
5. Maximum total harmonic distortion (THD): 10%.
6. Power factor: 95% minimum.
7. Sound rated: A.
8. Ballast case temperature not to exceed 90 degrees Centigrade during normal operation in 30 degrees Centigrade ambient temperature.
9. Certified Ballast Manufacturers' Certification.

Built-in self-resetting thermal actuated device shall remove ballast from line when excessive ballast temperature is reached. UL Class P, CBM certified 100% output.

The conductors between ballasts and lamp holders shall have 1,000 volts insulation includes conductors to and from remote ballasts.

Provide ballasts with voltage characteristics to match that of the circuitry shown on the Drawings. No extra compensation will be allowed for failure to properly coordinate ballast voltage with circuitry.

Lamp current crest factor less than 1.7 and ballast factor over 0.85 for T-8 lamps.

Ballasts shall comply with ANSI C62.41 – "Guide for Surge Voltages in Low-Voltage AC Power Circuits, Category A" for resistance to normal and common mode transient voltage surges. Comply with FCC Regulations Part 18 Class A for electromagnet interference.

Manufacturers: Advance, MagneTek, Motorola, or equal.

2.05 NOT USED

2.06 NOT USED

2.07 NOT USED

2.08 NOT USED

2.09 LAMPS

A. GENERAL:

Lamps shall be as specified on the applicable LIGHTSPECS or Fixtures Schedule.

B. MANUFACTURERS:

Lamps shall be General Electric, North American Philips (Norelco), Sylvania, Venture Lighting International, or equal.

C. FLUORESCENT LAMPS:

1. T8 RAPID-START LAMPS:

CRI of 75 minimum, color temperature of 3500 K, and average rated life of 20,000 hours, unless otherwise indicated.

2. COMPACT FLUORESCENT LAMPS:

CRI 80 minimum, color temperature 3500 K, average rated life of 10,000 hours at 3 hours operation per start, unless otherwise indicated.

D. NOT USED

E. INCANDESCENT LAMPS:

Rated 130Vac, standard A or PS shape, and frosted inside.

2.10 NOT USED

2.11 SITE JUNCTION BOXES

Junction boxes for the distribution of outdoor lighting circuits shall be precast concrete and set flush with the ground. Nominal size shall be approximately 10.5 x 17.25 x 12 inches deep. Lid shall be cast iron with cast inscription: "LIGHTING".

Boxes manufacture: Brooks Products, Christy Concrete Products, Forni Corporation, Utility Vault Company or equal. Example: Brooks catalog No. 3-1/2PB.

2.12 FIXTURE FINISHES

Manufacturer standard unless scheduled or shown.

1. Paint Finish: Applied over corrosion-resistant treatment or primer, free of defects.

2. Metallic Finish: Corrosion resistant.

2.13 NOT USED

2.14 PRODUCT DATA

The following information shall be provided in accordance with Section 01300:

1. Operation and maintenance items as specified in Section 01730 including final reviewed submittal.

PART 3--EXECUTION

3.01 GENERAL

The location and type of luminaries, associated poles, fixtures, and receptacles are as shown on the drawings.

Labels and marks, except the UL label, shall be removed from exposed parts of the fixtures. Fixtures shall be cleaned when the project is ready for acceptance. Photoelectric cells shall be oriented toward the north.

Raceways, wire, or cable shall be provided in accordance with Division 16. Raceways and wire shall be provided from the fixtures, switches and receptacles to the lighting panel in accordance with the NEC. Underground and outdoor wire splices shall be in accordance with Section 16120.

Fixtures labeled to require conductors with a temperature rating exceeding 75 degrees C shall be spliced to circuit conductors in a separately mounted junction box. Fixture wire shall meet UL and NEC requirements. Fixture shall be connected to junction box using flexible conduit with a temperature rating equal to that of the fixture.

Recessesed fixtures shall be provided with mounting hardware for the ceiling system specified. A concealed latch and hinge mechanism shall be provided to permit access to the lamps and ballasts and for removal and replacement of the diffuser without removing the fixture from ceiling panels. Fixtures recessed in concrete shall have protective coating of bituminous paint.

Fixtures shall be aligned and directed to illuminate an area as specified. Fixtures shall be directly and rigidly mounted on their supporting structures. The conduit system shall not be used to support fixtures.

Fixture supports that are welded to steel members shall be treated with rust-resistant primer and finish paint where brackets or supports for lighting fixtures.

Provide manufacturer recommended mounting hardware and brackets.

3.02 WIRE CONNECTIONS

Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values or use torque values specified in UL 486A and UL 486B.

3.03 FIELD QUALITY CONTROL

Inspect each installed fixture for damage then replace damaged fixtures and components. Verify normal operation of each fixture after installation.

Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. Retest to demonstrate compliance with specification requirements where adjustments are made. Replace fixtures with damage or corrosion during warranty period.

END OF SECTION

SECTION 16920

600 VOLT MOTOR CONTROL CENTERS

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies freestanding, low-profile, factory assembled 600 (480) volt EUSERC Motor Control Center (MCC) /Service Entrance Section (SES) for Salt River Project (SRP) Power Utility metering. MCC shall include a relay/control section for the Remote Terminal Unit (RTU) specified in Section 17110. MCC specified herein shall be furnished by a single manufacturer except for the RTU.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI/NEMA ICS 1	Industrial Control Systems: General Requirements
ANSI/NEMA ICS 18	Motor Control Centers
ANSI C57.13	Requirements for Instrument Transformers
EUSERC	Electric Utility Service Equipment Requirements Committee
NEMA ICS 10	AC Automatic Transfer Switches
NFPA 79	Electrical Standards for Industrial Machinery
NFPA 110	Emergency and Standby Power Systems
UL 67	Electric Panelboards
UL 489	Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
UL 845	Motor Control Centers
UL 1008	Standard for Automatic Transfer Switches
UL 1066	Low Voltage AC and DC Breakers used in Enclosures
UL 1449	Surge Protective Devices

B. LISTING

Motor Control Centers and all components except RTU shall be Underwriters Laboratory listed to UL 845 and shall conform to NEMA ICS 1 and ICS 18 standards.

The ATS shall be Underwriters Laboratory listed in accordance with UL 1008 and for use as legally required standby system use.

C. FACTORY TEST:

The ATS shall be factory tested to ensure proper operation.

1.03 SUBMITTALS

The following information shall be provided in accordance with Section 01300:

A. SHOP DRAWINGS:

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. A check mark shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested

by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. *Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration*

2. A copy of each of the following Specification Sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance. *Failure to include a copy of the marked-up specification section with the submittal shall be cause for rejection of the entire submittal with no further review*

   a. Section 01800.

3. A copy of the contract document Electrical Drawings E10; E11; and E12, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked *"no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.*

4. A copy of the contract document Process and Instrumentation Diagram Drawings P100 and P200, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked *"no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.*

5. Electrical single line, schematic diagrams, and conductor connection diagram.

6. List of starters and feeder tap compartments indicating the size and type of circuit protection.

7. Layout drawings indicating arrangement, dimensions, conduit entries, and weights.

8. Interrupting, withstand, and continuous current rating of:

   a. Bus bars
   b. Feeder tap units
   c. Starter units
   d. Main incoming units

9. Manufacturer's product and catalog data indicating equipment specifications and features including interrupting, withstand, and continuous current ratings of all overcurrent protection components. Catalog data shall be edited or "arrowhead" to indicate only the models and options to be provided as part of this specification.

10. Nameplate schedule.

11. List of spare parts to be provided.

B. POWER UTILITY:

1. The SES submittal information shall also be submitted to Power Utility Metering Department for their approval. Refer also to paragraph 2.16 Product Data.

C. STRUCTURAL BRACING AND ANCHORAGE:

Provide submittal separately from and after review of the Shop Drawings submittal.

1. A copy of specification section Spec. 01900, with addendum updates, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the specifications shall be marked *"no changes required". Failure to include copies of the relevant specifications with the submittal shall be cause for rejection of the entire submittal with no further review.*

2. Manufacturer's written certification confirming that the equipment bracing complies with the specified requirements.

3. Manufacturer's scaled drawings for the equipment showing internal assembly bracing.

4. Weight for each complete equipment assembly.

5. Manufacturer's recommended anchorage requirements in accordance with the specified requirements.

1.04 SITE CONDITIONS

The equipment shall be designed and manufactured to meet the specified requirements of Section 01800 for environmental conditions.

PART 2--PRODUCTS

2.01 MANUFACTURERS

The Owner and Construction Manager believe the following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed that named manufacturers' standard equipment or products will comply with the requirements of this Section. Candidate manufacturers include:

1. Eaton Cutler-Hammer
2. General Electric Co.
3. Square D

2.02 SERVICE

Motor control centers shall be rated as specified, suitable for operation at the specified voltages and short circuit capacities.

2.03 STRUCTURE AND CONSTRUCTION

A. STRUCTURE:

Motor control centers shall be made of No. 14 gage steel minimum and, unless otherwise shown, each section shall be maximum 78 inches high by 24 inches wide by 24 inches deep except as otherwise specified. The individual unit compartments shall be a minimum of 6 inches high. A separate SES section will not be permitted, SES must be provided as part of the MCC.

Each section shall have up to 72 inches for stacking starter units into the sections. Size NEMA 1 through 3 FVR starter units shall be provided with an additional 6 inches of vertical space.

The compartments shall have pan-type doors with a minimum of two quarter-turn hold-down latches; and neoprene gaskets.

A full height vertical wireway, 4 inch wide minimum, but not less than 30 square inches in cross section, shall be provided for each vertical motor control center section. The wireway

shall contain full height removable doors. Horizontal wireways shall be provided top and bottom, extending the length of motor control centers.

Bottom channel sills shall be mounted front and rear of the vertical sections extending the full length of the motor control center lineup. A removable lifting angle shall be mounted on top and shall extend the width of the motor control center lineup.

Equipment and materials shall be new and free from defects.

B. CONSTRUCTION:

Motor control centers located outdoors shall be NEMA 1 gasketed in a NEMA-3R weatherproof non-walk-in enclosure.

Starter units, size 4 and smaller, and feeder tap units less than 225 amperes shall be drawout plug-in construction with hardened, tin-plated copper free-floating stabs, steel spring backups. The door shall have interference tabs which prevent door closure if unit is improperly installed.

Units shall be latched in the position to assure proper bus contact. The unit disconnect device shall be interlocked to prevent removal or reinsertion of a unit when the disconnect is in the "ON" or "TRIPPED" positions.

Circuit breaker disconnect operators shall be capable of accommodating three padlocks for locking in the "OPEN" position.

Hardware for mounting future starter and feeder tap units shall be provided at compartments specified as "SPACE".

C. STRUCTURAL BRACING:

MCCs shall be braced by the Manufacturer per the seismic requirements for Seismic Design Category B.

D. FINISH AND COLOR:

The enclosure exterior shall be manufacturer standard gray finish, suitable for Contractor applied coatings per Section 09900.

2.04 BUS

A. GENERAL:

Bus shall be tin-plated copper with bolted connections between vertical and horizontal bus bars. Access for tightening these connections shall be from the front, without the need for

tools on the rear of the connection. Insulated horizontal and vertical bus barriers shall be provided. Barriers shall be fabricated from high-strength, glass-filled polyester resin.

The bus shall be braced to withstand a fault current as specified, RMS, symmetrical.

B. HORIZONTAL BUS:

The main horizontal bus shall be rated a minimum 600 amperes continuous. Horizontal bus is not required in the relay/control section.

C. VERTICAL BUS:

The vertical bus shall be insulated and rated a minimum 300 amperes continuous. Vertical bus is not required in the relay/control section.

D. NEUTRAL BUS:

The neutral bus shall be provided only in the service entrance section and have the same rating as the main horizontal bus, where specified.

E. GROUND BUS:

A 1/4-inch by 2-inch ground bus shall be provided the full length of the motor control center. Ground bus shall be located at the bottom of the motor control center. Provide a lug to terminate a bare 4/0 AWG copper ground conductors at each end of the ground bus.

2.05 WIRING

A. GENERAL:

Motor control centers shall be provided with NEMA ICS 18 Class II, Type B wiring. All starter units shall have terminal blocks for control wiring. Terminal blocks shall be provided for power wiring for starters size 2 and smaller.

Motor control centers shall be provided with all necessary interconnecting wiring and interlocking.

Provide elementary and connection diagrams for each starter unit and an interconnection diagram for the entire motor control center.

B. POWER WIRE:

Power wire shall be copper 90 degrees C insulated, sized to suit load; minimum power wire size shall be No. 12 AWG copper stranded.

C. CONTROL WIRE:

Control wire shall be No. 16 AWG stranded copper wire, rated 90 degrees C machine tool wiring (MTW) and UL listed for panel wiring.

D. TERMINATIONS AND CABLE CONNECTIONS:

1. TERMINALS: Control wiring shall be lugged with ring-tongue or locking spade crimp type terminals made from electrolytic copper, tin-plated.

2. CABLE CONNECTORS: Cable connectors for use with stranded copper wire, sizes No. 8 AWG to 1000 kCmil shall be UL listed. Dished conical washers shall be used for each bolted connection. Connectors shall be reusable and shall be rated for use with copper conductors. Incoming line and outgoing feeder compartments shall be provided with crimp type lugs, 3M Company, Burndy Company, or equal.

E. CONDUCTOR MARKERS:

Markers used for identification shall meet the requirements of Section 16000.

2.06 MAIN AND FEEDER CIRCUIT PROTECTION

A. GENERAL:

Main and feeder tap units shall consist of circuit breakers, with a minimum interrupting current of 42,000 amperes symmetrical RMS. Series ratings for overcurrent devices to meet specified short circuit withstand ratings is prohibited.

B. CIRCUIT BREAKER (SOLID STATE):

Circuit breaker with adjustable solid-state trip with sizes as specified. The circuit breaker settings shall be confirmed with a protective device coordination study per Section 16431.

1. GENERAL: Circuit breakers shall be stored energy type mechanism to provide quick-make, quick-break, trip-free operation:

a. Insulated case UL listed 100 percent continuous current capacity.

b. Ground fault protection shall be provided as specified.

Circuit breakers shall provide manual switching operation by means of a low-torque handle or pushbutton on the front of the unit. Automatic operation during overload and short circuit conditions shall be provided by solid state or thermal magnetic tripping devices located in the circuit breaker frame as specified on the drawings.

Circuit breakers shall be front accessible, stationary, individually mounted, and shall have short circuit capabilities equal to or greater than the system in which they are installed.

2. STATIC TRIPPING DEVICES: Solid state static tripping devices shall consist of current sensors, logic assembly, magnetic latch release, and required interconnecting wiring. Tripping devices shall be automatic and self-contained within the breaker frame and shall not require any external relaying or power supplies.

Tripping functions shall be field adjustable and contain the following tripping characteristics:

a. Overload tripping:

1) Adjustable ampere setting
2) Adjustable long-time delay

b. Short circuit tripping:

1) Adjustable short-time pickup
2) Adjustable short-time delay
3) Adjustable instantaneous pickup

c. Ground fault tripping:

1) Adjustable ground fault pickup
2) Adjustable ground fault delay

C. CIRCUIT BREAKERS (THERMAL MAGNETIC):

Thermal-magnetic circuit breakers shall be molded case equipped with toggle type handle, quick-make, quick-break over center switching mechanism that is trip-free so that breaker cannot be held closed against short circuits and abnormal currents. The tripped position shall be clearly indicated by breaker handle maintaining a position between "ON" and "OFF." All poles shall open, close, and trip simultaneously.

2.07 MOTOR STARTER UNITS

A. GENERAL:

Motor starter units shall be combination type with contactor, motor circuit protector, and solid-state overload unit as indicated on the drawings or specified in the MCC schedule.

B. MOTOR CIRCUIT PROTECTORS:

The molded case motor circuit protector (MCP) shall operate on the magnetic principle with a current sensing coil in each of the three poles to provide an instantaneous trip for short circuit protection. The trip setting shall be adjustable from 700 to 1300 percent of the motor full

load amperes from the front of the MCP. The motor circuit protector shall be set at its lowest position at the factory.

C. CONTROL TRANSFORMERS:

Each control transformer shall be rated 480/240-120V, single phase, 2-wires, 60 Hertz. The transformer shall be sized for the load it feeds but shall not be less than the minimum ratings as follows:

NEMA starter size	Minimum transformer volt-ampere rating
1	100
2	150
3	200
4	300

Each control transformer shall be provided with time-delay, slow-blow secondary fuse rated to interrupt 10,000 amperes short circuit at 250 volts AC. Two primary fuses rated to interrupt 200,000 amperes at 600 volts shall be provided on all starters.

Fuse holders for shall be fuse clips with full barriers between fuses.

D. CONTACTORS:

Unless otherwise specified or shown, contactors shall be full voltage, 3-pole, 600 volt AC, NEMA Size-1 minimum. Contacts shall be double break, silver-cadmium oxide, and weld resistant. Contacts shall be isolated to prevent arcing. Coils and magnets shall be capable of being removed or replaced without special tools. IEC contactors are prohibited.

E. AUXILIARY CONTACTS:

Contactors shall be equipped with auxiliary contacts, rated 10 amperes at 120 volts AC. Refer to drawings for actual quantities required.

F. OVERLOAD RELAY:

The solid-state overload relay shall protect the power wiring and motor from excessive overcurrents. The relay shall be ambient compensated and have adjustment from 90 to 110 percent of the normal rating.

The sensing element shall be adjustable Class 20 tripping time of 20-seconds at 600-percent of current setting. The faster overload trip Class 10 (10-seconds at 600-percent of current setting) and the longer overload trip Class 30 (30-seconds at 600-percent of current setting) shall be field set by the installer during the driven equipment startup with the overload settings that are required by the type of motor driven load.

G. CONTROL DEVICES:

Control devices such as pushbuttons, selector switches, indicating lights and overload reset pushbuttons shall be mounted on the unit compartment door.

The control devices shall comply with the requirements of Section 16175.

H. ELAPSED TIME INDICATOR:

Where shown or specified, the elapsed time indicator shall be as specified in Section 16175. The indicator shall be mounted on the unit compartment door.

I. TERMINAL BLOCKS:

Terminal blocks shall be screw type rated 600 volts; 20 amperes for control wiring and 30 amperes power wiring with starters Size 3 and larger shall terminate the power leads directly to the contactor.

The number of terminal blocks shall be specified on the drawings. Terminal blocks shall be provided with integral marking strips and shall be permanently marked with the conductor number as specified on the drawings. Internal wiring shall be connected on one side of the terminal block; outgoing conductors shall be connected to the other side.

2.08 SURGE PROTECTION

A. GENERAL:

All components and assemblies shall be factory installed inside the MCC at the assembly point by the original equipment manufacturer.

B. LIGHTNING ARRESTOR AND SURGE CAPACITOR:

Provide a lightning arrestor and surge capacitor for the incoming line:

1. Silicon Oxide Varistor (SOV)

2. Energy Rating: 3000 joules per pole.

3. Time Rating: 5 nanoseconds.

4. Resistors: Prohibited.

5. Manufacture and Models:

   a. Delta LA-603 for 3-phase, 3-wire or equal.

b. Delta LA-603 for 3-phase, 4-wire or equal.

C. SURGE PROTECTOR:

Provide metal oxide varistor (MOV) surge protective device (SPD), tested per NEMA LS-1, rated IEEE C3 Combined Wave of 20kV and 10kA and listed / labeled per UL 1449. Minimum surge rating: 400kA per phase. Device to include status LED indicators and trouble monitoring Form C relay output. Provide circuit breaker sized per SPD manufacturer recommendations.

Manufacturer: Eaton Cutler-Hammer PSPD, or equal.

2.09 DRY-TYPE TRANSFORMERS

Dry-type energy efficient power transformer provided within the MCC. The size and voltage shall be as specified.

2.10 PANELBOARDS

Panelboard shall be flush mounted in motor control center and shall have the quantity and size of branch circuit breakers specified. Bus shall be tin-plated copper and shall have current ratings as specified on the panelboard schedules, sized in accordance with UL 67.

A. SURGE PROTECTOR:

Provide metal oxide varistor (MOV) surge protective device (SPD) for the panelboard, tested per NEMA LS-1, rated IEEE C3 Combined Wave of 20kV and 10kA and listed / labeled per UL 1449. Minimum surge rating: 160kA per phase. Device to include status LED indicators and trouble monitoring Form C relay output. Provide circuit breaker in panelboard sized per SPD manufacturer recommendations.

Manufacturer: Eaton Cutler-Hammer PSPD, or equal.

2.11 POWER MONITORING

A. POWER MONITOR:

Power Monitors shall be hold minimum and maximum values, provide accuracy of 0.5% or better, and display and provide the following via 4-20 milliamp signals:

1. Phase-Phase Voltage

2. Average Current

3. Power Factor

Monitor shall include a power supply to operate from 480 Vac.

Provide power monitor configuration software.

B. INSTRUMENT TRANSFORMERS:

Instrument transformers shall be molded dry-type in accordance with ANSI C57.13. Transformer volt-ampere rating shall be suitable for carrying the specified load without overheating or exceeding the permissible accuracy for the transformer.

1. Current transformers shall be furnished with the specified ratios. The accuracies shall 1% or better.

2. Transformers shall be provided with the MCC.

3. Provide shorting blocks in the MCC.

2.12 MISCELLANEOUS

A. NAMEPLATES:

Nameplates shall be provided in accordance with the requirements of Section 16000, white with black letters. Nameplates shall be provided for all cubicles and compartments and identify the load per NEC. A Nameplate shall be provided identifying the motor control center. Provide equipment tag numbers and complete descriptions as shown.

B. SPACE HEATERS AND THERMOSTATS:

Motor control centers located outdoors shall be provided with space heaters and thermostats to maintain the interior temperature at more than 45 degrees F. Space heaters and thermostats shall be rated 120 volts AC. Space heater shall be powered from the MCC panelboard.

2.13 RELAY/CONTROL SECTION

A separate vertical section shall be provided for the RTU as specified. The RTU shall be as specified in Section 17110.

The control section shall be completely barriered and contain an equipment mounting panel made of 12-gage steel which is supported off the back of the enclosure by mounting studs. The usable depth shall be minimum 17 inches. Usable width shall be 36 inches, or as specified.

2.14 AUTOMATIC TRANSFER SWITCH

The ATS shall use electrically-operated, mechanically-held, power rated, electrical contactors to provide double throw switching action with number of poles as shown or specified.

Refer to the standby engine-generator interface and interlock requirements in Section 16231.

A. CONTROL AND MONITORING:

The switch shall contain the following devices in the control circuit:

1. Voltage pickup relay, adjustable 85 to 100 percent.

2. Frequency pickup relay, adjustable 90 to 100 percent.

3. Time delay relay for open transition from normal to emergency (TDNE): adjustable from 0.2 to 50 seconds, initially set at 0.2 seconds.

4. Time delay relay for open transition from emergency to normal (TDEN): adjustable from 0 to 30 minutes, initially set at 20 minutes.

5. Time delay for open-transition to allow motor load EMF decay: adjustable from 1 to 10 second, initially set as specified below.

6. Engine cool-down timer: 0-60 minutes, initially set at 30 minutes.

7. ATS transfer test switch mounted on equipment cover or door.

8. Switch position indicating lights: Green light for normal source and red light for standby source.

9. Generator start command: output relay.

10. Engine Generator Exerciser: Adjustable exerciser with no-load or load transfer, start time, duration, retransfer, and cool-down time.

11. Monitoring: Event logging with data, time, and reason.

12. Output status and alarm contacts:

    a. Normal status (4-sets Form-C)
    b. Standby status (2-sets Form-C)
    c. Trouble alarm (2-sets Form-C)

B. TERMINATIONS:

Arrange internal equipment items for power cable bottom entry and bottom exit.

Provide oversized termination lugs as required for the size and quantity of conductors shown. Provide copper bus, terminations and connections.

C. NAMEPLATES:

The switch shall be identified as indicated on the drawings and nameplates shall be provided as specified: "STANDBY GENERATOR LOCATED WEST OF THIS TRANSFER SWITCH".

2.15 SERVICE ENTRANCE SECTION

A. GENERAL:

Coordinate with Power Utility for the correct meter socket, test devices, potential transformers, current transformers, and other items installed in the metering section. Refer to SRP Electric Service Specifications and EUSERC, latest editions.

Continuous Current Ratings: 600 amperes at 600Vac.

B. NAMEPLATES:

In addition to the manufacturer's identification, an external nameplate shall be provided with engraving "SERVICE ENTRANCE SECTION".

Each section compartment shall be provided with nameplates indicating utility meter, pull sections, and any additional designations describing the compartment function or usage.

2.16 SPARE PARTS

One set consisting of the following spare parts shall be provided:

1. One set each fuse size and type

2. Ten of each type pilot lamp

2.17 PRODUCT DATA

The following information shall be provided in accordance with Section 01300:

1. One copy of the Power Utility reviewed and approved Power Utility submittal to the Engineer.

2. ATS installation certification form 11000-A as specified in Section 01999.

3. ATS instruction certification form 11000-B as specified in Section 01999.

4. Operation and maintenance (O&M) information as specified in Section 01730. Include also the following:

   a. Final reviewed submittal product literature.

   b. As-built drawings.

   c. Record of final power monitor configuration settings hard copy and software files. Turn over power monitor configuration software to Owner.

   d. Record of ATS factory and field configuration settings.

PART 3--EXECUTION

3.01 GENERAL

The motor control centers shall be erected in accordance with the recommendations of the manufacturer and with the details specified herein.

Cables larger than No. 6 AWG which hang from their vertical connections shall be supported within 2 feet of the connection.

The solid-state overload relay settings shall be implemented by the Contractor with the settings selected based on the actual full load amperes of the motor connected to the starter and the requirements of the motor driven equipment. Refer to the manufacturer's literature for setting the overload relays.

The motor circuit protectors shall be adjusted by the Contractor to the lowest setting not causing false tripping.

Install motor control centers level and plumb on 3-1/2-inch concrete housekeeping pads, per the manufacturer's installation instruction.

A. STRUCTURAL ANCHORAGE:

The MCC shall be anchored, supported, and restrained per the manufacturer's recommendations.

B. SERVICE ENTRANCE SECTION:

Coordinate the SES conduit installation with the power utility and request their inspection prior to covering up the work.

C. PROTECTIVE DEVICE SETTINGS:

The protective relays and static tripping devices shall be adjusted to the settings specified in the protective device coordination study in Section 16431 prior to energizing the MCCs.

D. ATS FIELD ADJUSTMENTS:

The time delay relays shall be adjusted to the following values:

1.	Normal to emergency time delay:	5 minutes
2.	Emergency to normal time delay:	20 minutes
3.	Open Position time delay:	3 seconds
4.	Voltage pickup:	90 percent
5.	Frequency pickup:	95 percent

Field settings shall be recorded and provided with O&M data.

E. POWER MONITOR:

Demonstrate that instrument transformer polarities are connected correctly. Configure monitor and record settings using configuration software.

3.02 FIELD TESTS

A. MOTOR CONTROL CENTER:

Motor control center and ground fault trip shall be tested in accordance with Section 16030.

B. AUTOMATIC TRANSFER SWITCH:

The automatic transfer switch shall be acceptance field tested in accordance with Section 16030. Test the ATS using engine-generator set as specified herein and per Sections 16030 and 16231.

Configure the ATS for weekly scheduled generator operation in accordance with Owner requested test schedule.

3.03 TRAINING

A minimum of a one hour session of training for each of two shifts of personnel shall be provided for the following:

1. Power Monitor.
2. Surge Protective Devices.
3. ATS.

Training shall be certified on Form 11000-B specified in Section 01999.

END OF SECTION

SECTION 17000

GENERAL REQUIREMENTS FOR
INSTRUMENTATION AND CONTROL

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies general requirements which are applicable to providing a complete, functional process control, instrumentation, and communication systems for the Sweetwater Lift Station. The requirements of this section are applicable to all work specified in Division 17 of these specifications.

Electrical requirements applicable to this work include those specified in Division 16.

Work shall be as specified, and per the IBC, NECA-1, and NFPA 70.

B. DESCRIPTION OF WORK:

1. INSTRUMENTATION AND CONTROL SYSTEM: Work includes a replacement PLC based control system and instrumentation for a sewage pumping station. Demolished, salvaged, and reused equipment: Spec. 01046.

2. PROGRAMMING: PLC, existing SCADA system, and exising SCADA data concentrator PLC programming will be provided by Owner's programmer. Refer to Section 17900 for control strategies.

C. DEFINITIONS:

1. GENERAL: Definitions of terminology related to Instrumentation and Industrial Electronic Systems used in the specifications shall be as defined in IEEE 100, ISA S51.1, and NEMA ICS 1.

2. TWO-WIRE TRANSMITTER: A transducer which derives operating power supply from the signal transmission circuit and requires no separate power supply connections. A two-wire transmitter produces a 4 to 20 milliampere current regulated signal in a series circuit with a 24 volt direct current driving potential and a maximum circuit resistance of 600 ohms.

3. FOUR-WIRE TRANSMITTER: A transducer which derives operating power from separate power supply connections. A four-wire transmitter produces a 4 to 20 milliampere current regulated signal in a series circuit with a maximum circuit resistance of 600 ohms. Four-wire transmitters typically require 120Vac or 24Vdc input power supply.

4. GALVANIC ISOLATION: Electrical node having no direct current path to another electrical node. Galvanic isolation refers to a device with electrical inputs and/or outputs which are isolated from ground, the device case, the process fluid, and separate power supply terminals. Inputs and/or outputs may be externally grounded without affecting the characteristics of the devices or providing path for circulation of ground currents.

5. PANEL: An instrument support system which may be a flat surface, a partial enclosure, or a complete enclosure for instruments and other devices used in process control systems including consoles, cabinets and racks. Panels provide mechanical protection, electrical isolation, and protection from dust, dirt, moisture, and chemical contaminants which may be present in the atmosphere.

6. SIGNAL TYPES: Used in systems specified in Division 17:

a. HIGH-LEVEL ANALOG: Signals with full output level greater than 100 millivolts but less than 30 volts, including 4 20 mA transmission.

b. DIGITAL CODE: Coded information from the output of an analog to digital converter or digital transmission terminal.

c. PULSE FREQUENCY: Counting pulses emitted from speed or flow transmitters.

d. DISCRETE CONTROL OR EVENTS: Dry contact closures and signals monitored by solid state equipment, relays, or control circuits.

e. LOW VOLTAGE DISCRETE CONTROL OR EVENTS: Dry contact closures and signals monitored by solid state equipment, relays, or control circuits operating at less than 30 volts and 250 milliamperes.

7. CONTROL SYSTEMS INTEGRATOR (CSI): A firm engaged in the business of detailed control system design and engineering, instrumentation component purchase, system and panel assembly, programming, and implementing the specified process control and industrial automation systems.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids).

If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
IBC	International Building Code
IEEE 100	Standard Dictionary of Electrical and Electronics Terms
ISA S5.1	Instrument Symbols and Identification
ISA S5.4	Instrument Loop Diagrams
ISA S20	Specification Forms For Process Measurement and Control Instrumentation, Primary Elements, and Control Valves
ISA S51.1	Process Instrumentation Terminology
ISA TR20.00.01	Specification Forms for Process Measurement and Control Instruments Part 1: General Considerations
NECA-1	National Electrical Contractors Association – Standard Practices for Good Workmanship in Electrical Contracting
NEMA ICS 1	General Standards for Industrial Control and Systems
NFPA 70	National Electrical Code

B. CONTROL SYSTEMS INTEGRATOR RESPONSIBILITY:

1. GENERAL

a. The specified control system and instrumentation integration including panel building, instrument calibration, testing, start-up, operational testing, and training shall be performed by a Control Systems Integrator staffed with qualified personnel, possessing necessary equipment and experience in performing similar installations.

b. The control system components shall, as far as practical, be of one manufacturer.

c. The components, modules, devices, and control system equipment shall be recognized industrial quality products. Recognized commercial or office grade products are prohibited.

d. The overall system performance shall be demonstrated to and accepted by Owner.

2. CONTROL SYSTEMS INTEGRATOR QUALIFICATIONS:

a. Contractor-proposed Control Systems Integrator shall be evaluated based on submittal of the following Evidence of Experience:

1) Submit evidence of experience in performing three similar successful projects in the last five years with one project currently in progress or competed within the last two years.

2) Submit project descriptions with contact names, addresses, and telephone numbers from the project Owner.

C. PROCESS EQUIPMENT COORDINATION:

1. Division 17 specified equipment shall be coordinated for proper operation with equipment related process equipment specified in other Divisions.

2. Equipment shall be integrated, furnished, and installed in conformance with the drawings, specifications, and the recommendations of the equipment manufacturer and the related processes equipment manufacturers.

3. Control Systems Integrator shall obtain manufacturer's technical information for items of equipment not provided with, but directly connected to, the control system. Provide the necessary coordination and components for correct signal interfaces between specified equipment and the control system.

4. Control Systems Integrator shall coordinate with project subcontractors and equipment suppliers.

5. Control Systems Integrator shall provide installation supervision for a minimum of 2 man-weeks on-site.

6. Conflicts between the plans, specifications, manufacturer/vendor drawings and installation instructions, etc., shall be presented to the Construction Manager for resolution before proceeding.

1.03 ENVIRONMENTAL CONDITIONS

A. GENERAL:

Specified data communication and process control equipment shall suitable for operation in indoor locations and in outdoor locations. Ambient conditions are specified in Section 01800.

B. CORROSIVE LOCATIONS:

Corrosive locations shall be as specified in Division 16.

C. HAZARDOUS (CLASSIFIED) AREAS:

Hazardous areas shall be as specified in Division 16.

1.04 FUNCTIONAL REQUIREMENTS

A. GENERAL:

The instrumentation and control system functions are shown on the drawings and specified in subsequent sections of Division 17. The Control Systems Integrator drawings and integration practices shall be as defined in IEEE 100, ISA S51.1, and NEMA ICS 1.

B. SUBMITTAL DRAWINGS:

1. GENERAL: The drawings included in the project manual are functional in nature and do not show exact locations of equipment or interconnections between equipment. The Contractor's Control Systems Integrator shall prepare detailed installation drawings as specified below.

Drawings prepared in AutoCAD with borders and title blocks identifying the project, system, revisions to the drawing, and type of drawing. Each revision of a drawing shall include the date and description of the revisions. Drawing prints shall be 11" x 17" with a minimum lettering size of 1/8".

Diagrams shall carry a uniform and coordinated set of wire numbers and terminal block numbers in compliance with panel wiring, Section 17110, to permit cross-referencing between contract documents and the drawings prepared by the Contractor.

2. CONNECTION DIAGRAMS: Show components of a control panel in an arrangement similar to the actual layout of the panel including internal wiring between devices within the panel. Show terminal blocks used for internal wiring or field wiring, identified as such. Indicate insulation color code, signal polarities, and wire numbers and terminal block numbers.

3. ELEMENTARY OR SCHEMATIC DIAGRAM: Shows, by means of graphic symbols, the electrical connections and functions of a specific circuit arrangement. Provide schematics for internal panel power distribution, lighting, and any panel HVAC.

4. ARRANGEMENT, LAYOUT, OR OUTLINE DRAWINGS: Show the dimensioned external and interior control panel views with components and Bill of Material. Provide panel heat load calculations, and indicate cooling or ventilation provisions as required.

5. NETWORK BLOCK DIAGRAM: A network block diagram is a diagram of the overall SCADA system, with annotated boxes to show the primary network components (controllers and switches), and annotated interconnecting lines that show the system communication media and communication protocols.

6. LOOP DIAGRAMS: Provide loop diagrams for analog and discrete loops interconnected into the control system circuits:

a. Show device element wiring of the system.

b. Show circuits for hardwired device interlocks.

c. Show circuit cable and wire cable numbers, signal polarities, and terminal block numbers.

1.05 SUBMITTALS

The following information shall be provided in accordance with and Section 01300:

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. A check mark shall denote full compliance with a paragraph as a whole.

If deviations from the specifications are indicated, and therefore requested by the Contractor, each requested deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation.

The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications.

Failure to include a copy of the marked-up specification sections, along with justification for requested deviations from the specification

requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

2. Detailed product literature, showing product specifications and model number breakdown. Mark to denote features and options included. Include only the applicable pages.

3. Manufacturer's installation manual excerpts, as to be used for this project:

   a. Installation details/drawings.

   b. Electrical connection diagrams.

   c. Calibration procedures.

4. Drawings and diagrams specified in paragraph 17000-1.04 B.

5. Nameplate list with material, tag number and description as specified herein.

6. Control Systems Integrator Evidence of Experience per paragraph 17000-1.02 B 3.

7. A copy of marked specification Section 17200, with addendum updates included.

8. Submittal requirements of Sections 17212 and 17510.

PART 2--PRODUCTS

2.01 GENERAL

A. MATERIALS AND QUALITY:

Equipment material shall be new, free from defects, and industrial-grade, as specified. Each type of instrument, instrument accessory, and device used throughout the work shall be manufactured by one firm, where possible.

Electronic equipment shall be of solid-state construction with printed or etched circuit boards of glass epoxy of sufficient thickness to prevent warping.

B. ENCLOSURES:

Table A specifies the instrument and control panel enclosure material and minimum NEMA rating for the location and application.

Table A

Location	Enclosure Material and NEMA Rating
Outdoor: Corrosive Area	NEMA 4X: 316 Stainless Steel
Hazardous and Corrosive Area	NEMA 7: Iron or Aluminum with factory applied corrosion resistant coating or NEMA 4X and UL listed or FM Approved for the Hazardous Area.

2.02 NAMEPLATES

Nameplates shall be provided for all field mounted instrument, analyzer, or equipment specified in Division 17. Nameplate lettering shall include the equipment or instrument loop title and the instrument or equipment tag number, where nameplate engraving is not specified or shown.

Nameplates shall be machine stainless steel with 5/32-inch high lettering, as minimum, unless otherwise specified or shown. Nameplate wording may be changed without additional cost or time, if changes are made prior to commencement of engraving.

Nameplates shall be attached to support hardware with a minimum of two self-tapping type 316 stainless steel screws in a readily visible location so the nameplate will remain to identify the service when the device is removed. Field instrument nameplates shall be attached with braided stainless steel straps where not stand mounted.

2.03 PRODUCT DATA

The following Product Data shall be provided in accordance with Section 01300.

1. Record drawings specified by paragraph 17000-1.04 B and the schedules included in Division 17 shall be provided in accordance with Section 01720.

   Provide record drawing prints of all drawings following project start-up, but prior to acceptance of the work showing the final constructed state of the instrumentation and control systems.

2. Operating and maintenance information shall be provided in accordance with Section 01730. Include the following in each Operation and Maintenance manual:

   a. Final reviewed Submittals, including revised as-built record drawings.

   b. Manufacturer's operation and maintenance instructions, edited for this project.

c. Written record of menu configuration, jumpers, switch settings, and other configurable parameters for each instrument.

PART 3--EXECUTION

3.01 INSTALLATION

A. GENERAL:

Equipment shall be installed in locations that are accessible for operation and maintenance services. Equipment not accessible shall be reinstalled at no cost to the Owner.

Installation, calibration, settings, and testing procedures are specified in Section 17000, Section 17200 – Instrument Index Part 3 Execution, and subsequent sections of Division 17.

B. FIELD EQUIPMENT:

Equipment shall be provided with ports and adjustable items accessible for in-place testing and calibration. Install equipment between 48 inches and 60 inches above the floor or permanent work platform. Equipment shall be mounted to avoid shock or vibration that may impair operation. Equipment shall be mounted for unobstructed access and walkways. Equipment support systems shall not be attached to handrails, process piping or mechanical equipment.

Instruments and cabinets supported by concrete walls shall be spaced 5/8 inch by framing channel between instrument or cabinet and wall. Block wall shall have additional installation supports, as required, to avoid damage to the wall. Equipment supports shall be hot-dip galvanized after fabrication or shall be 316L stainless steel, as shown or specified.

Support systems including panels shall be designed in accordance with Section 01900 to prevent deformation greater than 1/8 inch in any direction under the attached equipment load and under an external load of 200 pounds.

In wet or outdoor areas, conduit penetrations into instrument housing shall be made through the bottom (preferred) or side of enclosures to minimize water entry from around or from inside of conduits. Provide conduit hubs for connections and waterproof mastic for moisture sealant.

Nameplates shall be provided for all field mounted equipment. Nameplates shall be attached to support hardware with a minimum of two self-tapping Type 316 stainless steel screws in a readily visible location, but such that if the field device is changed out, the nameplate will remain to identify the service.

C. ELECTRICAL POWER CONNECTIONS:

Equipment electric power wiring shall comply with Division 16. Power disconnect switches shall be provided within sight of equipment and labeled to indicate the specific equipment served and the power source location. "Within sight of" is defined as having an unobstructed view from the equipment served and within 50 feet of the equipment served.

Equipment power disconnect switches shall be mounted between 36 inches and 72 inches above the floor or permanent work platform. Where equipment location requirements cannot be met by a single disconnect switch, provide two disconnect switches: one at the equipment and one at the work platform.

D. SIGNAL CONNECTIONS:

Equipment electric signal connections shall be made on terminal blocks or by locking plug and receptacle assemblies. Flexible cable, receptacle and plug assemblies shall be used where shown or specified.

Jacketed flexible conduit shall be used between equipment and rigid raceway systems. Flexible cable assemblies may be used where plug and receptacle assemblies are provided and the installation is not subject to mechanical damage in normal use. The length of flexible conduit or cord assemblies shall not exceed 2 feet, except where sufficient length is required to allow withdrawal of instruments for maintenance or calibration without disconnection of conduit or cord assemblies.

3.02 FIELD TESTS AND INSPECTIONS

A. DELIVERY INSPECTION:

The Contractor shall notify the Owner's Representative upon arrival of any material or equipment to be incorporated into the work. The Contractor shall remove protective covers or otherwise provide access in order that the Owner's Representative may inspect such items.

B. INSPECTION AND INSTALLED TESTS:

Refer to Section 17030.

END OF SECTION

SECTION 17030

PROCESS INSTRUMENTATION AND CONTROL SYSTEM TESTING

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies Contractor and Control Systems Integrator performance in testing and documentation of process instrumentation and control system materials and equipment (PICS).

The term instrumentation covers field and panel instruments, analyzers, primary sensing elements, transmitters, power supplies, and monitoring devices.

Provide the labor, tools, material, power, and services necessary to provide the process instrumentation and control system inspection and testing specified herein. Coordinate all testing with Section 01660:

A. Not used.

B. PRE-OPERATIONAL PERFORMANCE TESTING SEQUENCE:

1. Wiring Testing
2. Instrumentation Calibration
3. Loop Testing

C. FUNCTIONAL TESTING SEQUENCE:

1. Process Control Strategy Testing
2. Control System Closed Loop Commissioning
3. Functional Checkout

D. OPERATIONAL TESTING:

1. System Acceptance Testing (SAT)

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents with additional references listed in Section 17000.

All references shall be to the current edition of the document unless specifically stated otherwise. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no bids). If referenced documents have been discontinued by the issuing organization, reference to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Where document dates are given in the following listing, reference to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ISA RP7.1	
ISA S51.1	Process Instrumentation Terminology

B. PROJECT LABELING:

The items specifying project labeling herein shall include the following as a minimum: Owner's name, facility name, project name, and project number.

1.03 SUBMITTALS

Submittal material, to be submitted in accordance with Section 01300, shall consist of the following:

A. DEFINITION SUBMITTAL:

1. Control descriptions per paragraph 2.01 A.

2. I/O Interface Summaries per paragraph 2.01 B.

3. Test procedures per paragraph 3.01 D.

4. Proposed test forms per PART 3 of this Section, detailed for each test for this project.

5. Certified Factory Calibration Reports for all magnetic flow meters.

6. Provide a copy of this specification and the referenced and applicable sections with addenda updates included with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.

7. Provide a copy of Section 17200 Instrument Index with Addenda updates included, marked to indicate requested deviations from specified requirements.

8. Provide a copy of all referenced and applicable Process and Instrumentation Drawings with addenda updates included, marked to indicate requested deviations from specified requirements.

9. Failure to include a copy of the specifications and drawings with the submittal shall be cause for rejection of the entire submittal with no further consideration.

PART 2--PRODUCTS

2.01 TESTING DOCUMENTATION

A. CONTROL DESCRIPTION:

Provide a control description outlining operation for each process area's system. The Control Description Specification Section 17900 may be used as a basis.

B. I/O INTERFACE SUMMARY:

Provide I/O spreadsheet. Spreadsheets to include the following for each I/O point:

1. Tag number

2. Annotation description that may be logically abbreviated and that is subject to approval.

3. I/O type.

4. True/False status designations for digital I/O.

5. Process range; engineering units and any multipliers.

6. Remarks column.

2.02 PRODUCT DATA

Provide the following product data submittal after completion of testing.

The following information shall be provided in accordance with specification Section 01300:

1. Completed test forms per PART 3.

PART 3—EXECUTION

3.01 GENERAL

A. GENERAL REQUIREMENTS:

Materials, equipment, and construction included under this specification shall be inspected in accordance with this section and subsequent sections of this division. Testing shall be performed by the Contractor in accordance with this and subsequent sections of this division.

No required test shall be applied without prior notice to the Construction Manager. Between 60 and 70 days before the commencement of any testing activity, the Contractor shall provide a detailed step-by-step test procedure complete with forms for the recording of test results, testing equipment used, and a place for identification of the individual performing or, if applicable, witnessing the test.

Provide detail assistance to the Contractor in generating form 01660-A, customized for this project. Submit detailed form prior to testing per the requirements of Section 01660.

B. TECHNICIAN QUALIFICATIONS:

Field instruments and analyzers shall be calibrated and set up by a certified instrument technician qualified to calibrate the instrumentation.

Technicians shall be qualified by completion and certification from training courses offered by The Instrumentation, Systems, and Automation Society (ISA), the instrumentation and analyzer manufacturer's training courses, or technician training courses at a recognized trade school that specializes in instrumentation calibration.

C. TEST EQUIPMENT AND MATERIALS:

Provide test equipment to conduct the specified tests that simulate inputs and read outputs with a rated accuracy at the point of measurement at least three times greater than the component under test. Pressure instruments shall be calibrated by a digital manometer, +/- 0.1% of full scale accuracy, 3.5 digit display, ranges of 0 to 19.99/199.9/1999 psig. Milliamp signal calibrators shall be +/- 0.5% of full scale accuracy, 4 digit display.

Test instruments shall have a current calibration sticker showing date of calibration, deviation from standard, name of calibration laboratory and technician, and date recalibration is required. Certified calibration reports traceable to the National Institute of Standards and Technology shall be included with the final test report.

D. FIELD TEST PROCEDURE DOCUMENTATION:

Test procedures submitted for approval within 90 days from the date of Notice to Proceed.

Test procedures for each analog and discrete loop in the process control system shall be organized and assembled in separate volumes for each process area. Final test records shall be submitted in electronic form by scanning and converting the records and files to Adobe PDF format, to preserve actual signatures and signoffs.

Test procedure documentation shall include a detailed, step-by-step description of the required test procedure, panel and terminal block numbers for points of measurement, input test values, expected resultant values, test equipment required, process setup requirements, and safety precautions.

Test report forms for each loop, including forms for wiring, piping, and individual component tests, shall be included with the test procedure documentation. The actual test results shall be recorded on these forms and a final test report assembled as specified in paragraph 3.04.

Test report forms shall be preprinted and completed to the extent possible prior to commencing testing. Test report forms that document the field test procedures shall include the following information:

1. Project name
2. Process area associated with the equipment under test.
3. Instrument loop description.
4. Instrument loop identification number.
5. Instrument nameplate data.
6. Instrument setup and configuration parameters.

7. Time and date of test.

8. Inspection checklist and results.

9. Reference to applicable test procedure.

10. Expected and actual test results for each test point in the loop including programmable controller data table or register values.

11. Test equipment used.

12. Space for remarks regarding test procedure or results, unusual or noteworthy observations, etc.

13. Name, date, and signature of testing personnel.

E. PERFORMANCE DEVIATION TOLERANCES:

Tolerances shall be specified in Division 17. Where tolerances are not specified, refer to the manufacturer's published performance specifications.

Overall accuracy requirements for loops consisting of two or more components shall be the root-summation-square (RSS) of the component accuracy specifications. Tolerances for each required calibration point shall be calculated and recorded on the associated test report form.

F. INSTALLED TESTS:

Equipment and System Performance and Operational Testing - Section 01660 specifies testing of the mechanical, electrical, instrumentation and HVAC systems. The Contractor's Quality Assurance Manager shall coordinate, manage, and supervise the quality assurance program that includes:

1. Testing plan with the sequence for the test work.

2. Calibration program for all instruments and analyzers.

3. Documentation program that records tests results.

4. Performance testing program systems.

Test forms provided shall conform to the requirements of reference forms 17000-A through 17000-K included in Section 01999. Additional or detailed forms shall be developed as necessary to suit complex instrumentation. Usage of terms used on test forms shall comply with ISA S51.1.

G. WITNESSING:

The Construction Manager reserves the right to observe factory and field instrumentation testing and calibration procedures. The Construction Manager shall be notified prior to testing, as specified herein.

3.02 NOT USED

3.03 PRE-OPERATIONAL PERFORMANCE TESTING

A. GENERAL REQUIREMENTS:

In general, tests shall be performed in the following order:

B. WIRING TESTS:

Electrical power and signal cable ring-out and resistance testing. Conducted in accordance with Sections 16000 and 16030. Wiring tests shall not be conducted until cables have been properly terminated, tagged and inspected.

1. Power and Control: Per Section 16030.

2. Signal: Test form 17000-A.

C. INSTRUMENTATION CALIBRATION:

1. Instruments and final elements shall be field calibrated in accordance with the manufacturer's recommended procedures and tested in accordance with the Contractor's test procedure.

2. Individual Component Calibration and Testing shall not commence until Instruments and Component Inspections are completed and documented to the satisfaction of the Construction Manager.

3. Analog instrument calibrated at 0, 10, 50, 90, and 100 percent of the specified full scale range. Each signal sensing trip and process sensing switch shall be adjusted to the required setting. Test data recorded on test forms as specified herein

4. Final element alignment tested and adjusted to verify that each final element operates smoothly over the full range in response to the specified process control signals.

5. Test data shall be entered on the applicable test forms at the time of testing: Alarm trips, control trips, and switches shall be set to initial values specified in Section 17200 Instrument Index at this time. Final elements shall be checked for range, dead-band, and speed of response.

6. Any component that fails to meet the required tolerances shall be repaired or replaced by the manufacturer. Repeat the specified tests until the component is within tolerance.

7. Install a calibration sticker on each instrument following successful calibration that indicates the date of calibration, the name of the testing company, and personnel who calibrated the instrument.

8. Test forms 17000-C through 17000-I.

D. CERTIFIED TEST REPORTS:

Field test and inspection activities include verification of instrument parameter setup, verification of instrument zero, and performance at three operating points within the instrument range. Instrument which fail to demonstrate proper performance shall be returned for re-calibration or replaced as agreed depending on the impact to the project as determined by the Construction Manager.

Where instrument field calibration is not feasible, certified factory calibration reports may be submitted that includes the name and address of the laboratory that conducts the calibration testing. Certified factory test reports may be submitted for the following instrument types in lieu of field calibration:

TABLE-A. FACTORY CALIBRATION INSTRUMENT LIST

Instrument Identification	Instrument Section	Description
FM	17212	Magnetic flow metering system

E. LOOP TESTING:

1. Loop Testing shall not commence until the Individual Component Calibration and Testing has been completed and documented to the satisfaction of the Construction Manager.

2. Each instrument loop shall be tested as an integrated system. Check operation from field instruments to transmitter to receiving components to the Plant Control System Operator Interface Station. Test signals shall be injected at the process impulse line connection where the measuring technique permits, and otherwise at the most primary signal access point.

3. Testing of loops with an interface to a programmable logic controller shall include verification of the programmable logic controller input/output

assignment and verification of operation of the input/output system and processor. Inspect the data table or register in the programmable logic controller memory to verify proper operation.

4. If the output control or monitoring device fails to indicate properly, corrections to the loop circuitry or device shall be made. The test shall be repeated until devices and instruments operate as required.

5. Correct loop circuitry and repeat the test until the instruments operate properly.

6. Test form 17000-J.

3.04 FUNCTIONAL TESTING

A. PROCESS CONTROL STRATEGY/FUNCTIONAL TESTING:

1. Control Strategy Testing shall not commence until the Loop Testing has been completed and documented to the satisfaction of the Construction Manager.

2. Control Strategy Testing is performed by the Programmer and consist of installing and debugging the PLC control logic program, verifying the interface points between the PLCs and field devices and equipment, and exercising the control strategies. Control Strategy Testing will be performed on one PLC at a time.

3. Provide qualified personnel to immediately correct any deficiencies in the Work that may be encountered during Control Strategy Testing. Failure of the Contractor to provide such personnel in a timely manner may prolong the time allotted to complete Control Strategy Testing.

B. FUNCTIONAL CHECKOUT:

Conducted to verify the operation of discrete and hardwired control devices, refer to Section 01660. Exercise the operable devices and energizing the control circuit. Operate control element, alarm device, and interlocks to verify the specified action occurs.

3.05 OPERATIONAL TESTING

System Acceptance Test (SAT) shall be performed after component and subsystem tests have been completed. The test of the completed system shall be performed in full operation and shall demonstrate that all functional requirements of this specification have been met. SAT shall demonstrate the following:

1. Each component of the system operates correctly with all other components of the system.

2. Hard-wired and software equipment interlocks perform correctly.

3. Process control sequences perform correctly.

4. PLC application program performs monitoring and control functions correctly.

5. Operator interface graphics represent the monitoring and control functions correctly.

END OF SECTION

SECTION 17110

INSTRUMENT AND CONTROL PANELS

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies requirements for control panels for the Sweetwater Lift Station per the Panel Schedule herein.

Provide the instrument, control, and monitoring features indicated on the P&ID and electrical drawings. Panels shall be arranged to separate control and instrument devices from power wiring.

PLC shall comply with the specified products in Section 17310. Relocate existing PLC into MCC relay section per Spec. 16920, and make complete as specified.

B. PANEL SCHEDULE:

Refer to bid schedule for panels to be provided.

	Panel No.	Spec / P&ID	Features *	Enclosure Type	Panel Title
1	W_55SLS-RTU-1700	17110 / P100	1, 3, 5	MCC	Sweetwater Lift Station PLC / W_55SLSRTU-1700

1* - Programmable Logic Controller (PLC) or Remote I/O devices
2* - Panel mounted Operator Interface Station (OIS)
3* - Hardwired control logic required
4* - Windowed outer door and inner door for displays or devices
5* - UPS
6* - Fans
7* - Heating
8* - Air Conditioning
9* - Sun/Rain Hood

C. PANEL DESIGN:

1. GENERAL: Panel hardware is specified in other Division 17 sections.

2. CONTROL POWER DISTRIBUTION: Panel containing 120-volt powered equipment shall use the din-rail power distribution method with fuses and blown fuse indication. Power is restricted to 120 Vac and 24 Vdc.

3. POWER SUPPLIES: Panel containing direct current powered instruments or serving as the termination point for transmission loop powered field instruments shall contain direct current power supply system as specified herein.

4. ELECTRICAL CONTROL DEVICES: Pushbuttons, indicating lights, relays, and similar equipment located in panels specified in this section shall be as specified.

5. UNINTERRUPTIBLE POWER SUPPLIES: Panel mounted 120 Vac input and 120 Vac output are specified herein.

1.02 QUALITY ASSURANCE

A. REFERENCES

This section contains references to the following documents that are part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid or on the effective date of the Agreement if there were no Bids. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
EIA RS-310C	Racks, Panels, and Associated Equipment
NEMA 250	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 94	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 508A	Industrial Control Panels
UL 698A	Industrial Control Panels Relating to Hazardous (Classified) Locations

B. LISTED PRODUCTS:

Equipment and components shall be Underwriters Laboratory (UL) listed for the purpose per Section 16000 or UL recognized.

C. SHIPMENT, PROTECTION AND STORAGE:

Equipment shipment, protection and storage shall conform to the requirements specified in Section 01605.

1.03 SUBMITTALS

A. GENERAL:

Submittals and transmittal procedures for submittals are defined in Section 01300. Submit In accordance with the procedures set forth in Sections 00710 and 01300 that include drawings, information and technical data for equipment and as required in Section 17000. Submittal information shall be included in one complete submittal.

1. A copy of this specification section, and Section 17310, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.

   A check mark shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation.

   The Owners Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications.

   Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

2. Marked product literature of all the enclosure electrical devices and components mounted on or within the control panel.

3. Nameplate engraving schedule:

   a. Indicate engraving by line
   b. Nameplate size

c. Panel and equipment tag number and description

1.04 ENVIRONMENTAL CONDITIONS

Refer to Section 17000.

PART 2--PRODUCTS

2.01 FABRICATION

A. GENERAL:

Nameplates with tag number and equipment description shall identify face-mounted instruments. Instruments shall be mounted for access to components and ease of removal. Instrument tag numbers shall be identified on the panel rear.

2.02 NOT USED

2.03 NOT USED

2.04 NAMEPLATES

External door-mounted components and the panel description shall be identified with plastic nameplates. Machine embossed metallic adhesive labels shall identify tag number of instruments inside panels. Nameplates shall be attached to panel surfaces, not to instruments.

The machine engraved laminated black phenolic nameplates with white lettering shall be provided for panel-mounted equipment. Nameplate engraving shall include the instrument tag number and description in 3/32-inch minimum size lettering.

The machine embossed metallic adhesive labels shall identify tag number of instruments inside panels. Nameplates shall be attached to panel surfaces, not to instruments.

The nameplates shall be attached to the panel with a minimum of two self-tapping 316stainless steel screws. Provide RTV sealant for nameplates.

The nameplate wording may be changed without additional cost or time prior to commencement of engraving. Submit nameplate legend with the panel submittal.

2.05 PANEL FEATURES

A. INTERCONNECTION WIRING:

Panel Interconnecting Wiring:

1. Panel control wiring: Single conductor stranded copper NFPA No. 70 Type MTW No. 16 AWG minimum, with an exception for factory supplied PLC wiring harnesses that are U.L. approved.

2. Panel instrument wiring: Twisted No. 16 AWG shielded pair or tri conductors.

3. Panel power wiring: Conductors specified in Division 16 and meet the NFPA No. 70 NEC requirements for power including phase, grounded, and grounding conductors.

4. Wiring shall be supported independently of terminations by lacing to panel support structure or by slotted flame retardant plastic wiring channels.

5. Wiring channels shall comply with UL 94, Type V.

6. Wiring channel fill shall not exceed 50 percent.

B. CONDUCTOR IDENTIFICATION:

Wiring shall be tagged at terminations with machine printed plastic sleeves with wire numbers for instrument and control panel internal conductors based on rung number from the submitted control panel schematics.

Code	120 Vac Conductor	Color
L	Power	Black
C	Control	Red
N	Neutral	White
PG	Ground	Green

Code	V dc Conductor	Color
PS	24 Vdc Power	Blue
PS	24 Vdc Power Common	Brown
S+	Signal (+)	Black
SG	Signal Ground	White
EG	Equipment Ground	Green

C. CONDUCTOR INSTALLATION AND PROTECTION:

1. Power and control wiring shall be carried in covered channels separate from low voltage signal circuits. An interior steel barrier shall be provided between AC control devices and the electronic equipment.

2. Terminal blocks shall be strap screw type rated for 600 volts. Each terminal trip shall have a unique identifying alphanumeric code at one end and a vinyl-marking strip running the entire length of the terminal strip with a unique number for each terminal. Numbers shall be machine printed and 1/8 inch high.

3. No more than two connections shall be made to one terminal.

D. FIELD WIRING:

Field wiring shall be connected to separate dedicated terminal blocks in a dedicated part of the panel where the field cables enter the panel.

E. FUSE AND FUSE HOLDERS:

1. Fuses for 120 Vac circuits shall have a minimum of 12,000-amperes interrupting capacity and blown fuse indicators.

2. Fuses for 24 Vdc circuits shall be fast acting glass tube type rated 1/8 or 1/10 amp for 4-20 mA loops.

3. Fuses for 24 Vdc circuits shall be 1/2 amp for the power supply to individual instruments.

4. Fuse holders shall be tip-out or draw-out type.

5. Provide Phoenix Contact or equal products.

F. CONTROL POWER:

120 Vac control power source: Single power source for all control and DC power.

G. PANEL POWER:

Panel power source:

1. Provide a 120 Vac circuit for the panel light, receptacle, and control power as required.

2. Provide a 120 Vac circuit for air conditioning load as required.

H. ACCESSORIES:

1. Panels shall include convenience receptacle and fluorescent utility light.

2. Receptacles and utility lights shall not be powered by the UPS.

3. Print pocket.

I. SURGE PROTECTION:

Surge protectors shall be as shown.

2.06 NOT USED

2.07 PANEL GROUNDING

A. Not used.

B. Signal circuits, signal cable shields, and low-voltage DC power supply commons shall be bonded to the signal ground bar.

C. Field analog wiring shields shall only be grounded at the signal ground bar. Test to verify that single ground point at panel signal ground bar.

D. Surge protectors and separately derived AC power supplies shall be bonded to the frame ground bar.

2.08 PANEL DRAWING PROTECTION

Provide wiring diagrams in accordance with Section 01300. Provide a panel-wiring diagram and schematic for each panel in a plastic bag or plastic container to avoid water damage and aging.

2.09 NOT USED

2.10 NOT USED

2.11 NOT USED

2.12 PRODUCT DATA

The following data shall be provided in accordance with Section 01300:

1. Refer to Spec. 17310.

PART 3--EXECUTION

3.01 GENERAL

Floor mounted cabinets shall be mounted and shimmed to precise alignment so doors operate without binding. Sealant shall be provided for conduit entering the panels.

Provide panels with the Record As-built schematic, connection, and interconnection diagrams in a water proof clear bag in the panel document holder.

3.02 NOT USED

3.03 NOT USED

3.04 FIELD TESTING

Field verify the following for Instrument and Control Panels:

1. Control circuits grounded with one terminal of each load device connected to the grounded conductor.

2. Control contacts installed in the ungrounded side of the circuit.

3. Signal and control wiring installed in separate wireways.

4. Barriers between the power wiring and the signal and control wiring.

5. Connected to the plant grounding system, as specified.

6. Center-line of wall-mounted panels shall be 48 inches above the floor.

7. Inner door contains a copy of the Record elementary and wiring diagrams.

8. Inner door contains a protected drawing holder.

9. Drawings enclosed in a transparent, protective jacket.

10. Functions as specified.

11. Tested in accordance with Section 16030 and Section 17030.

END OF SECTION

SECTION 17200

INSTRUMENT INDEX

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies the Instrument Index and general requirements applicable to process instrumentation and analyzer systems consisting of process sensors, process indicators, signal conditioning modules, control and monitoring devices, transmitters, and accessories.

The Contractor shall provide, calibrate, and test the complete process instrumentation and analyzer systems and place in operation and test the system. Testing includes making final adjustments to instruments and analyzers during facility start-up.

The Contractor shall examine the mechanical drawings and specifications to determine actual locations, sizes, materials and ratings of process connections. Process taps shall be indicated on pipe shop drawings as specified in paragraph 15050-2.04.

1.02 REFERENCES

Refer to Section 17000.

1.03 SUBMITTALS

Refer to Section 17212.

PART 2--PRODUCTS

2.01 INSTRUMENT INDEX

The Instrument Index, paragraph 17200-3.03, lists instruments and analyzers required for the project. Instrument functions specified on this list shall be provided by the Contractor.

Additional instrumentation devices such as process taps, seals, and other items required to complete the instrument loops due to characteristics of the equipment selected by the Contractor and not specified in the instrument index or on the contract drawings shall be provided at no additional cost to provide a complete working system.

2.02 PRODUCT DATA

Test results as specified in paragraph 17200-3.02 B shall be provided in accordance with Section 01300. Refer to Section 17000 and 17030.

PART 3--EXECUTION

3.01 GENERAL REQUIREMENTS

Materials, equipment, and installation shall be tested and inspected per Sections 17000, 17030, and this section.

3.02 INSTALLED EQUIPMENT - TESTS AND INSPECTION

A. Refer to Section 17030 – Process Instrumentation and Control System Testing.

3.03 INSTRUMENT INDEX

The following is an index of the instrumentation equipment, analyzers, and devices.

A. DESCRIPTION OF HEADINGS:

1. TAG NUMBER: Tag Number appears as a heading (PREFIX and NUMBER) and consists of a two, three or four letter prefix indicating the instrument function followed by a number identifying the process loop with which the instrument is associated. Tag Number provides an identification of the instrument, analyzer, or device.

2. DESCRIPTION: Provides the functional description of the instrument, analyzer, or device.

3. P&ID NUMBER: Lists the Process and Instrumentation Diagram on which the instrument, analyzer, or device appears.

4. SPECIFICATION: Provides the specification reference and any applicable "INSTRUSPEC" designation for the instrument, analyzer, or device.

5. RANGE/SETPOINT: Provides the calibrated instrument range and/or setpoint for each application.

6. UNITS: Range or Setpoint units.

7. COMMENTS: Provides the features, interlocks, and information applicable to the instrument, analyzer, or device.

Instrument Index (Sorted By P&ID)

Tag Number	Description	P&ID	Spec	Range/ setpoint	Units	Comments
W_55SLSLE-1701, W_55SLSLIT-1701	Wetwell Level	P100	17212-3 03 LUT	0 – 29.0	FEET	Elev 1181 14 to 1210.14
W_55SLSLSHH-1702	Wetwell High High Level	P100	17212-3 03 LFS	M101	ELEV	M101
W_55SLSAE/AIT-1708	Wetwell Gas Analyzer	P100	17510-3 03 MUS	0 – 100 0 / 10	% LEL	Combusitble Gas WARNING
W_55SLSAAH-1708	Wetwell Gas Alarm Beacon	P100	16175	n/a	n/a	Amber, strobe
W_55SLSFE-1731, W_55SLSFIT-1731	Discharge Flow Meter	P100	17212-3 03 FM	0 – 1,200	GPM	

END OF SECTION

SECTION 17212

TRANSMITTERS

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies requirements for process parameter transmitters, associated indication devices, and accessories.

The application requirements are specified in the Instrument Index - Section 17200.

1.02 REFERENCES

References shall be as specified in Section 17000.

1.03 SUBMITTALS

Submittals shall be provided as specified in Sections 01300 and 17000, including:

A. SHOP DRAWINGS:

Submit under Section 17000.

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Referenced and applicable sections to be marked up and submitted include:

a. Section 17200 – INSTRUMENT INDEX

A check mark shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. *Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal*

shall be sufficient cause for rejection of the entire submittal with no further consideration.

2. A copy of the contract document Process and Instrumentation Diagrams P100 and P200, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked *"no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.*

3. A copy of the contract document Drawings E11, E101, and M101, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked *"no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.*

3. Marked product literature of all equipment and features to be provided.

4. Installation drawings for only the transmitters, sensors, and mounting accessories to be provided.

5. Electrical and signal connection drawings for only the transmitters and sensors to be provided.

6. List of miscellaneous items, cables, spare parts, that will be provided in accordance with INSTRUSPEC sheet requirements.

7. Marked product literature for surge protectors and intrinsic safety barriers to be provided.

1.04 ENVIRONMENTAL CONDITIONS

Refer to Section 17000.

PART 2--PRODUCTS

2.01 GENERAL

A. MANUFACTURERS:

The OWNER requires the specified candidate manufacturers to provide the equipment and/or products to be furnished under this section. The OWNER believes the manufacturers are

capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed to mean that the named manufacturer's standard product will comply with the requirements of this Section. For the purpose of commonality of spare parts, OWNER software and configuration tools, and OWNER training, the manufacturer shall as specified, no substitutions.

B. SURGE PROTECTION:

Measuring elements and transmitters shall comply with the following requirements:

1. Transmitters located outdoors shall be provided with surge protectors:

   a. Signal: Emerson/Rosemount Model 470 D, Emerson/EDCO SS64-036-2, CCI SPN-42 FS28 Series, or accepted equal.

   b. AC Power: UL 1449, LED indicator, screw terminal connections, NEMA 4X. EDCO HSP121A or accepted equal.

2.02 INSTRUMENTATION SPECIFICATION SHEETS (INSTRUSPEC)

General requirements for instruments specified in this section are listed on INSTRUSPEC sheets in paragraph 17212-3.03.

Application requirements are specified in the Instrument Index, paragraph 17200-2.03, and/or on the drawings.

2.03 SIGNAL CURRENT ISOLATOR

Isolator shall provide galvanic isolation of milliampere transmission signals from transmitters. Isolator shall be housed in a NEMA 250, Type 4/7 conduit body and derive operating power from the signal input circuit.

Input and output signals shall be 4 to 20 milliamperes, and error shall not exceed 0.1 percent of span. Input resistance shall not exceed 550 ohms with an output load of 250 ohms.

Isolator shall be Moore Industries SCX 4-20madc to 4-20madc / 5.5VPL / -RF [DIN rail mounted] with maximum 250 ohm output impedance, or equal.

2.04 PRODUCT DATA

The following data provided in accordance with Section 01300:

1. Operating and maintenance information as specified in paragraph 17000-2.03, including:

   a. Final reviewed submittal.

b. Separate record of all final configuration, jumper, and switch settings for each transmitter.

c. Provide factory certified calibrations for flow meters and temperature transmitter.

d. Test results as specified in Section 17030-Part 2.

PART 3--EXECUTION

3.01 INSTALLATION

Installation requirements are specified in paragraph 17000-3.01.

3.02 TESTING

Testing requirements are specified in Section 17030.

3.03 INSTRUMENT SPECIFICATION (INSTRUSPEC) SHEETS

General requirements for instruments specified in this section are listed on INSTRUSPEC sheets herein. Application requirements are specified in the Instrument Index, paragraph 17200-3.03, and/or on the drawings. INSTRUSPEC sheets for the transmitters listed in the following Table A are included in this paragraph:

Table A: Process Monitors and Indicating Transmitters

INSTRUSPEC Symbol	Instrument Description	Instrument Function
FM	Magnetic Flow Transmitter	Flow Measurement
LUT	Ultrasonic Level Transmitter	Level Measurement
LFS	Float Level Switch	Level Measurement

3.03 INSTRUMENT SPECIFICATION SHEET--INSTRUSPEC

Instrument Identification:	FM
Instrument Function:	Flow Measurement
Instrument Description:	Magnetic Flow Metering System
Power Supply:	120 volt, 60-Hertz nominal
Signal Input:	Process
Signal Output:	4-20 milliamperes Analog signal with HART protocol, and scaled pulse frequency
Process Connection:	Flange, ANSI B16.5, Class 150, raised face.
Product Requirements:	Magnetic flow meter provided as a system consisting of a flow tube with separate converter / indicating transmitter, as scheduled in the Section 17200 Instrument Index, complete with interconnecting cables Remote mounted indicating transmitter for full-scale flow rates from 1.0 to 30 feet per second. System error shall not exceed the greater of 0.5 percent of flowrate or 0.1 foot per second from 3 to 30 feet per second.
Flow Tube:	Flow tubes manufacturer shall provide separate grounding rings fabricated from the same metal as for the electrodes below. Units with integral grounding electrodes are not acceptable. Electrodes: 316L stainless steel unless otherwise specified in Section 17200. Liner: Compatible with domestic wastewater.
Transmitter:	Contain electronics associated with the magnetic flow meter system. Enclosure rating NEMA-4, cast aluminum or metal compartment for power, field connections and calibration adjustments separate from digital circuitry. Provide factory traceability certificate of actual flow lab certification for the flow range specified in Section 17200 with O&M.

Instrument Identification:	FM (continued)
	Integral 4-digit LCD flow indication calibrated in process units. Data retained in non-volatile memory.
Manufacturers:	ABB Magmaster MFE Krohne Optiflux 4000 No substitutions.

Execution:

Installation:	Install in accordance with manufacturer's instructions and the specified functional requirements.
Cable:	Signal cable between the flow tube and transmitter provided by the system manufacturer with sufficient length of cable for continuous installation between the flow tube and the transmitter.

3.03 INSTRUMENT SPECIFICATION SHEET--INSTRUSPEC

Instrument Identification:	LUT
Instrument Function:	Level Measurement
Instrument Description:	Ultrasonic Level Transmitter
Power Supply:	120 volt, 60-Hertz nominal
Signal Input	Process
Signal Output:	As specified in paragraph 17212-2.01
Process Connection:	As shown or specified

Signal Converter / Indicating Transmitter:

Indicator: 4-digit LCD with 0.50-inch display, scaled in engineering units.
Accuracy: 0.25% of level range.
Analog Outputs: Two 4-20 mA into a minimum of 600Ω.
Discrete Outputs: Two Form-C rated at 5A, 250 Vac.

Enclosure: NEMA 4X wall mount

Accessories:

Mounting hardware and cable glands.
Handheld infrared programming device
Programming software and cable.
Sensor cable to reach from sensor to transmitter, no splices.

Acceptable Manufacturer:

Pulsar/Echo Process Instrumentation Level Hunter II/XDS15.

Sensor:

Measuring range: 1 to 33 ft.
Beam Angle: 6°
Pressure Limit: 120 psi
Temperature Limits: -40 to +200°F.
Wetted Materials: PVDF
Cable: #16 to #20 TSP with PVC jacket
Maximum Sensor/Transmitter Separation: 1200 ft.
Rating: Class I, Div. 1, Groups A, B, C & D.

3.03 INSTRUMENT SPECIFICATION SHEET--INSTRUSPEC

Instrument Identification:	LUT (continued)
Execution:	
Installation:	Install in accordance with manufacturer's instructions and the Engineer's installation detail. Contractor to verify size and type of specified tank connection with approved tank submittals.
Calibration:	System calibrated in accordance with Section 17200-3.02. Configure signal output to hold last value in the event of echo loss.

3.03 INSTRUMENT SPECIFICATION SHEET--INSTRUSPEC

Instrument Identification:	LFS
Instrument Function:	Level Measurement
Instrument Description:	Float Switch, Free-floating
Power Supply:	N/A
Signal Input:	Process
Signal Output:	Contacts, in accordance with paragraph 2.01 of this section.
Process Connection:	N/A
Product Data:	Switch shall be free-floating type, suspended from an oil resistant waterproof cable. The cable designed to support the weight of the float without additional strain relief and permanently sealed where it enters the float body. The conductors shall be a minimum size of 18 AWG. The switch shall be a single pole double throw dry contact type and rated at not less than 10 amperes at 120 Vac. Mercury switches are not acceptable. The float shall have a PVC or ABS corrosion and impact resistant shell.
Execution:	
Installation:	Install in accordance with the manufacturer's instructions, paragraph 17200-3.01, and the specified functional requirements.
Test:	In accordance with paragraph 17200-3.02.
Application/Calibration:	Application, calibration and set points as specified in paragraph 17200-3.03.
Approved Manufacturers:	Anchor Scientific Roto-Float, or equal.

END OF SECTION

SECTION 17310

PROGRAMMABLE LOGIC CONTROLLER (PLC)

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies requirements for a solid-state programmable logic controller (PLC) designed to execute continuous discrete and analog control of process equipment with high reliability. Reuse the existing PLC panel and UPS, refer to Spec. 01046. Relocate both to the MCC relay section specified in Sectiion 16920. Provide pilots and other components shown on the front of the MCC door and on the PLC panel, provide wiring for a complete installation, and test.

PLC Programming: Refer to Section 17000.

1.02 QUALITY ASSURANCE

A. REFERENCES:

Refer to paragraph 17000-1.03 A.

B. SYSTEMS RESPONSIBILITY:

Refer to paragraph 17000-1.03 B.

1.03 SUBMITTALS

The following submittals shall be provided in accordance with Section 01300:

A. SHOP DRAWINGS:

Submit under Section 17110.

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. A check mark shall denote full compliance with a paragraph as a whole.

   If deviations from the specifications are indicated, and therefore requested by the Contractor, then each deviation shall be underlined and denoted by

a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation.

The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications.

Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

2. A copy of the Instrumentation drawings, with addendum updates included, marked to show deviations. If no changes are required, the drawing or drawings shall be marked "no changes required". *Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.*

3. A copy of the Process & Instrumentation Diagram drawings, with addendum updates included, marked to show deviations. If no changes are required, the drawing or drawings shall be marked "no changes required". *Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.*

PART 2--PRODUCTS

2.01 MANUFACTURERS

The Owner and Construction Manager require the following candidate manufacturer to provide the equipment and/or products to be furnished under this section. The Owner and Construction Manager believe the manufacturer is capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed to mean that the named manufacturer's standard product will comply with the requirements of this Section. For the purposes of standardization, personnel training and experience, and commonality of existing spare parts at another facility, the manufacturer shall be Modicon.

2.02 PROGRAMMABLE LOGIC CONTROLLER SYSTEMS

Each PLC system shall be configured as indicated on the Process Control System Configuration Diagrams in the Drawings, and this Specification. In addition to the requirements of the configuration diagrams, the following ancillary equipment shall be provided with each PLC system:

1. Interconnect cabling between components of the same chassis.

2. Network terminators.

3. Component mounting hardware as required for installation as detailed on the Drawings.

2.03 PRODUCT DATA

The following information shall be provided in accordance with Section 01300:

1. Record documents specified in Section 01720 and paragraph 17310-3.03.

PART 3--EXECUTION

3.01 INSTALLATION

Refer to Section 17110.

Connect input and output devices to the PLC via control panel terminal blocks, not directly to the PLC.

3.02 FIELD INSPECTION AND TESTING

The Programmer shall provide a PLC test program for Contractor's use in testing.

On-site inspection, testing, and certification of the completed PLC system installation shall be provided by the System Integrator. Refer to paragraph 17000-1.02 B. 2. e.
Test in accordance with Section 01660 and Section 17030.

3.03 RECORD DOCUMENTS

Contract document Instrumentation and Process and Instrumentation Drawings shall be maintained and annotated by the Contractor during construction, including the record drawings specified in Section 01720.

END OF SECTION

SECTION 17900

CONTROL SPECIFICATIONS

PART 1--GENERAL

1.01 DESCRIPTION

This section specifies the control specification strategies for the Sweetwater Lift Station Control System that is based on a Programmable Logic Controller (PLC) system as part of the existing Supervisory Control and Data Acquisition System (SCADA).

PLC Programming: Refer to Section 17000.

The Control Specification strategies describe sequential and interlocking control functions, analog control functions, and color-graphic video display operator interfaces including alarm and event logging. The generic term used herein shall be SCADA.

Provide all necessary labor and equipment to test the control strategies per Section 17030.

PART 2--NOT USED

PART 3--EXECUTION

3.01 INTERLOCKS

Interlocks (I) shutdown and prevent equipment from operating:

1. Hardwired interlocks are effective whether the PLC system is in operation or not, and in hand and auto modes unless noted.

2. Software interlocks are provided by the PLC, and are usually only effective when the equipment is operating in auto mode unless noted.

The following describe general interlock features for all systems:

I1 – MOTOR PROTECTION

Equipment motor protection includes overload and/or VFD or RVSS fault, hardwired only. Manual reset required at the starter, VFD, or RVSS.

I3 – HIGH MOTOR TEMPERATURE

Equipment motor protection from temperature switch or temperature sensors and switching relay, hardwired only. Manual reset required at the starter, VFD, or RVSS.

I10 – HIGH MOISTURE

Equipment motor protection from moisture sensor and switching relay, hardwired only. Typical for submersible sewage pumps. Manual reset required at the starter, VFD, or RVSS.

I21 – CHECK VALVE FAILED TO OPEN

Equipment protection from valve limit switch, hardwired only. Time delayed. Manual reset required at the starter, VFD, or RVSS.

I39 – ONLY ONE PUMP ALLOWED TO RUN ON STANDBY POWER

Standby generator protection from Automatic Transfer Switch in utility power position limit switch, hardwired only. Self-resetting.

3.02 GENERAL CONTROL STRATEGIES

Control Strategies (CS) define common equipment operations performed by the PLC and displayed by the SCADA system. Hardwired control strategies are effective for equipment control whether the PLC system is in operation or not, and in hand and auto modes unless noted.

Control Strategies unique to each process system are defined beginning in paragraph 3.10 below. The following describe general control features for all systems:

CS1 - EQUIPMENT RUN TIME TOTALIZATION

Equipment run time totalization will be calculated and maintained by the PLC based on equipment run status. Totalize in hours from 0 to 9999.

SCADA: Display total in hours.

CS2 - FLOW TOTALIZATION

Flow totalization will be calculated and maintained by the PLC whenever flow signals exceeds 2-1/2 % of full scale value and analog signal has not failed (refer to CS10). Totalize in gallons times 1,000 (kGal) or gallons times 1,000,000 (MGal) as shown on the P&ID. Totalize from 0 to 9999.

SCADA: Display total in kGal or MGal as shown on P&ID.

Previous 24 hour day flow totalization will also be calculated and maintained by the PLC.

SCADA: Summary display of previous day totals in kGal or MGal as shown on P&ID.

CS3 - PROCESS ALARM(S), SELF-RESETTING

Process alarms as shown on the P&ID will be determined and maintained by the PLC:

1. Low-Low Alarm: Point value is equal to or less than a predetermined alarm value.

2. Low Alarm: Point value is equal to or less than a predetermined alarm value.

3. High Alarm: Point value is equal to or greater than a predetermined alarm value.

4. High-High Alarm: Point value is equal to or greater than a predetermined alarm value.

An analog point which is in alarm status will not be changed to normal status until the point value changes by the predetermined deadband value for the point, initial setting of 5% of full scale range. PLC alarm setpoints are provided in paragraph 17200-3.03 instrument index.

SCADA: Display alarms. Display active and cleared-but-unacknowledged alarms in the alarm summary.

CS7 - PROCESS ALARM(S), MANUAL RESET FROM SCADA REQUIRED

Unless otherwise specified, all SCADA process alarms are this type. Process alarms as shown on the P&ID will be determined and maintained by the PLC:

1. Low-Low Alarm: Point value is equal to or less than a predetermined alarm value.

2. Low Alarm: Point value is equal to or less than a predetermined alarm value.

3. High Alarm: Point value is equal to or greater than a predetermined alarm value.

4. High-High Alarm: Point value is equal to or greater than a predetermined alarm value.

An analog point which is in alarm status will not be changed to normal status until reset by the SCADA Operator and the point value changes by the predetermined deadband value for the point, initial setting of 5% of full scale range. PLC alarm setpoints are provided in paragraph 17200-3.03.

SCADA: Display alarms. Display active and cleared-but-unacknowledged alarms in the alarm summary. SCADA allows Operator reset of alarms.

CS9 - DISCRETE POINT STATUS

The status of each discrete input point will be maintained in the PLC.

The status of each logical discrete point will also be maintained in the PLC. Logical points are points which depend upon the status of one or several discrete input points.

SCADA: Display the status of all discrete and logical discrete status points.

CS10 - ANALOG POINT STATUS

Analog input points will be checked by the PLC for the following status conditions:

Failed: Point value is less than or greater than the specified value range typically less than 3.6 milliamps (mA) and greater than 21.6 mA. Where the PLC module cannot read outside the 4-20 mA range, use discrete alarm bits available from the module or PLC status function block.

SCADA: Display alarm. Display active and cleared-but-unacknowledged alarm in the alarm summary

CS11 - GENERAL EQUIPMENT DISCREPANCY

The failure of driven equipment to respond will be monitored by the SCADA system. Equipment will be considered to be in discrepancy under the following conditions:

1. The equipment is in AUTO and the SCADA system attempts to operate the equipment and it does not respond within a defined time period, typically 15 seconds.

2. The equipment is in AUTO and running and for whatever reason other than the SCADA system requesting the equipment to "STOP," the equipment stops.

CS12 - SCADA INPUTS AND OUTPUTS STATUS

The PLC will monitor status of each individual input, output, and communication module, and all processor statuses available.

SCADA: Display racks with status for each module, using descriptive terms for alarms. Display processor battery status. Display alarms. Display active and cleared-but-unacknowledged alarm in the alarm summary

CS16 - TREND PLOTS

The touchscreen will graphically plot trends of all process variables (flow, temperature, levelelectrical kW, and VFD speed) in real-time and from historical data from up to 48 hours. The plant operator will be able to select the plotting interval, within the limits of the actual data collection. Four trends per display view will be possible.

In addition to the plotted data, a trend will include:

1. Time
2. Date
3. Tag number
4. Plotting interval
5. Time at start
6. Time at latest value.
7. Range and units

CS17 – COLOR NOTATION FOR DYNAMIC OBJECTS ON CONTROL GRAPHIC DISPLAY SCREENS

All dynamic objects on control graphic display screens will be provided with multiple-color display to identify status as tabulated below:

Equipment	Status	Required color
Motor	Running	Red
Motor	Ready or Off	Green
Valve	Opened position	Red
Valve	Closed position	Green
All	Power on	White
All	Abnormal condition	Amber (Yellow)
All	Advisory, Control Mode	Blue

CS18 - DIGITAL ALARM SYSTEM

Alarms as shown on the P&ID will be determined and maintained by the PLC, whether or not specific control strategies are provided. Digital inputs can be from field instruments (level switches, pressure switches, etc.), local control panels (relay outputs, alarm module outputs, switches), and packaged systems (designated terminals with packaged units).

SCADA: Display alarms. Display active and cleared-but-unacknowledged alarms in the alarm summary.

CS19 - DATA ARCHIVING HISTORIAN AND HISTORICAL FUNCTIONS

CS16 trend plots shall be logged for historical play-back.

CS2 previous day flow totals will be logged for later access.

CS20 - DIGITAL STATUS SYSTEM

All digital input status will be displayed on SCADA screens as required by the reference drawings and specifications regardless whether or not specific control strategies are provided. Each digital input will be shown in its appropriate process screen and/or equipment status screen. Digital inputs can be originated from field instruments (motorized actuators, HVAC related air handling units, power management related contact inputs, level switches, pressure switches, etc.), local control panels (relay outputs, alarm module outputs, switches), and packaged systems (designated terminals with packaged units).

CS24 - DATA TRANSFER REQUIREMENTS BETWEEN THE PLCs AND THE SCADA SYSTEM

Digital inputs and analog inputs to the SCADA system and the software logic generated alarms will be displayed or annunciated at the SCADA workstation as shown on P&IDs, the Instrument Index paragraph 17200-3.03, and this Section.

The SCADA system will generate separate alarms if communication is lost with any PLC.

Data displayed on the SCADA installed on this project will be available to the existing SCADA workstation via radio communications. The SCADA system will generate separate alarms if communication is lost with any PLC.

CS39 – ALTERNATION

Equipment run-time equalization by alternating the lead/follow assignment of two or more equipment items, hardwired. Alternation occurs when all equipment items stop.

3.03 CONTROL STRATEGY – LIFT STATION PUMPING

A. P&ID: P100

B. GENERAL DESCRIPTION:

A 10-inch sewer line crossing beneath the Arizona Canal Diversion Channel (ACDC) and the Salt River Project (SRP) Arizona Canal conveys collected wastewater from development north of the ACDC to the lift station. The lift station discharges through an 8-inch force main to an adjacent manhole within the lift station footprint. Gravity discharge is conveyed to the south through a 10-inch, then a 12-inch sewer line within Dahlia Drive. A 10-inch overflow pipe is provided to convey wastewater to the adjacent manhole if the lift station wetwell is surcharged to an overflow level.

There are two, submersible, nonclog, explosion proof, constant speed centrifugal pumps in the wet well that are operated in a Duty-Standby configuration. The standby pump only runs if the duty pump cannot meet the setpoint wetwell levels or if the duty pump fails.

Due to the nature of the overflow piping from the wetwell to the discharge sewage manhole, sewage will bypass to the next collection system zone even if pumps fail or are unavailable. On standby generator power, hardwired interlocks prevent operation of more than one pump.

C. CONTROL STRATEGY OVERVIEW:

In HAND, the pump is started. In OFF, the pump is stopped.

In AUTO, the pumps are started and stopped by level setpoints programmed in the ultrasonic level controller. The controller also provides pump alternation function.

Upon failure of the duty pump or if the level setpoints are not maintained, the standby pump starts.

Wetwell levels: (datum: EL 912.00 bottom of wetwell trench)

Level Instrument	Distance above bottom Wetwell, ft	Elevation, feet MSL	Description/action
LSL (LE/LIT)	3.75	1184.06	Stop operating pump
LS1 (LE/LIT)	7.2	1187.51	Start duty pump
LS2 (LE/LIT)	7.7	1188.01	Start standby pump
LSHH (float)		-	Refer to Drawing M101

D. LOCAL CONTROL:

1. Field: None.

2. VFD/MCC:

HAND-OFF-AUTO selector
RUN pilot
VFD FAULT pilot
HIGH MOTOR TEMPERATURE pilot
PUMP MOISTURE pilot
CHECK VALVE FAIL TO OPEN pilot
RESET pushbutton
ELAPSED TIME indicator

Wetwell level indication
Discharge flow indication

Wetwell combustible gas indication

3. Interlocks per 17900-3.01:

I1 – MOTOR PROTECTION
I3 – HIGH MOTOR TEMPERATURE
I10 – HIGH MOISTURE
I21 – CHECK VALVE FAILED TO OPEN
I39 – ONLY ONE PUMP ALLOWED TO RUN ON STANDBY POWER

E. REMOTE OR AUTOMATIC CONTROL:

1. Control Strategy in addition to the above:

CS2 - FLOW TOTALIZATION
CS11 - GENERAL EQUIPMENT DISCREPANCY
CS16 - TREND PLOTS
CS39 – ALTERNATION

2. Software Interlocks per 17900-3.01: None.

3.04 CONTROL STRATEGY – AUXILIARY SYSTEMS

A. P&ID: P200

B. GENERAL DESCRIPTION:

The standby generator provides power during power outages.

C. CONTROL STRATEGY OVERVIEW:

Generator start and stop control is the automatic transfer switch.

Generator enclosure door switch statuses are monitored.

D. LOCAL CONTROL:

1. Field:

HAND-OFF-AUTO selector (Generator)
LCD multi-function readout (Generator)

2. VFD/MCC: None.

3. Interlocks per 17900-3.01: None.

E. REMOTE OR AUTOMATIC CONTROL:

1. Control Strategy:

CS12 - SCADA INPUTS AND OUTPUTS STATUS
CS16 - TREND PLOTS

2. Software Interlocks per 17900-3.01: None.

3.05 CONTROL STRATEGY – POWER MONITORING

A. P&ID: P200

B. GENERAL DESCRIPTION:

Power monitor in the 480 volt MCC is monitored by SCADA.

C. CONTROL STRATEGY OVERVIEW:

Transfer switch positions are monitored.

MCC/electrical equipment door switch statuses are monitored.

Door and gate switch statuses are monitored.

Power in kiloWatts is calculated by multiplying phase-to-phase voltage by the current and by the power factor.

D. LOCAL CONTROL:

1. Field:

Power monitor readout and keypad

2. VFD/MCC: None.

3. Interlocks per 17900-3.01: None.

E. REMOTE OR AUTOMATIC CONTROL:

1. Control Strategy:

CS3 - PROCESS ALARM(S), SELF-RESETTING
CS16 - TREND PLOTS

2. Software Interlocks per 17900-3.01: None.

END OF SECTION