INVITATION FOR BIDS

City of Santa Rosa

FOR CONSTRUCTING

LAGUNA TREATMENT PLANT DIGESTER GAS CONDITIONING IMPROVEMENTS

CONTRACT NUMBER

C02101

ISSUED BY

CAPITAL PROJECTS ENGINEERING DIVISION

CITY OF SANTA ROSA, CALIFORNIA

2018

Last Updated: March 1, 2016

A T T E N T I O N
Prebid Conference
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City of Santa Rosa

STATE OF CALIFORNIA

INVITATION FOR BIDS

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CONTRACT

FOR

LAGUNA TREATMENT PLANT
DIGESTER GAS CONDITIONING IMPROVEMENTS

Contract No. C02101

LAGUNA TREATMENT PLANT
DIGESTER GAS CONDITIONING IMPROVEMENTS

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CONTRACT

CITY OF SANTA ROSA
STATE OF CALIFORNIA

NOTICE TO BIDDERS

➢	For technical questions regarding this project, contact Emma Walton at (707) 543-4516.
➢	For direct access to plans, specifications and planholders' lists, go to **www.srcity.org/bids** and click on Bid/Proposal Opportunities or call (707) 543-3800.
➢	For direct access to bid results, go to **www.srcity.org/bids**. Under Link to Capital Projects, click on Capital Projects Contracts or call (707) 543-3835.

- IMPORTANT -

Bid Acceptance Deadline

Sealed bids will be accepted at the Transportation and Public Works Department, 69 Stony Circle, Santa Rosa, California 95401 until 2:00 p.m., September 12, 2018, for Laguna Treatment Plant Digester Gas Conditioning Improvements, Contract No. C02101. (Engineer's Estimate: $570,000.)

Bids tendered after this deadline will not be accepted. The official time clock for accepting bids will be an electric date and time stamping clock, located in the Transportation and Public Works Department, 69 Stony Circle, Santa Rosa, California. In order to be accepted, bids must be received prior to 2:00 p.m. Therefore, a bid stamped in at 1:59 p.m. will be accepted, but one delivered at or after 2:00 p.m. is late and will not be accepted.

Pre-Bid Meeting

Prospective bidders, subcontractors, and material suppliers are invited to attend a pre-bid meeting scheduled to be held at 10:00 a.m., September 6, 2018, at the Laguna Treatment Plant, 4200 Llano Road, Santa Rosa, California.

Subcontractor Information; Department of Industrial Relations Registration

Bidders shall provide the names, business addresses and license numbers of all subcontractors listed on bidder's List of Subcontractors. No contractor or subcontractor may be listed on a bid for this public works project unless registered with the Department of Industrial Relations (DIR) pursuant to Labor Code section 1725.5. No contractor or subcontractor may be awarded a contract for this public works project unless registered with the DIR pursuant to Labor Code section 1725.5. This public works project is subject to compliance monitoring and enforcement by the DIR.

CITY OF SANTA ROSA ESTIMATED QUANTITIES
ESTIMATED QUANTITIES
LAGUNA TREATMENT PLANT DIGESTER GAS CONDITIONING IMPROVEMENTS

Item No.	Description	QUANTITY	Units
1	LAGUNA TREATMENT PLANT DIGESTER GAS CONDITIONING IMPROVEMENTS	1	LS

The foregoing quantities are approximate only, being given as a basis for the comparison of bids, and the City of Santa Rosa does not expressly or by implication, agree that the actual amount of work will correspond therewith, but reserves the right to increase or decrease the amount of any class or portion of the work, as may be deemed necessary or expedient by the Engineer.

Bids shall be made in accordance with the prevailing hourly rate of per diem wages for this locality and project as determined by the Director of the DIR pursuant to Labor Code sections 1770 *et seq.*

Contractor shall be responsible for compliance with the Immigration Reform Control Act of 1986.

If the project requires the employment of workers in any apprenticeable craft or trade, once awarded, Contractor and subcontractors must apply to the Joint Apprenticeship Council unless already covered by local apprentice standards (see Labor Code section 1777.5).

All bids are to be compared on the basis of the Engineer's estimate of the quantities of work to be performed. No bid will be awarded to a contractor who is not licensed in accordance with the provisions of Chapter 9 of Division 3 of the Business and Professions Code. Contractor must hold a Class C license for this project.

Project plans, bid and contract forms for Laguna Treatment Plant Digester Gas Conditioning Improvements may be obtained through PlanetBids at www.srcity.org/bids. These documents can no longer be obtained at the Transportation and Public Works Department.

No bid will be accepted unless it is made on the contract bid forms furnished by the Transportation and Public Works Department through PlanetBids. The original of the completed bid forms bearing original signatures must be submitted. A bid will not be accepted unless the bidder registers as a vendor through PlanetBids at www.srcity.org/bids, downloads documents/attachments, and is added to the prospective bidders list for this project. If there is an addendum, bidders must log into PlanetBids and acknowledge the addendum to be eligible for bidding.

The successful bidder will be required to hold a current City of Santa Rosa business tax certificate issued pursuant to Chapter 6.04 of the Santa Rosa City Code before commencing work on this project. For information regarding the business tax, contact Revenue and Collections at (707) 543-3170.

For any moneys earned by Contractor and withheld by the City of Santa Rosa to ensure the performance of the Contract, Contractor may, at its request and expense, substitute securities equivalent to the amount withheld in the form and manner and subject to the conditions provided in Section 22300 of the California Public Contract Code.

The City of Santa Rosa reserves the right to reject any or all bids and the right to waive minor irregularities or informalities in any bid or bonds.

Lori Urbanek

LORI URBANEK
Deputy Director

Date 8/14/18

SPECIAL PROVISIONS

General Specifications

CITY OF SANTA ROSA, CALIFORNIA

LAGUNA TREATMENT PLANT
DIGESTER GAS CONDITIONING IMPROVEMENTS

1 GENERAL

The work described herein shall be done in accordance with the "Contract Documents," which are the:

1. Special Provisions
2. Project Plans, consisting of 40 sheets entitled Laguna Treatment Plant Digester Gas Conditioning Improvements, 2018-0018
3. City of Santa Rosa Design and Construction Standards (City Standards)
4. City of Santa Rosa Construction Specifications for Public improvements (City Specifications)
5. State of California Department of Transportation Standard Specifications 2010 (Standard Specifications), and
6. State of California Department of Transportation Standard Plans 2010 (Standard Plans).

In the event of a conflict in any of these documents, the order of precedence shall be determined by Section 5-1.02 of these Special Provisions.

Whenever the Standard Specifications use the terms State of California, Department of Transportation, Director, Engineer, or Laboratory, the following terms shall be substituted therefor, and any reference to any of the foregoing terms shall be understood and interpreted to mean and refer to such substituted terms as follows:

For State of California - the City of Santa Rosa;

For Department - the City of Santa Rosa Department of Transportation and Public Works or the City of Santa Rosa Water Department;

For Director - the City Engineer of the City of Santa Rosa;

For Engineer - the City Engineer of the City of Santa Rosa or the City Engineer's authorized agents;

For Laboratory – Materials Engineering of the City of Santa Rosa Water Department, or such other laboratory as may be authorized by the City.

Whenever the Project Plans and Specifications use the terms Owner or Architect, the following terms shall be substituted therefor, and any reference to any of the foregoing terms shall be understood and interpreted to mean and refer to such substituted terms as follows:

For Owner, substitute - City Engineer of the City of Santa Rosa

Unless otherwise provided, whenever in these Special Provisions attention is directed to specific provisions in the Standard Specifications, such direction shall not be interpreted as excluding other applicable provisions of the Standard Specifications.

Unless otherwise provided, when sections and subsections of the Standard Specifications are used in these Special Provisions, such use is not exclusive and shall not be interpreted as excluding other applicable provisions of said sections and subsections, but is only intended to add to or modify such sections or subsections.

Unless otherwise provided, full compensation for compliance with these Special Provisions is included in the contract price and no additional allowance will be made to Contractor therefor.
The Standard Specifications are hereby modified to delete any reference or incorporation of provisions providing for or requiring arbitration of any and all claims and disputes arising under this contract.

2 BIDDING

2-1.06 Bid Documents: Prospective bidders will be furnished with an Invitation for Bids which will state the location and description of the contemplated public works project and will show the approximate estimate of the various quantities and kinds of work to be performed and materials to be furnished with a schedule of items for which unit prices are requested.

2-1.07 Approximate Estimate: The quantities given in the Contract Documents are approximate only, being given as a basis for the comparison of bids, and the City does not, expressly or by implication, agree that the actual amount of work will correspond therewith, but reserves the right to increase or decrease the amount of any class or part of the work or to omit parts of the work, as may be deemed necessary or advisable by the Engineer.

2-1.31 Examination of Project Plans, Specifications, City Standards, Invitation for Bids and Work Site: Prior to submitting a bid, the bidder shall carefully examine the Project Plans, Invitation for Bids, City Standards and the proposed work site. If any person contemplating submitting a bid for this public works project is in doubt as to the meaning of any part of the Contract Documents, or finds discrepancies in or omissions from the Contract Documents, he or she may submit a written request for interpretation or correction to the Engineer. The written request must be received by the Engineer a minimum of **96** hours prior to bid opening. Any interpretation or correction of the Contract Documents prior to bid opening will be made only by written addendum issued by the City. Notification of addenda will be handled through PlanetBids: the listed primary contact will receive an e-mail generated by PlanetBids informing them of a recently uploaded addendum. The City will not be bound by any other explanations or interpretations of the Contract Documents.

2-1.33 Bid Document Completion: Any references to Opt Out of Payment Adjustments for Price Index Fluctuations in the Standard Specifications are deleted in their entirety.

2-1.33A Bid Forms: All bids shall be made on bid forms obtained from PlanetBids at **www.srcity.org/bids**. The bidder shall submit its bid on the original bid forms furnished by the City. Bids submitted on forms other than the forms furnished to the bidder by the City will not be considered.

The bid forms to be submitted at the time of and with the bid are:

1. Unit Price Schedule
2. List of Subcontractors
3. List of Previous Similar Jobs
4. Noncollusion Declaration
5. Bid Guaranty Information and Bidder's Information and Signature
6. Bid Guaranty (Bid Bond or alternate security)

All bids shall give the proposed prices and must bear the original signature of the bidder. Bidders shall fill in all blanks on the bid forms where required. A bid will not be accepted unless the bidder registers as a vendor through PlanetBids at **www.srcity.org/bids**, downloads documents/attachments, and is added to the prospective bidders list for this project. If there is an addendum, bidders must log into PlanetBids and acknowledge the addendum to be eligible for bidding.

2-1.33B Registration with DIR: No contractor or subcontractor may be listed on a bid for this public works project unless registered with the Department of Industrial Relations (DIR) pursuant to Labor Code section 1725.5. No contractor or subcontractor may be awarded a contract for this

public works project unless registered with the DIR pursuant to Labor Code section 1725.5. This public works project is subject to compliance monitoring and enforcement by the DIR.

2-1.33C Subcontractors: The Subletting and Subcontracting Fair Practices Act, Public Contract Code sections 4100-4113, inclusive (the "Act") shall apply to all subcontracts in excess of one-half of one percent of the total amount of a bid. The Act requires subcontractors, if used for such work, to be listed in the contractor's bid and prohibits the substitution of subcontractors, except as authorized by the Act. Each bidder shall, with respect to the work of any subcontractor in excess of one-half of one percent of the total amount of the bid, include as part of the bid on the bid form provided:

1. The name, business address and DIR registration number of each subcontractor who will perform work or labor or render services to the Contractor in or about the construction of the work or improvement, or a subcontractor licensed by the State of California who, under subcontract to the Contractor, specially fabricates and installs a portion of the work or improvement according to detailed drawings contained in the Project Plans or other Contract Documents in an amount in excess of one-half of one percent of the Contractor's total bid; and

2. The portion of the work that will be done by each subcontractor. Only one subcontractor shall be listed for each portion.

The purchase of sand, gravel, crushed rock, batched concrete, aggregate, ready-mixed concrete, and/or any other materials produced and furnished by established and recognized commercial plants, together with the delivery of such materials to the work site by the source of the materials or by recognized commercial hauling companies, is not considered as subcontracting under this section.

2-1.33E Rejection of Bids Containing Alterations, Erasures or Irregularities: Bids may be rejected if they show any alterations of forms, additions not called for, conditional bids, incomplete bids, erasures or irregularities of any kind.

2-1.34 Bid Guaranty: All bids shall be presented under sealed cover and shall be accompanied by cash, cashier's or certified check, or by a bidder's bond made payable to the City of Santa Rosa and executed as surety by a corporate surety authorized and admitted to transact a surety business in the State of California in an amount equal to ten percent of the amount of the bid. No bid shall be considered unless such cash, cashiers or certified check, or bidder's bond is enclosed with the bid. Any bidder's bond shall contain provisions for forfeiture consistent with California Public Contract Code section 20172.

2-1.40 Withdrawal of Bid: A bid may be withdrawn prior to, but not after, the hour fixed in the public notice for the opening of bids, provided that a written request to withdraw the bid, executed by the bidder or the bidder's authorized representative, is filed with the Engineer before this deadline. The withdrawal of a bid shall not prejudice the right of a bidder to submit a new bid.

2-1.43 Public Opening of Bids: Bids will be opened and read publicly at the time and place indicated in the Notice to Bidders. Bidders or their authorized agents are invited to be present.

2-1.46 Disqualification of Bidders: Serial bids from the same bidder will not be accepted. This section shall not be interpreted to mean that the same contractor may not be the contractor in one bid and listed as a subcontractor in another bid, provided that no collusion exists.

2-1.48 Competency of Bidders: No bid will be accepted from or contract awarded to a contractor that is not licensed in accordance with the law, that does not hold a license qualifying it to perform work under this contract, to whom a bid form has not been issued by the Engineer, or that has not

successfully completed projects of similar character, scope and cost to the proposed project. Bidders will be required to provide a list of previous similar jobs with their bids.

3 CONTRACT AWARD AND EXECUTION

3-1.04 Contract Award: The City reserves the right to reject any or all bids. Bids are required for the entire work described herein. All bids will be compared with the Engineer's estimate of the quantities of work to be completed. Contract award, if any, will be made to the lowest responsible bidder within sixty days from the date bids are opened.

3-1.05 Contract Bonds: Within ten days after receipt of the Notice of Award, the successful bidder shall provide the following bonds to the City:

a. Performance Bond: A performance bond to guarantee the faithful performance of the terms and conditions of the Contract by Contractor, which shall be executed in a sum of not less than one-half of the Contract price;

b. Labor and Materials Bond: A labor and materials bond (payment bond) in accordance with Part 6 of Division 4, sections 8000 *et seq*. of the California Civil Code, to guarantee against any and all claims of subcontractors or other third parties furnishing labor, materials, or supplies for the Contract, which shall be executed in a sum of 100% of the Contract price; and

c. Material Guaranty Bond: A material guaranty bond (warranty bond) to serve as surety for the guarantee requirements outlined in Section 6-3.01B, which shall be executed in a sum of not less than one-half of the Contract price.

The bond(s) shall be provided in a form acceptable to the City and issued by a corporate surety in good financial standing and authorized and admitted to transact a surety business in the state of California for the purposes and in the amount(s) stated above.

Whenever the financial or legal status of any surety on any such bond(s) is/are unacceptable to the City, it may make a demand to Contractor for further bond(s) or additional surety, not exceeding the sums originally required. Thereafter, no payment shall be made upon the Contract to Contractor or any assignees of Contractor until such bond(s) or additional surety has/have been provided to the City.

3-1.07 Indemnification and Insurance: Indemnification: Contractor shall defend, hold harmless and indemnify City, its officers, agents and employees, and each and every one of them, from and against any and all actions, damages, costs, liabilities, claims, demands, losses, judgments, penalties, costs and expenses of every type and description, including, but not limited to, any fees and/or costs reasonably incurred by City's staff attorneys or outside attorneys and any fees and expenses incurred in enforcing this provision (hereafter collectively referred to as "Liabilities"), including but not limited to Liabilities arising from personal injury or death; damage to personal, real or intellectual property or the environment; contractual or other economic damages, or regulatory penalties, arising out of or in any way connected with the performance of or the failure to perform the Contract by Contractor, any subcontractor or agent, anyone directly or indirectly employed by any of them or anyone for whose acts any of them may be liable, whether or not such Liabilities are caused in part by a party indemnified hereunder, or such Liabilities are litigated, settled or reduced to judgment; provided, that the foregoing indemnity does not apply to liability for any damage or expense for death or bodily injury to persons or damage to property to the extent arising from (i) the sole negligence, or willful misconduct of, or defects in design furnished by City, its agents, servants, or independent contractors who are directly responsible to City (excluding Contractor), or (ii) the active negligence of City.

The existence of any of the insurance policies or coverages described in this Contract shall not affect or limit any of City's rights hereunder, nor shall the limits of such insurance limit Contractor's liability to the City hereunder. The provisions of this section shall survive any expiration or termination of the Contract.

Insurance: Contractor shall maintain in full force and effect all of the insurance coverage described in and in accordance with the insurance requirements set forth below. Maintenance of such insurance coverage during the entire performance of the Contract is a material element of the Contract. Failure by Contractor to (i) maintain or renew coverage, (ii) provide notice of any changes, modifications, or reductions in coverage, or (iii) provide evidence of renewal, if necessary, may be deemed a material breach of the Contract by Contractor, whereas the City shall be entitled to all rights and remedies at law or in equity. Notwithstanding the foregoing, any failure by Contractor to maintain required insurance coverage shall not excuse or alleviate Contractor from any of its other duties or obligations under the Contract. In the event Contractor retains or utilizes any subcontractors or sub-consultants in performance of the work, Contractor shall assure that any such subcontractor has first obtained, and shall maintain, all of the insurance coverage requirements herein set forth below.

Insurance Requirements:

A. Insurance Policies: Contractor shall maintain and keep in full force and effect, the following policies of insurance with minimum coverage as indicated below and issued by insurers with an AM Best rating of no less than A-:VI or a rating otherwise acceptable to the City.

	Insurance	Minimum Coverage Limits	Additional Coverage Requirements
1.	Commercial general liability	$5 million per occurrence $5 million aggregate	Coverage must be at least as broad as ISO CG 00 01 and must include products liability and completed operations coverage which shall continue for a period of three years after acceptance of the work by the City. If insurance applies separately to a project/location, aggregate may be equal to per occurrence amount. Coverage may be met by a combination of primary and umbrella or excess insurance but umbrella and excess shall provide coverage at least as broad as specified for underlying coverage. Completed Operations Coverage can be provided in the form of an endorsement to Contractor's insurance (at least as broad as ISO Form CG 20 37 04 13. See endorsements below for other Additional Insured Requirements. Coverage shall not exclude subsidence.
2.	Business auto coverage	$3 million	Coverage at least as broad as ISO Form Number CA 00 01 covering any auto (Code 1). Insurance shall cover owned, non-owned and hired autos.

3.	Workers' compensation and Employer's Liability	$1 million	As required by the State of California, with Statutory Limits and Employer's Liability Insurance with limit of no less than $1 million per accident for bodily injury or disease. The Workers' Compensation policy shall be endorsed with a waiver of subrogation in favor of the City for all work performed by Contractor, its employees, agents and subcontractors.

B. Endorsements:

1. All policies shall provide or be endorsed to provide that coverage shall not be canceled by either party, except after prior written notice has been provided to the City in accordance with the policy provisions.
2. Liability policies shall provide or be endorsed to provide the following:
   a. For any claims related to this Contract, Contractor's insurance coverage shall be primary and any insurance or self-insurance maintained by City shall be in excess of Contractor's insurance and shall not contribute with it. Endorsements at least as broad as 20 01 04 13 or evidence of policy language will be required in non ISO CGL policies.
   b. **The City of Santa Rosa, its officers, agents and employees are to be covered as additional insureds on the CGL policy**. Additional Insured Endorsements at least as broad as 20 10 04 13 or 20 38 04 13 are required.

C. Verification of Coverage and Certificates of Insurance: Contractor shall furnish City with original certificates and endorsements effecting coverage required above. Certificates and endorsements shall make reference to policy numbers. All certificates and endorsements are to be received and approved by the City before work commences and must be in effect for the duration of the Contract. The City reserves the right to require complete copies of all required policies and endorsements during the duration of the Contract and for a period of three years following City's acceptance of the work.

D. Other Insurance Provisions:

1. No policy required by this Contract shall prohibit Contractor from waiving any right of recovery prior to loss. Contractor hereby waives such right with regard to the indemnitees.
2. All insurance coverage amounts provided by Contractor and available or applicable to this Contract are intended to apply to the full extent of the policies. Nothing contained in this Contract limits the application of such insurance coverage. Coverage for an additional insured shall NOT be limited to the insured's vicarious liability. Defense costs must be paid in addition to coverage amounts.
3. Self-insured retentions above $10,000 must be approved by the City. At the City's option, Contractor may be required to provide financial guarantees.
4. City reserves the right to modify these insurance requirements, including limits, based on the nature of the risk, prior experience, insurer, coverage, or other special circumstances.

3-1.18 Contract Execution: The fully executed Contract, original bonds and insurance certificates and endorsements required under the Contract shall be delivered to the City within ten calendar days of Contractor's receipt of the Notice of Award.

The Engineer will supply Contractor with up to ten sets of the Invitation for Bids and Project Plans. At least one complete set of the Invitation for Bids and Project Plans shall be kept at the construction site in good condition and made available to the Engineer at all times. Additional copies of the Invitation for Bids and Project Plans will be provided by the Engineer at Contractor's cost.

3-1.20 Failure to Execute Contract: Contractor's failure to deliver to the City the fully executed Contract within ten calendar days of Contractor's receipt of the Notice of Award shall be cause for the cancellation of the award and the forfeiture of the bid guaranty to the City. If the successful bidder refuses or fails to execute the Contract, the City may award the Contract to the second lowest responsible bidder. If the second lowest responsible bidder refuses or fails to execute the Contract, the City may award the Contract to the third lowest responsible bidder. The refusal or failure by the second or third lowest responsible bidder to deliver to the City the fully executed Contract within ten calendar days of receipt of the Notice of Award to the respective bidder shall likewise be cause for the cancellation of the award and the forfeiture of the bid guaranty of the respective bidder. In its discretion, the City may then re-advertise the project or construct it by day labor.

3-1.21 Return of Bid Guarantees: Within ten days after the opening of bids, the City will return the bid guarantees to all bidders except the three lowest responsible bidders. The bid guarantees of the three lowest responsible bidders will be retained until the Contract has been fully executed. In the event all bids are rejected, all bid guarantees will be returned to the respective bidders.

3-1.22 Subcontractors: The successful bidder shall furnish a list of all subcontractors as required under Sections 2-1.33C. The list shall include the name, business address, DIR registration number and the state contractor's license number of each subcontractor on the list and the names of the responsible managing employees whose names appear on the subcontractors' licenses.

4 SCOPE OF WORK

4-1.05 Changes and Extra Work: All changes to the Contract shall be made by written change order only.

All extra work shall be recorded by Contractor on a daily report signed by both the City and Contractor. The "daily reports" shall thereafter be considered the true record of extra work performed. A copy of the daily reports will be furnished to Contractor. Contractor is directed to Section 9-1.04 of this Invitation for Bids.

4-1.05C Compensation for Altered Quantities: Payment and compensation for altered quantities shall conform to the provisions of Section 9-1.06 of the Standard Specifications, except as modified herein.

5 CONTROL OF WORK

5-1.02 Contractor's Copies of Contract Documents: In the event of a conflict in any of the Contract Documents, the order of precedence from highest to lowest shall be as follows:

1. Special Provisions
2. Project Plans, consisting of 40 sheets entitled Laguna Treatment Plant Digester Gas Conditioning Improvements, 2018-0018
3. City Standards
4. City Specifications
5. Standard Specifications
6. Standard Plans

5-1.05 Order of Work: The work as shown on the Project Plans and as specified in the Invitation for Bids shall be constructed in a sequence that is satisfactory to and approved by the Engineer.

Contractor shall prepare a work schedule per Section 8-1.02 of the Standard Specifications.

With the exception of trenching, all existing street, street light base, curb and gutter, storm drain, water line, and sewer line work shall be completed before any existing street paving is removed.

Full compensation for the conformance to the requirements of this section is included in the Contract price and no additional allowance will be made to Contractor for this work.

5-1.17 Character of Workers: Contractor is directed to Section 5-1.17 of the Standard Specifications which states:

> "If any subcontractor or person employed by the Contractor shall appear to the Engineer to be incompetent or to act in a disorderly or improper manner, he shall be discharged immediately on the request of the Engineer, and such person shall not again be employed on the work."

No additional compensation shall be granted to Contractor in the event City exercises any part of its rights under this section and any and all costs related to such exercise shall be borne by Contractor.

5-1.20 Cooperation with Other Entities: Attention is directed to Section 5-1.20 of the Standard Specifications.

Other construction including but not limited to utility, power, and pipe line relocation, may be in progress by other forces within and adjacent to the project area at the same time work is being performed under this Contract by Contractor.

Contractor shall cooperate with the forces performing other work, to the end that such forces may conduct their operations with as little inconvenience and delay as possible. Contractor shall grant such forces access to the project area as is reasonable and necessary to transport materials and equipment to the site of operations by the other forces.

5-1.20B(4)(a) Offsite Staging Areas and Construction Yards: Attention is directed to Santa Rosa City Code section 20-52.040, Temporary Use Permit.

A Temporary Use Permit shall be obtained for any offsite construction yard on private property to be used for any of the following:

a. Stockpiling of equipment and/or materials;
b. Staging of construction;
c. Placement of work trailers or mobile offices;
d. Storage of trench spoils; or
e. Other construction related activities not specifically enumerated above.

5-1.26 Lines and Grades: Contractor shall carefully preserve all bench marks, grade stakes, and all other survey markers. In the case of willful or careless destruction, Contractor shall bear the cost of replacing the markers.

Contractor shall contact the Engineer directly for coordination of survey staking. Written staking requests must be submitted at least two working days in advance of the date and time stakes are needed.

5-1.27B Examination and Audit: Pursuant to California Government Code section 8546.7, any contract with the City involving expenditures in excess of $10,000 shall be subject to the examination and audit of the California State Auditor for a period of three years after final payment is made to Contractor by City under this Contract. Any such examination and audit will be confined to those matters connected with the performance of this Contract.

5-1.30A Inspection: Contractor shall bear all costs associated with the re-inspection of any defective, rejected or unauthorized work as determined by the Engineer in Engineer's sole discretion. Such costs of re-inspection, including any costs incurred by the City for additional staff time or fees for third-party consultant inspectors, will be deducted from one or more progress payments hereunder.

5-1.36A Property and Facility Preservation: Attention is directed to Section 5-1.36 of the Standard Specifications.

At Contractor's sole expense, all fences, gates, landscaping, drainage ditches, sidewalks, irrigation systems, and any other improvements that are damaged, removed or destroyed because of Contractor's operations, shall be replaced in accordance with City Standards at a minimum and restored to the same or better condition. Concrete surface treatment and score marks shall match adjacent existing concrete improvements.

5-1.36E Obstructions: Attention is directed to Section 5-1.36 of the Standard Specifications and to the possible existence of underground gas mains, high voltage lines, telephone ducts, storm drains and water and sewers systems, the locations of which are not shown on the Project Plans. The determination of the location of these facilities and the cost of repair or replacement in the event of damage to such facilities are the sole responsibility of Contractor.

Should Contractor alter any public utility or private improvements to facilitate its operations or for its sole benefit, which alteration would not be otherwise required, Contractor shall make whatever arrangements are necessary with the owner or controlling authorities, and shall bear all expenses in connection therewith. Any damages to any public utility or private improvement caused by Contractor shall be repaired by Contractor at its sole expense and to the full satisfaction of the Engineer or the controlling authority.

Any subsurface information and data furnished under any part of this Contract are not intended as a representation or warranty but are furnished for information only. It is expressly understood that the City will not be responsible for the accuracy thereof or for any deduction, interpretation or conclusion drawn therefrom by Contractor. The information is made available so that Contractor may have ready access to the same information available to the City and is not part of this Contract.

PRIOR TO STARTING ANY EXCAVATION, CONTRACTOR SHALL (AT LEAST TWO WORKING DAYS IN ADVANCE) CALL UNDERGROUND SERVICE ALERT (USA) toll free at (800) 227-2600 and provide USA with all necessary data relative to the proposed excavation. USA will accept calls and process information to participating agencies who have underground facilities in the area between the hours of 7:30 a.m. and 5:00 p.m. daily, except Saturdays, Sundays, and holidays. Between the hours of 5:00 p.m. and 7:30 a.m., calls will be recorded and then processed after 7:30 a.m. For emergency situations, after hours, and on Saturdays, Sundays and holidays, Contractor shall contact the owner of the affected facility.

Contractor shall coordinate all work with the appropriate City field personnel. When City work forces are required at the job site to perform Contract items of work, Contractor shall give a minimum of two working days advanced notification to the appropriate field office:

Water Division:	(707) 543-4200
Sewer Division:	(707) 543-4200
Street Division:	(707) 543-3880
Survey Division:	(707) 543-3834

5-1.43 Potential Claims and Dispute Resolution: "Claim" means a separate demand by Contractor sent by registered mail or certified mail with return receipt requested, for one or more of the following: (A) A time extension, including, without limitation, for relief from damages or penalties for delay assessed by the City under the Contract; (B) Payment by the City of money or damages arising from work done by, or on behalf of, Contractor pursuant to the Contract and payment for which is not otherwise expressly provided or to which the claimant is not otherwise entitled; or (C) Payment of an amount that is disputed by the City.

Upon receipt of a Claim, the City shall conduct a reasonable review of the Claim and, within a period not to exceed 45 days, shall provide Contractor a written statement identifying what portion of the Claim is disputed and what portion is undisputed, provided, the parties may extend the 45 day time period by mutual agreement.

If the City needs approval from the City Council to provide the claimant a written statement identifying the disputed portion and the undisputed portion of the Claim, and the Council does not meet within the 45 days or within the mutually agreed to extension of time following receipt of a Claim, the City shall have up to three days following the next duly publicly noticed meeting of the City Council after the 45-day period, or extension expires to provide Contractor a written statement identifying the disputed portion and the undisputed portion.

Any payment due on an undisputed portion of the Claim shall be processed and made within 60 days after the City issues its written statement. If the City fails to issue a written statement, the Claim shall be deemed rejected in its entirety.

If a Contractor disputes the City's written response, or if the City fails to respond to a Claim within the time prescribed, the Contractor may demand in writing an informal conference to meet and confer for settlement of the issues in dispute. Upon receipt of a demand in writing sent by registered mail or certified mail, return receipt requested, the City shall conduct a meet and confer conference within 30 days for settlement of the dispute. Within 10 business days following the conclusion of the meet and confer conference, if the Claim or any portion of the Claim remains in dispute, the City shall provide the Contractor a written statement identifying the portion of the Claim that remains in dispute and the portion that is undisputed. Any payment due on an undisputed portion of the Claim shall be processed and made within 60 days after the City issues its written statement. Any disputed portion of the Claim, as identified by Contractor in writing, shall be submitted to nonbinding mediation, with the City and the Contractor sharing the associated costs equally. The City and Contractor shall mutually agree to a mediator within 10 business days after the disputed portion of the Claim has been identified in writing. If the parties cannot agree upon a mediator, each party shall select a

mediator and those mediators shall select a qualified neutral third party to mediate with regard to the disputed portion of the Claim. Each party shall bear the fees and costs charged by its respective mediator in connection with the selection of the neutral mediator.

6 CONTROL OF MATERIALS

6-2.01 Source of Supply and Quality of Materials: All materials required to complete the work under the Contract shall be furnished by Contractor and shall be free of hazardous substances.

6-3.01 General: Statistical means will not be used by the City for determination of Standard Specification compliance. Whenever both operating range test results and Contract compliance requirements are specified in these special provisions, the operating range requirements shall apply to the individual test results.

6-3.01A Material Submittals: Upon award of the Contract by City, Contractor shall submit to the Engineer a list of all materials proposed to be used on this project and any supporting documentation and/or samples required and source of supply.

For material listed on the "Engineer's List of Approved Items" which is located in the Sewer and Water sections only of the City Standards, the Engineer shall be provided with the name of the manufacturer and model/part number for all material proposed for this project, unless that item has been replaced as shown on the Project Plans or in the Invitation for Bids.

For all other materials used on this project, regardless of the type of work, Contractor shall provide to the Engineer the name of the manufacturer and model/part number along with supporting documentation and/or samples that will allow the Engineer to determine the material's acceptability.

The Engineer reserves the right to reject any proposed material, whether on the City's "Engineer's List of Approved Items" or not. If the City obtains information indicating that a listed item is not performing satisfactorily or is found to be defective, that item will be rejected and Contractor shall submit a replacement for review at no additional cost to the City.

6-3.01B Material Guarantee: Before any contract is awarded, the bidder may be required to furnish samples of materials and detailed descriptions of equipment to be used in the construction of the project. The materials samples may be subjected to the tests provided for in the Standard Specifications or in this Invitation for Bids to determine their quality and fitness for the project. The successful bidder shall unconditionally guarantee project materials and workmanship for a period of one year from the date of recording of the Notice of Completion. The guarantee shall cover 100% of all costs of repairs within the one year period, including all costs of labor, materials, equipment, and incidentals. Except as may be otherwise provided in Section 3-1.05, the successful bidder shall provide a surety bond executed by a corporate surety authorized and admitted to transact a surety business in the state of California in the minimum amount of one-half of the Contract price to cover this guarantee.

6-3.05 Quality Assurance: California Test 216 (Relative Compaction) testing will be modified as follows: A mechanical compactor (Ploog Engineering Co. Model M 100 or equivalent) with 10-pound hammer and split compaction molds shall be used in lieu of the specified manual compaction equipment.

California Test 231 (Nuclear Gage Determination of In-Place Density) will be modified as follows: In-place density and relative compaction may be determined on the basis of individual test sites in lieu of the area concept, at the discretion of the Engineer.

6-4 Water Utility

6-4.01A Construction Water: All water required for the performance of the work shall be provided by Contractor. Prior to obtaining water from the City's water system, Contractor shall obtain a Water

Use Permit from the City of Santa Rosa Water Department and rent a hydrant or bridge meter. Contractor is responsible for the cost of all water and the cost of all deposits, permits and fees.

Contractor is prohibited from operating gate valves or fire hydrants on the City system.

The acquisition of water from the City's water system through un-metered hydrants or other facilities is a violation of City ordinance and State law. The use of water from sources other than the City's water system must be approved by the Engineer in advance of the use.

Citations and fines will be levied for violation of these and other utility regulations and deductions will be made from payments consistent with Section 7-1.02A(1) of the Standard Specifications.

6-4.01B Water Utility Notification: Contractors or parties requiring work of any kind by the City of Santa Rosa Water Department forces shall request such services a minimum of 48 hours in advance of the time such services are desired. Work requests which will involve the City of Santa Rosa Water Department forces for more than eight hours or an extensive number of City parts shall be requested a minimum of seven calendar days in advance.

If it is necessary to terminate or disrupt utility service to any customer, Contractor shall make the request for such work by City forces an additional 72 hours (three additional working days for a total of five working days advance notice) in advance of the time such services are desired to allow affected customers a minimum of 72 hours' notice. Contractors who fail to keep field appointments will be billed for scheduled City of Santa Rosa Water Department crew standby time which was used and the Contractor shall bear the costs incurred by the City of Santa Rosa's Water Department for re-notification of customers.

City of Santa Rosa Water Department crews work a 9/80 schedule. This schedule may prohibit shutdowns for tie-ins on alternating Fridays. After hours work or weekend work may be performed if prior authorization from the Engineer is obtained.

Other than the hours specified in this Invitation for Bids, requests by Contractor for after hours or weekend work is to be avoided whenever possible. Any overtime costs incurred by City for such work shall be borne by Contractor.

Interruption of utilities service to commercial customers shall be coordinated with the customer to minimize disruption to the enterprise to the greatest extent practicable. After notification by the Contractor of the need, the City of Santa Rosa Water Department will contact all commercial customers and inform Contractor accordingly.

6-4.01C Water Facility Damage: All damage caused to the City's water system shall be immediately reported to the Engineer.

Damage caused to the City's water system by Contractor's operations shall be repaired by the Contractor at Contractor's sole expense in a manner satisfactory to the City of Santa Rosa Water Department. Such repairs shall not be charged to the City or any City project. All repair work shall be witnessed and approved by the City of Santa Rosa Water Department prior to backfilling the excavation. The City will require re-excavation if backfilling occurs prior to inspection, which costs shall be borne by Contractor.

Contractor is responsible for, at its sole cost and expense, the repair and remediation of damage to property and facilities caused by any of the following circumstances:

a. Contractor fails to make a written request for a markout or begins excavation without providing the City of Santa Rosa Water Department a reasonable opportunity to mark facilities;

b. Contractor destroys markouts;
c. Contractor fails to perform hand digging or probing for utilities near markouts; or
d. Contractor fails to use reasonable caution, regardless of whether markouts are present or clear. Reasonable caution includes any efforts to avoid damaging existing facilities, such as when excavating in the vicinity of water mains.

City may, in its discretion, opt to make the repairs for which Contractor is responsible with its own forces. In such cases, the repairs will be made at Contractor's expense in accordance with the emergency repair rate schedule of the City of Santa Rosa Water Department. The City may make repairs whenever restoration of service requires extraordinary speed or special equipment. Contractor will be billed accordingly and City shall have the right and option to withhold payment hereunder, or a portion thereof, for any such costs billed but not promptly paid by Contractor.

6-4.02 Salvage: All valves, hydrants, and other appurtenances of the water system that are the property of City and removed by Contractor shall be delivered to the City's Municipal Services Center (55 Stony Point Road) unless Contractor has obtained specific written approval from the City of Santa Rosa Water Department to otherwise dispose of the materials.

6-4.03 Trade Names and Alternatives: Unless otherwise specified, material and equipment specifications that identify a particular patent, trade name or manufacturer, may be satisfied through substitute materials and equipment accepted by the City. Contractor may offer substitute materials and equipment of equal or better quality y to the City. Any such offer shall be made in writing to the Engineer at least four weeks in advance of the time Contractor wishes to order the materials or equipment. Contractor shall include sufficient data which, together with any other information the Engineer may require, will enable the Engineer to determine the acceptability of the materials and equipment. When the substitute materials or equipment necessitate changes to any part of the work, the information shall include drawings and details showing all such changes and Contractor shall perform these changes as a part of any acceptance of substitute materials or equipment. The use of substituted materials and equipment will be permitted only after written acceptance of the materials and equipment by the Engineer. Such acceptance shall not relieve the Contractor from full responsibility for the sufficiency, quality and performance of the substitute materials and equipment.

The City will not, under any circumstances, acknowledge or consider any offers to accept substitute materials or equipment between the dates of public notice of advertisement and the bid opening.

7 LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC

7-1.02A(1) Forfeitures for Health and Safety Violations: Contractor shall comply with all applicable provisions of the Santa Rosa City Code and any failure to do so shall constitute a breach of the Contract. In the event of any violation of the Santa Rosa City Code that may impact public health and safety, including, but not limited to Chapter 17-12, "Storm Water" and Chapter 13-04, "Street Encroachments," City shall have the right to impose a charge against Contractor in an amount equal to $500.00 per violation per day. Prior to the imposition of any charge hereunder, City shall first provide a written notice to Contractor of the violation and setting forth a reasonable period of time for Contractor to cure the violation(s). In the event Contractor fails to cure any such violation within the time provided, City shall have the right, in addition to all other rights and remedies available to City, to deduct and withhold as a permanent forfeiture by Contractor the appropriate amounts from any payment otherwise due Contractor under this Contract.

7-1.02K(2) Wages: Pursuant to Labor Code sections 1770 *et seq*., each laborer or mechanic of Contractor or any subcontractor engaged in work on the project under this contract shall be paid not less than the hourly wage rate of per diem wages set forth in the prevailing wage rate schedule published by the Director of Industrial Relations, regardless of any contractual relationship which may be alleged to exist between Contractor or any subcontractor and such laborers and mechanics. A copy of the schedule of prevailing wage rates can be obtained online at www.dir.ca.gov or from the Department of Transportation and Public Works at 69 Stony Circle, Santa Rosa.

Any laborer or mechanic employed to perform work on the public works project under this Contract, which work is not covered by any of the foregoing classifications, shall be paid not less than the prevailing wage rate of per diem wages specified herein for the classification which most nearly corresponds to the work to be performed by the worker.

The foregoing specified prevailing wage rates are minimum rates only, and Contractor may pay any wage rate in excess of the applicable rate.

Pursuant to Labor Code Section 1775, Contractor as a penalty to the owner shall forfeit not more than $200.00 for each calendar day, or a portion thereof, for each worker paid less than the prevailing wage rate established by the Department of Industrial Relations for such work or craft in which such worker is employed. The difference between such prevailing wage rates and the amount paid to each worker for each calendar day or portion thereof for which the worker was paid less than the prevailing wage rate shall be paid to each worker by Contractor.

Contractor shall only provide prevailing wage reports upon written request from City.

7-1.02K(4) Apprentices: Contractor agrees to comply with Chapter 1, Part 7, Division 2, sections 1777.5 *et seq*. of the California Labor Code. These sections require contractors and subcontractors to employ apprentices in apprenticeable occupations in a ratio of not less than one hour of apprentice work for each five hours of journeyman work (unless an exception is granted in accordance with Section 1777.5), and the contractors and subcontractors shall not discriminate among otherwise qualified employees as apprentices solely on the ground of sex, race, religion, creed, national origin, ancestry, or color. Only apprentices as defined in Labor Code section 3077, who are in training under apprenticeship standards and who have written apprentice agreements will be employed on public works in apprenticeable occupations. The responsibility for compliance with these provisions is fixed with the prime contractor for all apprenticeable occupations.

7-1.02K(6)(a)(1) Notice to Vendors: Attention is directed to the current OSHA Standards. All equipment, tools and materials which are furnished and/or installed as part of this Contract shall meet or exceed the aforementioned standards in order to be considered acceptable.

7-1.02K(6)(b) Excavation Safety: When the digging or excavation occurs during project construction, Contractor shall:

a. Promptly notify City in writing of the following conditions before any such conditions are disturbed:

    1. Material that the Contractor believes may be hazardous waste as defined in Health and Safety Code section 25117 that is required to be removed to a Class I, Class II or Class III disposal site in accordance with provisions of existing law;
    2. Subsurface or latent physical conditions at the site differing from those indicated in the Invitation for Bids; and
    3. Physical conditions at the site of any unusual nature, materially different from those ordinarily encountered and generally recognized as inherent in the type of work under the Contract.

b. The City will investigate the conditions and will issue a change order under the terms of the Contract if it finds that the conditions warrant it.

c. If a dispute arises between City and Contractor as to whether a change order is warranted, Contractor shall not be excused from any scheduled completion date provided for in the Contract, but shall proceed with all work to be performed under the Contract.

7-1.02K(6)(b)(1) Trench Excavation Safety Plans: When the estimated cost for the excavation of any trench or trenches five feet or more in depth will exceed $25,000.00, Contractor shall submit to the Engineer in advance of excavation a detailed plan showing the design of shoring, bracing, sloping or other provisions to be made for worker protection from the hazard of caving ground during the excavation of such trench or trenches. If such plan varies from the shoring system standards established by the construction safety orders, or if the trench is anticipated to be greater than 20 feet, the plan shall be prepared by a registered civil or structural engineer.

A permit to do the above described work shall be obtained from the State of California, Division of Industrial Safety. Proof of such permit shall be submitted to the Engineer prior to starting the trench work.

Full compensation for complying with the provisions of this section shall be considered as included in the Contract price and no additional allowance will be made for the work.

7-1.02K(6)(d) Confined Space Safety: Any confined space entry for this project, including but not limited to manhole or water storage tank entry, will require a confined space entry permit pursuant to Cal/OSHA regulations as set forth in title 8 California Code of Regulations (CCR) sections 5157 or 5158. Confined space entry shall have the meaning ascribed in title 8 CCR sections 5157 and 5158. For any confined space entry for construction operations regulated by title 8 CCR section 1502, Contractor shall comply with title 8 CCR section 5158, “Other Confined Space Operations.” For any other confined space operations, Contractor shall comply with title 8 CCR section 5157, “Permit-Required Confined Spaces.”

Attention is directed to the technical specifications in the Special Provisions for information regarding entry to any City maintained confined space. Pursuant to title 8 CCR section 5157, Contractor is required to obtain any available information regarding hazards and operations for any City maintained confined spaces. The City maintained Confined Space Entry Manual is available

for viewing at the City of Santa Rosa Water Department or Transportation and Public Works Department office at 69 Stony Circle, Santa Rosa.

Contractor shall immediately inform the Engineer of any previously unidentified hazards confronted or created during confined space entry.

7-1.02L(2)(a) Patents and Royalties: All fees, royalties, or claims for any patented invention, article, process or method that may be used upon or in any manner connected with the work under this Contract shall be paid by Contractor. Contractor and its sureties shall protect and hold harmless City and its officers, agents, and employees from any and all demands made for such fees royalties or claims brought or made by any third party, and before the final payment is made on the account of the Contract, Contractor shall, if requested by City, furnish acceptable proof of a proper release from all such claims and liabilities.

Should Contractor, its officers, agents, or employees, or any one of them be enjoined from furnishing or using any invention, article, material, or plans supplied or required to be supplied or used under the Contract, Contractor shall promptly substitute other articles, materials, or appliances in lieu thereof of equal efficiency, quality, finish, suitability, and market value, and satisfactory in all respects to the Engineer. In the event that the Engineer elects, in lieu of such substitution, to have supplied and to retain and use any such invention, article, materials, or plans as may be required to be supplied by the Contract, Contractor shall pay such royalties and secure such valid licenses as may be requisite and necessary for City, its officers, agents, and employees, or any one of them to use such invention, article, materials, or appliance without being disturbed or in any way interfered with by any proceeding in law of equity on account thereof. Should Contractor neglect or refuse to make the substitution promptly or to pay such royalties and secure such licenses as may be necessary, then in that event the Engineer shall have the right to make such substitutions or City may pay such royalties and secure such licenses and charge Contractor even though final payment under the Contract may have been made.

7-1.02M(3) Mined Materials: California Public Contract Code section 20676 prohibits surface mining operators which are subject to the Surface Mining and Reclamation Act of 1975 (SMARA) from selling California mined construction material to the City unless the operator is identified in a list referred as the **3098 List**. The List, which is maintained by the Department of Conservation's Office of Mine Reclamation (OMR), changes throughout the year and can be viewed at the OMR website: http://www.consrv.ca.gov/OMR/ab_3098_list/index.htm. To confirm whether or not a specific operator is on the List at any given time, Contractor shall call the OMR at (916)323-9198.

7-1.03A Maintaining Traffic: Attention is directed to Sections 7-1.04 of the Standard Specifications and to the following modifications thereof.

If construction is within City owned right-of-way, provisions shall be made for the safe passage of public traffic through the work site at all times consistent with the requirements of Santa Rosa City Code Chapter 13-04.

Except for projects to be performed under a minor contract, Contractor shall install and maintain project identification signs at each end of the project or as directed by the Engineer two weeks prior to any construction activity. City shall furnish the appropriate sign panels upon request from Contractor. To mount the sign panels, Contractor shall furnish and install 4" X 4" posts or mount by other appropriate methods as approved by the Engineer. These sign panels shall be returned to the City Corporation Yard at 55 Stony Point Road after completion of the project.

Two weeks prior to any construction activity, advance notice signs for road closures shall be furnished and installed by Contractor at each end of the project and shall remain in place throughout the duration of the subject closure. Details of panel construction and lettering shall be approved by the Engineer.

Contractor shall furnish, install, and maintain at its expense all barricades, signs, lights, and other devices necessary to adequately warn of any obstructions to the traveled and pedestrian way and provide flaggers as necessary for the safety of public traffic and pedestrians and to provide access to property adjacent to the work site and Contractor shall comply with the Americans with Disabilities Act of 1990 (42 U.S.C. 12101, *et seq*.) (ADA) and any regulations and guidelines issued pursuant to the ADA.

Contractor shall comply with the current edition of the California Manual of Uniform Traffic Control Devices (CA MUTCD) for all items related to traffic within the work site.

Rain and other occurrences that may cause the suspension or delay of the work shall in no way relieve Contractor of its responsibility to provide traffic control and public access through the work site as specified herein. At all times, Contractor shall keep at the work site such materials, forces and equipment as may be necessary to keep roads, streets, and driveways within the work site open to traffic and in good repair and shall expedite the passage of such traffic, using such forces and equipment as may be necessary.

Should Contractor fail, in the opinion of the Engineer, to provide all the materials, forces and equipment necessary to maintain traffic through the work site as set forth herein, City may take steps necessary to remedy any such failure, including but not limited to causing such work to be performed and/or suspending any further work under the Contract. Any such remedial cost and expense incurred by the City, plus an administrative charge of 15%, shall be immediately due and payable by Contractor and may be deducted from any amounts owed to Contractor hereunder. In the event there are insufficient sums owed to Contractor hereunder to cover the foregoing costs and charges, City shall have the right to pursue any other remedy to recover the same, including but not limited to, proceeding against any surety or bond in favor of City. City's rights under Section 7-1.02 are intended to be in addition to and not in lieu of any charges imposed by City against Contractor under Section 7-1.02A(1) above for violations of the Santa Rosa City Code.

Contractor shall be responsible for informing emergency response agencies operating within the area of the work of obstructions to either public or private roads caused by reason of Contractor's operations hereunder.

Contractor shall make provisions for the safe passage of pedestrians around the project work site at all times.

8 PROSECUTION AND PROGRESS

8-1.01A Assignments: Once awarded, this Contract shall not be transferred, assigned, or sub-contracted, except as herein expressly provided without the prior written consent of the City in the City's sole and absolute discretion. See Section 5-1.12 of the Standard Specifications.

8-1.04B Standard Start: Contractor shall begin work within ten calendar days after the date authorized in the Notice to Proceed and shall diligently prosecute the Contract to completion before the expiration of:

160 WORKING DAYS

8-1.05 Time: Working days will be counted beginning with the day the Contractor begins work or with the tenth day after the date authorized in the Notice to Proceed, whichever occurs first.

Unless otherwise directed by Engineer, Contractor shall not conduct any activities that generate noise earlier than 7:00 a.m. or later than 7:00 p.m.

8-1.10 Liquidated Damages: Contractor hereby agrees that Contractor shall pay to the City liquidated damages for each and every calendar day delay over and above the number of working days prescribed above for finishing the work in the amount shown in Section 8-1.10 of the Standard Specifications.

9 MEASUREMENT AND PAYMENT

9-1.04 Force Account Work: All work done on a force account basis shall be recorded daily on report sheets prepared by Contractor and signed by both the Engineer and Contractor. Such reports shall thereafter be considered the true record of force account work performed during the project. Such reports shall be furnished to the Engineer and a copy retained by Contractor.

All extensions of labor, equipment, and material costs shall be completed by Contractor and submitted to the Engineer within 30 days of the completion of the extra work. Completed and extended extra work reports received later than the times herein prescribed may be deemed invalid and rejected without payment at the discretion of the Engineer.

9-1.07 Payment Adjustments For Price Index Fluctuations: Any references to Opt Out of Payment Adjustments for Price Index Fluctuations in the Standard Specifications are deleted in their entirety.

9-1.16 Progress Payments: Once each month for progress pay purposes, the City will prepare a written estimate of the total amount of completed work and accepted materials purchased by Contractor but not installed. The City shall retain five percent of such estimated value of the completed work and the unused materials and pay Contractor the balance after deducting all previous payments and all sums to be retained under the provisions of the Contract. No such estimate or payment shall be required to be made when, in the judgment of the Engineer, the work is not proceeding in accordance with the provisions of the Contract or when, in the Engineer's judgment, the total value of the completed work since the last estimate is less than $500.00. No such estimate or payment shall be construed to be an acceptance of any defective work or improper materials.

After Contract acceptance, the Engineer will prepare a written proposed final estimate of the proposed final quantities of work completed under the Contract and the value of such work and will submit such estimate to Contractor. The City shall retain five percent of such estimated value of the work done and shall pay to Contractor the balance after deducting all amounts to be retained under the provisions of the Contract.

The City may, at its option and at any time, retain out of any amounts due Contractor sums sufficient to cover any unpaid claims of City or others, provided that sworn statements of all non-City claims shall have been filed with the Director of Finance.

9-1.16E(6) Substitution of Securities for Withheld Amounts: Pursuant to Public Contract Code section 22300, securities may be substituted for any moneys withheld by City to ensure performance under this Contract, provided that substitution of securities provisions shall not be required in contracts in which there will be financing provided by the Farmer's Home Administration of the United States Department of Agriculture pursuant to the Consolidated Farm and Rural Development Act (7 USC sections 1921 *et seq*.), and where federal regulations or policies or both do not allow the substitution of securities. At the request and expense of Contractor, securities equivalent to the amount withheld shall be deposited with the City, or with a state or federally chartered bank as the escrow agent, which shall then pay such moneys to Contractor. The Director of Finance is authorized to execute substitution of securities agreements on behalf of the City. The City will return the securities to Contractor upon satisfactory completion of the Contract as determined by City in its sole discretion and the resolution of all outstanding claims against the securities. Contractor shall be the beneficial owner of any securities substituted for moneys withheld and shall receive any interest thereon.

Securities eligible for investment under this section shall include those listed in Government Code section 16430, bank or savings and loan certificates of deposit, interest bearing demand deposit accounts, standby letters of credit or any other security mutually agreed to by Contractor and the City, provided that the substituted security is equal to or not less than five percent of the Contract amount.

Security substitutions must be submitted by Contractor and approved by City prior to the time of the first progress payment to be made under the Contract. No other method of substituting securities for retention will be accepted. The security substitution shall be done only upon execution of an agreement satisfactory to City which includes the following provisions:

a. The amount of securities to be deposited;
b. The terms and conditions of conversion to cash in case of the default of Contractor; and
c. The procedure for return of securities upon completion of the Contract.

9-1.17D Final Payment and Claims: The processing of payment of the final estimate shall not be commenced less than 35 days after the date of recording of the Notice of Completion with the County Recorder's Office. Contractor is advised that it takes approximately ten days for a check to be issued following a request for payment.

Contractor shall submit its written statement of all claims for additional compensation under the Contract to the Engineer within 15 days after submission to Contractor of the proposed final estimate.

If Contractor does not file a claim within the 15 day period, or upon Contractor's approval, the Engineer will issue a final written estimate and the City shall pay to Contractor the entire sum due after deducting all previous payments, if any, and all amounts to be retained under the provisions of the Contract.

If Contractor files a claim within the 15 day period, the Engineer will furnish a semi-final estimate and pay the amount due under the semi-final estimate within 30 days. The semi-final estimate is conclusive as to the amount payable except as may be affected by claims and any amount retained. The Engineer shall then consider and investigate such claim, and shall make such revision in the final quantities as the Engineer may find to be due, and shall then make and issue a final written estimate. The City will pay the amount due, after deducting all previous payments, if any, and amounts to be retained under the provisions of the Contract.

Any and all prior partial estimates and payments shall be subject to correction in the final estimate and payment.

The final estimate shall be conclusive and binding against both parties to the Contract on all questions relating to the performance of the Contract and the amount of work done thereunder and compensation therefor, except in the case of gross error.

9-1.17D(3) Final Determination of Claims: Claims filed by Contractor shall be in sufficient detail to enable the Engineer to determine the basis and amount of the Claims. Contractor shall also furnish reasonable documentation to the City to support Claims. If additional information is required by the Engineer, Contractor shall provide such information to the Engineer no later than the 15th day after receipt of the written request from the Engineer. If the 15th day falls on a weekend, holiday, or day City offices are closed, then the information shall be provided to the Engineer no later than close of the next business day. Failure to submit the requested information to the Engineer within the time specified will be sufficient cause for denying the Claim.

Contractor shall keep full and complete records of the costs and additional time incurred for any work for which a claim for additional compensation is made. The Engineer or any designated Claim

investigator or auditor shall have access to those records and any other records as may be reasonably required by the Engineer to determine the facts or contentions in each Claim. Failure to grant access to such records shall be sufficient cause for denying the Claims.

9-1.22 Arbitration: Any references to Arbitration in the Standard Specifications are deleted in their entirety.

Claims submitted by Contractor shall be accompanied by a notarized certificate containing the following language:

Under the penalty of law for perjury or falsification and with specific reference to the California False Claims Act, Government Code sections 12650 *et seq*., the undersigned,

_____,
(Name)

_____ of
(Title)

_____
(Contractor)

hereby certifies that the claim for additional compensation made herein is supported by a true statement of the actual costs incurred and time expended on this project, and is fully documented by records maintained by Contractor.

Dated _____

/s/_____

Subscribed and sworn before me this _____ day of

_____

_____
Notary Public

My Commission Expires _____

Failure to submit the notarized certificate will be sufficient cause for denying the claim.

Any claim for overhead expenses, in addition to being certified as stated above, shall be supported by an audit report of an independent Certified Public Accountant. Any such overhead claim shall also be subject to audit by the City at its discretion.

Any costs or expenses incurred by the City in reviewing or auditing any claims that are not supported by Contractor's cost accounting or other records shall be deemed to be damages incurred by the City within the meaning of the California False Claims Act.

City of Santa Rosa

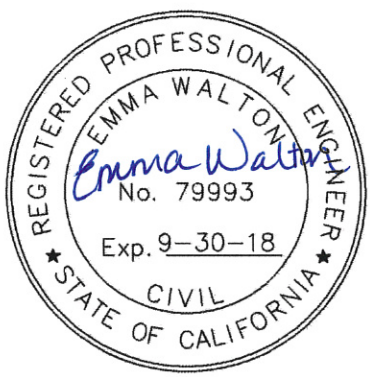
Technical Specifications

For

LAGUNA TREATMENT PLANT DIGESTER GAS CONDITIONING IMPROVEMENTS

Contract No. C02101

AUGUST 2018



13 WATER POLLUTION CONTROL (EXEMPT PROJECTS ONLY)

13-1 General

13-1.01A: Water Pollution Control shall be performed in accordance with Section 13, Water Pollution Control, of the Standard Specifications and these technical specifications. In addition, construction activities shall comply with:

The current California Water Quality Control Board, North Coast Region Order No. National Pollutant Discharge Elimination System Municipal Storm Water Permit, commonly referred to as the "Storm Water Permit". A copy of the Storm Water Permit is available for review at the City of Santa Rosa Transportation and Public Works Department, 69 Stony Circle, Santa Rosa, CA, and at www.srcity.org/stormwaterpermit.
The California Stormwater Quality Association Storm Water BMP Handbook for Construction (CASQA Handbook). BMPs shall be selected, installed and maintained in accordance with the latest edition. A copy of the handbook can be viewed at the City of Santa Rosa Department of Transportation and Public Works office at 69 Stony Circle or downloaded from CASQA, http://www.casqa.org/.

In this technical specification the CASQA Handbook BMP numbers are appended to the associated Standard Specification sections. If a conflict occurs the CASQA Handbook BMP's shall govern.

13-2 Water Pollution Control Program

13-2.01B Submittals: The program to control water pollution required to be submitted under this section of the Standard Specifications shall include a spill contingency plan that establishes clean-up procedures that will be followed in the event of a spill of potentially hazardous, toxic, or polluting materials.

13-2.04 Payment: Full compensation for conforming to this section shall be considered as included in the prices paid for the various contract items of work and no additional compensation will be allowed.

13-3 Storm Water Pollution Prevention Plan

13-3.01A Summary: This project is exempt from the State Water Resources Control Board General NPDES Permit for the Discharge of Storm Water related to Construction Activities (Construction General Permit), and not required to have a Storm Water Pollution Prevention Plan (SWPPP), therefore Section 13-3, Storm Water Pollution Prevention Plan, of the Standard Specifications does not apply to this project.

13-4 Job Site Management

13-4.03B: Spill Prevention and Control/CASQA Spill Prevention and Control (BMP WM-4):
If a spill occurs at the construction site and the contractor does not take immediate and adequate steps to contain and clean up the spill, especially if rain is threatening or if a discharge to a storm drain or creek could occur, the City shall have the right, in its sole and absolute discretion, to clean up the spill using City forces or an independent contractor. The cost of any such cleanup, in addition to recovery of any penalty or fine imposed upon the City, plus an

administrative charge of fifteen percent (15%) of the costs incurred by the City, shall be deducted from any amounts owed to Contractor hereunder.

In the event there are insufficient amounts owed to Contractor hereunder to cover the foregoing costs and charges, the City shall have the right to pursue any other remedy to recover same, including, but not limited to, proceeding against any surety or bond in favor of the City. The City's rights under this section are intended to be in addition to and not in lieu of any imposed by the City against Contractor for violations of City Code Chapter 17-12, "Storm Water".

13-4.03C(2): Material Storage/CASQA Material Delivery and Storage (BMP WM-1)

13-4.03C(3): Stockpile Management/CASQA Stockpile Management (BMP WM-3): Do not block storm water flows.

13-4.03D(1): Waste Management/CASQA Solid Waste Management (BMP WM-5): The Contractor shall dispose of all trash, rubbish, and waste materials of any kind generated by the contractor, subcontractor, or any company hired by the Contractor on a daily basis.

13-4.03D(3): Concrete Waste/CASQA Concrete Waste Management (BMP WM-8): Ensure the containment of concrete washout areas and other washout areas that may contain pollutants so there is no discharge into the underlying soil and onto the surrounding areas.

13-4.03D(4): Sanitary and Septic Waste/CASQA Sanitary and Septic Waste Management (BMP WM-9): Sanitation facilities must be maintained periodically by a licensed service to keep them in good working order and prevent overflows. Portable toilets are required to have secondary containment.

13-4.03D(5): Liquid Waste: Liquid waste includes water generated from excavation dewatering. Minimize transfer piping by locating containers near the excavation to be dewatered while protecting the containers from moving vehicles and equipment.

13-4.03E(1): Water Control and Conservation/CASQA Water Conservation Practices (BMP NS-1 and NS-2)

13-4.03E(3): Vehicle and Equipment Cleaning/CASQA Vehicle and Equipment Cleaning (BMP NS-8)

13-4.03E(4): Vehicle and Equipment Fueling and Maintenance/CASQA Vehicle and Equipment Fueling (BMP NS-9), and CASQA Vehicle and Equipment Maintenance (BMP NS-10)

13-4.03E(7): Paving, Sealing, Sawcutting, Grooving, and Grinding Activities: As listed in Part 9, sections 4 and 5 of the Storm Water Permit, the following additional BMPs shall be implemented for street paving, repaving, reconstruction, patching, digouts or resurfacing.

1. Restrict paving and repaving activity to exclude periods of rainfall or predicted rainfall unless required by emergency conditions;
2. Install BMPs at all susceptible storm drain inlets and manholes to prevent paving products and tack coat from entering;
3. Prevent the discharge of release agents including soybean oil, other oils, or diesel to the storm water drainage system or watercourses;
4. Minimize non-storm water runoff from water use for the roller and for evaporative cooling of the asphalt;

5. Clean equipment over absorbent pads, drip pans, plastic sheeting or other material to capture all spillage and dispose of properly
6. Collect liquid waste in a container, with a secure lid, for transport to a maintenance facility to be reused, recycled, or disposed of properly **13-4.03D(5)**;
7. Collect solid waste by shoveling and vacuuming or sweeping and securing in an appropriate container for transport to a maintenance facility to be reused, recycled, or disposed of properly **13-4.03D(5)**;
8. Cover "cold-mix" asphalt (i.e., pre-mixed aggregate and asphalt binder) with protective sheeting during a rainstorm **13-4.03C(3)**;
9. Cover loads with tarp before haul-off to a storage site, ensuring that trucks are not overloaded;
10. Minimize airborne dust by using water spray during grinding **14-9.03**;
11. Protect stockpiles with a cover or sediment barriers during a rain event and;
12. Avoid stockpiling soil, sand, sediment, asphalt material and asphalt grindings materials or rubble in or near storm water drainage system or watercourses **13-4.03C(1)**,

13-4.03F: Sweeping/CASQA Street Sweeping and Vacuuming (BMP SE-7)

13-4.04 Payment: Full compensation for conforming to this section shall be considered as included in the prices paid for the various contract items of work and no additional compensation will be allowed.

13-6 Temporary Sediment Control

13-6.03C: Temporary Drainage Inlet Protection/CASQA Storm Drain Inlet Protection (BMP SE-10)

13-6.04: Payment: Full compensation for conforming to this section shall be considered as included in the prices paid for the various contract items of work and no additional compensation will be allowed.

13-7 Temporary Tracking Control

13-7.01A: Temporary Tracking Control/Stabilized Construction Entrance and Exit (BMP TC-1), Entrance Outlet Tire Wash (BMP TC-3)

13-7.03 Construction/CASQA Stabilized Construction Site Entrance / Exit (BMP TC-1)

13-7.04 Payment: Full compensation for conforming to this section shall be considered as included in the prices paid for the various contract items of work and no additional compensation will be allowed.

13-10 Temporary Linear Sediment Barrier

13-10 Temporary/CASQA Silt Fence and Sand Bag Barrier (BMP SE-1 and SE-8)

13-10.04 Payment: Full compensation for conforming to this section shall be considered as included in the prices paid for the various contract items of work and no additional compensation will be allowed.

[Revised: 12/15/16 CDA STD2010]

14 ENVIRONMENTAL STEWARDSHIP

14-9.03 Dust Control

14-9.03A General: Sweeping per section 14-9.03C shall also be performed to prevent and alleviate dust.

Sweeping, covering stockpiles, applying water, and/or dust palliative, to control dust caused by public traffic is not change order work.

14-9.03C Construction: All dust-producing work and unpaved construction sites shall require a minimum watering in the middle and ending of each workday. The frequency of watering shall increase if dust is airborne. Watering shall not produce runoff.

Contractor shall maintain dust control to the satisfaction of the Engineer, 7 days a week, 24 hours per day.

At the end of each work day the Contractor shall thoroughly sweep all streets in the work zone to minimize airborne dust.

At the end of each work week the Contractor shall sweep all streets in the work zone with a commercial street sweeping truck equipped with a rear pick up broom.

At the Engineer's discretion additional sweeping or watering may be required, including the use of a commercial street sweeping truck equipped with a rear pick up broom, at any time or place.

14-9.03D Payment: Full compensation for conforming to this section shall be considered as included in the prices paid for the various contract items of work and no additional compensation will be allowed.

14-10.01 General: The Contractor shall dispose of all portland cement concrete and asphalt concrete, generated from removal or demolition activities on the project, at a recycler for these materials. The Contractor shall provide receipts verifying delivery and approximate quantity (in tons) of the material delivered to a material recycler.

All other excess materials from the project shall become the property of the Contractor and shall be disposed of by him, at his expense.

14-10.02A(1) Submittals: Submit a Solid Waste Disposal and Recycling Report prior to final acceptance of work performed under the Contract. Show the types and amounts of project-generated solid waste taken to or diverted from landfills or reused on the project.

Submit a Solid Waste Disposal and Recycling Report prior to Contract acceptance. Show the types and amounts of project-generated solid waste taken to or diverted from landfills or reused on the project.

14-10.02D Payment: Full compensation for material recycling as specified herein shall be considered as included in the contract prices paid for various items of work, and no additional compensation will be allowed therefor.

[Revised: 01/08/18-CDA STD2010]

SECTION 00 01 07

PROFESSIONAL SEALS

The technical specifications contained herein have been prepared by or under the direction of the following Registered Persons:

_____

Date: June 22, 2018

ADAM ROSS
BROWN AND CALDWELL
California License C 72161

END OF SECTION

SECTION 01 11 00

SUMMARY OF WORK

PART 1 GENERAL

1.01 SUMMARY

A. The work covered under this contract will be performed at the site of the Laguna Treatment Plant. The Laguna Treatment Plant is a continuously operating wastewater treatment facility serving the City of Santa Rosa and its Subregional partners.

1.02 DESCRIPTION OF OWNER'S PROJECT

A. The overall project will consist of all work as represented by the drawings, the specifications, and all other contract documents issued for construction and subsequent approved revisions and addenda.

1.03 WORK OF THIS CONTRACT

A. The work to be performed under this contract includes, but is not limited to, the following elements:
   1. Installation of new Siloxane Removal Vessel, associated piping, and process components
   2. Installation of two new Aftercooler Heat Exchangers (Duty/Standby), associated pads, piping, and process components
   3. Relocation of existing Particulate Filters to make room for the new Siloxane Removal Vessel
   4. Replace Glycol Pumps
   5. Relocation of the Digester Gas Pressure Regulating Valve
   6. Installation of new Digester Gas Bypass piping to be routed to the existing Waste Gas Burner
   7. Modification of Engine Fuel System in the CHP Building in preparation for future addition of SCR systems
   8. Site demolition work associated with the installation/relocation of new equipment and piping

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 11 80

ENVIRONMENTAL CONDITIONS

PART 1 GENERAL

1.01 ENVIRONMENTAL CONDITIONS

A. 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.

1.02 CLIMATE CONDITIONS

A. The site of the work is at an elevation of 100 feet above mean sea level.

B. Climate conditions are described as follows:

Description	Range of Conditions
Winter	November 1 through April 30. Mild to cold but little chance of snow or freezing. Light to moderate rain probably on any day.
Summer	May 1 through October 31. Warm to hot. Light rain probable on any day.
Average annual rainfall (inches)	24 inches
Relative humidity, percent	
• Indoors	30-80
• Average outdoors	20-100
Air temperature, degrees F	
• Outdoors	36-105
• Indoors	50-100
Barometric pressure, inches, mercury	30.00

1.03 ADDITIONAL CONDITIONS

A. Additional conditions which may be applicable are specified in other sections.

END OF SECTION

SECTION 01 12 16

WORK SEQUENCE

PART 1 GENERAL

1.01 CONTINUITY OF PLANT OPERATIONS

A. The existing wastewater treatment plant is currently and continuously receiving and treating sewage, and those functions shall not be interrupted except as specified herein. The Contractor shall coordinate the work to avoid any interference with normal operation of plant equipment and processes.

1.02 BYPASSING AND VENTING

A. Bypassing of untreated or partially treated sewage to surface waters or drainage courses is prohibited during construction. In the event accidental bypassing is caused by the Contractor's operations, the Owner shall immediately be entitled to employ others to stop the bypassing without giving written notice to the Contractor.

B. Venting of digester gas or natural gas to the atmosphere is prohibited during construction. Work, shutdowns, and purging shall be planned to avoid venting of digester gas or natural gas. In the event accidental venting is caused by the Contractor's operations, the Owner shall immediately be entitled to employ others to stop the venting without giving written notice to the Contractor.

C. Penalties imposed on the Owner as a result of any bypass or venting caused by the actions of the Contractor, his employees, or subcontractors, shall be borne in full by the Contractor, including legal fees and other expenses to the Owner resulting directly or indirectly from the bypass or venting.

1.03 SUBMITTAL

A. In accordance with Section 01 33 00, the Contractor shall submit a detailed outage plan and time schedule for operations which will make it necessary to remove a tank, pipeline, channel, electrical circuit, equipment, or structure from service. The schedule shall be coordinated with the construction schedule specified in the General Conditions of the Contract Documents and shall meet the restrictions and conditions specified in this section. The detailed plan shall describe the Contractor's method for preventing venting to atmosphere, the length of time required to complete said operation, the necessary plant, and equipment which the Contractor shall provide in order to prevent bypassing of associated treatment units.

B. The Contractor shall observe the following restrictions:
   1. Systems or individual equipment items shall be isolated, dewatered, decommissioned, deenergized, or depressurized in accordance with the detailed outage plan and schedule.
   2. The Construction Manager shall be notified in writing at least one week in advance of the planned operation.

C. To permit continuous treatment of wastewater and compliance with effluent quality requirements, the construction schedule required in in the Contract Documents shall provide for the specific conditions listed in Part 2 of this specifcation.

PART 2 ADDITIONAL REQUIREMENTS

A. The following work sequences are organized by process types and list the major work items, constraints and suggested work sequences. The sequences outlined below represent one approach to meeting the construction constraints. The sequences do not address every operation or construction detail; see other parts of the construction documents for additional requirements. The Contractor may propose modifications to the sequences as long as the construction constraints are met.

B. The anaerobic sludge digestion system, overall, must stay in operation throughout the construction. Individual subsystems may be out of service for limited periods.

C. The CONTRACTOR shall note that not all valves that may be used to isolate lines will completely seal. The CONTRACTOR shall allow for leakage in planning its work and may, with the CITY'S concurrence, test certain valves before work involving isolation has begun. The CONTRACTOR shall provide adequate temporary pumping and piping facilities to clear the work areas as necessary of water, sewage, and sludge. The CONTRACTOR shall clean the work areas as required to perform work.

D. Only CITY personnel shall perform operational functions or shutdown of existing facilities or systems required to facilitate the CONTRACTOR'S operation. The CONTRACTOR shall not adjust or operate any in-service equipment.

E. The CITY'S operation and maintenance personnel will cooperate in every way that is practicable in order to facilitate CONTRACTOR'S operation; however, certain shutdown and connections may only be permissible at times other than normal working hours.

2.02 DEMOLITION

A. Demolition shown on the drawings must be performed in phases based on the requirements in this Section.

B. CONTRACTOR shall be responsible for temporary valves, caps and blind flanges required for execution of phased demolition.

2.03 SAFE PURGING PRACTICES

A. CONTRACTOR shall be responsible for safe work practices related to work on hazardous piping systems. This includes purging systems out of service, and into service, with nitrogen.

B. Hazardous systems include digester gas, compressed digester gas, natural gas, and blend gas.

C. At no time shall an explosive mixture of air and gas be permitted within a pipe, tank, or headspace.

D. The CONTRACTOR shall prepare project purging guidelines which describe the methods, monitoring and purge end points.

E. The CONTRACTOR shall provide all nitrogen gas required for purging.

F. Nitrogen and gas mixtures may be directed through the City's existing waste gas burner. Any mixture of nitrogen shall not be routed through the City's engines.

2.04 DIGESTER GAS SYSTEM

A. Work sequence is as follows:
   1. Prepare site.
   2. Construct Aftercooler HEX foundation and Particulate Filter foundation.
   3. Install equipment and piping.
      a. Install new MSG piping to the waste gas burner
      b. Install DG PRV on MSG line (DG system shutdown required)
      c. Install connection taps for MSG to/from Aftercooler HEXs (DG system shutdown required)
      d. Replace Glycol Pumps (Glycol system shutdown required)
      e. Install CHWS/R piping modifications to Aftercooler HEXs (Glycol system shutdown required)
   4. Install temporary MSG bypass piping
   5. Demolish existing MSG piping and PRV assembly
   6. Install remaining equipment and piping
      a. Install relocated Particulate Filters
      b. Install Siloxane Vessel and associated piping
      c. Install permenant bypass line to flares (DG system shutdown required)
   7. Install electrical and instrumentation.
   8. Startup and testing.

B. Constraints are as follows:
   1. Digester gas system shutdowns will be limited to 8 hours and no more than one shutdown per week. Shutdowns shall be coordinated with CITY staff.
   2. The combined heat and power engines must remain in operation throughout construction (with digester gas fueling). Engine shutdows due to digester gas fueling disruptions shall be limited to 24 hours and no more than one shutdown per week.
   3. New MSG PRV must be installed prior to installing and using the temporary MSG bypass. Bypass must be installed and operated prior to demolishing existing Particulate Filters, existing PRV, or associated piping. The remainder of the DG treatment and conveyance system shall remain in service during bypass operation, including sending treated MSG to the cogeneration system.

2.05 ENGINE FUEL SYSTEM MODIFICATIONS

A. Work sequence is as follows:
   1. Install equipment and piping
      a. Install NG tie-in (NG mixing system shutdown required)

b. Install MSG check valve/flowmeter segment (Engines via DG or DG/NG mixtures shutdown required.)

2. Install electrical and instrumentation.
3. Startup and testing.

B. Constraints are as follows:

1. The combined heat and power engines must remain in operation throughout construction (with digester gas fueling). Engine shutdows due to digester gas fueling disruptions shall be limited to 24 hours and no more than one shutdown per week.

END OF SECTION

SECTION 01 14 19

USE OF SITE

PART 1 GENERAL

1.01 SUMMARY

A. The Owner's operating personnel will be responsible for operating the existing treatment plant throughout the execution of this contract. Equipment presently installed in the treatment plant must be available to plant personnel at all times for use, maintenance, and repair. If it is necessary in the course of operating the plant, for the Contractor to move his equipment, materials, or any material included in the work, he shall do so promptly and place that equipment or material in an area which does not interfere with the plant operation. The Contractor shall not adjust or operate serviceable or functioning equipment or systems except as specifically required by this contract.

B. The existing treatment plant will remain in operation throughout the execution of this contract. The Contractor shall schedule and conduct his work to minimize necessary shutdowns and interference with normal plant operations and maintenance.

C. The Contractor shall notify the City, in accordance with Section 01 12 16, 2 months in advance of the time it is necessary to take the digester gas system, natural gas mixing system, or engines out of service. The Contractor shall be responsible for providing whatever temporary piping, pumping, power, and control facilities as are required to maintain continuous plant operation and complete treatment except as otherwise specified. The integrity of existing plant utilities shall be maintained by the Contractor at all times.

END OF SECTION

SECTION 01 29 00

PAYMENT PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

A. This section includes the administrative and procedural requirements for CONTRACTOR payments as herein specified and further described in the General Conditions document. This section includes requirements for and information concerning Contractor Submittals, Schedule of Values, Applications for Payment, Conditions of Payment, and Final Payment.

B. Related Sections:
   1. Section 01 11 00 – Summary of Work
   2. Section 01 32 16 – Progress Schedules and Reports
   3. Section 01 33 00 – Submittal Procedures
   4. Section 01 33 23 – Record Drawings
   5. Section 01 99 90 – Reference Forms

1.02 SUBMITTALS

A. The following information shall be provided in accordance with Section 01 33 00 Submittals for review and approval and shall be submitted on forms approved by the City:
   1. Schedule of Values: Within ten (10) days of the award of the Contract, submit using the CONTRACTOR's standard form.
   2. Schedule of Estimated Progress Payments:
      a. Submit within ten (10) days of the award of the Contract.
      b. Schedule of Estimated Progress Payments shall show the values and construction time of the various portions of work to be performed by the Contractor and by its Subcontractors or material and equipment suppliers containing such supporting evidence as to its correctness as the City may require.
      c. Submit adjustments thereto with Applications for Payment.
   3. Within ten (10) days of the award of the Contract, the Contractor shall supply the name, address, telephone number, fax number, license number, and classification of all its Subcontractors and of all other parties furnishing labor, material, or equipment for its Contract, along with the amount of each such subcontract or the price of such labor, material, and equipment needed for its entire portion of the Work.
   4. Five (5) days prior to the submission of a pay request, an itemized breakdown of work done for the purpose of requesting partial payments;
   5. Five (5) days prior to the submission of a pay request, the minutes of Coordination Meetings as specified in Section 01 31 19.
   6. Five (5) days prior to the submission of a pay request, updated Construction Progress Schedule as specified in Section 01 32 16.
   7. Application for Payment: Submit using CONTRACTOR's Transmittal Summary form, provided in Section 01 99 90
   8. Final Application for Payment

B. The City shall review all submissions received pursuant to this Section in a timely manner. All submissions must be approved by the City before becoming the basis of any payment.

1.03 SCHEDULE OF VALUES

A. The Schedule of Values shall be used only as the basis for the Contractor's Progress Payments.

B. Upon request of CITY, provide documentation to support the accuracy of the Schedule of Values.

C. Provide a detailed breakdown and prepare a separate Schedule of Values for each schedule of the Work under the Agreement.

D. Schedule of Values shall be a listing of all cost loaded, on-site construction activities from the progress schedule, and will be used as the basis for progress payments during construction. Such prices will include an appropriate amount of overhead and profit applicable to each item of work.

E. Follow the table of contents of this Project Manual as the form for listing component items.
   1. Identify each line item with the number and title of the respective section of the specifications.
   2. Include separate line items for each section.

F. For each major line item, which has an installed value of more than $10,000.00, list sub-values of major products or operations under the item.

G. For the various portions of the Work:
   1. Itemize separate line item cost for each of following general cost items (if provided):
      a. Performance and payment bonds.
      b. Field supervision and layout.
      c. Temporary facilities and controls.
      d. Mobilization.
   2. Each item shall include a directly proportional amount of the Contractor's overhead and profit.
   3. For items on which progress payments will be requested for stored materials, break down the value into:
      a. The cost of the materials, delivered and unloaded, with taxes paid.
      b. The total installed value.

H. Correlate line items in the Schedule of Values with other required administrative schedules and forms, including:
   1. Contractor's construction schedule.
   2. Application for Payment form.
   3. List of subcontractors
   4. List of products.

5. List of principal suppliers and fabricators.
6. Schedule of submittals.

I. Base Schedule of Values on initially acceptable progress schedule (Section 01 32 16). Adjust to reflect subsequent adjustments in progress schedule and Contract Sum Price as reflected by modifications to the Contract Documents.

J. An unbalanced or front-end loaded schedule will not be acceptable.

K. CONTRACTOR shall include the costs necessary to complete the Work throughout the entire contract duration.

L. Summation of the complete Schedule of Values representing all the Work shall equal the Contract Sum.

M. Submittal of the Schedule of Values is a condition precedent to the issuance of any payment under the Contract.

N. Items in the Schedule of Values are to accurately reflect the cost of work.

O. Acceptance by CITY shall only indicate consent to the cash flow as a basis for preparation of partial payment estimates and shall not constitute an agreement as to the value of each indicated item.

1.04 APPLICATION FOR PAYMENT

A. Transmittal Summary Form: Attach one Summary Form with each detailed Application for Payment for each schedule and include Request for Payment of Materials and Equipment installed as applicable. Execute certification by authorized officer of CONTRACTOR.

B. Use CONTRACTOR'S detailed Application for Payment Summary Form as approved by CITY. Submit application using CITY's web based Design and Construction Management System (DCMS) or as directed by ENGINEER.

C. Provide separate form for each schedule as applicable.

D. Include accepted Schedule of Values for each schedule or portion of lump sum Work and the unit price breakdown for the Work to be paid on a unit priced basis.

E. Include separate line item for each Change Order and Work Change Directive executed prior to date of submission. Provide further breakdown of such as requested by CITY. Identify change order by number and description.

F. The CITY shall not release Payment until the CONTRACTOR provides all supporting documentation, as specified herein. Supporting documentation shall include, but is not limited to, updated project schedule (Section 01 32 16), lien release, and acceptable progress on the Record Drawings (Section 01 33 23).

G. Deviation from the above requirements or incomplete submission shall require resubmission of the application for payment

1.05 MEASUREMENT – GENERAL

A. Where measurement of quantities depends on elevation of existing ground, elevations obtained during construction will be compared with those shown on Drawings. Variations of one (1) foot or less will be ignored, and profiles shown on Drawings will be used for determining quantities.

B. Unit of measure shown on Proposal Form shall be as follows, unless specified otherwise:

Item	Method of Measurement
AC	Acre—Field Measure by Engineer
CY	Cubic Yard—Field Measure by Engineer within limits specified or shown
CY-VM	Cubic Yard—Measured in Vehicle by Volume
EA	Each—Field Count by Engineer
GAL	Gallon—Field Measure by Engineer
HR	Hour
LB	Pound(s)—Weight Measure by Scale
LF	Linear Foot—Field Measure by Engineer
SF	Square Foot
SY	Square Yard
TON	Ton—Weight Measure by Scale (2,000 pounds)

1.06 PAYMENT

A. The date for CONTRACTOR's submission of monthly Application for Payment shall be established at the Preconstruction Meeting.

B. Payment for all the Work shown or specified in Contract Documents is included in the Contract Sum Price. Payment will be made for Work completed during the payment period based on a percentage complete basis for each line item of the accepted Schedule of Values per the Agreement Documents.

C. Payment for Unit Price items covers all the Work necessary to furnish and install the items identified in the schedule in the Proposal Form. Payment will be made for the actual quantity of Work completed during the payment period per the Agreement Documents.

1.07 NONPAYMENT FOR REJECTED OR UNUSED PRODUCTS

A. Payment will not be made for following:
   1. Loading, hauling, and disposing of rejected material.
   2. Quantities of material wasted or disposed of in manner not called for under Contract Documents.
   3. Rejected loads of material, including material rejected after it has been placed by reason of failure of CONTRACTOR to conform to provisions of Contract Documents.
   4. Material not unloaded from transporting vehicle.
   5. Defective Work not accepted by CITY.

6. Material remaining on hand after completion of Work.

1.08 PARTIAL PAYMENT FOR STORED MATERIALS AND EQUIPMENT

A. Partial Payment: Partial payments will be made for uninstalled materials and equipment on an exception basis only, based on prior written approval from the CITY.

B. Final Payment: Will be made only for products incorporated in Work.

1.09 PAYMENT FOR MOBILIZATION

A. Limit amounts included under Mobilization to the following items:
   1. Moving on the site any equipment required for first month operations.
   2. Installing temporary construction power and wiring.
   3. Establishing fire protection system.
   4. Developing construction water supply.
   5. Providing field office trailers for the CONTRACTOR.
   6. Providing on-site sanitary facilities and potable water facilities as specified.
   7. Arranging for and erection of CONTRACTOR's work and storage yard.
   8. Subcontractor insurance and bonds.
   9. Obtaining all required permits, licenses, and fees.
   10. Developing construction schedule.
   11. CONTRACTOR bonds and insurance.

B. Furnish data and documentation to substantiate the amounts claimed under mobilization.

C. Limit price for mobilization to no more than 3 percent of Contract Sum Price.

1.10 PAYMENT FOR START-UP AND DEMOBILIZATION

A. Lien releases are to be provided.

B. All specified submittals, data and documents have been delivered and accepted.

C. Limit price for demobilization to no more than 3 percent of Contract Sum Price.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

PART 4 ADDITIONAL REQUIREMENTS (NOT USED)

END OF SECTION

SECTION 01 31 19

Project Meetings

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Requirements for conducting conferences and meetings for the purposes of addressing issues related to the Work, reviewing and coordinating progress of the Work and other matters of common interest, and includes the following:
   1. Qualifications of Meeting Participants
   2. Preconstruction Conference
   3. Progress Meetings
   4. Pre-installation Meetings
   5. Post Construction Meeting
   6. Partnering Meetings (as applicable)

B. The CONTRACTOR, or authorized representative, shall attend all Project related meetings as indicated by the Contract. The Contractor's representatives, as a minimum, shall include the Project Manager and Superintendent.

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

D. Related Sections
   1. Section 01 12 16 – Work Sequence and Restrictions
   2. Section 01 32 16 – Progress Schedules and Reports
   3. Section 01 91 14 – Testing, Training, and Facility Start-up

1.02 QUALIFICATIONS OF MEETING PARTICIPANTS

A. Representatives of entities participating in meetings shall be qualified and authorized to act on behalf of entity each represents

1.03 PRECONSTRUCTION CONFERENCE

A. Fifteen (15) days after Award of Contract, (OR as soon as possible after the award and execution of the Contract and before any Work at the site is started), CITY will schedule a preconstruction conference.

B. After the conference, CITY will issue the Notice to Proceed. The applicable Contract Time requirements will begin to run on the day indicated in the Notice to Proceed for the Work covered in such Notice.

C. Attendees shall include: CONTRACTOR's superintendent. Attendees may include ENGINEER, representatives of utilities, major subcontractors, CITY and others involved in performance of the Work.

D. CITY will preside at conference, and will prepare and distribute the meeting agenda and minutes.

E. Purpose of Conference includes, but will not be limited to: To establish working understanding between parties and to discuss Construction Schedule, shop drawing and other submittals, lines of communication and chains of command, cost breakdown of major lump sum items, processing of submittals and applications for payment, maintaining required records, wage and personnel records and reporting requirements, testing requirements, field decisions and change orders, use of premises, permits, security, housekeeping, assignments for safety and first aid, major equipment deliveries, critical work sequencing, and other subjects pertinent to execution of the Work.

F. Agenda may include:
   1. Adequacy of distribution of Contract Documents
   2. Distribution and discussion of list of major subcontractors and suppliers
   3. Proposed progress schedules and critical construction sequencing
   4. Major equipment deliveries and priorities
   5. Project coordination
   6. Designation of responsible personnel
   7. Procedures and Processing of:
      a. Field decisions
      b. Proposal requests
      c. Submittals
      d. Change Orders
      e. Applications for Payment
      f. Record Documents
   8. Use of Premises:
      a. Office, construction, and storage areas
      b. CITY's requirements
   9. Construction facilities, controls and construction aids
   10. Temporary utilities
   11. Safety and first aid procedures
   12. Security procedures
   13. Housekeeping procedures
   14. Warranties or warranty items

1.01 CONSTRUCTION PROGRESS MEETINGS

A. Progress meetings will be conducted weekly in a mutually agreed place as specified in Section 01 32 16.

B. CITY will distribute to each anticipated participant written notice and agenda of each meeting at least the day prior to the meeting

C. CONTRACTOR shall prepare and distribute 3-week look-ahead schedule at or prior to the meeting as detailed under Section 01 32 16.

D. Attendees shall include: CONTRACTOR's superintendent. Attendees will include CITY, ENGINEER, CITY representation may also include operations and maintenance personnel, as required.

E. CITY will preside at meetings.

F. Purpose of Progress Meetings: To discuss Project status, expedite work of subcontractors or other organizations that are not meeting scheduled progress, resolve conflicts, and coordinate and expedite execution of the Work

G. Review progress of the Work, updated Progress Schedule, narrative report, Application for Payment, record documents, and additional items of current interest that are pertinent to execution of the Work

H. Agenda topics shall include, but are not limited to:
   1. Report on construction progress
   2. Work schedule and sequencing requirements, delays to critical path and mitigation plan
   3. Coordination of building trades
   4. Process Shutdown Requests, Coordination with FACILITY other Contracts and public utilities
   5. Submittal review status
   6. Requests for Information review status
   7. Notifications by Contractor
   8. Proposed Contract Modifications and Change Orders
   9. Safety
   10. Quality Assurance
   11. General business

I. CONTRACTOR shall provide schedules, logs and other construction activity data in support of the issues discussed and recorded in meeting minutes.

J. Discuss potential problems, which may include scheduled progress and corrective measures and discuss solutions to such problems.

K. CITY will record meeting minutes and distribute copies of minutes within four (4) working days of meeting to participants and interested parties.

1.04 PRE-INSTALLATION MEETINGS

A. Prior to a process shutdown in Section 01 12 16 and when required in individual Specification sections, convene at Site prior to commencing the Work of that section.

B. Require attendance of Superintendent, manufacturers and installers, affected subcontractors, and other entities directly affecting, or affected by, the Work of that section.

C. CONTRACTOR shall distribute to each anticipated participant written notice and agenda of each meeting at least four (4) working days before meeting.

D. Schedule meeting at least seven (7) days in advance of installation

E. Conduct meetings in CONTRACTOR's field office or other mutually agreed upon place.

F. Invite CITY.

G. CONTRACTOR shall preside at meetings.

H. CONTRACTOR shall record meeting minutes and distribute copies of minutes within three (3) working days of meeting to participants and interested parties.

1.05 FACILITY STARTUP MEETINGS

A. Schedule and attend a minimum of two facility startup meetings. The first of such meetings shall be held prior to submitting the Facility Startup Plan, as specified in Section 01 91 14, and shall include preliminary discussions regarding such plan.

B. Agenda items shall include, but not be limited to, content of Facility Startup Plan, coordination needed between various parties in attendance, and potential problems associated with startup.

C. Attendees shall include: CONTRACTOR's superintendent, subcontractors and equipment manufacturer's representatives whom CONTRACTOR deems to be directly involved in facility startup. Attendees will include CITY, and others as required by Contract Documents or as deemed necessary by CONTRACTOR and CITY.

1.06 POST CONSTRUCTION MEETING

A. Prior to warranty expiration, meet with and inspect the Work with CITY and ENGINEER.

B. Inspect the Work and draft list of items to be completed or corrected.

C. Review service and maintenance contracts, and take appropriate corrective action when necessary.

D. Complete or correct defective work and extend correction period accordingly.

E. Require attendance of Superintendent, appropriate manufacturers and installers of major units of constructions, and subcontractors.

1.07 PARTNERING MEETINGS (NOT USED)

1.08 OTHER MEETINGS

A. In accordance with Contract Documents and as may be required by CITY and ENGINEER.

B. CITY reserves the right to call additional site meetings, or to request attendance of particular personnel at any meeting.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

PART 4 ADDITIONAL REQUIREMENTS (NOT USED)

END OF SECTION

SECTION 01 32 16

CONSTRUCTION PROGRESS SCHEDULE

PART 1 GENERAL

1.01 SCOPE

A. This section specifies reports and schedules for planning and monitoring the progress of the work.

1.02 DESCRIPTION

A. The Contractor shall provide a graphic construction schedule indicating the various subdivisions of the work and the dates of commencing and finishing each. The schedule shall show the time allowed for testing and for other procedures which must be completed prior to the work being put into operation. The schedule will take into account the time of completion and the specific dates as specified in the Contract Documents and the work sequence described in Section 01 12 16.

1.03 SUBMITTAL PROCEDURES

A. Within 20 working days after the date of the Notice to Proceed, the Contractor shall submit, in accordance with Section 01 33 00, a construction schedule conforming to Section 01 32 16 paragraph 1.02 Description. The submittal shall consist of a reproducible original and two copies.

B. Within 7 calendar days after receipt of the submittal, the Construction Manager shall review the submitted schedule and return one copy of the marked up original to the Contractor. If the Construction Manager finds that the submitted schedule does not comply with specified requirements, the corrective revisions will be noted on the submittal copy returned to the Contractor.

1.04 SCHEDULE REVISIONS

A. Revisions to the accepted construction schedule may be made only with the written approval of the Contractor and Owner. A change affecting the contract value of any activity, the completion time, and specific dates as specified in the Contract Documents and sequencing (Section 01 12 16) may be made only in accordance with applicable provisions of the General Conditions of the Contract Documents.

1.05 PROJECT STATUS UPDATE

A. Project status review and update shall be provided each month as specified in the General Conditions of the Contract Documents.

END OF SECTION

SECTION 01 32 33

PHOTOGRAPHIC DOCUMENTATION

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies progress photographs to be provided for pre-construction, during construction, and post-construction.

B. Related Sections:
   1. Section 01 33 00 – Submittal Procedures

1.02 SUBMITTALS

A. CONTRACTOR shall be responsible for submission of videos and photographs to be taken during Pre-construction, Construction, and Post-construction, as indicated in this Section.

1.03 DIGITAL IMAGES

A. All phases of the project including preconstruction, construction progress, and post construction shall be documented photographically.

B. ENGINEER shall have the right to select the subject matter and vantage point from which photographs are to be taken.

C. Archive images using a commercially available photo management system or DCMS.

D. Label each disc with the following information:
   1. Project name
   2. CITY's name
   3. Date images were taken
   4. CONTRACTOR's name
   5. Brief description of photos

E. All photographs shall be digital and with a minimum resolution of 2592x1944 pixels (5 megapixels) and a minimum 24-bit, millions of color.

F. When supported by the camera's functionality, the date stamp shall be displayed on each image.

G. All photographs shall be stored in .jpeg file format.

1.04 PRECONSTRUCTION PHOTOGRAPHS

A. Before construction may start and before the CONTRACTOR may begin any work that may cause site disturbance, CONTRACTOR shall provide and deliver to the CITY digital still photographs to provide site coverage on a compact disc (CD) or Digital Video Disc (DVD) with proper labeling.

B. Photographs shall be acceptable to the ENGINEER prior to commencing work.

C. Preconstruction photographs of the site and any adjacent areas may serve as a basis for determining subsequent damage due to the CONTRACTOR's operations.

1.05 PRE-CONSTRUCTION VIDEO

A. Prior to commencement of construction, the CONTRACTOR and CITY, accompanies by a professional videographer hired by the CONTRACTOR shall survey the site including all entrance roads, parking and storage areas and any other areas that will be affected by construction, and video record existing facilities and conditions. Video may be in digital or VHS format with adequate resolution to produce sharp and clear images with accurate colors and free of distortion. Audio commentary shall be provided describing the areas and items viewed and direction with additional commentary as requested by the CITY.

B. Video-audio recording shall be acceptable to the CITY prior to commencing work.

1.06 CONSTRUCTION PHOTOGRAPHS

A. Photographs during construction shall demonstrate progress, showing every aspect of the site and any adjacent areas, including interiors and exteriors or new or impacted areas or structures.

B. Photographs ahll also be taken prior to demolition, during demolition and at other significant stages of construction.

C. On a weekly basis, take a minimum of forty (40) photographs.

D. Every month provide CITY with an acceptable electronic submittal containing photographs taken during the past month.

E. The CD or DVD shall have the proper labeling as indicated in Section 1.03.

1.07 POST CONSTRUCTION PHOTOGRAPHS

A. Upon issuance of Substantial Completion, CONTRACTOR shall provide and deliver to ENGINEER as many digital still photographs as necessary on a CD or DVD with proper labeling.

B. These photographs should be identical or similar to the subject matter and vantage point as the photographs taken during preconstruction. These photos may be compared to preconstruction images to determine subsequent damage due to CONTRACTOR's operations.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

PART 4 ADDITIONAL REQUIREMENTS (NOT USED)

END OF SECTION

SECTION 01 33 00

SUBMITTAL PROCEDURES

PART 1 GENERAL

1.01 SUBMITTALS

A. 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

A. General:

1. 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 his subcontractors and suppliers including those submittals complying with unit responsibility requirements specified in paragraph 43 05 11-1.02 Unit Responsibility and applicable technical sections.
2. The Contractor shall coordinate submittals with the work so that work will not be delayed. He 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."
3. The Contractor shall certify on each submittal document that he has reviewed the submittal, verified field conditions, and complied with the contract documents.
4. 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:
   1. 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.
   2. 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:
   1. 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:
   1. 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 01 78 23.

1.04 TRANSMITTAL PROCEDURE

A. General:
   1. Unless otherwise specified, submittals regarding material and equipment shall be accompanied by Transmittal Form 01 33 00-A specified in Section 01 99 90. Submittals for operation and maintenance manuals, information and data shall be accompanied by Transmittal Form 01 78 23-A specified in Section 01 99 90. 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.
   2. 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:
   1. If the Contractor proposes to provide material, equipment, or method of work which deviates from the project manual, he shall indicate so under "deviations" on the transmittal form accompanying the submittal copies.

C. Submittal completeness:
   1. 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:
   1. 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.
   2. When the contract documents require a submittal, the Contractor shall submit the specified information as follows:
      a. 3 copies of all submitted information plus one electronic version (PDF format) of all information shall be transmitted with submittals for review and comment.
      b. Unless otherwise specified, 3 copies of all submitted information shall be transmitted with submittals (Product Data) for information only.

B. Submittals for review and comment:
   1. Unless otherwise specified, within 21 calendar days after receipt of a submittal for review and comment, the Construction Manager shall review the submittal and return 1 copy of the marked-up reproducible original noted in 1 above. The reproducible original will be retained by the Construction Manager. The returned submittal shall indicate one of the following actions:
      a. 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.
      b. 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.
      c. If the review reveals that the submittal is insufficient or contains incorrect data, copies will be marked "AMEND AND RESUBMIT." Except at his own risk, 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."
      d. 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. Except at his own risk, 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:
   1. 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:

A. General:
   1. 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.

END OF SECTION

SECTION 01 35 29

HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES

PART 1 GENERAL

1.01 REQUIREMENTS

A. Portions of the existing plant are exposed to wastewaters of varying degrees of treatment. The Contractor shall be experienced and qualified to anticipate and meet the safety and health requirements of this project.

B. Workmen involved in the removal, renovation, or installation of equipment within the treatment plant may be exposed to disease-producing organisms in wastewater. The Contractor shall require his personnel to observe proper hygienic precautions.

C. Solvents, gasoline, and other hazardous materials enter the plant with incoming sewage, and, therefore, certain areas are hazardous to open flame, sparks, or unventilated occupancy. The Contractor shall take measures to assure his personnel observe proper safety precautions when working in these areas.

1.02 SAFETY AND HEALTH REGULATIONS

A. 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.

END OF SECTION

SECTION 01 35 43

ENVIRONMENTAL PROCEDURES

PART 1 GENERAL

1.01 SITE MAINTENANCE

A. 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 TEMPORARY DAMS

A. Except in time of emergency, earth dams are not acceptable at catch basin openings, local depressions, or elsewhere. Temporary dams of sand bags, asphaltic concrete, or other acceptable material will be permitted when necessary to protect the work, provided their use does not create a hazard or nuisance to the public. Such dams shall be removed from the site as soon as they are no longer necessary.

1.03 AIR POLLUTION CONTROL

A. The Contractor shall not discharge smoke, dust, and other contaminants into the atmosphere that violate the regulations of any legally constituted authority. He 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.

1.04 NOISE CONTROL

A. Between 7:30 p.m. and 7:00 a.m., 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 50 feet from the noise source.

END OF SECTION

SECTION 01 40 00

QUALITY REQUIREMENTS

PART 1 GENERAL

1.01 DESCRIPTION

A. This Section specifies administrative and procedural requirements for quality control services, field inspections and field testing of civil and structural constructs required for this project. Contractor is responsible for the quality assurance and quality control of their respective work.

1.02 DEFINITIONS

A. Quality Control System (QCS): The quality control, assurance, and inspection system established and carried out to ensure compliance with the Plans and Specifications.

B. QCS Supervisor: That person in charge of the work occurring, as designated by the Contractor in the QCS Plan.

C. QCS Inspector: Responsible, certified personnel inspecting the various constructs at specified milestones and during the project overall and designated by the Construction Manager. The Special Inspector is part of the QCS Inspector team.

D. Factory Test: Tests made on various materials, products and component parts prior to shipment to the job site.

E. Field Tests: Tests and analyses made at or in the vicinity of the job site in connection with the actual construction.

F. Certified Inspection Report: Reports signed by approved inspectors attesting that the items inspected meet the specification requirements other than any exceptions included in the report

G. Certificate of Compliance: Certificate from the manufacturer of the material or equipment identifying said manufacturer, product and referenced standard, and shall be signed by a designated officer of the manufacturer.

H. Standard Compliance: Condition whereby specified materials or equipment must conform to the standards of organizations such as the American National Standard Institute (ANSI), American Society for Testing and Materials (ASTM), Underwriters Laboratories (UL) or similar organization.

I. Quality Assurance: The day-to-day, in-process supervisory observations of work and materials conducted by the Contractor to assure that the proper methods and materials are being used and installed by tradesmen.

J. Source Quality Control: The in-process testing and inspections conducted by the QCS Inspector(s) to verify that the materials, equipment, workmanship and shop manufactured constructs are in compliance with the Contract Documents, applicable Codes and standards.

K. Field Quality Control: The testing and inspections conducted by the QCS Inspector(s) in the field during and at the completion of each construct to verify that the in-process and completed construction is in compliance with the Contract Documents, applicable Codes and standards.

1.03 REFERENCES

A. 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.

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

Reference	Title
ASTM C102	Practice for Laboratories Engaged in the Testing of Building Sealants.
ASTM C802	Practice for Conducting an Inter-Laboratory Test Program to Determine the Precision of Test Methods for Construction.
ASTM C1093	Practice for Accreditation of Testing Agencies for Unit Masonry.
ASTM D3740	Practice for Evaluation of Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
ASTM D4561	Practice for Quality Control Systems for an Inspection and testing Agency for Bituminous Paving Materials.
ASTM E329	Practice for Use in the Evaluation of Inspection and Testing Agencies as Used in Construction.
CBC	2013 California Building Code

1.04 CONTRACTOR'S RESPONSIBILITIES

A. Monitor quality assurance over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce work of specified quality.

B. Coordinate with, schedule specified inspections by, and provide normal and customary assistance to the QCS Inspectors.

C. Comply fully with manufacturers' instructions, including each step in sequence.

D. Should manufacturers' instructions conflict with Contract Documents, request clarification before proceeding from Construction Manager.

E. Comply with specified standards as a minimum quality for the work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

F. Perform work by persons qualified to produce workmanship of specified quality.

1.05 REGULATORY REQUIREMENTS

A. General:
   1. Comply with all Federal, State, and local Codes as referenced herein. Such regulations apply to activities including, but not limited to, sitework and zoning, building practices and quality, on and offsite disposal, safety, sanitation, nuisance, and environmental quality.

B. Special Inspection:
   1. Special Inspection shall be performed by the Special Inspector under contract with the Construction Manager in conformance with the IBC. 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.

C. Structural Observation:
   1. Engineer shall make visual inspections of the work to assess general conformance with the Contract Documents at significant construction stages and at completion of the structural system. The QCS shall include a preliminary set of Structural Observations and what items are expected to be observed. Contractor shall request this preliminary set from Engineer through Construction Manager and submit as part of their QCS submittal.
   2. The following structural milestones shall be considered significant construction stages:
      a. Structure fill.
      b. Foundations prepared for concrete placement, including monolithic slabs on grade.

1.06 FIELD SAMPLE PROCEDURES

A. When field samples are specified in a unit of work, construct each field sample to include work of all trades required to complete the field sample prior to starting related field work. Field samples may be incorporated into the project after acceptance by Construction Manager. Remove unacceptable field samples when directed by Construction Manager. Acceptable samples represent a quality level for the work.

1.07 CONTRACTOR DESIGNED STRUCTURAL SYSTEMS

A. Design Engineering:
   1. Contractor shall employ and pay for engineering services from a Professional Engineer registered in the State of California for structural design of Contractor designed structural systems including but not limited to temporary shoring and bracing, formwork support, interior structural wall and ceiling systems, and support

systems for fire sprinkler, plumbing, mechanical, and electrical systems and equipment

B. Tests And Inspections Of Contractor Designed Structural Systems:
   1. Contractor shall pay for preliminary testing of concrete, grout, and mortar mix designs where required by Code or the submittal process prior to start of such work. Contractor shall pay for required shop and site inspection of Contractor designed structural systems where required by Code or these specifications, to the extent such testing and inspection exceeds that required for the structural system on the drawings and in these specifications.

1.08 MANUFACTURERS' FIELD SERVICES AND REPORTS

A. When specified in individual specification sections, product suppliers or manufacturers shall provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust, and balance of equipment as applicable, and to provide instructions when necessary. Contractor shall submit qualifications of observer to Construction Manager 30 days in advance of required observations. QCS Inspector shall record observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

1.09 JOB SITE CONDITIONS

A. Schedule to ensure all preparatory work has been accomplished prior to proceeding with current work. Proceeding with the work constitutes acceptance of conditions. Allow adequate time for materials susceptible to temperature and humidity to "stabilize" prior to installation. Establish and maintain environmental conditions (i.e., temperature, humidity, lighting) as recommended by the various material manufacturers for the duration of the work.

1.10 SUBMITTALS

A. The following information shall be provided in accordance with Section 01 33 00 :
   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 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. Written description of Contractor's proposed QCS plan in sufficient detail to illustrate understanding and approach. The QCS plan and submittal shall include a log showing anticipated inspections, Special Inspections, and source and field Quality Assurance

procedures. Preliminary submittal of the QCS plan may be made prior to commencing field work. The preliminary submittal will illustrate the project's initial three (3) month's work, and be followed one month later by a final QCS plan submittal.

3. Contractor's proposed QCS Supervisor, qualifications, and if requested, references.
4. Preliminary structural observation set as described in paragraph 1.05 Structural Observation.
5. Complete structural system information describing Contractor designed structural systems, including sealed calculations, shop and erection drawings, product literature for the various components, ICBO Evaluation Reports for structural components, and a discussion of risk issues associated with the proposed system which could adversely impact overall project completion.
6. If requested by the Construction Manager during the work, manufacturer's field services and reports. If not so requested, treat same as Product Data.

PART 2 PRODUCTS

2.01 SOURCE QUALITY CONTROL

A. Contractor Responsibilities:
   1. Provide source quality control according to the reviewed and accepted QCS plan and paragraph 1.04 herein. Coordinate with Construction Manager to facilitate the work of the Testing Laboratory and Special Inspector. Provide ready access to sampling and inspection locations and incidental labor customary in such sampling and inspections. Timely prepare and submit submittals, and revise as indicated by review comments. Comply with technical requirements in each specification Section that applies to the work.

B. Construction Manager Responsibilities:
   1. Review Contractor's tracking of QCS activities at monthly meetings. Facilitate completion of submittal review per Section 01 33 00. Assist Contractor to ensure that Special Inspection occurs where and when specified.

C. Acceptance Criteria:
   1. Acceptable characteristics and quality of a particular item or construct is defined in that item's or construct's specification Section.

2.02 PRODUCT DATA

A. The following product data shall be provided in accordance with Section 01 33 00.
   1. Manufacturers' field services and reports unless requested by Construction Manager to be submitted for review.
   2. Special Inspection reports, unless otherwise directed in each technical specification Section.

PART 3 EXECUTION

3.01 FIELD QUALITY CONTROL

A. Field quality control responsibilities of the Contractor and Construction Manager are substantially the same as described in paragraph 2.01, with the exception that this work occurs primarily on the jobsite as the work progresses, and Special Inspection will occur more often than at the source.

B. Acceptable characteristics and quality of a particular item or construct is defined in that item's or construct's specification Section.

3.02 REGULATORY COMPLIANCE – SPECIAL INSPECTIONS

A. The following types of work require Special Inspection according to Chapter 17 of the CBC and each system's specification Section:
   1. Structure Fill.
   2. Structural concrete and reinforcing.
   3. Anchor bolts.
   4. Structural steel and aluminum including connections.
   5. All components of the lateral force resisting system not included in the above.

B. Contractor designed structural systems are subject to the same Special Inspection requirements as all other work.

3.03 CORRECTION OF DEFECTIVE WORK

A. Remove and replace defective, rejected, and condemned work at Contractor's expense until such work meets the requirements of Contract Documents.

END OF SECTION

SECTION 01 42 19

REFERENCE STANDARDS

PART 1 GENERAL

1.01 ABBREVIATOINS

A. Wherever used in the project manual, the following abbreviations will have the meanings listed:

Abbreviation	Meaning
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

Abbreviation	Meaning
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

Abbreviation	Meaning
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

Abbreviation	Meaning
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 (see FEDSPECS)	Federal Standards
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

Abbreviation	Meaning
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
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

Abbreviation	Meaning
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

Abbreviation	Meaning
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

Abbreviation	Meaning
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 01 45 20

EQUIPMENT AND SYSTEM PERFORMANCE AND OPERATIONAL TESTING

PART 1 GENERAL

1.01 DESCRIPTION

A. This section contains requirements for the Contractor's performance in documenting testing work required under this contract. In addition, this section contains requirements 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. Calibration:
   1. 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.
   2. Liquid flow meters, including all open channel flow meters and all meters installed in pipelines with diameters greater than 2 inches shall be calibrated in situ using either the total count or dye dilution methods. 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.

B. References:
   1. 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.
   2. 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
ASHRAE 41.8	Standard Methods of Measurement of Flow of Gas
Dye Dilution Calibration Method	Flow Measurements in Sanitary Sewers By Dye Dilution, Turner Designs Mountain View, California,

1.03 SUBMITTALS

A. Submittal material, to be submitted in accordance with Section 01 33 00, 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 2.02 Documentation Plans, 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.
7. A summary of the QCS Supervisor’s qualifications, showing conformance to Section 01 40 00 requirements.

PART 2 PRODUCTS

2.01 GENERAL

A. 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:

1. 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.
2. 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's quality assurance manager. A separate file shall be established for each system and item of equipment. These files shall include the following information as a minimum:
   a. Metallurgical tests
   b. Factory performance tests
   c. Accelerometer recordings made during shipment
   d. Field calibration tests[1]
   e. Field pressure tests[1]
   f. Field performance tests[1]
   g. Field operational tests[1]
3. Section 01 99 90 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.

B. Test Plans:

1. 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]Each of these tests is required even though not specifically noted in detailed specification section.

a. 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.
b. Calibration of all analysis instruments and control sensors.
c. 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.
d. System tests designed to duplicate, as closely as possible, operating conditions described in the project manual.

2. Test plans shall contain a complete description of the procedures to be employed to achieve the desired test environment.
3. 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:
1. 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 01 32 16. 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 4 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

A. 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

A. 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. After filling operations have been completed, the Contractor

shall operate all systems for a continuous period of not less than 5 days, 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's QCS Supervisor and testing team shall monitor the characteristics of each machine and system and report any unusual conditions to the Construction Manager.

2.05 PRODUCT DATA

A. Product data, to be provided in accordance with Section 01 33 00, shall be the original and three copies of all records produced during the testing program.

PART 3 EXECUTION

3.01 GENERAL

A. 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

A. 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.

B. 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. All analysis instruments, sensors, gages, and meters installed under this contract shall be subject to recalibration as a condition precedent to commissioning under the provisions of Section 01 91 00.

3.03 PERFORMANCE TESTS

A. General:
   1. Performance tests shall consist of the following:
      a. Pressure and/or leakage tests.
      b. Electrical testing as specified in Division 26.
      c. Wiring and piping, individual component, loop, loop commissioning and tuning testing as described in Division 40.

d. Preoperational checkout for all mechanical and HVAC equipment. Preoperational check-out procedures shall be reviewed and approved by the respective equipment manufacturers.

e. Initial operation tests of all mechanical, electrical, HVAC, and instrumentation equipment and systems to demonstrate compliance with the performance requirements of this project manual.

2. 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:

1. Pressure and leakage tests shall be conducted in accordance with applicable portions of Divisions 3 and 40. 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:

1. 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 26.

D. Component Calibration And Loop Testing:

1. 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 40.

E. Electrical Resistance:

1. Electrical resistance testing shall be in accordance with Division 26.

F. Preoperational Tests:

1. Preoperational tests shall include the following:

a. Alignment of equipment using reverse dial indicator method.

b. Pre-operation lubrication.

c. 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. If available, plant effluent may be employed for the testing of all liquid systems except gaseous, oil, or chemical systems. If not available, potable water shall be employed as the test medium. Test media for these systems shall either be the intended fluid or a compatible substitute. 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 functional test period, the Contractor shall obtain baseline operating data on all equipment with motors greater than 1 horsepower to include amperage, bearing temperatures, and vibration. The baseline data shall be collected for the Owner to enter in a preventive maintenance system.

a. 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.

b. 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. Post-test 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

A. 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 domestic water, oil, air, or chemicals, with plant effluent water. All domestic water, oil, air, and chemical systems shall be filled with the specified fluid.

B. Upon completion of the filling operations, the Contractor shall circulate water through the completed facility for a period of not less than 48 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. 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.

C. As-built documents specified in Section 01 78 39 of facilities involved shall be accepted and ready for turnover to the Owner at the time of operational testing.

END OF SECTION

SECTION 01 45 23

TESTING AND INSPECTION SERVICES

PART 1 GENERAL

1.01 SUMMARY

A. GENERAL REQUIREMENTS: Comply with the testing and inspection specified in this Section and elsewhere in the Construction Documents. For the purpose of this Section, all references made herein to Testing Agency or Special Inspector or Geotechnical Consulting Firm shall be referred to as those tests or inspections which will be conducted by an inspector provided by the Owner.

1. The Owner or registered design professional in responsible charge acting as the Owner's agent will select and employ an independent Testing Agency to conduct the tests and inspections in accordance with applicable standard methods of American Society for Testing and Materials (ASTM) or other standards specified by the local governing authorities having jurisdiction (AHJ) as a requirement of the building permit. The Owner may require other special inspection services to inspect and verify the Work installed is in accordance with the Construction Documents and construction industry standards.
2. The Contractor shall provide and pay for other inspection and testing services where specified in the Construction Documents or required to obtain regulatory approval by State or AHJ.

1.02 DEFINITIONS

A. Special Inspector – A qualified individual employed or retained by an approved agency and approved by the AHJ as having the competency necessary to inspect a particular type of construction requiring special inspection.

B. Testing Agency - firm responsible for performing specific inspections and/or tests as part of the Special Inspection program.

1.03 QUALITY ASSURANCE

A. QUALIFICATIONS: The inspector for all Work as hereinafter specified, except for geotechnical inspections, waterproofing and roofing, shall be a registered Special Inspector employed by an approved inspection and/or Testing Agency. All inspection personnel used on this Project are subject to being disapproved from the Project at the discretion of the Owner.

1. The Special Inspector shall have the required technical knowledge and experience for the product or construction element being installed.
2. Geotechnical Inspection will be performed by a licensed Geotechnical Consulting Firm.

1.04 DUTIES OF OWNER'S TESTING AGENCY

A. GENERAL: The Owner's Testing Agency will conduct testing and inspection services, interpret them, and evaluate the results for compliance with the building permit, the site development permit, and the Construction Documents; agency will report findings to the

Owner, Contractor, and AHJ. Testing and inspection services shall be in accordance with applicable standard methods of ASTM or other standards specified by AHJ, the Construction Documents, and construction industry standards. The Testing Agency will reasonably support overtime, second shift, and out-of-area activity if requested by the Contractor and approved at the Owner's sole discretion.

B. TESTING AND INSPECTION: Materials to be tested are specified by the building permit and as required by the Construction Documents, as directed by Owner, or required by AHJ. Quantities and extent of tests and inspections shall be as specified and/or required by the Owner's Inspector or AHJ.

C. NON-CONFORMING WORK: The Owner's Inspector shall document and immediately notify the Contractor and Owner of any Work found defective or not in accordance with the requirements of the Construction Documents. Non-conforming Work shall be corrected.

D. The Owner's inspectors are not authorized to do the following:
   1. Release, revoke, alter or enlarge on requirements of Construction Documents.
   2. Approve or accept any portion of the Work, except as allowed by the special inspection duties delegated by governing AHJ for building permit inspections and testing.
   3. Perform any duties of the Contractor.
   4. Stop Work.

1.05 COSTS

A. The Owner's Testing Agency and Special Inspector costs for initial testing and inspection as specified in the Construction Documents will be paid for by the Owner or registered design professional in responsible charge acting as the Owner's agent . Initial tests and inspections are defined as those required to complete the first tests and inspections specified. Costs for subsequent re-testing and re-inspection of items found not to be in compliance with Construction Documents shall be borne by the Contractor.

B. Additional tests and inspections not herein specified, but requested by the Owner, shall be paid for by the Owner. However, if the results of such tests or inspections are found to be not in compliance with Construction Documents, the Contractor will be back charged for all costs for initial testing as well as re-testing, re-inspection and Owner's Consultants services.

C. Costs for additional tests or inspections required because of Contractor changes to reviewed and accepted products or materials provided, or source, or supply shall be borne by the Contractor.

D. Costs for any Work which is required to correct any deficiencies shall be borne by the Contractor.

E. Costs of any testing which is required solely for the convenience of Contractor in its scheduling and performance of the Work shall be borne by the Contractor.

F. Costs for verification testing of Work done without prior notice, with improper supervision, or contrary to construction practice shall be borne by the Contractor.

G. Costs for testing of materials for which fabrication and mill reports are required but not furnished shall be borne by the Contractor.

H. The cost, if any, of providing access for inspections and tests shall be considered part of the normal expense of conducting business and therefore non-reimbursable.

I. In those instances where inspector(s) arrive at the agreed-upon location, at the agreed upon date and time, and find articles to be inspected are not ready for inspection, the inspector(s) shall return to their home office and all expenses incurred shall be borne by the Contractor.

1.06 TESTS AND INSPECTION REPORTS

A. Copies of Owner and Contractor test and inspection reports shall be distributed at intervals. All reports will be signed by certified Special Inspector or Professional Engineer registered in the State of California, as appropriate. Such reports shall include all tests made, regardless of whether such tests indicate that the material is satisfactory or unsatisfactory; a final report should be submitted documenting corrective work done on of any unsatisfactory material and or work identified in the testing or inspection reports. Samples taken, but not tested, shall also be reported. Records of special sampling operations that are required shall also be reported. Test and inspection reports shall be distributed as follows:
   1. Owner
   2. Owner's Testing Agency
   3. Contractor
   4. Authority Having Jurisdiction

B. A report shall be prepared for each inspection and test and shall include:
   1. Date issued.
   2. Project title and number.
   3. Name and signature of inspector.
   4. Date of inspection or sampling and test.
   5. Record of temperature and weather.
   6. Identification of product and Specification Section.
   7. Location in Project.
   8. Type of inspection or test.
   9. Results of inspections and tests, and observations regarding compliance with Laws and Regulations, and standards.

1.07 CONTRACTOR'S RESPONSIBILITIES

A. COORDINATION: It is the Contractor's responsibility to initiate, coordinate, and conform to the required tests and inspections of governing State and AHJ. Inspection of the Work by the Owner's Special Inspectors and/or Testing Agency shall not relieve the Contractor from responsibility for compliance with the Construction Documents requirements. Owner's Special Inspectors and/or Testing Agency and Owner shall have authority to reject Work whenever the provisions of the Construction Documents are not being complied with, and the Contractor shall instruct his employees accordingly.

B. ACCESS FOR THE PURPOSE OF INSPECTION: Ensure the Owner's Special Inspectors and/or Testing Agency have free access to all parts of the Work and to the shops where the Work is in preparation; are provided proper facilities and safe access for such inspection; and are reasonably furnished access, equipment, tools, samples, certifications, test reports, design mixes, storage, and assistance as requested by the Owner's Inspector.

C. STORAGE FACILITIES: Furnish adequate storage facilities as approved by the Owner for the sole use of the Owner's Testing Agency for safe storage and curing of such specimens which must remain on the site prior to transport to the laboratory.

D. DATA: Furnish records, Contract Drawings and shop drawings, certificates, approved Change Orders, and similar data as required by Owner's Inspectors to perform their work to assure compliance with the Construction Documents.

E. NOTICE: Furnish notice to Owner and coordinate with Owner's Inspectors a minimum of five (5) working days in advance of all required tests and a minimum of forty-eight (48) hours in advance of all required inspections, unless otherwise specified.

F. NON-CONFORMING WORK: Remove and replace Non-conforming Work at no additional cost to the Owner prior to Final Completion. Where Non-conforming Work requires design modifications, such re-design shall be performed by the Engineer of Record and costs shall be borne by the Contractor.

G. CANCELLATIONS: Contractor shall give sufficient advance notice to Owner and Inspectors to allow rescheduling of their work load in the event of cancellation or time extension of any scheduled test or inspection

1.08 TEST FAILURES

A. GENERAL: The Owner may require re-test of a sampled material when a sample or procedure has failed to pass the required tests. In the event any test or inspection indicates failure of a material or procedure to meet requirements of Construction Documents, all costs for re-testing or re-inspection shall be borne by the Contractor. The Contractor may opt to replace the imperfect Work, equipment or material in lieu of performing the tests.

1.09 REPORT TEST FAILURES

A. GENERAL: Immediately upon determination of a test failure, the Owner's Inspector shall notify the Owner and Contractor. By the end of the following day the Owner's Inspector shall send written test results to those named on the distribution list.

B. Contractor shall similarly report test failures to Owner resulting from work of testing agencies provided by the Contractor.

PART 2 - NOT USED

PART 3 - NOT USED

END OF SECTION

SECTION 01 57 23

TEMPORARY STORM WATER POLLUTION CONTROL

PART 1 GENERAL

1.01 SUMMARY

A. Use this specification in conjunction with the provisions and other requirements of the State Water Resources Control Board, Regional Water Quality Control Board, Sonoma County, City of Santa Rosa, and other local agencies.

1.02 WATER POLLUTION CONTROL PLAN

A. CONTRACTOR shall submit a Water Pollution Control Plan accordance with Section 01 33 00 to the CITY for approval prior to proceeding with any work.

B. The Water Pollution Control Plan shall comply with the requirements set forth in the most recent version of the Erosion Control and Sediment Control Field Manual for California and the 2009 California Stormwater Quality Association (CASQA) Best Management Practice (BMP) Handbook, Construction.

C. The Water Pollution Control Plan shall ensure the project site is protected during all storm events for the entire duration of the project by implementing and maintaining temporary erosion and sediment control including, but not limited to, the following:
   1. Construction of any and all necessary systems required to eliminate contaminants from entering the storm system.
   2. Clean up and control of work site materials, spoils and debris.
   3. Removal of contaminants produced by equipment used for the construction of the project.
   4. Prohibition of illicit discharge (non-rain water) into the storm system.
   5. Provisions for all labor, materials, equipment and apparatus not specifically mentioned herein or noted on the plans, which are incidental and necessary to complete the work.

PART 2 PRODUCTS

A. BMP PRODUCTS

B. BMP Products shall be as specified in the 2009 CASQA BMP Handbook, Construction.

PART 3 EXECUTION

3.01 WATER POLLUTION CONTROL MEASURES

A. Erosion and sediment control work shall consist of applying BMP's to control the discharge of stormwater pollutants from the project site.

B. BMP's shall be used to cover all temporary erosion and sediment control situations that arise during construction, including unanticipated field conditions.

C. Erosion and sediment control measures shall control and contain erosion-caused silt deposits and provide for the safe discharge of silt-free storm water into existing and proposed storm facilities.

D. CONTRACTOR shall be responsible for ensuring that all sub-contractors and suppliers are aware of all water pollution control measures and that they implement such measures.

E. Failure to comply with the stormwater quality regulations and specifications will result in the issuance of corrective notices, citations, fines, and/or a project stop order.

F. CONTRACTOR shall assign a person responsible for CONTRACTOR's daily compliance with erosion and sediment control measures. The name of this person shall be on record with the CITY and Project Inspector, along with a phone number where they can be reached twenty-four (24) hours a day.

3.02 EROSION AND SEDIMENT CONTROL

A. Temporary erosion and sediment control work shall consist of applying erosion control materials to embankment slopes, excavation slopes and other areas designated on the Water Pollution Control Plan.

B. Sediment control includes, but is not limited to:
   1. Fiber roll
   2. Silt fence
   3. Inlet protection
   4. Gravel bags
   5. Headwall protection
   6. Stabilized construction entrances and exits

3.03 EMERGENCY EROSION AND SEDIMENT CONTROL (NOT USED)

PART 4 ADDITIONAL REQUIREMENTS (NOT USED)

END OF SECTION

SECTION 01 58 01

IDENTIFICATION SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: this section specifies the supply and installation of permanent identification nameplates, labels and markers for mechanical and HVAC equipment, piping, ducts, and valves.

B. Requirements for the supply and installation of permanent identification nameplates, labels and markers for electrical equipment, panels and instruments are specified in Division 26 and 40 of the Specifications.

1.02 RELATED SECTIONS

A. Section 01 11 80 – Environmental Conditions

B. Section 01 33 00 – Submittal Procedures

C. Section 01 61 45 – Area Exposure Designation

1.03 QUALITY ASSURANCE

A. References:

1. 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.
2. 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
ASME A13.1	Scheme for the Identification of Piping Systems
ANSI Z535.1	Safety Color Code

1.04 SUBMITTALS

A. The following information shall be provided in accordance with Section 01 33 00:
   1. Sample equipment nameplates
   2. Sample Valve Tags
   3. Sample Pipe Labels

PART 2 PRODUCTS

2.01 EQUIPMENT MANUFACTURER'S NAMEPLATES

A. Nameplates will be supplied and installed by the City.

2.02 EQUIPMENT AND MOTOR NAMEPLATES

A. Nameplates and tags will be supplied and installed by the City.

2.03 VALVE AND INSTRUMENT TAGS

A. Nameplates and tags will be supplied and installed by the City.

2.04 PIPING IDENTIFICATION

A. Above Ground Piping
   1. Identify material contained in above ground piping system using plastic background colored marking and legend system conforming to ASME A13.1 and as specified herein. For controlled or hazardous substances, use pictograms in addition to the pipe marking and legends.
   2. For above ground pipework, provide mechanically attached type background color markers that are easily removable; adhesive type markers are not acceptable.
   3. Each piping system to be color coded for identification and labelled with the system identification code letters, including temperature and pressure, if applicable, and directional flow arrows in accordance with the Marker/Legend Color Coding schedule shown below.
   4. Identification arrows labels and letters to be vinyl cloth or vinyl film with adhesive compatible with the surface temperature.
   5. Identify piping with pipe markers and direction arrows in accordance with ASME A13.1 and, as a minimum, at the following locations:
      a. Apply intermittent markings on straight pipe runs, close to all valve, fittings, and adjacent to all changes in direction.
      b. Where pipes pass through walls, partitions, and floors, apply markings on both sides of walls, partitions, and floors.
      c. At point of entry and leaving each pipe chase and/or confined space, and piping accessible at each access opening.
      d. Adjacent to major valves and where valves are in series at intervals of no more 6 feet.
      e. At least once in each room and at maximum spacing in open areas of 40 feet. Exception: gas piping to be identified at 6-ft intervals in ceiling plenums.

f. Spacing for markings shall not be less than 1 foot.

g. At the beginning and end points of each run; and, at each piece of equipment in each run.

6. Markers

a. Provide identification marking material that is appropriate for the environment specified in Section 01 61 45. At a minimum, provide identification marking material which is not degraded by exposure to ultraviolet radiation, abrasion, moisture, and that does not wrinkle with age or exposure.

b. Plastic coding markers shall not be the individual letter type but shall be manufactured and applied in one continuous length.

c. Marker/Legend Color Coding: per ASME A13.1. See the Table below for label marker and background color.

Process Service	Pipe Marker Background Color
Chilled Water Return	White Text on Green
Chilled Water Supply	White Text on Green
Drain	White Text on Green
Low Pressure Sludge Gas	Black Text on Yellow
Medium Pressure Sludge Gas	Black Text on Yellow
Natural Gas	Black Text on Yellow

7. Legend

a. Identify material contained in a piping system by a legend made up of clearly legible letters and/or numbers giving the name or identifier of the material. Place legend on background color marker in accordance with color coding.

8. Provide direction arrows for flow; double arrows for reversible flow.

a. Letter: Sans serif gothic bold

b. Legend sizing (per ASME A13.1):

Outside Diameter of Pipe or Covering (inches)	Length of Color Field (inches)	Legend Size (inches)
Less than 1 ¼-inch	8	½
1 ½ to 2	8	¾
2 ½ to 6	12	1 ¼
8 to 10	24	2 ½
Over 10	31	3 ½

9. Visibility

a. Place identification on the bottom of the piping system for pipe systems located near ceiling or above the normal line of sight.

b. Place identification on the side of the piping systems for pipe systems located at the normal line of sight or below.

c. Place identification approximately at line of sight for vertical pipe systems.

10. Acceptable Products:

a. Piping Identification:

1) Candidate products and models are listed below. The manufacturer's standard product may require modification to conform to specified requirements.
2) Identification arrows labels and letters:
   a) Vinyl cloth: W.H. Brady Inc. Brady B500, or approved equal.
   b) Vinyl film: W.H. Brady Inc. Brady B946, or approved equal.
3) Identification color bands for primary and secondary colors:
4) Vinyl cloth tape: W.H. Brady Inc. Brady B550, or approved equal.
5) Vinyl film tape: W.H. Brady Inc. Brady B946, or approved equal.

b. Markers:
1) Candidate products and models are listed below. The manufacturer's standard product may require modification to conform to specified requirements.
2) W.H. Brady Inc.: Bradysnap-On markers.
3) Approved Equal.

B. Below Ground Piping
1. Provide tracer wire and wire boxes as shown on C-0-506-00, Detail C1006 for all below grade piping.
2. Provide tracer tape for all below grade piping:
   a. Tracer tape shall be 6 inches wide, colored the same as the background colors as specified in the table for "Marker/Legend Color Coding", and made of inert plastic material suitable for direct burial. 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.
   b. Two messages shall be printed on the tape. The first message shall read **"CAUTION CAUTION CAUTION _____ PIPE BURIED BELOW"** with bold letters approximately 2 inches high. The blank shall be filled with the particular system fluid such as chlorine, oxygen or sulfur dioxide. The second message shall read **"CALL_____"** with letters approximately 3/4 inch high. Both messages shall be printed at maximum intervals of 2 feet. Phone number will be provided by the CITY after NTP.
   c. A single line of tape 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.

2.05 CABLES, CONDUITS, AND CONDUCTORS

1. Provide labels for electric cables, conduits, and conductors.
2. Refer to Division 26 and Division 40 for cable, conduit, and conductor identification and labeling.

PART 3 EXECUTION

3.01 GENERAL

A. Affix nameplates, where possible, to an area of the piece of equipment that would remain fixed if for example the piece of equipment is removed for maintenance. Examples:
   1. Mount the nameplates for pumps and motors on the base plate.
   2. Hang the nameplate for an inline pump by a nylon tie near the electrical connection at the pump.

B. Affix nameplates for electrical equipment housed in metal cabinets in a highly visible area, horizontally centered in the upper region of the cabinet or door of the cabinet.

C. Install nameplates, labels and markers before initiation of Functional Testing.

END OF SECTION

SECTION 01 61 45

AREA EXPOSURE DESIGNATIONS

PART 1 GENERAL

1.01 DESCRIPTION

A. SCOPE:
   1. This section designates area exposure types for each location, room, area, or space at the site of the Work.
   2. Area exposures are used to specify materials based on the corrosion environment that the material is exposed to when the materials for the component are not scheduled or otherwise identified for each specific installation (e.g., pipe, anchor bolts, pipe supports, coatings, etc.). Where materials are scheduled for specific individual components (e.g., equipment, instruments, conduit, panels, etc.), furnish materials as specified.

1.02 RELATED SECTIONS:

1. Section 01 11 80 – Environmental Conditions

1.03 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:
   1. Atmospheric: Air space surrounding a structure or process.
   2. Solution: Liquid or solid which may contain water or other free liquid.

B. EXPOSURE TYPE: Included as a supplement to this Section, the Area Exposure Table designates an Exposure Type for each room or area. Each Exposure Type, listed from least to most severe corrosion potential, is defined below:
   1. Indoor Dry: locations inside a building or other enclosed structure not subjected to wash down and not in contact with a liquid holding or earth retaining wall.
   2. Indoor Wet: locations inside a building or structure that are damp, subject to wash down, or surfaces of structures that are in contact with a liquid holding or earth retaining wall or slab.
   3. Outdoor: locations not protected from the weather, or only partly protected by a roof or open enclosure, and exposed to exterior ambient conditions. Local ambient conditions may be expected to vary, generally within the ranges specified in Section 01 11 80.
   4. Buried: below grade wall or roofs; locations covered and in contact with earth/soil.
   5. Submerged: locations inside a covered liquid or solids holding structure that are below a plane located 12 inches below the minimum operating level of the liquid in the tank or structure.
   6. Process Corrosive: locations exposed to high humidity, frequent wash down and/or corrosive gases or vapors from the process stream. Process corrosive includes locations inside an open (not covered) liquid or solids holding structure that are above a plane located 12 inches below the minimum operating level of liquid in the structure and below the top of the wall of the structure.

7. Head Space: locations inside a covered liquid or solids holding structure that are above a plane that starts 1-foot below the minimum operating liquid level in the structure.
8. Chemical Corrosive: walls, ceilings, floors, trenches and other surfaces exposed to delivery, storage, transfer, use or containment of corrosive chemicals.

C. ENVIRONMENTAL CONDITIONS: Environmental conditions for each Exposure Type are tabulated below:

Exposure Type	Environment	Chemical Exposure	Chemical Concentration
Indoor Dry	Atmospheric, Dry	None	Not Applicable
Indoor Wet	Atmospheric, Wet	None	Not Applicable
Outdoor	Atmospheric, Wet	None	Not Applicable
Buried	Solution	Earth/Soil	Not Applicable
Submerged	Solution	Various Chemicals	Dilute
Process Corrosive	Atmospheric	Hydrogen Sulfide	1 - 10 ppm
		Chlorides	Dilute
		Ferric chloride	Dilute
		Sodium hypochlorite	Dilute
		Sulfuric acid	Dilute
		Trace Chemicals	
Head Space	Low Oxygen, Wet	Hydrogen Sulfide	10 - 1500 ppm
		Other trace gases	Dilute
Chemical Corrosive	Atmospheric, Wet	Ferric chloride	45% wt
		Sodium hypochlorite	12% wt
		Sulfuric acid	98% wt

D. AREA EXPOSURE TABLE: The Area Exposure Table schedules an Exposure Type for each location, room, area, or space at the site of the Work. The Area Exposure Table is provided in Part 4 of this Section.

PART 2 NOT USED

PART 3 EXECUTION

A. MATERIAL SELECTION

1. Provide construction materials, coating systems, and lining systems consistent with materials requirements specified in individual equipment/material Specifications for the exposure assigned in the area exposure table. In the event of a conflict between the individual equipment/material specification and this Section, the individual equipment/material specification governs. In the event an area exposure is not designated for a particular location, the area exposure with the most severe corrosion potential from all area exposures for adjacent locations, rooms, areas, or spaces governs, and shall be the basis of the Contract Price.

2. Where components are assigned multiple area exposures, select the material and coating specified for the area exposure that has the most severe corrosion potential. When components cross, span, or straddle the boundary separating two or more area exposures, select materials specified for the area exposure that has the most severe corrosion potential. Where materials change at a boundary between exposures, change the material at the boundary or within the less severe exposure. At material transitions, separate dissimilar metals by a dielectric coupling or other suitable barrier.

PART 4 AREA EXPOSURE TABLE

Facility Name	Room Name / Delineation	Exposure Type	Notes
Laguna Treatment Plant	Gas Booster Area	Outdoor	Contains processing and containment equipment for medium pressure sludge gas (MSG)
Laguna Treatment Plant	CHP Building	Indoor Dry	Contains processing and containment equipment for MSG and natural gas
Laguna Treatment Plant	Gas Pressure Reducing Area	Outdoor	Contains processing and containment equipment for MSG
Laguna Treatment Plant	Digesters	Outdoor	Contains processing and containment equipment for MSG

END OF SECTION

SECTION 01 66 00

SHIPMENT, PROTECTION AND STORAGE

1.01 GENERAL

A. Equipment, products and materials shall be shipped, handled, stored, and installed in ways which will 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.

1.02 PIPE

A. 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 when recommended by the pipe manufacturer.

1.03 EQUIPMENT

A. PACKAGE AND MARKING:
   1. 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.
   2. 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 shall be easily visible.

C. SHIPPING:
   1. Bearing housings, vents and other types of openings shall be wrapped or otherwise sealed to prevent contamination by grit and dirt.
   2. 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. STORAGE:
   1. 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.
   2. 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.

E. PROTECTION OF EQUIPMENT AFTER INSTALLATION:

1. After installation, all equipment shall be protected against 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.

F. SPECIAL MONITORING:

1. Shipment of variable frequency drive equipment shall be on special vans with air suspension and accompanied by recording accelerometers designed to record the magnitude of sudden impacts in three directions on a continuous trip chart with both time and "g" force scales. The recorder shall be fixed to one of the shipping crates or truck bed. Upon arrival of each shipment, the Contractor shall immediately notify the Construction Manager. The accelerometer shall be removed in the presence of representatives of the Construction Manager and Contractor. If the magnitude of the maximum acceleration exceeds 3.0 g, the equipment in the shipment shall not be unloaded from the carrier until the carrier dispatcher makes a determination as to the next step. The direction given by the carrier dispatcher shall be recorded on the driver's Bill of Lading and signed by the Contractor and driver. The manufacturer shall be notified and the equipment returned to the factory for inspection and repair or to the nearest service center at the discretion of the manufacturer. The manufacturer shall certify in writing that the equipment is serviceable and shall be returned to the jobsite, again, with an accelerometer in place to record the travel conditions.

END OF SECTION

SECTION 01 73 23

BRACING AND ANCHORING

PART 1 GENERAL

1.01 SUMMARY

A. Scope

1. 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.
2. This section applies to nonstructural components that are permanently attached to structures, and nonbuilding structures as defined below in paragraph 1.01 Definitions and ASCE 7-10. Note that equipment is defined as a non-structural component and tanks are defined as a nonbuilding structure.
3. 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.
4. The following nonstructural components are exempt from the seismic design loading requirements of this section.
    a. Components in Seismic Design Category A.
    b. 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.
    c. Mechanical and electrical components in Seismic Design Category B.
    d. Mechanical and electrical components in Seismic Design Category C provided that the component importance factor, I_p, is equal to 1.0.
    e. 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:
        1) Flexible connections between the components and associated ductwork, piping and conduit are provided, and
        2) 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).
    f. 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:
        1) Flexible connections between the components and associated ductwork, piping and conduit are provided, and

2) The components weigh 20 lb or less or, for distribution systems, weighing 5 lb/ft or less.

1.02 REFERENCES:

1. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly.
2. 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
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
ASTM C635	Standard Specification for the Manufacture, Performance and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings
ASTM C636	Standard Practice for Installation for Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings
AWS D1.1	Structural Welding Code – Steel
AWS D1.2	Structural Welding Code - Aluminum
AWS D1.2	Structural Welding Code – Stainless Steel
CBC	California Building Code with local amendments (2016
NFPA-13	Standard for the Installation of Sprinkler Systems
Cal/OSHA	Division of Occupantional Safety and Health
SMACNA	Seismic Restraint Manual Guidelines for Mechanical Systems

1.03 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.

1.04 SUBMITTALS

A. 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 California licensed professional engineer qualified to perform structural engineering.

B. 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.
   1. The following submittals shall be provided in accordance with Section 01 33 00:
      a. List of all nonstructural components and nonbuilding structures requiring wind and seismic design and anchorage.
      b. Shop drawings showing details of complete wind and seismic bracing and anchorage attachment assemblies including connection hardware, and embedment into concrete.
      c. 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.
      d. 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.
      e. 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.
      f. Product Data: Manufacturer's certificates of compliance with the seismic force requirements of this section.

1.05 QUALITY CONTROL BY OWNER:

1. 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 CBC, Chapter 17 and the drawings.
2. Special Inspector(s) and laboratory shall be acceptable to the Owner in their sole discretion.

3. Special Inspection is in addition to, but not replacing, other inspections and quality control requirements. Where sampling and testing required conforms to Special Inspection standards, such sampling and testing need not be duplicated.

1.06 DESIGN CODES

A. The following standard codes have application at this site for:

Design:	Code Reference:
Structures and Buildings	2016 California Building Code with Local Amendments and ASCE 7-10
Reinforced Concrete:	ACI 350-06 for Concrete Liquid Containing Tanks, ACI 318-14 for all other Reinforced Concrete
Structural Steel:	AISC 360-10 and AISC 341-10
Aluminum:	Aluminum Design Manual, Latest Edition
Welding:	AWS Welding Codes, Latest Edition
Occupational Health and Safety Requirements:	Cal/OSHA

Note: When conflicting requirements occur, the most stringent requirements will govern the design.

1.07 DESIGN LOADS

A. 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.
   1. Dead Loads:
      a. An additional allowance will also be added for piping and conduit when supported and hung from the underside of equipment and platforms.
      b. Typical allowance for piping and conduit unless noted otherwise: 20 psf
   2. Uniform Live Loads:

Elevated grating floors:	100 psf
Columns:	No column live load reduction allowed
Stairs and Landings:	100 psf
Equipment Platforms, Walkways/ Catwalks (other than exitways):	100 psf

   1. Wind Loads:
      a. Wind design criteria shall be as specified in Section 01 88 15.
      b. Design exterior nonstrutural components and nonbuilding structures, unless located in a pit or basin, to withstand the design wind loads without consideration of shielding effects by other structures.

   2. Seismic Loads:
      a. Seismic design criteria shall be as specified in Section 01 88 14.
      b. Design exterior nonstrutural components and nonbuilding structures, unless located in a pit or basin, to withstand the design wind loads without consideration of shielding effects by other structures.

c. Calculate seismic loads on the basis of the governing building code. Include equipment operating loads in the structure dead load.

d. Check individual members for seismic and full member live load acting simultaneously, except that flooded equipment loads (infrequent occurrence) need not be combined with seismic loads. Combine equipment operating loads with seismic loads.

3. Impact Loads:

a. Impact loads shall be considered in the design of support systems.

b. 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 lifted load
• Longitudinal	10% of lifted load
Hangers supporting floors and platforms:	33% of live and dead load

4. Temperature:

a. The effects of temperature shall be included in design where nonstructural components and nonbuilding structures are exposed to differential climatic conditions. See paragraph 1.07 for temperature extremes.

1.08 LOAD COMBINATIONS

A. 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.

1.09 DESIGN CONSIDERATIONS

A. All nonstructural components and nonbuilding structures shall be designed for the following conditions:

1. Climatic Conditions:

Maximum design temperature:	105	degrees Fahrenheit
Minimum design temperature:	32	degrees Fahrenheit

B. Foundations:

1. Foundations supporting nonstructural components and nonbuilding structures shall extend below the frost line, or be supported on non-frost susceptible structural fill down to the frost line.

Frost line for foundations:	12 inches

Note: Consult project geotechnical report for allowable soil bearing recommendations at location of structure.

1.10 COLUMN BASE FIXITY

A. Column bases shall be designed as pinned connections. No moments shall be assumed to be transferred to the foundations.

B. Where significant shear loads (greater than 5,000 lb. per anchor bolt) are transferred at column base plates, the equipment vendor shall provide a shear key.

1.11 DEFLECTIONS

A. Maximum beam deflections as a fraction of span for walkways and platforms shall be L/240 for total load and L/360 for live load. Maximum total load deflection for equipment supports shall be L/450.

PART 2 PRODUCTS

2.01 GENERAL

A. 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 3 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 05 05 23. 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 01 73 29

CUTTING AND PATCHING

PART 1 GENERAL

1.01 STRUCTURES

A. 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

A. 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

A. 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.

B. Existing guard posts, barricades, and fences shall be protected and replaced if damaged.

1.04 PROTECTION OF EXISTING INSTALLATIONS

A. 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.

END OF SECTION

SECTION 01 77 00

Closeout Procedures

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Contract closeout requirements including:
   1. Final cleaning
   2. Preparation and submittal of closeout documents
   3. Final completion certification

B. Related Sections:
   1. Section 01 45 20 – Equipment and System Performance and Operational Testing
   2. Section 01 78 23 – Operations and Maintenance Data
   3. Section 01 78 23.01 – Closeout Submittal
   4. Section 01 78 39 – Project Record Documents

1.02 CLOSEOUT DOCUMENTS

A. Informational Submittal:
   1. CONTRACTOR shall submit closeout documents to CITY with the application for final payment.

1.03 FINAL CLEANING

A. Perform final cleaning prior to inspections for Substantial Completion.

B. Use cleaning materials which are recommended by manufacturers of surfaces to be cleaned.

C. Prevent scratching, discoloring, and otherwise damaging surfaces being cleaned.

D. Clean roofs, gutters, downspouts, and drainage systems.

E. Remove dust, cobwebs, and traces of insects and dirt.

F. Broom clean exterior paved surfaces (e.g. walks, steps and platforms) and remove dust, dirt and other disfigurations from exterior surfaces of site work.

G. Clean grease, mastic, adhesives, dust, dirt, stains, fingerprints, paint, blemishes, sealants, plaster, concrete, and other foreign materials from sight-exposed surfaces, and fixtures and equipment.

H. Clean each surface or unit of Work and remove non-permanent protection and labels.

I. Wipe surfaces of mechanical and electrical equipment clean. CONTRACTOR shall remove excess lubrication and other substances.

J. Clean light fixtures and replace burned out or dim lights.

K. Repair any damage to existing roadway, fencing, etcetera, due to construction activities.

L. Remove all temporary work form the site including but not limited to fencing, sign boards, samples, and any other items not considered to be part of the permanent Work.

1.04 WASTE DISPOSAL

A. Arrange for and dispose of surplus materials, waste products, and debris off-site. Prior to making disposal on private property, obtain written permission from CITY of such property.

B. Do not fill ditches, washes, or drainage ways which may create drainage problems.

C. Do not create unsightly or unsanitary nuisances during disposal operations.

D. Maintain disposal site in safe condition and good appearance.

E. Complete leveling and cleanup prior to final acceptance of the Work.

1.05 TOUCH-UP AND REPAIR

A. Touch-up or repair finished surfaces on structures, equipment, fixtures, and installations that have been damaged prior to inspection for Substantial Completion.

B. Refinish or replace entire surfaces which cannot be touched-up or repaired satisfactorily.

1.06 CLOSEOUT DOCUMENTS

A. Submit the following Closeout Submittals upon Substantial Completion and at least seven (7) days prior to submitting Application for Final Payment:
   1. Evidence of Compliance with Requirements of Governing Authorities
   2. Project Record Documents (Section 01 78 39)
   3. Operation and Maintenance Data (Section 01 78 23)
   4. Asset Management Data (Section 01 78 23.01)
   5. Warranties and Bonds
   6. Evidence of Payment and Release of Stop Payment Notices as outlined in Conditions of the Contract
   7. Release of claims as outlined in Conditions of the Contract
   8. Certificate of Final Completion

1.07 PROJECT RECORD DOCUMENTS

A. Provide record drawings in accordance with Section 01 78 39.

1.08 WARRANTIES AND BONDS

A. Provide executed Warranty or Guaranty Form if required by Contract Documents.

B. Provide specified additional warranties, guarantees, and bonds from manufacturers and suppliers.

C. Warranties, Guaranties, and Bonds shall be included in the individual equipment specifications and in Section 01 78 23.

1.09 CERTIFICATE OF FINAL COMPLETION

A. Once the acceptance test in Section 01 45 20 has been successfully completed, CITY will certify that new facilities are operationally complete. CITY will then schedule and conduct a walk-through inspection with CITY and CONTRACTOR and publish a punch list to the CONTRACTOR for correction.

B. List of items to be completed or corrected will be amended as items are resolved by CONTRACTOR.

C. When all items have been completed or corrected, submit written certification that the entire work is complete in accordance with the Contract Documents and request final inspection.

D. Upon completion of final inspection, CITY will either prepare a written acceptance of the entire work or advise CONTRACTOR of work not complete. If necessary, inspection procedures will be repeated.

E. The certificate will not be issued until record drawings are complete and submitted, and CONTRACTOR has satisfied all requirements for Substantial Completion and Final Completion of the Work.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

PART 4 ADDITIONAL REQUIREMENTS (NOT USED)

END OF SECTION

SECTION 01 78 23

OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.01 SCOPE

A. 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.

B. O&M instructions must be submitted and accepted before on-site training may start.

1.02 TYPES OF INFORMATION REQUIRED

A. General:
   1. 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:
   1. Specific instructions, procedures, and illustrations shall be provided for the following phases of operations:
      a. Safety Precautions: List personnel hazards for equipment and list safety precautions for all operating conditions.
      b. Operator Prestart: Provide requirements to set up and prepare each system for use.
      c. Start-Up, Shutdown, And Postshutdown Procedures: Provide a control sequence for each of these operations.
      d. Normal Operations: Provide control diagrams with data to explain operation and control of systems and specific equipment.
      e. 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.
      f. Operator Service Requirements: Provide instructions for services to be performed by the operator such as lubrication, adjustments, and inspection.
      g. 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:
   1. The following information shall be provided for preventive and scheduled maintenance to minimize corrective maintenance and repair:
      a. Lubrication Data: Provide lubrication data, other than instructions for lubrication in accordance with paragraph 1.02 Operator Service Requirements.
         1) A table showing recommended lubricants for specific temperature ranges and applications;
         2) Charts with a schematic diagram of the equipment showing lubrication points, recommended types and grades of lubricants, and capacities; and
         3) A lubrication schedule showing service interval frequency.
      b. 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:
   1. Manufacturer's recommendations shall be provided on procedures and instructions for correcting problems and making repairs.
      a. 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.
      b. 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.
      c. Maintenance And Repair Procedures: Provide instructions and list tools required to restore product or equipment to proper condition or operating standards.
      d. 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.
      e. 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.
      f. 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:

1. 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.

a. 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.

b. 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.

c. Personnel Training Requirements: Provide information available from the manufacturers to use in training designated personnel to operate and maintain the equipment and systems properly.

d. 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

A. Unless otherwise specified, O&M manuals, information, and data shall be transmitted in accordance with Section 01 33 00 accompanied by Transmittal Form 01 78 23-A and Equipment Record Forms 01 78 23-B and/or 01 78 23-C, as appropriate, all as specified in Section 01 99 90. 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.

B. 3 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.

C. 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

A. 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

A. 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.

END OF SECTION

SECTION 01 78 39

PROJECT RECORD DOCUMENTS

PART 1 GENERAL

1.01 DRAWINGS

A. 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.

B. 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.

C. In addition to Record Prints, Record Digital Drawings shall be provided.
   1. Format: Annotated PDF electronic file with comment function enabled.
   2. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each data file.
   3. Indentification: Provide the following
      a. Project name
      b. Date
      c. Designation: “PROJECT RECORD DRAWINGS”
      d. Name of Engineer
      e. Name of Contractor

D. 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:
   1. Additions - Red
   2. Deletions - Green
   3. Comments - Blue
   4. Dimensions - Graphite*

   **Legibly mark to record actual depths, horizontal and vertical location of underground raceways, cables, and appurtenances referenced to permanent surface improvements.*

END OF SECTION

SECTION 01 79 00

DEMONSTRATION AND TRAINING

PART 1 GENERAL

1.01 DESCRIPTION

A. 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

A. 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

A. The following information shall be submitted to the Construction Manager in accordance with the provisions of Section 01 33 00. The material shall be reviewed and accepted by the Construction Manager as a condition precedent to receiving progress payments in excess of 50 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

A. 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 30 days prior to the date scheduled for the individual training session.

2.02 LOCATION

A. Training sessions shall take place at the site of the work in Santa Rosa, CA.

2.03 LESSON PLANS

A. 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.

B. 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

A. 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 plant 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:

A. The Owner will 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

3.01 SUMMARY

A. 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 43 05 11-B specified in Section 01 99 90.

B. 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.

C. 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 plant and an operational overview.
        b. Purpose and plant 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. Classroom 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 01 88 14

SEISMIC DESIGN CRITERIA

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Seismic design criteria for the following:
   1. For the design, anchorage and bracing of: nonstructural components such as architectural, mechanical, HVAC, electrical components, equipment, and systems, and non-building structures.
   2. Other structures or items as specified or indicated on the Drawings.

B. Submittals and other requirements shall be as required in Section 01 73 23.

C. Related Sections:
   1. Section 01 73 23 – Bracing and Anchoring.
   2. Section 01 88 15 – Wind Design Criteria.

1.02 REFERENCES

A. California Building Code (2016 CBC).

B. Minimum Design Loads for Building and Other Structures, American Society of Civil Engineers Standard 7-10 (ASCE 7-10).

1.03 SYSTEM DESCRIPTION

A. Design Requirements
   1. The following parameters shall be used for the development of seismic loads in accordance with the 2016 California Building Code (CBC):
      a. Risk Category: III.
      b. Seismic Importance Factor, I_E: 1.25.
      c. Seismic Design Category: D.
      d. Mapped MCE spectral acceleration parameter at short period: S_S = 1.50g.
      e. Mapped MCE spectral acceleration parameter at 1-second period: S_1 =0.60g.
      f. Site Class: E.
      g. Design, 5 percent damped, spectral response acceleration parameter at short periods: S_{DS} = 0.90 g.
      h. Design, 5 percent damped, spectral response acceleration parameter at a period of 1 second: S_{D1} = 0.96 g.
      i. Long period transition period, T_L = 12 seconds.
   2. The design of seismic loads for nonstructural components, nonbuilding structures, and structures other than tanks: In accordance with the requirements of 2016 California Building Code (CBC), Section 1613 – Earthquake Loads, with design parameters listed above and the following:
      a. Seismic Component Importance Factor for Nonstructural Components, I_P: 1.0.

b. Nonstructural Component Amplification Factor, a_p: In accordance with Table 13.5-1 and 13.6-1 of the ASCE 7-10.

c. Nonstructural Component Response Modification Factor, R_p: In accordance with Table 13.5-1 and 13.6-1 of ASCE 7-10.

d. Nonbuilding Structures (similar to buildings and not similar to buildings) Response Modification Coefficient, R: Table 15.4-1 and 15.4-2 of ASCE 7-10.

e. Load Combinations: In accordance with 2016 CBC

1) Section 1605.2, Load combinations using strength design; or

2) Section 1605.3.1, Basic load combinations using allowable stress design

3. Design of seismic loads for Tanks: In accordance with AWWA D100-11, Section 13 – Seismic Design of Water Storage Tanks, with the design parameters listed above and the following:

a. Seismic Importance Factor for the Design of Tanks and the Anchorage of Tanks, I_E: 1.25.

b. Component Response Modification Factors: In accordance with Table 28 of AWWA D100-11.

c. Load combinations: In accordance with 2016 CBC.

1) Section 1605.3.1, Basic load combinations using allowable stress design.

4. The effects of vertical acceleration shall be considered in accordance with the 2016 CBC and ASCE 7-10.

5. Anchorage to Concrete:

a. Anchorage to concrete shall be designed in accordance with the 2016 CBC, Chapter 1901.3 and ACI 318-14, Chapter 17.

b. Reference Specification Section 01 73 23 – Bracing and Anchoring.

c. Post-installed anchors must comply with ICC-ES AC193 and AC308.

B. Resistance Requirements:

1. Seismic loads must be resisted by assemblies of welded plates, and anchor bolts embedded in concrete or bolts fastened to steel frames. All steel assemblies, anchor bolts and fasteners shall be of Type 316 Stainless Steel, unless otherwise indicated on Drawings.

2. Seismic loads must be resisted by direct bearing on anchors. Do not use connections in which forces are developed by friction in any part.

3. Use anchor bolts, bolts or welded studs for anchors for resisting seismic forces. Anchor bolts shall have a standard hex bolt head unless otherwise indicated on Drawings. Do not use anchor bolts fabricated from rod stock with an L or J shape.

4. Do not use sleeve anchors, concrete anchors, chemical anchors, flush shells, power actuated fasteners, screws, or other types of anchors for resisting seismic loads unless indicated on the Drawings or accepted in writing by the ENGINEER.

5. Do not use more than 60 percent of the weight of the mechanical and electrical equipment for designing anchors for resisting overturning due to seismic forces.

6. Do not use more than 60 percent of the weight of the tank for resisting overturning due to seismic forces.

1.04 SUBMITTAL PREPARATION REQUIREMENTS

A. Complete calculations, details, and complete reference drawings that are required to be submitted as part of a deferred submittal and as defined in the CBC and the Contract Documents, shall be prepared, stamped, signed, and furnished by a Professional Civil or Structural Engineer licensed to practice in the State of California. The following requirements apply for each deferred submittal:
   1. Qualification of Civil or Structural Engineer: Minimum of three (3) years of experience in water, wastewater or similar public works projects.
   2. The Civil or Structural Engineer shall be responsible to obtain all necessary reference drawings and data from the CONTRACTOR or Manufacturer for his or her calculations.

B. Calculations shall be independently checked and signed by a Professional Civil or Structural Engineer licensed to practice in the State of California.
   1. Qualification of Civil or Structural Engineer: Minimum of three (3) years of experience in water, wastewater or similar public works projects.

C. Minimum Calculation and Reference Drawing Requirements:
   1. Calculations shall be comprehensible and complete. When evaluating the structural strengths, indicate stress for comparing with strengths or show the demand versus capacity ratio in the structural elements. Evaluating the results by stating “Okay by Inspection” is not acceptable. When spreadsheets are used, clearly reference equations and formulas presented in submittal calculations.
   2. Reference drawings shall include plans, sections, details and equipment information as necessary for seismic calculations. Indicate the location of the equipment on plan which is necessary for load calculations.
   3. Submittals shall be returned without review if:
      a. Submittals include only calculations without reference drawings
      b. Calculations have no sheet numbers or sheets are missing
      c. Calculations or reference drawings are illegible
      d. Calculations are made based on wrong information, assumptions or design parameters
      e. Information in reference drawings is insufficient for calculations or review
   4. The calculations and details shall demonstrate a complete vertical and lateral load path, and shall clearly indicate all forces imposed on the supporting structure.
   5. Anchor Bolt Calculations and Details:
      a. Anchor bolt calculations shall clearly show that the capacity of the anchor and the capacity of the concrete that the anchor is embedded in are adequate to resist all applicable load combinations, including wind and seismic loads.
         1) The design of anchors resisting seismic forces shall satisfy the ductility requirements stated in the 2016 CBC, ASCE 7-10, and ACI 318-14.
      b. Reduction factors associated with edge distance, embedment length, grout and base plate thickness, and bolt spacing shall be considered in the design and clearly indicated on the submittal drawings.
      c. Anchor bolts shall be designed for bending due to eccentricity where raised grout pads will be installed for leveling.

d. Anchor bolt details shall include the required bolt diameter, embed, spacing, and edge distances consistent with the calculations.
e. Reference Specification Section 01 73 23 – Bracing and Anchoring for information not indicated in this section.

PART 2 PRODUCTS (**NOT USED**)

PART 3 EXECUTION (**NOT USED**)

PART 4 ADDITIONAL REQUIREMENTS

END OF SECTION

SECTION 01 88 15

WIND DESIGN CRITERIA

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Wind design criteria for the following:
   1. For the design, anchorage and bracing of: architectural, mechanical, HVAC, electrical components, equipment, and systems, and non-building structures, as specified in Section 01 73 23.
   2. Other structures or items as specified or indicated on the Drawings.

B. Submittals and other requirements shall be as required in Section 01 73 23.

C. Related Sections:
   1. Section 01 73 23 – Bracing and Anchoring
   2. Section 01 88 14 – Seismic Design Criteria

1.02 REFERENCES

A. California Building Code (2016 CBC).

B. Minimum Design Loads for Building and Other Structures, American Society of Civil Engineers Standard 7-10 (ASCE 7-10).

1.03 SYSTEM DESCRIPTION

A. Design Requirements:
   1. The following parameters shall be used for the development of wind loads in accordance with the 2016 California Building Code (CBC):
      a. Ultimate Wind Speed: 115 miles per hour
      b. Nominal Design Wind Speed: 89 miles per hour
      c. Risk Category: III.
      d. Wind Exposure: D.
      e. Topographic Factor, K_{zt} = 1.0.
      f. Internal Pressure Coefficients: in accordance with the 2016 CBC and ASCE 7-10.
      g. Load Combinations: In accordance with 2016 CBC
         1) Section 1605.2, Load combinations using strength design; or
         2) Section 1605.3.1, Basic load combinations using allowable stress design
   2. Anchorage to Concrete:
      a. Anchorage to concrete shall be designed in accordance with the 2016 CBC, Chapter 1901.3 and ACI 318-14, Chapter 17.
      b. Reference Specification Section 01 73 23 – Bracing and Anchoring.
      c. Post-installed anchors must comply with ICC-ES AC193 and AC308.

B. Resistance Requirements:
   1. Wind loads must be resisted by assemblies of welded plates, and anchor bolts embedded in concrete or bolts fastened to steel frames. All steel assemblies, anchor bolts and fasteners shall be of Type 316 Stainless Steel, unless otherwise indicated on Drawings.
   2. Wind loads must be resisted by direct bearing on anchors. Do not use connections in which forces are developed by friction in any part.
   3. Anchor bolts shall have a standard hex bolt head unless otherwise indicated on Drawings
   4. Do not use: sleeve anchors, concrete anchors, chemical anchors, flush shells, power actuated fasteners, screws or other types of anchors unless indicated on the Drawings or accepted in writing by the Engineer
      a. Do not use anchor bolts fabricated from rod stock with an L or J shape.
      b. Wind forces must be resisted by direct bearing on the anchors used to resist wind forces. Do not use connections which use friction to resist wind forces.

1.04 SUBMITTALS PREPARATION REQUIREMENTS

A. Complete calculations, details, and complete reference drawings that are required to be submitted as part of a deferred submittal and as defined in the CBC and the Contract Documents, shall be prepared, stamped, signed, and furnished by a Professional Civil or Structural Engineer licensed to practice in the State of California. The following requirements apply for each deferred submittal:
   1. Qualification of Civil or Structural Engineer: Minimum of three (3) years of experience in water, wastewater or similar public works projects.
   2. The Civil or Structural Engineer shall be responsible to obtain all necessary reference drawings and data from the CONTRACTOR or Manufacturer for his or her calculations.

B. Calculations shall be independently checked and signed by a Professional Civil or Structural Engineer licensed to practice in the State of California.
   1. Qualification of Civil or Structural Engineer: Minimum of three (3) years of experience in water, wastewater or similar public works projects.

C. Minimum Calculation and Reference Drawing Requirements:
   1. Calculations shall be comprehensible and complete. When evaluating the structural strengths, indicate stress for comparing with strengths or show the demand versus capacity ratio in the structural elements. Evaluating the results by stating “Okay by Inspection” is not acceptable. When spreadsheets are used, clearly reference equations and formulas presented in submittal calculations.
   2. Reference drawings shall include plans, sections, details and equipment information as necessary for seismic calculations. Indicate the location of the equipment on plan which is necessary for load calculations.
   3. Submittals shall be returned without review if:
      a. Submittals include only calculations without reference drawings
      b. Calculations have no sheet numbers or sheets are missing
      c. Calculations or reference drawings are illegible
      d. Calculations are made based on wrong information, assumptions or design parameters

e. Information in reference drawings is insufficient for calculations or review

4. The calculations and details shall demonstrate a complete vertical and lateral load path, and shall clearly indicate all forces imposed on the supporting structure.
5. Anchor Bolt Calculations and Details:
   a. Anchor bolt calculations shall clearly show that the capacity of the anchor and the capacity of the concrete that the anchor is embedded in are adequate to resist all applicable load combinations, including wind and seismic loads.
   b. Reduction factors associated with edge distance, embedment length, grout and base plate thickness, and bolt spacing shall be considered in the design and clearly indicated on the submittal drawings.
   c. Anchor bolts shall be designed for bending due to eccentricity where raised grout pads will be installed for leveling.
   d. Anchor bolt details shall include the required bolt diameter, embed, spacing, and edge distances consistent with the calculations.
   e. Reference Specification Section 01 73 23 – Bracing and Anchoring for information not indicated in this section.

PART 2 PRODUCTS (**NOT USED**)

PART 3 EXECUTION (**NOT USED**)

PART 4 ADDITIONAL REQUIREMENTS

END OF SECTION

SECTION 01 91 00

COMMISSIONING

PART 1 GENERAL

1.01 DESCRIPTION:

A. This section contains requirements for the Contractor's performance during the commissioning of the structures, equipment and systems constructed and installed during the course of this contract. All commissioning work, as described in this section, shall be performed by the Contractor.

1.02 QUALITY ASSURANCE

A. Cleanup:
   1. Following completion of the operational testing period, the Contractor shall remove, clean, and replace all permanent and temporary filters and strainers in all pipeline systems; replace all HVAC filters; dewater and clean all sumps; and dewater all process units for final inspection as a condition precedent to commissioning.

B. Commissioning Team:
   1. The Contractor shall assemble a commissioning team under the direction of an individual duly authorized to commit the Contractor's personnel and resources to respond to requests for assistance on the part of the Construction Manager or, through the Construction Manager, the Owner. The commissioning team shall consist of representatives of the Contractor's mechanical, electrical, and instrumentation subcontractors, and others as appropriate. The commissioning team shall be available at the site of the work during normal working hours (8 hours a day, 5 days a week, Saturdays, Sundays, and legal holidays excepted) and shall be available within 2 hours' notice at all other times upon notice by telephone. The commissioning team shall at all times be equipped and ready to provide for emergency repairs, adjustments, and corrections to the equipment and systems installed and modified as a part of this contract.

1.03 SUBMITTALS

A. The following information shall be submitted to the Construction Manager in accordance with the provisions of Section 01 33 00:
   1. Detailed plans for commissioning each process unit and each system constructed or modified as a part of the work performed under this contract.
   2. The Contractor's plan for providing a commissioning team conforming to the requirements of paragraph 1.02 Commissioning Team during the commissioning period. The plan shall be complete with a daytime staffing plan and names, qualifications, and telephone numbers of those assigned to off-hour standby duty.

PART 2 PRODUCTS

2.01 SUMMARY

A. Working with representatives of the Owner and the Construction Manager, the Contractor shall develop and produce a detailed, written plan for the startup and initial operation, under actual operating conditions, of the equipment and systems installed and constructed under this contract. The document, after acceptance by the Construction Manager, shall serve as the guidance manual for the commissioning process.

PART 3 EXECUTION

3.01 SUMMARY

A. After completion of the equipment and system performance and operational testing, where required, and agreement on the part of the Construction Manager that the systems did meet all test requirements, commissioning will begin. The Contractor shall remove all temporary piping, bulkheads, controls and other alterations to the permanent systems that may have been needed during the performance and operational testing and shall perform the tasks necessary to make the improvements constructed under this contract fully operational. The Construction Manager shall confirm in writing the date(s) that the system is ready for commissioning and on which actual commissioning activities commence. Activities conducted prior to such written confirmation shall not constitute commissioning.

B. The Owner's operation and maintenance personnel will be responsible for operation of the systems to be commissioned. The portion of the work to be commissioned shall be fully operational, performing all functions for which it was designed.

C. The Contractor shall be available at all times during commissioning periods to provide immediate assistance in case of failure of any portion of the system being constructed. At the end of the commissioning period and when all corrections required by the Construction Manager to assure a reliable and completely operational facility are complete, the Construction Manager shall issue a completion certificate. Each system shall have been issued a completion certificate as a condition precedent to the final acceptance of the work of this contract.

D. During the commissioning period, the Owner shall be responsible for all normal operational costs and the Contractor shall bear the costs of all necessary repairs or replacements, including labor and materials, required to keep the portion of the plant being commissioned, operational.

E. The commissioning period for each modified or new unit process system shall be 4 weeks without equipment or system failure. Failure of equipment or systems where, in the opinion of the Construction Manager, a significant interruption or impact to performance occurs, will be grounds for restarting the commissioning period. Minor failures that require less than 8 hours to correct will not result in restarting the commissioning period; however, the period will be extended by the time it took to resolve the minor failure.

END OF SECTION

SECTION 01 99 90

REFERENCE FORMS

PART 1 FORMS

1.01 DESCRIPTION

A. The forms listed below and included in this section are referenced from other sections of the project manual:

Form No.	Title
01 33 00-A	Submittal Transmittal Form
01 45 20-A	Equipment Test Report Form
01 78 23-A	Operation and Maintenance Transmittal Form
01 78 23-B	Equipment Record Form
01 78 23-C	Equipment Record Form
40 61 13-A	Loop Wiring and Insulation Resistance Test Data Form
40 61 13-B	Control Circuit Piping Leak Test Form
40 61 13-C	Controller Calibration Test Data Form
40 61 13-D	Panel Indicator Calibration Test Data Form
40 61 13-E	Recorder Calibration Test Data Form
40 61 13-F	Signal Trip Calibration Test Data Form
40 61 13-G	Field Switch Calibration Test Data Form
40 61 13-H	Transmitter Calibration Test Data Form
40 61 13-I	Miscellaneous Instrument Calibration Test Data Form
40 61 13-J	Individual Loop Test Data Form
40 61 13-K	Loop Commissioning Test Data Form
43 05 11-A	Manufacturer's Installation Certification Form
43 05 11-B	Manufacturer's Instruction Certification Form
43 05 11-C	Unit Responsibility Certification Form
43 05 13-A	Rigid Equipment Mount Installation Inspection Checklist

01 33 00-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 *Section 01 33 00-1.04. A, Transmittal Procedure.*

01 45 20-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.

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
A. Preoperational Checklist				
1. Mechanical				
a. Lubrication				
b. Alignment				
c. Anchor bolts				
d. Seal water system operational				
e. Equipment rotates freely				
f. Safety guards				
g. Valves operational				
h. Hopper purge systems operational				
i. Sedimentation tank/hopper clean				
j. O&M manual information complete				
k. Manufacturer's installation certificate complete				
2. Electrical (circuit ring-out and high-pot tests)				
a. Circuits:				
1) Power to MCC 5				
2) Control to HOA				
3) Indicators at MCC:				
a) Red (running)				
b) Green (power)				
c) Amber (auto)				
4) Indicators at local control panel				
b. Wiring labels complete				
c. Nameplates:				
1) MCC				
2) Control station				
3) Control panel				

	Contractor		Construction Manager	
	Verified	Date	Verified	Date
d. Equipment bumped for rotation				
3. Piping Systems				
a. Cleaned and flushed:				
1) Suction				
2) Discharge				
b. Pressure tests				
c. Temporary piping screens in place				
4. Instrumentation and Controls				
a. Flowmeter FE2502F calibration				
1) Calibration Report No.				
b. Flow recorder FR2502G calibrated against transmitter				
c. VFD speed indicator calibrated against independent reference				
d. Discharge overpressure shutdown switch calibration				
e. Simulate discharge overpressure Shutdown				
B. Functional Tests				
1. Mechanical				
a. Motor operation temperature satisfactory				
b. Pump operating temperature satisfactory				
c. Unusual noise, etc?				
d. Pump operation: 75 gpm/50 psig				
(1) Measurement:				
(a) Flow:				
(b) Pressure:				
(c) Test gage number:				
e. Alignment hot				
f. Dowelled in				
g. Remarks:				
2. Electrical				
a. Local switch function:				
1) Runs in HAND				
2) No control power in OFF				
3) Timer control in AUTO				
b. Overpressure protection switch PS2502C functional in both HAND and AUTO				
c. Overpressure protection switch PS2502C set at 75 psig				
d. PLC 2500 set at 24-hour cycle, 25 min ON				
C. Operational Test				
1. 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

01 78 23-A. OPERATION AND MAINTENANCE TRANSMITTAL FORM

Date:	Submittal No:[2]
To:	Contract No:
	Spec. Section:
	Submittal Description:
Attention:	From:

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 Section 01 33 00-1.04.A, Transmittal Procedure.

01 78 23-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					Electrical Nameplate Data			
Part No	Quan	Part Name	Cost		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			

01 78 23-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

40 61 13-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

40 61 13-B. CONTROL CIRCUIT PIPING LEAK TEST FORM

Loop No.:_____

List tubing associated with loop in table below. Make applicable measurements after isolating any air consuming pilots from circuit.

Tube No.	Tubing Equivalent Length of 1/4-Inch Copper[a]	Test Period (seconds)	Permitted Pressure Drop (psi)[b]	Measured Pressure Drop (psi)
A				
B				
C				
D				
etc.				

NOTES:

a. Convert actual tubing and air motor volume to equivalent 1/4-inch copper tubing.

b. Pressure drop shall not exceed 1 psi per hundred feet 1/4-inch tubing per 5 seconds.

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

40 61 13-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

40 61 13-D. PANEL INDICATOR CALIBRATION TEST DATA FORM

Tag No. and Description: _____

Make & Model No.: _____ Serial No.: _____

Input: _____

Scale: _____ Range: _____

PV Scale Calibration

% of Range	Input	Expected Reading	Actual Reading	% Deviation
0				
50				
100				
			% Deviation Allowed:	

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

40 61 13-E. RECORDER CALIBRATION TEST DATA FORM

Tag No. and Description: _____

Make & Model No.: _____ Serial No.: _____

Input: _____ Chart: _____

Scale: _____ Range: _____

% of Range	Input	Expected Reading	Actual Reading	% Deviation
0				
50				
100				
			% Deviation Allowed:	

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

40 61 13-F. SIGNAL TRIP CALIBRATION TEST DATA FORM

Tag No. and Description: _____

Make & Model No.: _____ Serial No.: _____

Input: _____

Scale: _____ Range: _____

Set Point(s): _____

After setting set point(s), run signal input through entire range and calculate deadband.

Set Point	Incr. Input Trip Point	Decr. Input Trip Point	Calc. Deadband	Required Deadband

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

40 61 13-G. FIELD SWITCH CALIBRATION TEST DATA FORM

Tag No. and Description: _____

Make & Model No.: _____ Serial No: _____

Input: _____

Range: _____

Set Point(s): _____

Simulate process variable (flow, pressure, temperature, etc.) and set desired set point(s). Run through entire range of switch and calculate deadband.

Set Point	Incr. Input Trip Point	Decr. Input Trip Point	Calc. Deadband	Required Deadband

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

40 61 13-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

40 61 13-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

40 61 13-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 40 61 13-A)

b. Instrumentation tubing/piping tested:

(Attach test form 40 61 13-B)

c. Instruments calibrated:

(Attach test forms 40 61 13-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

40 61 13-K. LOOP COMMISSIONING TEST DATA FORM

Loop No.: _____

a. Loop tested:

(Attach test form 40 61 13-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

43 05 11-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:	

Manufacturer	Contractor
Signature of Authorized Representative	Signature of Authorized Representative
Date	Date

43 05 11-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:	

Manufacturer	Signature of Contractor Representative Date
Signature of Authorized Representative	
Date	Signature of Authorized Representative Date

43 05 11-C. UNIT RESPONSIBILITY CERTIFICATION FORM

GAS CONDITIONING IMPROVEMENTS PROJECT

CERTIFICATE OF UNIT RESPONSIBILITY

FOR SPECIFICATION SECTION _____

_____

In accordance with Section 43 05 11-1.02 Unit Responsibility 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 Section 43 05 11 and all sections referencing this section, 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

43 05 13-A. RIGID EQUIPMENT MOUNT INSTALLATION CHECKLIST

CITY OF SANTA ROSA – GAS CONDITIONING IMPROVEMENTS PROJECT

Equipment Tag No.: _____ Date: _____

Grout Product Name and Type: _____

Grouting System Manufacturer: _____

Grouting Application Contractor: _____

General Contractor: _____

Step 1: Verify Equipment Anchor Installation Conformance to Equipment Pad Details		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Millwright		Date
Step 2: Completion of Cleaning and Concrete Substrate Preparation Prior to Grouting		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date
Step 3: Equipment Leveling		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Millwright		Date
Step 4: Installation of Protection of Adjacent Surfaces or Structures NOT TO BE GROUTED		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date
Step 5: Preparation and Construction of Forms and Epoxy Grout Filling Standpipes		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date
Step 6: Completion of Ambient Condition Control in Structure or Building Area and Acceptance of Ambient Conditions as They Apply to Application and Curing Requirements for the Grouting System		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date
Step 7: Epoxy Grout Installation		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date

Step 8: Completion of Full and Proper Cure of Epoxy Grout		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date
Step 9: Completion of Localized Repair of Grout Voids		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date
Step 10: Final Acceptance of Grouting System Installation Including Final Clean-Up of the Work Site Complying with All Specification Requirements and the GSM's Quality Requirements		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date

43 05 21-A. MOTOR DATA FORM

Equipment Name: _____ Equipment No(s): _____

Project Site Location: _____

Nameplate Markings

Mfr:		Mfr Model:		Frame:		Horsepower:	
Volts:		Phase:		RPM:		Service Factor:	
FLA:		LRA:		Frequency:		Amb Temp Rating:	ºC

Time rating:		Design Letter:	
	(NEMA MG1-10.35)		(NEMA MG-1.16)
KVA Code Letter:		Insulation Class:	

The following information is required for explosion-proof motors only:

A. Approved by UL for installation in Class _____, Div _____, Group _____
B. UL frame temperature code ____ (NEC Tables 500-8B)

The following information is required for all motors 1/2 horsepower and larger:

A. Guaranteed minimum efficiency _____

(Section 43 05 21-2.04 Motor Efficiency)

B. Nameplate or nominal efficiency _____

Data Not Necessarily Marked on Nameplate

Type of Enclosure:			Enclosure Material:		
Temp Rise:		ºC (NEMA MG1-12.41,42)			
Space Heater included?	☐ Yes	☐ No	If Yes:	Watts	Volts
Type of motor winding over-temperature protection, if specified:					

Provide information on other motor features specified:

_____

SECTION 02 41 00

DEMOLITION, SALVAGE, RELOCATION, AND MODIFICATIONS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope. This Section specifies:
   1. Demolition and removal of portions of buildings and structures.
   2. Demolition and removal of exposed piping, equipment and appurtenances.
   3. Removal of equipment, electrical controllers and instruments for salvage or relocation.
   4. Safety requirements for protecting individuals, property and the environment.
   5. Disposal of demolition products.
   6. Modification of existing equipment.

B. Additional Sections and Paragraphs Required For Compliance:
   1. The work specified in this section shall be provided in accordance with the following additional sections and paragraphs. This is not a comprehensive list of related and referenced sections and paragraphs and additional related and referenced sections and paragraphs requiring compliance may be specified throughout this section and within other sections. This list is provided as a convenience for the CONTRACTOR. Related and referenced sections shall be reviewed and submittal information provided as required in paragraph 1.06 of this section.
      a. Section 01 12 16 – Work Sequence
      b. Section 01 33 00 – Submittal Procedures
      c. Section 01 35 29 – Health, Safety, and Emergency Response Procedures
      d. Section 01 35 43 – Environmental Procedures
      e. Section 31 10 00 – Site Clearing
      f. Section 31 23 00 – Excavation and Fill

1.02 REFERENCES

A. 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.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Request for Proposals (or on the effective date of the Agreement if there were no Proposals). 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
SSPWC	Standard Specifications for Public Works Construction

1.03 DEFINITIONS

A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.

B. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to CITY.

C. Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.

D. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

E. Abandon-In-Place: Render item permanently nonoperational in its existing location, detach from any existing construction and cease to maintain.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Demolition Work shall be in accordance with applicable City, County, State, and Federal regulations. The CONTRACTOR is responsible for determining all applicable requirements, obtaining required permits, paying all related fees, and filing required reports. As a minimum:
   1. Comply with the 2010 California Building Code.
   2. Comply with the California Code Title 8, Title 22, Title 26 and all applicable state codes.

B. Comply with the Safety Program specified in Section 01 35 23.

C. Where cited in the Contract Documents, comply with applicable sections of the SSPWC.

D. Coordination:
   1. Comply with Section 01 14 00 Work Sequence and Restrictions.
   2. Detail demolition activities in the construction schedule.
   3. Coordinate demolition activities with related Work in the area.

1.05 PRE-DEMOLITION MEETINGS

A. Pre-demolition Conference: Conduct conference at Project site.
   1. Request from the CITY the list of the items to be salvaged.
   2. Inspect and discuss condition of construction to be demolished.
   3. Review structural load limitations of existing structures.

4. Review and finalize demolition schedule and verify availability of materials, demolition personnel, equipment and facilities needed to make progress and avoid delays.
5. Review requirements of work performed by other trades that rely on substrates exposed by demolition operations.
6. Review areas where existing construction is to remain and requires protection.

1.06 SUBMITTALS

A. The following information shall be provided in accordance with Section 01 33 00:
   1. Proposed Protection Measures: Submit report, including drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control, and for noise control. Indicate proposed locations and construction of barriers.
   2. Schedule of Demolition Activities for each Demolition Phase: Schedule the following activities in conjunction with the requirements of Section 01 14 00:
      a. Detailed sequence of demolition and removal work, with starting and ending dates for each activity. Ensure CITY's on-site operations are uninterrupted.
      b. Interruption of utility services. Indicate the frequency and duration of each utility, power and instrumentation service interruption.
      c. Coordination for utility shutoff, capping, and continuation of service to facilities that will remain in service.
      d. Coordination of CITY's continuing occupancy of portions of existing facilities and of CITY's partial occupancy of completed Work.
   3. Inventory: Submit an updated list of items to be removed and salvaged or relocated and delivered to CITY prior to start of demolition. Include proposed dates for delivery of salvaged items to CITY.
   4. Pre-demolition Photographs or Video: Submit to CITY during the pre-demolition meetings.
   5. Proposed methods and operations for conducting the demolition Work.

1.07 EQUIPMENT TO BE SALVAGED OR RELOCATED OR MODIFIED

A. Salvage Items:
   1. During demolition of existing facilities, the CONTRACTOR shall salvage and return the following items to the CITY:

ITEM #	EQUIPMENT	QUANTITY	PACKAGE REQUIREMENTS	ITEM DESTINATION
Gas Booster Area				
	Particulate Filters	2	Pallets	Refer to Contract Drawings
	Particulate Filter Isolation Inlet/Outlet Isolation Valves	4	Pallets	Refer to Contract Drawings
	Pressure Regulating Valve Downstream of Particulate Filter Outlet	1	Pallets	Coordinate with City
Gas Pressure Reducer Area				
	Pressure Regulating Valve (Fisher 37B-1)	1	Pallets	Refer to Contract Drawings

a. Additional items may be added to this list as demolition Work proceeds.

2. Not all salvaged items will be requested for return to the CITY. It is the CONTRACTOR'S responsibility to coordinate with the CITY on which items are to be returned to the CITY. Items rejected by the CITY are to be disposed by the contractor in accordance with Section 3.12.
3. Salvage requirements are specified under "Salvage Requirements".

PART 2 PRODUCTS

2.01 GENERAL

A. Provide all materials and equipment in suitable and adequate quantity as required to accomplish the demolition work shown, specified herein, and as required to complete the Project.

2.02 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00:
   1. All demolition permits issued and demolition reports required to be filed by City, County, State and Federal agencies.
   2. Vehicular and pedestrian traffic control and protection and restoration plans approved by the CITY
   3. Inventory: Submit separate lists of items that have been removed and salvaged, removed and relocated, and removed and disposed.
   4. Landfill Records: For hazardous wastes removed under this specification section, submit acceptance receipts from the licensed landfill facilities that accepted these hazardous wastes.

PART 3 EXECUTION

3.01 SITE CONDITIONS

A. The demolition Drawings are based on available information, but the structures and facilities therein may differ from what is presented. The CONTRACTOR is responsible for determining the existing conditions and the scope and intent of the required work prior to submittal of proposal.
   1. Visit the site and inspect the existing facilities.

2. Request and review existing drawings available from the CITY to assist in clarifying existing conditions.
3. Review the project geotechnical report.

B. The Demolition Reference Drawings are representative of the nature of the structures, mechanical equipment, piping and other facilities to be encountered and demolished, salvaged, modified or relocated. Neither the CITY nor the Designer warrants the accuracy of the existing information shown on the Demolition Reference Drawings and used to depict the nature of the demolition requirements. Except as noted, all piping, equipment and other facilities within the limits marked for demolition shall be demolished whether or not the facilities marked for demolition are accurately represented.

C. The Demolition Photos drawings accurately depict current facilities including the portions thereof to be demolished.

D. The location and general condition of the facilities to be demolished are shown on the Drawings and/or listed in the Specifications. The CONTRACTOR shall rely upon the Project Specifications, the Site inspection, the demolition intent, the Project demolition Drawings, existing drawings, and reference materials provided pertaining to the facilities to be demolished for a complete understanding of the Project demolition Work requirements. The CONTRACTOR shall make allowance in its Proposal for actual condition of facilities to be demolished. No claim for additional compensation for alleged extra demolition Work will be considered on the basis that the marked or example demolition Drawings did not fully depict the scope of the demolition.

E. Major obstructions encountered that are not shown or indicated on the Drawings or specifications, or in the available reference materials, and could not have been foreseen by visual inspection of the site prior to proposing, shall immediately be brought to the attention of the CITY. The CITY will make a determination for proceeding with the work.

3.02 PROTECTION AND DEMOLITION METHODS

A. Provide protection devices including barricades, fencing, warning signs, lights, and whatever else is necessary to ensure the security of, and within, the facility during all phases of demolition. Comply with requirements of federal, state and local statutes and regulations dealing with demolition and public safety.

B. Ensure safe passage of persons around areas of demolition. Conduct operations to prevent damage to adjacent buildings, structures, other facilities, and people.

C. Provide temporary six feet tall chain link fencing around each demolition Work area to keep CITY and unauthorized personnel and vehicles out of the demolition Work areas. Temporary fencing design shall provide for controlled access for CITY personnel across demolition Work areas where required for normal operation of the plant, such as access to active CITY facilities (e.g., Power Bldgs, utility tunnels, digesters, electrical rooms, etc.). The temporary fencing perimeter may extend up to 50 feet beyond the demolition boundary where necessary to allow for placement of equipment (e.g., cranes, trucks, etc.) required to conduct the demolition and debris removal. Demolition shall not be conducted by reaching across open sections of any facilities to be protected in place or reaching across active plant facilities other than enclosed utility tunnels. Submit proposed temporary fencing design and signage to CITY for review and acceptance prior to submittal as product data. Submittal shall address restoration of the undemolished

areas within the fenced areas to the original pre-contract condition following removal of the temporary fencing.

D. Provide K rails to block all CITY treatment plant roads that will be inaccessible during performance of demolition Work. Roads shall not be closed or obstructed without written permission from CITY.

E. Interior and exterior shoring, bracing, or supports shall be provided to prevent movement, settlement, or collapse of structures to be demolished or partially demolished, and to adjacent structures or other facilities to remain.

F. Existing landscaping materials, structures, and appurtenances, which are not to be demolished, shall be protected and maintained as necessary and in accordance with General Conditions and as specified herein.

G. Protect and maintain conduits, drains, sewers, pipes, and wires that are to remain on the property.

H. Demolition by deliberate collapse, wrecking ball, explosion or implosion methods will not be allowed.

3.03 POLLUTION CONTROL

A. Use removal methods that minimize generation of dust. Capture all airborne dust from the demolition Work to prevent dust/debris migration to off-site property.

B. Provide physical boundaries around the control area by roping off the area or providing portable partitions, or other enclosures to ensure that airborne concentrations of dust/debris will not reach outside the property line or any wetland near the plant.

C. Comply with OSHA requirements for worker protection.

D. Perform all cutting during suitable weather conditions.

E. Employ water sprinkling, temporary enclosures, chutes, and other suitable methods to limit dust and dirt rising and scattering in the air. Comply with government regulations pertaining to environmental protection.

F. Water shall not be used when it creates hazardous or objectionable conditions such as ice, flooding, or pollution.

G. Prevent water contaminated with sediment or hazardous or toxic materials from running off into the public storm drain system (including street gutters). Intercept, collect, and dispose of such runoff according to existing environmental regulations. Water contaminated with wastewater products excluding sludge can be discharged to a Plant process drain or sewer at locations approved by the CITY.

3.04 PRE-DEMOLITION

A. Prior to the removal of existing construction, create photographs or videos of the existing construction to be removed to provide complete documentation of the existing

facility and its surroundings. Submit these photographs and /or videos to the CITY during the pre-demolition meetings described in Part 1.

B. Prior to each phase of demolition, make arrangements with the CITY's operations and maintenance staff to walk through the demolition areas. Items to be salvaged or relocated are described in Part 1. Prior to the walk through, request from the CITY an updated list of the items to be salvaged or relocated. The CONTRACTOR shall tag all salvage and relocation items during the walk through. The tags shall indicate what the item is, the location, and the equipment it is part of or connected to; and the date of removal shall be added by the CONTRACTOR on the date of removal.

A. Apply color-coded spray–paint markings to identify the exposed equipment, piping and conduit located in tunnels and galleries that is planned to be removed for each phase of demolition Work. Color shall be acceptable to the CITY.

C. Obtain CITY approval of all submittals specified in Part 1 that are applicable to the corresponding phase of demolition Work.

D. Existing Utilities in Demolition Areas:

1. Prior to starting demolition, determine whether there are utilities in demolition areas that are needed for continued service to other facilities. All such utilities shall be identified and protected in place or relocated to continue serving facilities to remain, or disconnected, de-energized, removed and capped prior to starting demolition.
2. Provide temporary services during interruptions to existing utilities as acceptable to CITY.
3. Utilities serving facilities to be demolished shall be isolated as shown on the Drawings or as may be directed by the CITY. Where not shown or not directed by the CITY, isolation shall occur at a point closest to the remaining active portion of the utility.

B. Obtain CITY's written approval to proceed with each phase of demolition, salvage and relocation work.

3.05 GENERAL DEMOLITION REQUIREMENTS

A. Protect in place structures, equipment, piping and utilities to remain from damage during demolition, salvage and relocation Work. Any facilities damaged during the demolition process shall be repaired or replaced to the original pre-contract condition at the CONTRACTOR's expense.

B. Unless otherwise specified, equipment and materials marked or specified to be demolished, including piping and utilities within the limits of demolition, will become the property of the CONTRACTOR.

C. The Contract Documents indicate existing facilities to be demolished, salvaged, relocated, retained or electrical reconnected. Auxiliary utilities including such services as water, air, hot water, chemicals, drainage, lubrication, fluid power, electrical wiring, controls, and instrumentation are not necessarily indicated. The CONTRACTOR shall verify the scope of the Work to remove or electrically re-feed the equipment indicated; coordinate its shutdown, removal, or reconnection; and submit an outage plan in

accordance with the requirements of Section 01 12 16. The removal of existing facilities for demolition, salvage or relocation shall include the following requirements:

1. Only remove equipment specified herein, shown on the Drawings, designated by the CITY in the field for removal, or approved by the CITY during construction. Comply with the sequence of equipment removal and remove equipment with minimal damage. The limits of removal of equipment shall be as specified on the Drawings, specified herein, or as directed by the CITY. Equipment removal includes removal of such items as equipment, piping and accessories, supports, piping and tubing supports, fasteners, anchor bolts, connected utilities (such as water, air, hydraulic fluid, etc.), and other items. Removal of equipment includes removal of conduits and wiring as specified in paragraph 3.09. Removal of equipment includes removal of concrete pads that support equipment, piping and other accessories.
2. Remove equipment and piping, supports including concrete pads, baseplates, mounting bolts, support hangers except for overhead concrete inserts for threaded rods, and seismic and thrust restraints. Cut off all pipes, structural attachments, and embedded metal supports 2-inches into the wall, floor or ceiling. Repair the concrete as specified in paragraph 3.16.
3. Exposed piping including vents, drains, and valves shall be removed. Where exposed piping penetrates existing floors, walls or ceilings, the piping, including wall thimbles, shall be removed to a minimum depth of 2-inches. Remove all pipe hangers, supports and mounting bolts. Resultant openings in the structures shall be repaired as specified in paragraph 3.16. For walls in fire rated areas, plug empty pipes or sleeves through walls with fireproof sealant to maintain fire ratings for walls.
4. Embedded anchor bolts remaining after demolition of equipment, supports and other items shall be removed to a minimum depth of 2-inches. Repair the concrete as specified in paragraph 3.16.
5. Auxiliary utility support systems shall be removed.
6. Where equipment is removed from a structure or demolished, repair the surface of the remaining structure as specified in paragraph 3.16.
7. In areas where concrete portions are to be removed from a structure, cut the edge of removal with a concrete saw to leave a perpendicular edge, or core drill when the required removal is circular in shape. Cut and remove all reinforcing unless otherwise shown or instructed. Remove cracked or damaged concrete to solid concrete. Spalled edges may be required to be re-sawn at the discretion of the CITY.
8. Asphalt and concrete pavement, curbs, and gutters shall be removed as necessary to perform reconstruction. The limits of removal shall be saw cut. When the required improvements have been constructed, new asphalt and concrete pavement, curbs, and gutters shall be placed to match the original unless otherwise indicated.
9. When existing pipe is removed, the CONTRACTOR shall plug the resulting open pipe ends whether or not so indicated, unless noted otherwise. Where removed piping is exposed, the remaining piping shall be blind-flanged or fitted with a removable cap or plug using like materials suitable for the piping system test pressures. A welded cap and insulation shall be applied to remaining process hot water piping.
10. When existing piping is removed from existing structures, the CONTRACTOR shall fill resulting openings in the structures and repair any damage using reinforced concrete and as specified in paragraph 3.16. Wall and floor openings in below grade structures and ceiling openings in tunnels shall be reinforced as required or indicated and filled with non-shrink grout to be watertight and as specified in paragraph 3.16. In locations where the surface of the grout will be exposed to view, the grout shall be

recessed approximately 1/2-inch and the recessed area filled with cement mortar grout.

11. Electrical reconstruction shall be conducted by the CONTRACTOR in a safe and proper manner to avoid injury from electrical shock to the CITY's and CONTRACTOR's personnel. Electrical equipment to be shut off for a period of time shall be tagged, locked out, and sealed with a crimped wire and lead seal and made inoperable. At no time shall electrical wiring or connections which are energized or could become energized be accessible to CONTRACTOR, CITY, or other personnel without suitable protection or warning signs.
12. The CONTRACTOR shall perform a functional test of existing equipment that is relocated or electrically reconnected to ensure the equipment functions in the manner documented during the initial inspection. The CONTRACTOR shall inform the CITY in writing a minimum of 5 Days prior to the functional testing in order for the CITY to witness the test. If, in the opinion of the CITY, the reconnected equipment does not function in a satisfactory manner, the CONTRACTOR shall make repairs and modifications necessary to restore the equipment to its pre-construction operating condition at no additional cost to the CITY.
13. Unless otherwise specified, remove abandoned piping and utilities exposed by excavation from areas to be backfilled.
14. Buried piping to be abandoned in place shall be cleaned and filled with sand, slurry or cellular concrete as specified in Section 02 27 80.
15. Unless otherwise specified, remove all manholes, catch basins, and vault type structures no longer in use if specified or exposed by demolition excavation.
16. Additional structural demolition requirements are specified in paragraph 3.08.
17. Additional electrical demolition requirements are specified in paragraph entitled 3.09.

3.06 REMOVAL FOR SALVAGE OR RELOCATION

A. The CITY will determine the condition of equipment to be salvaged or relocated prior to removal.

B. General removal requirements are specified in the paragraph 3.06.

A. Items of existing equipment, piping, valves, electrical gear, instrumentation, utilities, and appurtenances indicated to be salvaged shall be removed without any degradation in condition from that prior to removal. Salvaged items shall be stockpiled for not less than 14 days and protected in the same condition as when removed, at a Site location directed by the CITY. Properly safeguard all salvaged items against damage and loss during removal, handling and storage.
   1. Upon request of the CITY, the CONTRACTOR shall deliver all salvaged items to the CITY at the Site location designated by the CITY.

B. Items of existing equipment, piping, valves, electrical gear, instrumentation, utilities, and appurtenances indicated to be relocated shall be removed without any degradation in condition from that prior to removal. Properly safeguard the relocated items against damage and loss during removal, handling, storage, and the installation and testing process in the new location, until accepted by the CITY.

C. Damaged salvaged and relocated equipment shall be repaired by the CONTRACTOR to the satisfaction of the CITY or replaced at the CONTRACTOR's expense. All non-salvageable items shall be removed at the CONTRACTOR's expense.

3.07 STRUCTURAL DEMOLITION

A. Building structures and appurtenances shall be demolished as shown on the Contract Documents or as required to complete Work in conformance with governing regulations.

B. Small structures may be removed intact when acceptable to the CITY and approved by authorities having jurisdiction.

C. Remove all structures that are scheduled for demolition to their full depth, including foundation slabs and footings, unless otherwise shown or specified. Above ground piping which is demolished to grade level shall be capped unless otherwise shown on the demolilton drawings.

D. Partial demolition procedures shall not impair the integrity of the existing structures that are to remain. Where necessary and where shown, the CONTRACTOR shall saw cut or line core drill the existing structure to prevent rupturing or cracking facilities that remain in use. Those structures damaged by the CONTRACTOR that are to remain in service or be rehabilitated shall be repaired at the CONTRACTOR's expense.

E. Drawings define portions of facilities and structures to be removed. Unless otherwise shown, clean saw cuts shall be made to limits of demolition shown. If cuts or breaks are made exceeding limits shown, repair the cuts or breaks back to the dimensions shown on Drawings at the CONTRACTOR's expense. Submit repair procedures for CITY's review.

F. Unless otherwise noted on the drawings where concrete removal occurs, existing reinforcing that is exposed shall be burned off at least 2 inches into the remaining concrete. All holes shall be patched as specified in paragraph 3.16.

G. Demolition shall proceed in a systematic manner, in accordance with permits and accepted submittals.

H. Concrete and masonry shall be demolished in sections. Use bracing and shoring to prevent collapse.

I. Demolition equipment shall be dispersed throughout the structure and demolished materials removed in a timely manner to prevent excessive loads on supporting walls, floors, or framing.

3.08 ELECTRICAL DEMOLITION AND MODIFICATION

A. Provide all labor, materials and incidentals required to modify and/or remove the electrical and instrumentation systems and equipment as shown on the Drawings and/ or as specified herein. Unless specifically noted as being reused, all conduit, wire, boxes, etc. detailed on the Drawings shall be new equipment provided under this Work as shown on the Drawings and specified in Division 26.

B. The electrical modifications and removal work shall consist of, but not necessarily be limited to, removal or modification of existing equipment as described in the following generalized categories:

1. Unless otherwise noted on the Drawings. demolish existing electrical equipment, components, and panels including related exposed conduit and all wire associated with the equipment indicated for removal under this Contract.
2. Unless otherwise noted on the Drawings, demolish existing instrumentation and control equipment and related exposed conduit and all wire associated with the equipment indicated for removal under this Contract.

C. Enclosures and other panels including motor control centers requiring modification under this Work shall comply with the following general requirements:

1. Newly installed equipment shall be mounted, connected, and identified consistent with the other equipment in or on the panel.
2. Mounting holes required for new equipment shall be neatly cut and de-burred.
3. Nameplates shall be provided for all new equipment mounted in existing motor control centers.. Interior panel wiring for newly added devices shall match the existing panel wiring and mounting.
4. For existing motor control centers where process equipment loads are being removed and disconnected from the existing motor control center the starter controls and breaker will remain as spares where noted on the drawings. The CONTRACTOR shall remove the existing nameplate and replace with a new nameplate labeled “SPARE”.

D. Removal of instrumentation and electrical equipment shall be as follows:

1. Not all existing conduits are shown on the Drawings. In general, existing conduits are shown only where they may be reused; or where they potentially affect or may be affected by new work under this Contract; or for providing useful background information to the CONTRACTOR regarding the existing electrical installation.
2. Prior to removal of existing relays, power supplies, etc. the wires shall be tagged indicating the device it is connected to and the related existing equipment.
3. Where existing conduit or wire associated with removed equipment is to be reused, it is specifically noted on the Drawings. Where existing conduit is clearly required to be removed or relocated including the buried or embedded portion due to new construction, it is noted as such on the Drawings. In instances where existing electrical underground or concealed work is close to but not clearly in the way of new construction, it shall be the CONTRACTOR's responsibility to notify and coordinate with the CITY for potential conflicts during construction.
4. No existing conduits, wiring, or electrical appurtenances shall be removed or in any way damaged unless allowed by the provisions of this Section. Any existing conduits or wiring or other electrical appurtenances that are encountered as an obstruction to new construction and which are not covered by the provisions of this Specification shall be brought to the attention of the CITY. The CITY will make a determination of the required action.
5. Where functions of existing cables and/or conduits are replaced by new cable and/or conduits because of additions of new panels, instruments, revision to control strategy, etc., the existing cables and exposed conduits shall be removed unless noted otherwise. Concealed conduits shall be retained and marked as spares unless noted otherwise.

6. Equipment removed shall not be reused under this contract unless specifically noted on the Drawings or Specifications. Prior to disposal of equipment, notify the CITY.
7. To minimize disruptions to the existing plant operations, the schedule for modifications and removal of existing equipment shall be coordinated with the work sequence and restrictions specified in Section 01 14 00 and approved by the CITY.
8. Completely remove exposed portions of demolished conduits and pull all demolished wire out of the entire conduit system. Unless otherwise noted on the Drawings, demolished conduits hidden in slabs or walls shall be cut off 2-inches below the existing finished surfaces and permanently sealed with non-shrink grout or other approved permanent sealing compound.
9. For existing conduit to remain in place, intercept existing conduit at the most convenient location or as shown and extend conduit to new location shown on the Drawings. Install new conductors where indicated, specified or required to serve equipment or instruments.

3.09 MISCELLANEOUS DEMOLITION

A. All existing pavement, landscaping, and other surface features demolished because of the CONTRACTOR's activities shall be replaced back to its original condition unless other restoration work is called for on the Drawings.

3.10 ABANDONMENT

A. Existing structures and piping to be abandoned shall be prepared as indicated. Where existing buried piping is to be abandoned, the CONTRACTOR shall remove the abandoned pipe for a distance of 5-feet from any connecting structures. The pipe wall penetrations shall be removed and the wall openings at the existing structures shall be repaired as specified in paragraph 3.16. Unless otherwise noted, where buried piping to be abandoned is connected to exposed piping to be demolished, the exposed portion of the buried piping shall be removed to a pipe joint at least 30 inches below grade. The remaining buried pipe shall be cleaned then abandoned in place as specified in Section 02 27 80. Cleaning shall be performed as specified in paragraph 3.13. Excavations made to abandon pipes shall be backfilled and compacted in accordance with Section 31 23 00, and any pavement removed shall be replaced to match the existing adjacent pavement. Buried piping to be abandoned that is 12-inches in diameter or greater shall be completely sand-filled unless otherwise specified.

3.11 CLEANING , PIPES AND DEMOLITION IMPACTS

A. CITY will drain cooling water supply and return pipes to be demolished.

B. During and upon completion of demolition Work, the CONTRACTOR shall promptly remove unused tools and equipment, surplus materials, rubbish, debris and dust, and shall leave areas affected by Work in a clean condition, acceptable to the CITY.

C. Clean adjacent structures and facilities of dust, dirt, and debris caused by demolition, as directed by the CITY, and return adjacent areas to the condition that existed prior to start of Work.

D. The CONTRACTOR shall remove and legally dispose of demolished materials and debris from the Site.

E. The CONTRACTOR shall clean and sweep the streets and roads daily.

3.12 DISPOSAL OF DEMOLITION MATERIALS

A. Safely remove demolition products from the work site and dispose in accordance with all local laws, codes and ordinances at the CONTRACTOR's expense. CONTRACTOR is responsible for determining these regulations and shall bear all costs associated with disposal of these items. Items to be demolished include those items indicated on Contract Documents.

B. Conduct demolition and removal of debris to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities, which shall not be closed or obstructed without permission from CITY. Provide alternate routes around closed or obstructed traffic ways.

C. On site pulverizing of concrete is not allowed. Any and all concrete pulverizing must occur off-site.

D. Remove debris, rubbish, and other materials resulting from demolition operations at the CONTRACTOR's expense. On site burning of removed materials from demolition operations is not allowed.

E. Provide a schedule for acceptance by the CITY, for removal of demolished materials. Removal and disposal shall be performed in a timely manner.

3.13 PATCHING AND REPAIRING

A. The CONTRACTOR shall provide cleaning, patching, replacing, repairing, and refinishing of damaged areas involved in demolition as necessary to match the existing adjacent surfaces, whether shown or not shown on the Drawings, with materials and procedures accepted by the CITY. The finished structure repairs shall appear as new homogeneous units with little or no indication of where the new and old materials join.

B. The CONTRACTOR shall repair all damages caused to adjacent facilities by the demolition Work as directed by the CITY and at the CONTRACTOR's expense.

C. The CONTRACTOR shall make a detailed inspection after patching and repairing has been completed, and shall carefully remove splattering of mortar from adjoining Work (particularly, but not limited to, plumbing fixtures, trim, tile, and finish metal surfaces), and repair any damage caused by such cleaning operations.

END OF SECTION

SECTION 03 11 00

CONCRETE FORMING

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies formwork requirements for concrete construction.

1.02 QUALITY ASSURANCE

A. References:

1. 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.
2. 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:

1. Formwork design requirements shall conform to the following:
   a. Formwork, shoring and reshoring shall be designed by a Professional Engineer currently registered in the State of California_ having a minimum of 3 years experience in this type of design work.
   b. Design and engineering of formwork, shoring and reshoring, as well as its construction, is the sole responsibility of the Contractor.
   c. 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.

d. 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.

e. 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:

1. Design of formwork shall conform to the following criteria:

a. 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.

b. 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

A. Submittals shall be provided in accordance with Section 01 33 00 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.

d. Void forms.

2. Formwork designer qualifications.

3. Submit letter of certification stamped by the registered Engineer referenced in paragraph 1.02 Design 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:

1. 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.

2. When approved by the Construction Manager, plywood may be reused.

B. Metal Forms:
   1. 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

A. 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

A. 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

A. 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

A. 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

A. 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. Allowable deviation from specified thickness of footings and foundations shall be minus 5 percent with no limit on the 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

A. 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 03 30 00.
   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 03 20 00

CONCRETE REINFORCING

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies reinforcing steel for use in reinforced concrete.

1.02 QUALITY ASSURANCE

A. References:

1. 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.
2. 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 REV B	Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A706/A706M REV B	Low-Alloy Steel Deformed Bars for Concrete Reinforcement
ASTM A775/A775M REV B	Epoxy-Coated Reinforcing Steel Bars
ASTM A884/A884M	Epoxy-Coated Steel Wire and Welded Wire Reinforcement
AWS D1.4	Structural Welding Code--Reinforcing Steel
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:
   1. 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. Use only plastic tags secured to the reinforcing steel bars with nylon or plastic tags for epoxy coated reinforcing steel bars.

C. Fabrication:
   1. Reinforcing steel bars shall be fabricated in accordance with ACI 315 and the following tolerances:
      a. Sheared lengths shall be within +/- 1 inch.
      b. Overall dimensions of stirrups, ties, and spirals shall be within +/- ½ inch.
      c. All other bends shall be within +0 inch, -½ inch
      d. Minimum diameter of bends of reinforcing steel bars shall be as indicated in ACI-318 paragraph 7.2.

1.03 SUBMITTALS

A. Submittals shall be provided in accordance with Section 01 33 00 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. Qualifications of welding operators, welding processes and procedures.
   5. 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

A. Reinforcing steel bars shall be deformed billet steel in conformance with ASTM A615, Grade 60. Bars to be welded shall be deformed billet steel conforming to ASTM A706.

2.02 WIRE FABRIC

A. Wire fabric shall be welded steel mesh conforming to ASTM A185.

2.03 WIRE AND PLAIN BARS

A. Wire used as reinforcement and bars used as spiral reinforcement in structures shall be cold drawn steel conforming to ASTM A82.

2.04 REINFORCING STEEL MECHANICAL SPLICES

A. Reinforcing steel mechanical splices shall be a positive connecting threaded type mechanical splice system manufactured by Erico, Inc., Dayton Superior, Williams Form Engineering Company, or approved equal.

B. Type 1 mechanical splices shall develop in tension or compression a strength of not less than 125 percent of the ASTM specified minimum yield strength of the reinforcement and shall meet all other ACI 318 requirements. Type 1 mechanical splices are typical except for locations noted below where Type 2 mechanical splices are required.

C. Type 2 mechanical splices shall meet the requirements for a Type 1 mechanical splice, plus develop the ASTM specified tensile strength of the reinforcement. Type 2 mechanical splices shall be provided at locations specifically noted on the design drawings.

2.05 TIE WIRE

A. The wire shall be minimum 16 gage annealed steel conforming to FEDSPEC QQ-W-461H.

2.06 BAR SUPPORTS

A. 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

A. 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

A. 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.
   4. Reinforcing steel bar cover shall be 1 ½ inches for reinforcing not in the above categories unless noted otherwise on the design drawings.

3.03 SPLICING

A. 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 unless approved by the Construction Manager.

3.04 CLEANING

A. 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

A. Reinforcing steel bar placement shall conform to the following:
   1. Uncoated 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. Coated reinforcing steel bars shall be fastened together to prevent displacement. Plastic or nylon ties shall be used to hold the coated reinforcing steel bars rigidly in place. The coated reinforcing steel bars shall be supported with plastic or plastic coated chairs, runners, bolsters, spacers and supports as required.
   3. Support reinforcing steel bars over cardboard void forms by means of concrete supports which will not puncture or damage the void forms nor impair the strength of the concrete member.
   4. Where parallel horizontal reinforcement in beams is indicated to be placed in two or more layers, reinforcing steel bars in the upper layers shall be placed directly over the reinforcing steel bars in the bottom layer with the clear distance between each layer to be 2 inches unless otherwise noted on the Drawings. Spacer reinforcing steel bars shall be placed at a maximum of 3'-0" on center to maintain the minimum clear spacing between layers.
   5. Reinforcement shall be extended to within 2 inches of formed edges and 3 inches of the concrete perimeter when concrete is placed against earth.
   6. Reinforcing steel bars shall not be bent after embedding in hardened concrete unless approved by the Construction Manager.
   7. Tack welding or bending reinforcing steel bars by means of heat is prohibited.
   8. 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.
   9. Bars with kinks or with bends not shown shall not be used.
   10. Heating or welding bars shall be performed in accordance with AWS D1.4 and shall only be permitted where specified or approved by the Construction Manager. Bars shall not be welded at the bend.

3.06 FIELD QUALITY CONTROL

A. 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 paragraph 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.

3. An independent laboratory shall be employed to review and approve Contractor welding procedures and qualify welders in accordance with AWS D1.4. The laboratory shall visually inspect each weld for visible defects and conduct non-destructive field testing (radiographic or magnetic particle) on not less than one sample for each 10 welds. If a defective weld is found, the previous 5 welds by the same welder shall also be tested.

END OF SECTION

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 DESCRIPTION

A. 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:
   1. 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.
   2. 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.
   3. Owner provided testing shall be in accordance with Section 01 40 00.

B. Quality Control By Contractor:
   1. 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 2.01, 2.02, and 3.11. Costs of testing laboratory services shall be borne by the Contractor.

C. Basis For Quality:
   1. Cast-in-place concrete shall conform to the requirements of ACI 301, except as modified herein.

D. References:
   1. 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.

2. 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
ACI 350.1	Tightness Testing of 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
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 C595	Blended Hydraulic Cements
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 C989	Slag Cement for use in Concrete and Mortars
ASTM C1059	Latex Agents for Bonding Fresh to Hardened Concrete
ASTM C1260	Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)

Reference	Title
ASTM C1567	Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar Bar Method)
ASTM C1602	Mixing Water Used in the Production of Hydraulic Cement 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
CRD-C572	U.S. Corps of Engineer's Specifications for Polyvinylchloride Waterstop
CBC 2013	California Building Code with local amendments

1.03 SUBMITTALS

A. The following information shall be provided in accordance with Section 01 33 00:
   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

      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/or retarding admixtures and shrinkage reducing admixtures at liquid containing concrete.
   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 waterstops, curing and sealing compounds, bonding compounds,epoxy and chemical grout for crack injection, retardant, bearing pads and trench drains.
   7. Concrete delivery truck tickets showing the information listed in ASTM C94, section 14.

1.04 CONCRETE PRODUCTION

1. On site production of concrete will not be allowed.

PART 2 PRODUCTS

2.01 MATERIALS

A. Cement:

1. 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.
2. If low alkali cement is not available, aggregates shall show an expansion of less than 0.1% when tested in accordance with ASTM C1260 or ASTM C1567 concrete mix test results shall be submitted verifying that the aggregates are not reactive per the criteria in this standard. ASTM C1260 and ASTM C1567 results shall be no older than 1 year.
3. Portland-pozzolan cement shall be ASTM C595, Type IP (MS), interground, low alkali.
4. 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.

B. Aggregates:

1. General:
   a. 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.
      1) Aggregates shall be checked for alkali-silica reactive constituents per ASTM C1260. Aggregate shall have less than 0.1% expansion when tested in accordance with ASTM C1260. Aggregates having 0.1% or greater expansion when tested in accordance with ASTM C1260 may still be satisfactory provided ASTM C1567 concrete mix test results are submitted and show an expansion of less than 0.1% at 16 days. ASTM C1260 and ASTM C1567 test results shall be no older than 1 year.
      2) 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.
      3) 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.
2. Fine Aggregate:
   a. 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.

1) 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

2) 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:
   a. 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 2.02 Mix Proportioning shall conform to ASTM C33, Table 2.
      1) 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:
   1. 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 paragraph 2.01 Change of Materials.
   2. The pozzolan color shall not substantially alter the resulting concrete from the normal gray color and appearance.
   3. 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:
      a. 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:
      a. 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:
    a. 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:
    a. 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:
    a. 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:
    a. 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 2.02 Mix Proportioning for each class of concrete.

E. Water:
1. 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:
1. 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:
1. 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.
2. 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[f] (inches)
C-1	57 or 67	0.40	560	15-20	4-6	4500	3-5
E[c]	57	--	-	15-20[d]	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] *Compressive strength of Class A concrete may be determined at 56 days.*

[c] *Concrete encasement for electrical conduit shall contain 3 pounds of red oxide per sack of cement.*

[d] *Pozzolan use optional for this class of concrete.*

[e] *Minimum 28-day compressive strength shall be 500 psi and maximum 28-day compressive strength shall be 1,000 psi.*

[f] *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:

1. Concrete shall be provided by class for the corresponding use listed as follows:

Type of use	Class of concrete
Typical cast-in-place structural concrete, and for non-structural concrete (sidewalks, curbs, pavers, etc.)	C-1
Pipe bedding and encasement, electrical conduit encasement (duct banks) and concrete fill	E

C. Control Tests:

1. General:
   a. 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:
   a. 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 2.02. Testing, data and reporting shall conform to ACI 318 Section 5.3 and the following:
      1) 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.
      2) 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.

3) 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.

4) 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.

5) From results of the cylinder tests, plot a curve showing the relationship between w/cm ratio and compressive strength.

6) 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 2.02 Mix Proportioning.

3. Field Experience Data:

a. 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.

1) 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

f) slump after introduction of admixtures +0/-1 inch.

b. 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 SEALANTS AND JOINT FILLERS

A. Sealants and preformed joint fillers shall be as specified in Sections 07 92 00 and 07 91 26.

2.04 BONDING COMPOUNDS

A. Epoxy resin bonding compounds to be used for wet areas 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.

B. Non-epoxy bonding compounds may be used in dry areas for non-structural bonding or as specifically noted on the drawings only and shall conform to ASTM C1059 Type II. Acceptable products include: Edoco "Burke Acrylic Bondcrete"; ChemMasters "Cretelox"; or equal.

C. Bonding compounds shall be applied in accordance with the manufacturer's instructions.

2.05 EPOXY FOR CRACK INJECTION

A. Epoxy for crack injection shall be a two-component, moisture insensitive, high modulus, injection grade, 100 percent solids, blend of epoxy-resin compounds. The consistency shall be as required to achieve complete penetration in hairline cracks and larger. Material shall conform to ASTM C881 Type 1 Grade 1. Acceptable products include Sika Corporation “Sikadur 52”; Adhesives Technology Corporation “Crackbond SLV302”; or equal. Epoxy grout shall be used for all crack repairs except as noted below for non-structural cracks in liquid-containing concrete. The Engineer shall determine whether a crack is classified as structural or non-structural. Structural cracks must be repaired with epoxy.

2.06 CHEMICAL GROUT FOR CRACK INJECTION

A. Chemical (hydrophobic polyurethane) grout shall be used at the Engineer's discretion as an alternative to the injection of the epoxy grout for sealing non-structural cracks in structures intended to be watertight. Acceptable products include "Hydro Active Cut" by De Neef Construction Chemicals or SikaFix HH by Sika Corporation, or equal approved by the Engineer.

2.07 RETARDANT

A. Retardant for exposing aggregates for unformed surfaces in construction joints shall be Sika “Rugasol-S”; W.R. Grace “Top-Cast”; or equal. Retardant shall be applied in accordance with manufacturer’s instructions sufficient to assure a minimum penetration of 1/4 inch.

2.08 CURING AND SEALING COMPOUNDS

A. Curing and sealing compound shall be BASF Sonneborn “Kure-N-Seal 25LV”; Edoco, “Spartan-Cote VOC”; or equal, conforming to ASTM C309.

B. 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

A. 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

A. 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.

B. 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:
   1. 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:
      a. 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:
      a. 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.
         1) 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.
      b. 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.
      c. 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.
      d. 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:
   a. In hot weather (above 80 degrees F), concrete shall be placed in accordance with ACI 305.1.
4. Placing Concrete In Cold Weather:
   a. In cold weather (below 45 degrees F), concrete shall be placed in accordance with ACI 306.1.

C. Consolidating Concrete:
1. 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:
1. 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.
2. 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:
1. 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.
2. 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:
1. 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.
2. 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

A. Concrete shall be protected from injurious action by sun, rain, flowing water, frost and mechanical injury.

B. Loading green concrete will not be permitted. Green concrete is defined as concrete with less than 100 percent of the specified strength.

C. 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.

D. Arrangements for covering, insulating, and protecting concrete in cold weather shall be in accordance with ACI 306.1.

3.06 CONSTRUCTION JOINTS

A. General:

1. 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:

1. 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.

3.07 INSERTS AND EMBEDMENTS

A. Inserts:

1. 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.
2. Additional reinforcement shall be provided around openings as shown. Grout fill around inserts shall be non-shrink grout as specified in Section 03 60 00.
3. 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:
   1. Gate frames, gate thimbles, special castings, channels or other miscellaneous 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 ther embedments, and to align accurately with equipment.

3.08 FORMED SURFACE FINISHES

A. Repair Of Surface Defects:
   1. 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:
   1. Formed surfaces shall be finished as soon as practicable after form removal and repair of surface defects. Finishes shall be as follows.
      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.
      b. 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.

c. 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.

3.09 SLAB FINISHES

A. General:

1. The finishes specified herein include surface finishes, treatments and toppings 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:

1. 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 top of tank foundation slab and the top of the truck apron.

C. Broomed Finish:

1. 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 walks, top of tank foundation slab and the top of the truck apron, and where otherwise indicated or specified.

3.10 RELATED SURFACES

A. Finishing Of Unformed Surfaces:

1. Related Unformed Surfaces:

a. Tops of walls or buttresses, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces shall be struck smooth after concrete is placed and shall be floated to a texture reasonably consistent with that of the adjacent formed surfaces. Final treatment of formed surfaces shall continue uniformly across the unformed surfaces.

2. Pavements And Sidewalks:

a. The surfaces of the concrete shall be screeded to grade and sloped to drain. After screeding, the surface shall receive a broomed finish as specified in paragraph 3.09 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.

3.11 FIELD SAMPLING AND TESTS

A. General:
   1. 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 3.11 Sampling 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 3.11 Testing.

B. Sampling:
   1. Aggregates:
      a. General:
         1) 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 3.11Testing. 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 idenified.
      b. Coarse Aggregate:
         1) 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:
         1) 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:
      a. 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 paragraph 3.03 Placing Concrete by Pumping.

C. Testing:
   1. Aggregate:
      a. 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:

1) 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.
    a) 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.
    b) 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.
    c) 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.
    d) 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.
    e) 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.

f) 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:

1) 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 3.03 Placing Concrete by Pumping.

a) 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:

1) 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.

a) 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 3.03 Placing Concrete by Pumping.

D. Final Laboratory Report:

1. 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.

3.12 REPAIR OF DAMAGED CONCRETE, CRACKING:

A. Acceptance Of Concrete:

1. 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:

1. 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:
    a. Repair Method 1:
        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.
    b. Repair Method 2:
        1) 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 3:
        1) Cut a bevel groove 3/8 to 1/2 inch in width and depth, and caulk with sealant in accordance with manufacturer's instructions. This repair method is only to be used where expressly allowed by the Engineer. Groove and caulk shall be applied on wet or hydrostatic pressure side of surface where occurs.

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. Repair Method 3 shall be limited to dry-surface slabs, walls subject to less than three feet of liquid pressure, or as specifically directed by the Engineer. Method 3 is not an equivalent repair method to Methods 1 or 2, which shall be considered the standards.

3.13 CLEANUP

A. 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.

B. Floors that have curing and sealing compound shall be cleaned of loose dirt and debris by sweeping with ordinary brooms. They shall then be washed and mopped with clean

water. Finally, one additional coat of the same clear curing and sealing compound shall be applied in the same manner as specified.

END OF SECTION

SECTION 03 60 00

GROUTING

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies grout for column and other structural support bases, equipment bases, crack repair, and surface repair.

1.02 QUALITY ASSURANCE

A. Quality Control by Owner
   1. The Owner will provide the services of a qualified Special Inspector in accordance with Section 01 40 00.

B. Quality Control by Contractor
   1. If a product other than those listed below is proposed and test data is not available from the supplier to demonstrate equivalence to the specified grout, then to demonstrate equivalence with the grout properties of the specified product, 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 the proposed grout materials. Costs of testing laboratory services shall be borne by the Contractor.

C. References:
   1. 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.
   2. 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 C230	Standard Specification for Flow Table for Use in Tests of Hydraulic Cement
ASTM C307	Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings
ASTM C531	Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes

Reference	Title
ASTM C579	Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings and Polymer Concretes
ASTM C882	Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear
ASTM C942	Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear
ASTM C1107	Standard Test Method for Compressive Strength of Grouts for Preplaced-Aggregate Concrete in the Laboratory
ASTM C1181	Packaged Dry, Hydraulic-Cement Grout (Non-shrink)
COE CRD-C611	Standard Test Methods for Compressive Creep of Chemical-Resistant Polymer Machinery Grouts
COE CRD-C621	Flow of Grout for Preplaced Aggregate Concrete
COE CRD-C621	Specification for Non-shrink Grout
CBC	California Building Code, 2013 edition

1.03 SUBMITTALS

A. The following information shall be provided in accordance with Section 01 33 00:
   1. Complete product literature and installation instructions for epoxy grout (all uses) and cementitious non-shrink grout.
   2. Current ICC Evaluation Service report for adhesives used for dowel and anchor setting.
   3. Installer certification in accordance with ACI/CRSI Adhesive Anchor Installer Certification Program for installers of horizontal or upwardly inclined adhesive anchors.

PART 2 PRODUCTS

2.01 CEMETITIOUS NON-SHRINK GROUT

A. Cementitious non-shrink non-metallic aggregate grout shall be Five Star Products, Inc. Five Star Grout, BASF Masterflow 928, Sika Corporation SikaGrout 212, Hi-Flow Grout by Euclid Chemical Company, or equal.

2.02 EPOXY GROUT FOR EQUIPMENT MOUNTING:

A. Epoxy grout for equipment mounting shall be a non-cementitious, resin based, multi-component formulation. Epoxy grout shall be flowable, with shrinkage minimized to achieve minimum 98% effective bearing area. Acceptable products include: BASF Masterflow 648 CP Plus; Sikadur 42 by Sika Corporation; E3-G by Euclid Chemical Company; or equal.

2.03 ADHESIVE FOR DOWEL AND ANCHOR SETTING

A. Adhesive for setting dowels and anchoring connection/base plate bolts shall be an injectable two-component epoxy adhesive. Adhesive shall be approved for the intended use per the product ICC Report.

B. Adhesive shall be HIT-RE 500-SD by Hilti or approved equal (equivalent product must have ICC approval for use in cracked concrete in areas with high seismic risk).

2.04 CONCRETE REPAIR MORTAR

A. Horizontal Applications: Horizontal repair mortars shall be Emaco S66 CI by BASF, SikaTop 111 Plus by Sika Corp, or approved equal.

B. Vertical and Overhead Applications: Vertical and overhead repair mortars shall be SikaTop 123 Plus or approved equal.

PART 3 EXECUTION

3.01 CEMENTITIOUS NONSHRINK GROUT

A. Non-shrink, 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 this grout to support the bearing surfaces of machinery shall be as detailed on the Drawings for specific locations or pieces of equipment. If guidance is not provided in locations noted above, use of non-shrink grout for equipment mounting shall be limited to equipment less than 25 horsepower or 750 pounds. Grout shall be placed and cured in accordance with manufacturer's instructions.

B. Non-shrink cementitious grout shall not be used as a surface patch or topping. Non-shrink cementitious grout must be used in confined applications only.

3.02 EPOXY GROUT FOR EQUIPMENT MOUNTING

A. 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 the details on the Drawings and in strict conformance with manufacturer’s recommendations.

3.03 CONCRETE REPAIR MORTAR

A. Concrete repair materials and procedures shall be submitted for review to the Engineer and shall be accepted prior to commencement of the repair work.

B. Follow all manufacturer's instructions, including those for minimum and maximum application thickness, surface preparation and curing. Add aggregate as required per manufacturer's recommendations. Any deviations from the manufacturer's instructions shall be submitted for review to the Engineer and shall be accepted prior to commencement of the work.

END OF SECTION

SECTION 05 05 20

ANCHOR BOLTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Bolts and all-thread rods used to attach structural elements and equipment to concrete. Included are cast-in-place and post-installed anchors (adhesive systems and wedge type expansion anchors), nuts and washers.

B. Cast-in-place and post-installed anchors shall be Type 316 stainless steel unless noted otherwise.

1.01 RELATED SECTIONS

C. Related Sections: This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 73 23 Bracing and Anchoring
   2. Section 01 88 14 Seismic Design Criteria
   3. Section 01 88 15 Wind Design Criteria
   4. Section 03 30 00 Cast-In-Place Concrete
   5. Section 03 60 00 Grouting
   6. Section 43 05 13 Rigid Equipment Mounts

1.02 REFERENCE CODES AND STANDARDS

A. The references listed below are a part of this section. 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.

Reference	Title
ACI 318	Building Code Requirements for Structural Concrete
ASTM A193	Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
ASTM A194	Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
ASTM A320	Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service
ASTM A563	Carbon and Alloy Steel Nuts
ASTM F593	Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	Stainless Steel Nuts
ASTM F844	Washers, Steel, Plain (Flat), Unhardened for General Use
ASTM F1554	Anchor Bolts, Steel, 36, 55, 105-ksi Yield Strength
CBC	California Building Code 2016

1.03 SUBMITTALS

A. Action Submittals
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations 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. Include 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. Anchor bolt placement plans.
   5. Anchor bolt, nut, and washer material information, including material certifications.
   6. Record copy of design calculations and details showing the required diameter, length, embedment, edge distance, confinement, anchor reinforcement, anchor bolt sleeves, connection redesign, and other conditions, stamped and signed by a Professional Civil or Structural Engineer currently registered in the state of California. Calculations shall comply with the provisions of ACI 318-14, Chapter 17. Base anchor capacity determination on cracked concrete condition and compressive strength of new concrete per Section 03 30 00. Assume compressive strength of existing concrete is 3,000 psi unless otherwise noted.
      a. Reference Section 01 88 14 and 01 88 15 for additional information relating to anchorage calculations that consider seismic and wind design, respectively.
   7. Submit record copy of proof loading test results within five days after test.
   8. Product Data:
      a. ICC-ES or IAPMO UES Reports for post-installed adhesive type anchors and expansion (wedge type) anchors when allowed. Products shall be ICC approved for use in cracked concrete in high seismic areas (Seismic Design Category D, E and F).
      b. Product data indicating load capacity charts/calculations.
      c. Chemical resistance.
      d. Temperature limitations.
      e. Manufacturers written installation instructions.
   9. Installer certification for horizontal or upwardly inclined adhesive anchors in accordance with ACI/CRSI Adhesive Anchor Installer Certification Program.

1.04 QUALITY ASSURANCE

A. Quality Assurance By Owner
   1. Special inspection of anchor bolts shall be performed by the Special Inspector under contract with the Owner and in accordance with CBC Chapter 17.

2. A five percent sample of installed post-installed anchors shall be proof-loaded by an independent laboratory contracted by the Contractor. The quantity of samples and locations shall be coordinated with the Owner's Representative.
3. Adhesive anchors installed in horizontal or upwardly inclined orientations to resist sustained tension loads shall be continuously inspected during installation by a Special Inspector.
4. The Special Inspector shall furnish a report to the Engineer, Owner's Representative, and Building Official that the work covered by the report has been performed and that the materials used and the installation procedures used conform with the approved Project Manual and the Manufacturer's Printed Installation Instructions (MPII).

B. Certifications
1. Installer certification shall be in accordance with ACI/CRSI Adhesive Anchor Installer Certification Program for installers of horizontal or upwardly inclined adhesive anchors.

PART 2 PRODUCTS

2.01 GENERAL

A. Anchor bolt holes in equipment support frames shall not exceed the bolt diameters by more than 1/4 inch. Minimum anchor bolt diameter shall be 1/2 inch. Anchor bolts for equipment mounting and vibration isolation systems shall be provided as specified in Sections 43 05 13.

B. Tapered washers shall be provided where mating surface is not square with the nut.

C. Anchor bolts shall be cast-in-place anchors unless post-installed anchors are specified or shown on the Drawings. Substitution of post-installed anchors will not be permitted unless specifically requested by the Contractor and approved by the Engineer.

2.02 PERFORMANCE / DESIGN CRITERIA

A. Anchor bolts for equipment shall be designed by the equipment manufacturer to include equipment operational loads combined with seismic and wind forces when applicable. Design criteria provided in Section 01 73 23.

B. Design anchor bolts for support and bracing of non-structural components and non-building structures for loading specified in Section 01 73 23.

2.03 MATERIALS

A. Anchor bolt materials shall be as specified in the following table:

Material	Specification
Stainless Steel Anchor Bolts	ASTM A193 or A320, Type 316
Stainless Steel Threaded Rods	ASTM F593, Type 316
Stainless Steel Nuts	ASTM A194 Heavy Hex Nuts, Type 316 ASTM F594 Heavy Hex Nuts at Adhesive Anchors, Type 316

Material	Specification
Stainless Steel Washers	Type 316 to match bolt material
Carbon Steel Anchor Bolts	ASTM F1554, Grade 36, Hot Dip Galvanized
High-Strength Carbon Steel Anchor Bolts	ASTM F1554, Grade 55, Weldable per Supplementary Requirement S1, Hot Dip Galvanized
Carbon Steel Nuts and Washers	ASTM A563 and F844, Heavy Hex, Hot-Dip Galvanized
Concrete Adhesive Anchors	Hilti "HIT-RE 500v3", Simpson Strong-Tie "SET-XP", or approved equal, with Type 316 Stainless Steel threaded rods
Concrete Expansion (wedge) Anchors *	Hilti "KWIK BOLT TZ", or approved equal, Type 316 Stainless Steel

**Post installed anchors shall always be an adhesive type anchor system except where noted otherwise or when Contractor makes a request for a specific application and Engineer approves.*

2.04 STAINLESS STEEL FASTENER LUBRICANT (ANTI-SEIZING)

A. Anti-seizing Lubricant for Stainless Steel Threaded Connections:
   1. Formulated to resist washout.
   2. Acceptable manufacturers are Bostik, Saf-T-Eze, or equal.

2.05 ANCHOR BOLT SLEEVES

A. Provide anchor bolt sleeves as shown on design drawings and as required by equipment manufacturer's design.
   1. Provide high density polyethylene plastic sleeves of single unit construction with deformed sidewalls such that the concrete and grout lock in place.
   2. The top of the sleeve shall be self-threading to provide adjustment of the threaded anchor bolt projection.
   3. Acceptable manufacturers are Contec, Wilson, or equal.

PART 3 EXECUTION

3.01 GENERAL

A. Anchor bolts shall be cast-in-place anchors unless post-installed anchors are specified or shown on the Drawings.

B. Grouting of anchor bolts using plastic sleeves with non-shrink or epoxy grout, where specified, shall be in accordance with Section 03 60 00.

C. The threaded end of anchor bolts and all-thread rods shall be long enough to project through the entire depth of the nut and if too long, shall be cut off at ½-inch beyond top of nut and ground smooth.

3.02 CAST-IN-PLACE ANCHOR BOLTS

A. Anchor bolts to be embedded in concrete shall be placed accurately and held in correct position using templates while the concrete is placed.

B. After anchor bolts have been embedded, their threads shall be protected by grease and the nuts run on.

3.03 ADHESIVE ANCHOR BOLTS

A. Note that adhesive anchors shall not be substituted for cast-in-place anchor bolts unless the adhesive anchors have been specified or shown on the Drawings, or approval has been obtained from the Engineer that substitution of adhesive anchors is acceptable for the specific use and location. Use of adhesive anchors shall be subject to the following conditions:
   1. Limit to locations where intermittent or continuous exposure to the following is extremely unlikely:
      a. Acid concentrations higher than 10 percent
      b. Chlorine gas
      c. Machine or diesel oils
   2. Limit to applications where exposure to the following is extremely unlikely:
      a. Fire
      b. Concrete or rod temperature above 120 degrees F
   3. Overhead applications (such as pipe supports) shall not be allowed unless approved by the Engineer and installation is by an Installer specially certified for overhead applications.
   4. Approval from Engineer for specific application and from supplier of equipment to be anchored, if applicable.
   5. Anchor diameter and material shall be per Contract Documents or equipment manufacturer's specifications. Anchor shall be threaded or deformed the full length of embedment and shall be free of rust, scale, grease, and oils.
   6. Embedment depth shall be as specified or as required by the equipment manufacturer.
   7. Follow the anchor system manufacturer's installation instructions.
   8. Holes shall have rough surfaces created by using a hammer drill with carbide bit. Core drilled holes are not allowed.
   9. Holes shall be blown clean with oil-free compressed air and be free of dust or standing water prior to installation. Follow additional requirements of the adhesive manufacturer.
   10. Concrete and air temperature shall be compatible with curing requirements of adhesives per adhesive manufacturer's instructions. Anchors shall not be placed in concrete when the temperature is below 25 degrees F.
   11. Anchors shall be left undisturbed and unloaded for full adhesive curing period, which is based on temperature of the concrete.

3.04 EXPANSION ANCHORS

A. Expansion (wedge type) anchors shall not be substituted for cast-in-place anchor bolts or adhesive anchors unless approved by the Engineer for a specific application. Use of expansion anchors shall be subject to conditions 4 through 9 as specified above for adhesive anchors. Expansion anchors shall not be used in a submerged condition or in mounting of equipment subject to vibration or cyclic motion.

3.05 REINFORCING STEEL CONFLICTS WITH POST-INSTALLED ANCHOR INSTALLATION

A. Locate and avoid all reinforcement prior to drilling into concrete.

B. When reinforcing steel is encountered in the drill path, slant drill to clear obstruction and provide beveled washer to match angle of anchor. Drill shall not be slanted more than 10 degrees.

C. Where slanting the drill does not resolve the conflict, notify the Owner's Representative and resolve the conflict to the satisfaction of the Owner's Representative in consultation with the Engineer.

D. Abandoned post-installed anchor holes shall be cleaned and filled with non-shrink grout and struck off flush with adjacent surface.

E. The costs of determining and executing the resolution shall be borne by the Contractor. The determination and execution of the resolution shall not result in additional cost to the Owner.

F. In order to avoid or resolve a conflict, locate embedded reinforcing steel using non-destructive methods and/or redesign the attachment.
   1. Redesign shall be done by the Contractor's Professional Civil or Structural Engineer currently registered in the state of California.
   2. Calculations and details for redesign shall be submitted.

END OF SECTION

SECTION 05 05 23

WELDING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Requirements for shop and field welding.

1.02 REFERENCE CODES AND STANDARDS

A. This Section contains references to the following codes and standards. These documents are a part of this Section as specified and modified. In the event of conflict between the requirements of this Section and these referenced documents, the requirements of this Section shall prevail.

B. The referenced codes and standards are the current versions of each, unless otherwise noted. In all cases, the 2016 California Building Code shall be considered as the Building Code in effect.

Reference	Title
ASME	American Society of Mechanical Engineers (ASME)
BPVC SEC V	Nondestructive Examination
BPVC SEC IX	Welding and Brazing Qualifications
American Society of Nondestructive Testing (ASNT)	
SNT-TC-1A	Personnel Qualification and Certification in Nondestructive Testing
ASTM International (ASTM)	
A370	Standard Test Methods and Definitions for Mechanical Testing of Steel Products
American Welding Society (AWS)	
A2.4	Standard Symbols for Welding, Brazing, and Nondestructive Examination
A3.0	Standard Welding Terms and Definitions
D1.1/D1.1M	Structural Welding Code - Steel
D1.2/D1.2M	Structural Welding Code - Aluminum
D1.3/D1.3M	Structural Welding Code - Sheet Steel
D1.4/D1.4M	Structural Welding Code - Reinforcing Steel
D1.6/D1.6M	Structural Welding Code - Stainless Steel
QC1	Standard for AWS Certification of Welding Inspectors

1.03 DEFINITIONS

A. CJP: Complete Joint Penetration.

B. CWI: Certified Welding Inspector.

C. MT: Magnetic Particle Testing.

D. NDE: Nondestructive Examination.

E. NDT: Nondestructive Testing.

F. PJP: Partial Joint Penetration.

G. PQR: Procedure Qualification Record.

H. PT: Liquid Penetrant Testing.

I. RT: Radiographic Testing.

J. UT: Ultrasonic Testing.

K. VT: Visual Testing.

L. WPQ: Welder/Welding Operator Performance Qualification.

M. WPS: Welding Procedure Specification.

1.04 SUBMITTALS

A. Preconstruction / Action Submittals: The following minimum submittals shall be submitted prior to construction of this element of the Work in accordance with Section 01 33 00 - Submittal Procedures.

1. A copy of this Section, with addendum updates included, and all referenced and applicable Sections, with addendum updates included, with each paragraph check-marked to indicate Specification compliance or marked to indicate requested deviations from Specification requirements or those parts which are to be provided by the Contractor or others shall be provided. Check marks (✓) shall denote full compliance with a paragraph as a whole.

   If deviations from the Specifications are indicated, and therefore requested, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The City Representative shall be the final authority for determining acceptability of requested deviations.

   The remaining portions of the paragraph not underlined shall signify compliance with the Specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the requirements of the Specification shall be cause for rejection of the entire submittal and no further submittal material will be reviewed.

2. Shop Drawings:
    a. Shop and field WPSs and PQRs.
    b. NDT procedure specifications prepared in accordance with ASME BPVC SEC V.
    c. Welding Data (Shop and Field): Submit welding data together with Shop Drawings as a complete package.
        1) Show on Shop Drawings or a weld map complete information regarding base metal specification designation, location, type, size, and extent of welds with reference called out for WPS and NDE numbers in tails of combined welding and NDE symbols as indicated in AWS A2.4.
        2) Clearly distinguish between shop and field welds.
        3) Indicate, by welding symbols or sketches, details of welded joints and preparation of base metal. Provide complete joint-welding details showing bevels, groove angles, and root openings for welds.
        4) Welding and NDE symbols shall be in accordance with AWS A2.4.
        5) Welding terms and definitions shall be in accordance with AWS A3.0.

B. Informational Submittals: The following minimum informational submittals shall be submitted in accordance with the timing requirements specified in these Contract Documents, prior to Substantial Completion and in accordance with Section 01 33 00 - Submittal Procedures.
    1. WPQs.
    2. CWI credentials.
    3. Testing agency personnel credentials.
    4. CWI and NDT reports.
    5. Welding Documentation: Submit on forms in referenced welding codes.

1.05 QUALIFICATIONS

A. WPSs: In accordance with AWS D1.1/D1.1M (Annex M Forms) for shop or field welding; or ASME BPVC SEC IX (Forms QW-482 and QW-483) for shop welding only..

B. WPQs: In accordance with A: AWS D1.1/D1.1M (Annex M Forms); or ASME BPVC SEC IX (Form QW-484)

C. Welding Inspectors: The Contractor's welding inspectors shall hold current AWS QC1, CWI certification and have prior experience with specified welding codes. Alternate welding inspector qualifications require approval by City Representative.

D. Testing Agency: Personnel performing tests shall be NDT Level II certified in accordance with ASNT SNT-TC-1A.

1.06 SEQUENCING AND SCHEDULING

A. Unless otherwise specified, Submittals required in this section shall be submitted and approved prior to commencement of welding operations.

PART 2 PRODUCTS

2.01 SOURCE QUALITY CONTROL

A. Contractor's CWI shall be present whenever shop welding is performed. CWI shall perform inspection at suitable intervals prior to assembly, during assembly, during welding, and after welding. CWI shall perform inspections in accordance with AWS D1.1/D1.1M, or referenced welding code, and as follows:
   1. Verify conformance of specified job material and proper storage.
   2. Monitor conformance with approved WPSs.
   3. Monitor welder performance and conformance of WPQs.
   4. Inspect weld joint fit-up and perform in-process inspections.
   5. Provide 100 percent visual inspection of all welds.
   6. Coordinate with nondestructive testing personnel to select welds to be nondestructively tested and evaluate test results.
   7. Maintain records and prepare reports confirming that the results of inspection and testing comply with the Work.

PART 3 EXECUTION

3.01 GENERAL

A. Welding and Fabrication by Welding: Conform to governing welding codes referenced in attached Welding and Nondestructive Testing Table.

3.02 NONDESTRUCTIVE WELD TESTING REQUIREMENTS

A. Weld Inspection Criteria:
   1. Selection of welds to be tested, unless 100 percent NDT is specified herein, shall be as agreed upon between the City Representative and welding inspector.
   2. Unless otherwise specified, perform NDT of welds at a frequency as shown below and in the attached Table in accordance with referenced welding codes. In case there is a conflict, higher frequency level of NDT shall apply.
      a. Nontubular Connections:
         1) CJP Butt Joint Groove Welds: 10 percent random RT. Use UT for CJP butt joint groove welds that, in the opinion of the Engineer, cannot be readily radiographed.
         2) All other CJP Groove Welds: 10 percent random UT.
         3) Fillet Welds and PJP Groove Welds: 10 percent random PT or MT.
      b. Tubular Connections:
         1) CJP Butt Joint Groove Welds made from one side without backing: 100 percent RT or UT in accordance with AWS D1.1/D1.1M, Paragraph 9.26.2 requirements.
         2) CJP Butt Joint Groove Welds made without backing or backgouging: 10 percent random RT. Use UT for CJP butt joint groove welds that, in the opinion of the Engineer, cannot be readily radiographed.
         3) All other CJP Groove Welds: 10 percent random UT.

4) Fillet Welds and PJP Groove Welds: 10 percent random PT or MT.

3. NDT Procedures and Acceptance Criteria:
   a. Nontubular Connections:
      1) RT: Perform in accordance with AWS D1.1/D1.1M, Clause 6, Part E. Acceptance criteria per AWS D1.1/D1.1M, Paragraph 6.12.1.
      2) UT: Perform in accordance with AWS D1.1/D1.1M, Clause 6, Part F. Acceptance criteria per AWS D1.1/D1.1M, Paragraph 6.13.1.
      3) PT and MT:
         (1) Perform on fillet and PJP groove welds in accordance with AWS D1.1/D1.1M, Paragraph 6.14.4 and Paragraph 6.14.5.
         (2) Acceptance criteria per AWS D1.1/D1.1M, Paragraph 6.9, Visual Inspection, Statically Loaded Nontubular Connections.
   b. Tubular Connections:
      1) RT: Comply with requirements for Nontubular Connections and additional requirements of AWS D1.1/D1.1M, Clause 9, Paragraph 9.28 and Paragraph 9.29.
      2) UT: Comply with requirements for Nontubular Connections and additional requirements of AWS D1.1/D1.1M, Clause 9, Paragraph 9.27.
      3) PT and MT:
         (1) Perform on fillet and PJP groove welds in accordance with AWS D1.1/D1.1M, Paragraph 6.14.4 and Paragraph 6.14.5.
         (2) Acceptance criteria per AWS D1.1/D1.1M, Paragraph 9.25.
   c. Stud Connections: AWS D1.1/D1.1M, Paragraph 7.8.1.
      1) Welded anchor studs, headed concrete anchor studs (HAS), welded studs, deformed bar anchors (DBA), or threaded studs (TAS) shall be attached with a stud gun in accordance with AWS D1.1. Fillet welding will not be permitted.

3.03 FIELD QUALITY CONTROL

A. Contractor's CWI shall be present whenever field welding is performed. CWI shall perform inspections at suitable intervals prior to assembly, during assembly, during welding, and after welding. CWI shall perform inspections as required in AWS D1.1/D1.1M or referenced welding code and as follows:
   1. Verify conformance of specified job material and proper storage.
   2. Monitor conformance with approved WPSs.
   3. Monitor welder performance and conformance of WPQs.
   4. Inspect weld joint fit-up and perform in-process inspections.
   5. Provide 100 percent visual inspection of all welds.
   6. Coordinate with nondestructive testing personnel to select welds to be nondestructively tested and evaluate test results.
   7. Maintain records and prepare reports confirming that the results of inspection and testing comply with the Work.

3.04 WELD DEFECT REPAIR

A. Repair and retest rejectable weld defects until sound weld metal has been deposited in accordance with appropriate welding codes.

3.05 SUPPLEMENTS

A. The supplement listed below, is a part of this Specification.
   1. Welding and Nondestructive Testing Table.

Welding and Nondestructive Testing

Specification Section	Governing Welding Codes or Standards	Submit WPS	Submit WPQ	Onsite CWI Req'd	Submit Written NDT Procedure Specifications	NDT Requirements
03 21 00 Reinforcing Steel	AWS D1.4/D 1.4M, Structural Welding Code - Reinforcing Steel	Yes	Yes	Yes	Yes	100% RT of direct butt joints and 100% MT of all other rebar splices Also see Section 03 2 0 00.
05 10 00 Structural Metal Framing	AWS D1.1/D 1.1M, Structural Welding Code - Steel	Yes	Yes	Yes	Yes	100% VT and as specified in paragraph 3.02; also see Section 05 1 0 00
05 52 10, Aluminum Railings	AWS D1.2/D 1.2M, Structural Welding Code - Aluminum	No	No	No	No	100% VT; also see Section 5 52 16, Aluminum Railings
05 53 00 Metal Gratings	AWS D1.1/D 1.1M, Structural Welding Code - Steel or AWS D1.2/D 1.2M, Structural Welding Code - Aluminum	No	No	No	No	100% VT; also see Section 05 5 3 00
33 16 13.13 Welded Steel Tank	ASME BPV Code, Section IX or AWS D1.1/D 1.1M, Structural Welding Code - Steel	Yes	Yes	Yes	Yes	100% VT and AWWA D100; also see Section 33 1 6 13.13

END OF SECTION

SECTION 05 52 10

ALUMINUM RAILINGS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Prefabricated anodized aluminum component type guardrail and handrail systems; herein referred to as railing.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 03 30 00 Cast-in-Place Concrete.

1.03 REFERENCES

A. The references listed below are a part of this section. 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.

Reference	Title
Aluminum Design Manual	The Aluminum Association, Aluminum Design Manual with Specifications and Guidelines for Aluminum Structures
ASTM B209	Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B210	Aluminum and Aluminum-Alloy Drawn Seamless Tubes
ASTM B221	Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B429	Aluminum-Alloy Extruded Structural Pipe and Tube
ASTM B483	Aluminum and Aluminum-Alloy Drawn Tube and Drawn Pipe for General Purpose Applications
ASTM F593	Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	Stainless Steel Nuts
AWS D1.2	Structural Welding Code, Aluminum
OSHA	U.S. Dept. of Labor, Occupational Safety and Health Administration
IBC	International Building Code with local amendments

1.04 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations 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. Include 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. Layout, installation, and detail shop drawings for railing.
5. Design calculations stamped and signed by a licensed professional engineer in the State of California. Railing and base support connections to be designed by the Contractor incorporating specified criteria and provisions in the current building code with local governing amendments.

B. Informational Submittals:

1. Material certification for compliance with this specification for aluminum and stainless steel materials.

1.05 QUALITY ASSURANCE

A. General:

1. Railing shall conform to the standards of the Occupational Safety and Health Administration (OSHA) and International Building Code.

1.06 DELIVERY, STORAGE AND HANDLING

A. Cushion wrap complete rails, modules and components to prevent scratching and denting during shipment, storage, and installation.

B. Leave wrap intact, insofar as possible, until railing is completely installed.

PART 2 PRODUCTS

2.01 PERFORMANCE/DESIGN CRITERIA

A. Railing assembly and attachments shall resist a minimum uniform load of 50 pounds per linear foot on the top rail and a concentrated load of 200 pounds (not acting concurrently with the uniform load) applied in any direction. Contractor's supplier and engineer are responsible for designing the guardrail/handrail system along with its base support and anchor bolt size and embedment depth into concrete, or connection to metal framing, to resist the above loading condition taking into account anchor edge distances and concrete strengths at the point of attachment. Contractor shall submit calculations signed and sealed by a professional engineer in the State of California.

B. Thermal Movements: Provide railing that allow for thermal movements resulting from the project site maximum range in ambient and surface temperatures. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime sky heat loss.

2.02 MANUFACTURERS

A. Julius Blum & Co., Inc.

B. Golden Railing Inc.

C. Moultrie Manufacturing.

D. American Railing Systems, Inc.

E. Approved equal.

2.03 MATERIALS

Component	Material
Aluminum pipe	ASTM B210 Alloy 65060-T832; ASTM B 221 Alloy 6063-T5/T52; ASTM B 429, Alloy 6063-T832; ASTM B483, Alloy T832
Aluminum plate	ASTM B209, Alloy 6061-T6
Stainless steel bolts	ASTM A593, Type 316
Stainless steel nuts and washers	ASTM A594, Type316

2.04 CONFIGURATION/COMPONENTS

A. Guard Top Rails: Minimum 1 1/2 inch nominal diameter pipe, Schedule 40.

B. Intermediate Rails: Minimum 1 1/2 inch nominal diameter pipe, Schedule 40.

C. Handrails: 1 1/2 inch nominal diameter pipe, Schedule 40.

D. Posts: Minimum 1 1/2 inch nominal diameter pipe, Schedule 80.

E. Provide manufacturer’s heavy-duty base fitting with stainless steel set screws.

F. Provide aluminum toe boards at guardrails, except where concrete curbs are indicated. Aluminum toe boards shall be minimum 3/16-inch thick plate, connected to the posts.

G. Bolts, including anchor bolts, shall be Type 316 stainless steel.

H. Fittings:
   1. Fittings shall be cast aluminum elbows, T-shapes, post brackets and escutcheons. Provide adapter and anchor plugs as required for a complete installation.
   2. Floor sleeves for removable railing shall be stainless steel, embedded in concrete.

2.05 ASSEMBLY/FABRICATION

A. Pipe cuts shall be clean, straight, square and accurate for minimum joint gap. Work shall be done in conformance with the guardrail and handrail manufacturer's instructions. Work shall be free from blemishes, defects, and misfits of any type which can affect durability, strength, or appearance.

B. Guardrailing and handrailing shall be connected by screws or bolts or welding. Holes shall be punched 1/16 inch larger than the nominal size of the bolts, unless otherwise specified. Wherever needed because of the thickness of the metal, holes shall be subpunched and reamed or drilled. Components with mismatched holes shall be replaced. No drifting of bolts or enlargement of holes will be allowed to correct misalignment.

C. Supply components required for anchorage of fabrications.

D. Where shop welding is used, grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints tight and flush. Round exposed edges to small, uniform radius. Use filler alloy rods that will not discolor when anodized, such as ER 5154, ER 5254, ER 5183, ER 5356 or ER 5556 filler alloy rods.

2.06 ISOLATION COATING

A. Isolation coating shall be applied to all aluminum surfaces in contact with concrete, masonry, or dissimilar metals. Use a heavy coat of bituminous paint.

2.07 FINISHES

A. Clear anodized in accordance with the Aluminum Association AA-M12-C22-A41. Anodize exposed prefabricated components, except stainless steel fasteners, after fabrication.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine and accept existing conditions before beginning work.

B. Field verify measurements for railings before fabrication.

3.02 INSTALLATION

A. Install in accordance with manufacturer's written instructions.

B. Protect dissimilar metals 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.

C. Accurately place metal to be embedded in concrete and hold in correct position while the concrete is placed. Where recesses or blockouts are formed in the concrete, grout metalwork in place after concrete has attained its design strength in accordance with Section 03 30 00.

D. Unless otherwise indicated, field welding of railing is not permitted.

3.03 TOLERANCES

A. Maximum variance from plumb: 1/4 inch.

B. Maximum offset from true alignment: 1/4 inch.

END OF SECTION

SECTION 07 91 26

JOINT FILLERS

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies preformed joint fillers.

1.02 QUALITY ASSURANCE

A. References:

1. 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.
2. 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 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

A. 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

A. 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

A. The following information shall be provided in accordance with Section 01 33 00:

1. Manufacturer's recommendations for handling and installation of the material.

PART 3 EXECUTION

3.01 GENERAL

A. 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

A. Preformed asphalt fiberboard joint fillers shall be used for expansion joints in concrete sidewalks, curbs, and between the new truck apron and the existing pavement.

3.03 PREFORMED RESIN-BONDED CORK

A. Preformed resin-bonded cork joint filler shall be used for expansion joints between the concrete tank foundation slab and the concrete truck apron The expansion joint shall be sealed with backer rod and sealant as specified in Section 07 92 00.

END OF SECTION

SECTION 07 92 00

JOINT SEALANTS

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies sealants for concrete joints.

1.02 QUALITY ASSURANCE

A. References:

1. 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.
2. 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
FEDSPEC TT-S-00230C	Sealing Compound: Elastomeric Type, Single Component
FEDSPEC TT-S-00227E	Sealing Compound: Elastomeric Type, Multi-Component

PART 2 PRODUCTS

2.01 POLYURETHANE SEALANT

A. Acceptable Products:

1. Acceptable products shall be Sikaflex by Sika Chemical Corporation, Vulkem by Mameco International, U-Seal Joint Sealant by Burke Company, or Rubber Calk by Products Research and Chemical Corporation.

B. General:

1. Polyurethane sealants shall conform to FEDSPEC TT-S-0230C for one-component systems and FEDSPEC TT-S-00227E for two-component systems. Polyurethane sealant shall be one of the following two types.
   a. Self-Leveling:
      1) Self-leveling polyurethane sealant shall be Type I, Class A as specified by the FEDSPECs referenced above.

b. Nonsag:
   1) Nonsag polyurethane sealant shall be Type II, Class A as specified by the FEDSPECs referenced above.

C. Primer:
   1. Primer shall be as recommended by the sealant manufacturer.

D. Backer Rod or Backer Tape:
   1. Backer rod shall be open cell polyethylene or polyurethane foam. Rod shall be cylindrical unless otherwise specified. Backer tape shall be polyethylene or polyurethane with adhesive on one side.

2.02 MASTIC SEALANT

A. General:
   1. Mastic joint sealant shall consist of a blend of refined asphalts, resins and plasticizing compounds, reinforced with fiber. Sealant shall be compatible with joint fillers and shall be pressure grade.

B. Primer:
   1. Primer shall be as recommended by the mastic sealant manufacturer.

2.03 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00:
   1. Manufacturer's product data showing conformance to the specified products.
   2. Manufacturer's recommendations for storage, handling and application of sealants and primers.

PART 3 EXECUTION

3.01 GENERAL

A. Sealants and primers shall be applied according to the sealant manufacturer's recommendations. Polyurethane sealants shall be used on all expansion joints and specified construction joints.

B. Joints and spaces to be sealed shall be clean, dry and free of dust, loose mortar, concrete and plaster. Additional preparation of joints and spaces shall be provided in accordance with manufacturer's recommendations. Primer shall be applied only to the surfaces that will be covered by the sealant.

3.02 POLYURETHANE SEALANTS

A. General:
   1. Nonsag polyurethane sealants shall be used on vertical joints. Self-leveling polyurethane sealants shall be used on horizontal joints.

B. Joint Dimensions:

1. Unless otherwise specified, joints and spaces to be filled shall be constructed to the following criteria. Joints and spaces shall have a minimum width of 1/4 inch and a maximum width of 1 inch. The depth of the sealant shall be one-half the width of the joint, but in no case less than 1/4 inch deep. Sealant depth shall be measured at the point of smallest cross section. When joints exceed the depth requirements, backing rod shall be inserted to provide the joint depth specified. If the joint sealant depth is within the specified tolerances, backer tape shall be placed in the bottom of the joint.

3.03 MASTIC SEALANT

A. Joint Dimensions:

1. Joints to be sealed shall be 2 inches deep, 1 inch wide at the top, and 3/4 inch wide at the base.

END OF SECTION

SECTION 09 90 00

PAINTING AND COATING

Table of Contents

SECTION 09 90 00

PAINTING AND COATING

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. This Section specifies coating systems, surface preparations, and application requirements for coating systems.

B. Definitions:
   1. Specific coating terminology used in this Section is in accordance with definitions contained in ASTM D16, ASTM D3960, and the following definitions.
      a. 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.
         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, 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:

1. 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.
2. 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
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

Reference	Title
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
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
SSPC-TR2	Wet Abrasive Blast Cleaning
SSPC-TU-3	Overcoating

Reference	Title
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:
   1. Materials and supplies provided shall be the standard products of CSMs. Materials in each coating system shall be the products of a single CSM.
   2. 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 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.
      a. The proposed coating system shall use an equal or greater number of separate coats to achieve the required total dry film thickness.
      b. The proposed coating system shall use coatings of the same generic type as that specified including curing agent type.
      c. Requests for consideration of products from CSMs other than those specified in this Section shall include information listed in paragraph 1.04, demonstrating that the proposed CSM's product is equal to the specified coating system.
      d. 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 09 90 00; 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. 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.
   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 09 90 00-A, included in Section 01 99 90, 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:
1. The Contractor shall conduct inspections at Hold Points during the coating system installation and record the results from those inspections on Form 09 90 00-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:
    a. 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.
    b. 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.
    c. 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.
    d. 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 09 90 00 and in the CSM's written instructions.

e. 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.

f. 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.

g. 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 09 90 00 and/or in the CSM's written instructions.

h. 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

A. General:

1. 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.
2. Labels on material containers shall show the following information:
   a. Name or title of product.
   b. CSM's batch number.
   c. CSM's name.
   d. Generic type of material.
   e. Application and mixing instructions.
   f. Hazardous material identification label.
   g. Shelf life expiration date.
3. 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.
4. Containers shall be clearly marked indicating personnel safety hazards associated with the use of or exposure to the materials.
5. Material Safety Data Sheets (MSDS) for each material shall be provided to the Construction Manager.
6. 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:

A. General:

1. Provide in accordance with Section 01 33 00:

a. 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.

b. CSM's current printed recommendations and product data sheets for coating systems including:
   1) Volatile organic compound (VOC) data.
   2) Surface preparation recommendations.
   3) Primer type, where required.
   4) Maximum dry and wet-mil thickness per coat.
   5) Minimum and maximum curing time between coats, including atmospheric conditions for each.
   6) Curing time before submergence in liquid.
   7) Thinner to be used with each coating.
   8) Ventilation requirements.
   9) Minimum atmospheric conditions during which the paint shall be applied.
   10) Allowable application methods.
   11) Maximum allowable moisture content.
   12) Maximum shelf life.

c. 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.

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

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

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

g. 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.

h. 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

A. General:

1. 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 09 90 00 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 Coating System Installation Training. for further details on these CTR requirements. This inspection is in addition to the inspection performed by the Contractor in accordance with this Section 09 90 00.

B. 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.

C. Coating System Inspection:

1. While on site to routinely inspect and verify, the CTR shall perform the following activities to confirm acceptability and conformance with the specifications:
    a. Inspect ambient conditions during various coating system installation at hold points for conformance with the specified requirements.
    b. Inspect the surface preparation of the substrates where the coating system will terminate or will be applied for conformance to the specified application criteria.
    c. Inspect preparation and application of coating detail treatment (for example, terminations at joints, metal embedments in concrete, etc.).
    d. Inspect application of the filler/surface materials for concrete and masonry substrates.

e. Inspect application of the primers and finish coats including wet and dry film thickness of the coatings.
f. Inspect coating systems for cure.
g. Review adhesion testing of the cured coating systems for conformance to specified criteria.
h. Review coating system continuity testing for conformance to specified criteria.
i. Inspect and record representative localized repairs made to discontinuities identified via continuity testing.
j. Conduct a final review of completed coating system installation for conformance to the specifications.
k. 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.

D. Final Report:
1. 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 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 09 90 00 and the CSM's recommendations.

PART 2 PRODUCTS

2.01 MATERIALS

A. General:
1. Notwithstanding the listing of product names in this Section 09 90 00, 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.
2. 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.

Material Requirements for Coating Systems: All California Except SCAQMD

Coating System	CSM	First Coat(s)	Finish Coat(s)
Epoxy Coatings			
E-1	PPG PMC	Amerlock 2/400 Series	Amerlock 2/400 Series
	Carboline	Carboguard 890	Carboguard 890
	International Paint/ICI*	Devran 224 HS	Devran 224 HS

Material Requirements for Coating Systems: All California Except SCAQMD

Coating System	CSM	First Coat(s)	Finish Coat(s)
	Sherwin Williams	Macropoxy 646 CA	Macropoxy 646 CA
	Tnemec	Series V69	Series V69
E-1-G	PPG PMC	Amerlock 2/400 Series	Amerlock 2/400 Series
	Carboline	Carboguard 890	Carboguard 890
	International Paint/ICI*	Devran 224 HS	Devran 224 HS
	Sherwin Williams	Macropoxy 646 CA	Macropoxy 646 CA
	Tnemec	Series V69	Series V69
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	Macropoxy 646-100	Macropoxy 646-100
	Tnemec	Series V69	Series V69
E-3	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	Macropoxy 646	Macropoxy 646
	Tnemec	Series V69	Series V69
E-4	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	Macropoxy 646	Macropoxy 646
	Tnemec	Series V69	Series V69
E-5	PPG PMC	Amercoat 333	Amercoat 333
	Carboline	Carboguard 691	Carboguard 691
	International Paint/ICI	Bar-Rust 233H	Bar-Rust 233H
	Sherwin Williams	Macropoxy 646	Macropoxy 646
	Tnemec	Series V69	Series V69
E6	PPG PMC	Amercoat 333	Amercoat 333
	Carboline	Carboguard 691	Carboguard 691
	International Paint/ICI	Bar-Rust 233H	Bar-Rust 233H
	Sherwin Williams	Macropoxy 646	Macropoxy 646
	Tnemec	Series V69	Series V69
E7	PPG PMC	Amerlock 400	Amerlock 400
	Carboline	Sanitile 120	Sanitile 120
	International Paint/ICI	Bar-Rust 236	Bar-Rust 236
	Sherwin Williams	Macropoxy 646	Macropoxy 646
	Tnemec	Series V69	Series V69
E8	PPG PMC	Amerlock 400	Amerlock 400
	Carboline	Carboguard 1340	Carboguard 1340

Material Requirements for Coating Systems: All California Except SCAQMD

Coating System	CSM	First Coat(s)	Finish Coat(s)
	International Paint/ICI	UH Gripper 3210	Tru-Glaze 4408
	Sherwin Williams	Macropoxy 646 CA	Macropoxy 646 CA
	Tnemec	Series 201	Series 201
E-9	PPG PMC	Amercoat 253	Amercoat 253
	Carboline	Carboguard 890	Carboguard 890
	International Paint/ICI	Bar-Rust 231	Bar-Rust 231
	Sherwin Williams	CorCote HCR-FF	CorCote HCR-FF
	Tnemec	Series 104	Series 104
E-9-C	PPG PMC	Amercoat 253	Amercoat 253
	Carboline	Carboguard 890	Carboguard 890
	International Paint/ICI	Bar-Rust 231	Bar-Rust 231
	Sherwin Williams	CorCote HCR-FF	CorCote HCR-FF
	Tnemec	Series 104	Series 104
E-10	PPG PMC	Amerlock 400	Amerlock 400
	Carboline	Carboguard 890	Carboguard 890
	International Paint/ICI	Bar-Rust 236	Bar-Rust 236
	Sherwin Williams	Macropoxy 646	Macropoxy 646
	Tnemec	Series V69	Series V69

Specialty Epoxy Linings

EA-1	Carboline	Plasite 4550S		Plasite 4550S
	Sauereisen	Sewergard 210S		Sewergard 210S
	Tnemec	Series 435		Series 435
Coating System	CSM	Base Coat	Filler/Surfacer	Glaze Coat
EA-2	Carboline	Semstone 501 optional	Carboguard 510	Plasite 4550S
	Sauereisen	Sewergard 210S	Series 209 HB	Sewergard 210S
	Tnemec	Series 435	Series 218	Series 435
EA-3	Carboline	Semstone 501 optional	Carboguard 510	Plasite 5371
	Sauereisen	Sewergard 210T	209 HB	Sewergard 210T
	Tnemec	Series 435	Series 218	Series 434
Coating System	CSM	Primer	Base Coat	Glaze Coat
EA-4	Carboline	N/A	Plasite 5371	Plasite 4500S
	Sauereisen	N/A	Sewergard 210T	Sewergard 210G
	Tnemec	N/A	Series 434	Series 435

Coating System	CSM	Primer	Filler/ Surfacer	Base Coat w/Scrim Cloth	Saturation Coat w/Silica Sand	Finish Coats
EA-5	Tnemec	Series 201	Series 218	Series 239	Series 239	Series 282
	Carboline	Semstone 110/110EP	Carboguard 510	Semstone 145	Semstone 145	Semstone 145

Elastomeric Coatings

EC-1	Carboline	Carboguard 954	Policlad 708

Material Requirements for Coating Systems: All California Except SCAQMD

Coating System	CSM	First Coat(s)	Finish Coat(s)
	Sherwin Williams	Corobond 100	Envirolastic 170
	Tnemec	Series V69	Series 406 (2 coats)
EC-2	Carboline	Carboguard 954	Polyclad 708/Polibrand 705
	Sherwin Williams	Corobond 100	Envirolastic 520 PW
	Tnemec	Series V69	Series 264

Epoxy Flooring Systems

Coating System	CSM	Primer	Intermediate Coat	Finish Coat
EF-1	Stonhard	Stonhard Standard Primer	Stonshield Undercoat and Broadcoat	Stoneshield Sealer
	Tnemec	Series 238	Series 238 with Broadcoat	Series 284 Clear
EF-2	Stonhard	Stonhard Standard Primer	Stonclad GS	Stonkote GS-4
	Tnemec	Series 238	Series 238	Series 280

Epoxy Polyurethane

	CSM	Primer Coat(s)	Intermediate Coat(s)	Finish Coat(s)
EU-1	Ameron	N/A	Amerlock 400	Amershield VOC
	Carboline	N/A	Carboguard 890	Carbothane 134 VOC
	Sherwin Williams	N/A	Macropoxy 646 100	Hi Solids Polyurethane 100
	Tnemec	N/A	Series V69	Series 1075
EU-1-FRP	Ameron	Amercoat 400		Amershield VOC
	Carboline	Carboguard 890		Carbothane 134 VOC
	Sherwin Williams	Macropoxy 646-100		VOC Hi Solids
	Tnemec	Series V69		Polyurethane 100 Series 1075

Grease

G	Texaco	N/A	Rust Inhibitive Grease
	Chevron	N/A	E.P. Roller Grease

High Heat

HH-1	High Temperature Coatings, Inc.	Hi Temp 1027	1000 VS (any color)
HH-2	High Temperature Coatings, Inc.	Hi Temp 1027	1000 VS (black or aluminum)

Latex Acrylic

L-1	PPG PMC	Amercoat 148	Amercoat 220
	Carboline	Sanitile 120	Carbocrylic 3359 DTM
	International Paint/ICI	Prep and Prime Gripper	Ultrahide 250-1406
	Sherwin Williams	Loxon Acrylic Primer	Sher Cryl
	Tnemec	Series 1028 or 1029	Series 1028 or 1029
L-2	PPG PMC	Amercoat 220	Amercoat 220
	Carboline	Sanitile 120	Carbocrylic 3359 DTM
	International Paint/ICI	UH Gripper 3210	Dulux Pro 4206
	Sherwin Williams	Sher Cryl	Sher Cryl
	Tnemec	Series 1028 or 1029	Series 1028 or 1029

Material Requirements for Coating Systems: All California Except SCAQMD

Coating System	CSM	First Coat(s)	Finish Coat(s)
L-3	PPG PMC	Amercoat 148	Amercoat 220
	Carboline	Carbocrylic 3359 DTM	Carbocrylic 3359 DTM
	International Paint/ICI	Devflex 4020 PF	Dulux Pro 1406
	Sherwin Williams	Procryl Primer	Sher Cryl
	Tnemec	Series 1028 or 1029	Series 1028 or 1029
L-4	PPG PMC	Amercoat 148	Amercoat 220
	Carboline	Carbocrylic 3359 DTM	Carbocrylic 3359 DTM
	International Paint/ICI	Prep and Prime Gripper	Ultrahide 250-146
	Sherwin Williams	Prep Rite ProBlock	Sher Cryl
	Tnemec	Series 1028 or 1029	Series 1028 or 1029
Miscellaneous			
M-1	Carboline	Carbowrap Tape Paste	Carbowrap Petrolatum Tape
	Denso	Denso Paste	Densyl Tape
	Trenton	Waxtape Primer	#1 Wax Tape
M-2	PPG PMC	Amerlock 400	Amerlock 400
	Carboline	Carbomastic 615 HS	Carbomastic 615 HS
	International Paint/ICI	Bar-Rust 231	Bar-Rust 231
	Sherwin Williams	Macropoxy 646-100	Macropoxy 646-100
	Tnemec	Series 135	Series 135
Penetrating Stain			
S-1	Tnemec	Series 617	Series 617
S-2	Tnemec	N/A	Series 636 Dur A Pell 20
	Curecrete Chemical Company	N/A	Ashford Formula
S-3	Tnemec	N/A	Series V626 Dur A Pell GS
S-4	Tnemec	N/A	Series V626 Dur A Pell GS
	Professional Products of Kansas	N/A	PWS-15 Super

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

2.02 PRODUCT DATA

A. General:

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 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 1.02 Quality Control Requirements and 1.05 Coating System Inspection when the work is underway.
3. Submit the Coating System Inspection Checklists, using Form 09 90 00-A, included in Section 01 99 90, for the coating work.
4. CTR final report in accordance with paragraph 1.05 Final Report.

PART 3 EXECUTION

3.01 COATINGS

A. General:

1. Coating products shall not be used until the Construction Manager has accepted the affidavits specified in paragraphs 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.
2. Erect and maintain protective enclosures as stipulated per SSPC-Guide 6 Guide for Containing Debris Generated During Paint Removal Operations.

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 3.01 Adhesion Confirmation. Damaged, deteriorated and poorly applied shop coatings that do not meet the requirements of this Section 09 90 00 shall be removed and the surfaces recoated. If the shop primer coat meets the requirements of this Section 09 90 00, 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.

3. Steel Water Tanks: The interior surfaces of steel water tanks or reservoirs shall have surface preparation and coating work performed in the field.

3.02 PREPARATION

A. General:
   1. 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.
   2. 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.
   3. 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.
   4. 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:
   1. When abrasive blast cleaning is required to achieve the specified surface preparation the following requirements for blast cleaning materials and equipment shall be met:
      a. Used or spent blast abrasive shall not be reused on this project.
      b. 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.
      c. 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 above.
      d. Regulators, gauges, filters, and separators shall be in use on compressor air lines to blasting nozzles times during this work.
      e. 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.
      f. 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.

g. 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.

h. 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.

i. 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:

1. 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.
2. Clean white cloths and clean fluids shall be used in solvent cleaning.

D. Metallic Surfaces:

1. 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 09 90 00. 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 Contractor to produce the specified surface profile. The solvent in solvent cleaning operations shall be as recommended by the CSM.
2. 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.
3. Blast cleaning requirements for steel, ductile iron and stainless steel substrates are as follows:
    a. 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.
    b. 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.
    c. 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.

d. 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.

e. 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.
    b. 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.
    c. 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 07 10 00, 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.

G. Fiberglass Reinforced Plastic (FRP) Surfaces:
   1. Prepare FRP surfaces by sanding to establish uniform surface roughness and to remove gloss from the resin in the FRP. Next, vacuum clean to remove loose FRP dust, dirt, and other materials. Next, solvent clean using clean white rags and allow solvent to evaporate completely before application of coating materials.

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:
1. 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:
1. 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.

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

E. Protection of Coated Surfaces:
1. 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 26 and 40 shall be coated as specified in paragraph 3.03 Electrical and Instrumentation Equipment and Materials.
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:
1. 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:
1. Electrical and instrumentation equipment and materials shall be coated by the equipment manufacturer as specified below.
    a. 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.
        1) Unless otherwise specified, instrumentation panels shall be coated with system E-1 for indoor mounting and system EU-1 for outdoor mounting.
        2) 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.
    b. 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.
        1) 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.

J. Soluble Salt Contamination of Metallic Substrates:

1. Contractor shall test in accordance with SSPC-TU-4 metallic substrates to be coated that have been exposed to seawater or coastal air or to industrial fallout of particulate or other sources of soluble chlorides (such as wastewater exposure). If testing indicates detrimental levels of soluble salts, those in excess of 25 ppm, the Contractor shall clean and prepare these surfaces to remove the soluble salts.

3.04 CLEANUP

A. General:

1. 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)

A. General:

1. 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 3.06. In case of conflict between the schedule and the COATSPECS, the requirements of the schedule shall prevail.
2. Coating Specification Sheets included in Table A are included this paragraph 3.05.

Table A Coating Specification Sheets

Coating System ID	Coating Material	Surface	Service Condition
E-1	Epoxy	Metal	Interior; exterior, covered, not exposed to direct sunlight, non-corrosive exposure.
E-1-G	Epoxy	Galvanized Steel	Interior; exterior, covered non-corrosive exposure. Do not use in immersion service.
E-2	Epoxy	Metal	Immersed, nonpotable; non-immersed, moderately corrosive environment, color required.
E-3	Epoxy	Concrete or Masonry	Immersed, nonpotable; non-immersed, corrosive environment, color required.
E-4	Epoxy	Concrete, masonry, plaster, gypsum board	Interior
E-9	Epoxy	Metal	Immersed, nonpotable; non-immersed, corrosive environment, color required. (Not for Biogenic Sulfide Corrosion areas.)
E-9-C	Epoxy	Concrete or masonry	Immersed, nonpotable; non-immersed, moderately corrosive environment, color required. (Not for Biogenic Sulfide Corrosion areas.)
E-10	Polyamidoamine epoxy	Metal or concrete	Below grade (buried).
EF-1	Amine Epoxy Broadcast Floor Coating	Concrete Floors	Light duty, wheeled traffic, frequent foot traffic, mildly corrosive.
EF-2	Amine Epoxy Troweled Floor Coating	Concrete Floors	Heavy-duty, wheeled traffic, frequent foot traffic, wet and moderately corrosive.

Table A Coating Specification Sheets

Coating System ID	Coating Material	Surface	Service Condition
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.
EA-2	Blended Amine Cured Epoxy	Concrete or masonry	Immersed, nonpotable; non-immersed, corrosive environment, color not required, new construction especially for headspace environments that are corrosive due to biogenic sulfide corrosion.
EA-3	Blended Amine Cured Epoxy	Concrete or Masonry	Immersed, nonpotable; non-immersed, corrosive environment, color not required, new or existing construction, especially for headspace environments that are corrosive due to biogenic sulfide corrosion.
EA-4	Blended Amine Cured Epoxy – For Very Corrosive Conditions	Concrete or Masonry Potable	Non-immersed or immersed, very corrosive environment. Very high H_2S conditions.
HH-1	Proprietary Primer Plus Silicone Topcoat	Metal	Temperature to 750 degrees F.
HH-2	Proprietary Primer Plus Silicone Topcoat (black or aluminum only)	Metal	Temperature to 1200 degrees F.
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.
EU-1	Zinc-epoxy-polyurethane system	Ferrous Metal	Exterior, exposed to direct sunlight, moderately corrosive non-immersed.
EU-1-FRP	Specialty Primer plus Polyurethane Finish Coat	Exterior of FRP pipe and tanks, etc.	Exterior, exposed to direct sunlight, non-immersed.
S-1	Penetrating acrylic stain, color required	Concrete	Non-immersed, exposure to moisture and sunlight.
S-2	Silane/Siloxane or Blended Sealer	Concrete Floors	Wet, non-immersed, non-corrosive. Interior or exterior for waterproofing.
S-3	RTV Silicone Rubber Based Sealer	Concrete or Masonry Walls	Exterior or Interior – Weathering Exposure, Non-Corrosive.
S-4	Acrylic Co-polymer Blend	Concrete Floors	Wet, non-immersed, non-corrosive, interior for oil and water repellent.

Coating System Specification Sheets (COATSPEC)

A.	Coating System Identification: E-1	
1.	Coating Material:	Epoxy
2.	Surface:	Metal
3.	Service Condition:	Interior; exterior, covered, not exposed to direct sunlight, non-corrosive exposure.
4.	Surface Preparation:	
a.	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-5 (White Metal Blast Cleaning) to achieve a uniform surface profile of 2.0 to 2.5 mils and spot primed with the primer specified. Shop epoxy primed surfaces shall require light abrasive and vacuum cleaning blasting prior to receiving finish coats.
b.	Ferrous Metal:	Bare ferrous metal surfaces shall be prepared in accordance with SSPC SP-6 (Commercial Blast Cleaning) to achieve a uniform, surface profile of 2.0 to 2.5 mils.
		Ferrous metal with rust bleeding shall be cleaned in accordance with SSPC SP-1 (Solvent Cleaning). Areas of rust penetration shall be spot blasted to SSPC SP-10 (Near White Blast) (to achieve the 2.0- to 2.5-mil surface profile) and spot primed with the specified primer. For ductile iron surfaces, refer to the requirements in paragraph 3.02 Metallic Surfaces.
c.	Nonferrous and Galvanized Metal:	Nonferrous and galvanized metal shall be prepared in accordance with SSPC SP-7 (Brush-off Blast Cleaning) to achieve uniform, minimum surface profile 1.0 to 1.5 mils.
5.	Application:	Field
a.	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.
b.	Ferrous Metal:	Prime coats shall be an epoxy primer compatible with the specified finish coats and applied in accordance with the written instructions of the CSM.
c.	Nonferrous and Galvanized Metal:	Nonferrous and galvanized metal shall be cleaned prior to the application of the prime coat in accordance with SSPC SP-1 (Solvent Cleaning).
6.	System Thickness:	10 mils dry film.
7.	Coatings:	
a.	Primer:	One coat at CSM's recommended dry film thickness.
b.	Finish:	One or more coats at CSM's recommended dry film thickness per coat to achieve the specified system thickness.
B.	Coating System Identification: E-1-G	
8.	Coating Material:	Epoxy
9.	Surface:	Galvanized Steel
10.	Service Condition:	Interior; exterior, covered, non-corrosive exposure. Do not use in immersion service.
11.	Surface Preparation:	
a.	General:	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-milprofile and spot primed with the primer specified.
b.	Galvanized Metal:	Nonferrous and galvanized metal shall be prepared in accordance with SSPC SP-7 (Brush-off Blast Cleaning) impart a 1- to 2-milprofile 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.
12.	Application:	Field
a.	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.

b. Galvanized Metal:	Nonferrous and galvanized metal shall be cleaned prior to the application of the prime coat in accordance with SSPC SP-1 (Solvent Cleaning).
13. System Thickness:	5 to 8 mils dry film.
14. Coatings:	
a. Primer:	One coat at CSM's recommended dry film thickness.
b. Finish:	One or more coats at CSM's recommended dry film thickness per coat to the specified system thickness.
	If the coated galvanized steel is to be exposed to ultraviolet light, apply one polyurethane top coat from coating system EU-1 over the second coat of the two epoxy coats specified.
C. Coating System Identification: E-2	
15. Coating Material:	Epoxy
16. Surface:	Metal
17. Service Condition:	Immersed, nonpotable; non-immersed, moderately corrosive environment, color required.
18. Surface Preparation:	
a. 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 3.02 Metallic Surfaces.
b. 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.
19. Application:	Field
a. 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.
b. Ferrous Metal:	Prime coat shall be an epoxy primer compatible with the specified finish coats.
c. 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.
20. System Thickness:	16 mils dry film.
21. Coatings:	
a. Primer:	One coat at CSM's recommended dry film thickness.
b. Finish:	Two or more coats at CSM's recommended dry film thickness per coat to the specified system thickness.
D. Coating System Identification: E-3	
22. Coating Material:	Epoxy
23. Surface:	Concrete or masonry
24. Service Condition:	Immersed, nonpotable; non-immersed, corrosive environment, color required.
25. Surface Preparation:	
a. Concrete:	Concrete surfaces shall be allowed to cure for at least 28 days and allowed to dry to the moisture content recommended by the CSM before coating work proceeds. Moisture content may be tested by the Construction Manager with a Delmhorst Instrument Company moisture detector, or equal. Except as otherwise specified, loose concrete, form oils, surface hardeners, curing compounds, and laitance shall

	be removed from surfaces by abrasive blasting and chipping, and voids and cracks shall be repaired as specified in Section 03 30 00. Surface preparation can be performed by abrasive blast cleaning or water blast cleaning and must achieve a uniform concrete surface profile of CSP3 in accordance with ICRI 03732. After cleaning, air voids or bugholes in the concrete shall be filled with a surfacer or block filler compatible with the specified primer and finish coats.
b. Masonry:	Masonry surfaces shall be allowed to cure for at least 28 days after being constructed and be allowed to dry to the moisture content recommended by the CSM. Holes or other joint defects shall be filled with a material compatible with the primers and finish coats or shall be filled with masonry mortar that shall cure for at least 28 days. 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, loose, and deleterious substances.
	Muriatic acid shall not be used. After cleaning, masonry surfaces shall be sealed or filled with a sealer or block filler compatible with the specified primer.
26. Application:	Field
a. General:	Apply filler/surfacer as recommended by CSM to fill bugholes and air voids or block texture, etc. leaving a uniformly filled surface that does not produce blowholes or outgassing causing pinholing of the coating system. Filler/surfacers shall dry a minimum of 48 hours prior to application of prime coat or as required by the CSM.
	Prime coat shall 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 recommended by CSM.
27. System Thickness:	15 mils dry film.
28. Coatings:	
a. Primer:	One coat at CSM's recommended dry film thickness.
b. Finish:	Two or more coats at CSM's recommended dry film thickness per coat to the specified system thickness.
E. Coating System Identification: E-4	
29. Coating Material:	Epoxy
30. Surfaces:	Concrete, masonry, plaster, gypsum board.
31. Service Condition:	Interior
32. Surface Preparation:	
a. 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, form oils, surface hardeners, curing compounds and laitance shall be removed from surfaces, and voids and cracks shall be repaired as specified in Section 03 30 00. Surface preparation shall produce a concrete surface profile of CSP-2 in accordance with ICRI 03732. After cleaning, air voids or bugholes in the concrete shall be filled with a surfacer or block filler compatible with the specified primer and finish coats.
b. 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 scrapping 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, exterior masonry surfaces shall be sealed or filled with a sealer or block filler compatible with the specified primer.
c. 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 clean water by washing and scrubbing to remove foreign and deleterious substances.

Coating System Specification Sheets (COATSPEC)

33. Application:	Field
a. General:	Block Filler shall be multiple component epoxy block filler or an acrylic based or waterborne epoxy based block filler and shall dry a minimum of 48 hours prior to primer application or as required by the CSM.
	Prime coat shall be thinned and applied as recommended by CSM, provided the coating as applied complies with prevailing air pollution control regulations.
	Drying time between coats shall be as recommended by CSM.
34. System Thickness:	10 mils dry film, excluding block filler and sealer.
35. Coatings:	
a. Primer:	One coat at CSM's recommended dry film thickness.
b. Finish:	One or more coats at CSM's recommended dry film thickness per coat to the specified system thickness.
F. Coating System Identification: E-9	
36. Coating Material:	Epoxy
37. Surface:	Metal
38. Service Condition:	Immersed, nonpotable; non-immersed, corrosive environment, color required. (Not for Biogenic Sulfide Corrosion areas.)
39. Surface Preparation:	
a. 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 2.5 to 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-2 (Hand Tool Cleaning) or SSPC-SP-3 (Power Tool Cleaning). Damaged shop coating shall be cleaned in accordance with SSPC SP-5 (White Metal Blast Cleaning) to achieve a uniform surface profile of 2.5 to 3.0 mils and spot primed with the primer specified. Shop epoxy primed surfaces shall require light abrasive blasting or abrading to achieve a uniform surface profile of 1.0 to 1.5 mils in the intact shop primer prior to receiving finish coats if the maximum recoat time for the primer has been exceeded. For ductile iron surfaces, refer to the requirements in paragraph 3.02 Metallic Surfaces.
b. Nonferrous and Galvanized Metal:	Nonferrous and galvanized metal shall be prepared in accordance with SSPC SP-7 (Brush-off Blast Cleaning) to achieve a 1.5- to 2.0-mil profile that is uniform. Galvanized steel with this E-2 coating system shall not be used in immersion service in wastewater.
40. Application:	Field
a. 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.
b. Ferrous Metal:	Prime coat shall be an epoxy primer compatible with the specified finish coats.
c. 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. Non-ferrous metal to be immersed shall not be painted. Galvanized metal shall not be immersed even if it is painted with this coating system.
41. System Thickness:	15 to 20 mils dry film.
42. Coatings:	
a. Primer:	One coat at CSM's recommended dry film thickness.
b. Finish:	Two or more coats at CSM's recommended dry film thickness per coat to the specified system thickness.
G. Coating System Identification: E-9-C	
43. Coating Material:	Epoxy
44. Surface:	Concrete or masonry
45. Service Condition:	Immersed, nonpotable; non-immersed, moderately corrosive environment, color required. (Not for Biogenic Sulfide Corrosion areas.)

Coating System Specification Sheets (COATSPEC)

46. Surface Preparation:	
a. Concrete:	Concrete surfaces shall be allowed to cure for at least 28 days following initial concrete placement and allowed to dry to the moisture content recommended by the CSM before coating work proceeds. Moisture content may be tested by the Construction Manager with a Delmhorst Instrument Company moisture detector, or equal. Except as otherwise specified, loose concrete, form oils, surface hardeners, curing compounds, and laitance shall be removed from surfaces by abrasive blasting and chipping, and voids and cracks shall be repaired as specified in Section 03 30 00. Cleaning can be performed using abrasive blast cleaning or water blast cleaning methods to produce a minimum concrete surface profile of CSP-3 in accordance with ICRI 03732. After cleaning, all air voids or bugholes in the concrete shall be filled with a surfacer or block filler compatible with the specified primer and finish coats.
b. Masonry:	Masonry surfaces shall be allowed to cure for at least 28 days after being constructed and be allowed to dry to the moisture content recommended by the CSM. Holes or other joint defects shall be filled with a material compatible with the primers and finish coats or shall be filled with masonry mortar that shall cure for at least 28 days. 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 sealed or filled with a sealer or block filler compatible with the specified primer.
47. Application:	Field
a. General:	Apply filler/surfacer as recommended by CSM to fill bugholes and air voids or block texture, etc. leaving a uniformly filled surface that does not produce blowholes or outgassing causing pinholing of the coating system.
	Filler/Surfacers shall dry a minimum of 48 hours prior to application of prime coat or as required by the CSM.
	Prime coat shall 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 recommended by CSM.
48. System Thickness:	16 to 20 mils dry film.
49. Coatings:	
a. Primer:	One coat at CSM's recommended dry film thickness.
b. Finish:	Two or more coats at CSM's recommended dry film thickness per coat to the specified system thickness.
H. Coating System Identification: E-10	
50. Coating Material:	Polyamidoamine epoxy
51. Surface:	Metal or concrete
52. Service Condition:	Below grade (buried, exterior) in contact with soil
53. Surface Preparation:	
a. Ferrous Metal:	Ferrous metal surfaces shall be prepared in accordance with SSPC SP-5 (White Metal Blast Cleaning).
b. Nonferrous 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.
c. 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. Except as otherwise specified, loose concrete and laitance shall be removed from surfaces by abrasive blasting and chipping, and voids and cracks shall be repaired as specified in Section 03 30 00. Concrete surface preparation can be performed using abrasive blast cleaning or water blast cleaning methods

	and must achieve a concrete surface profile of CSP-3 in accordance with ICRI 03732.
54. Application:	Field
55. System Thickness:	16 mils
56. Coating:	Two or more coats at CSM's recommended dry film thickness per coat to the specified system thickness.
I. Coating System Identification: EF-1	
57. Coating Material:	Epoxy Resin Based Floor Coating
58. Surface:	Concrete Floors
59. Service Condition:	For interior light duty applications light wheel traffic, mostly foot traffic, and mildly corrosive. Mainly for wear resistance, aesthetics, and cleanability. Non-slip texture can be varied depending on wetness of exposure. Test patches to be installed for deciding on level of non-slip texture required.
60. Surface Preparation:	Concrete floor slabs shall be allowed to age for at least 28 days and must meet a moisture vapor transmission rate of less than 3.0 lbs. of moisture per 24 hours per 1,000 SF in accordance with ASTM F1869. It is also essential that a well-sealed and intact vapor barrier has been installed beneath all slabs on grade to receive this floor coating system. Except as otherwise specified, loose concrete, curing compounds, and laitance shall be removed by abrasive blast cleaning or preferably by shotblasting. Surface preparation shall produce a clean sound concrete substrate with a concrete surface profile of CSP-6 minimum in accordance with ICRI 03732. Surface preparation shall be in accordance with SSPC-SP-13.
	Additionally, all coating termination and transition details shall be prepared in accordance with the CSM's standard detail drawings. This includes coating termination details, coating transitions at vertical and vertical to horizontal corners, coating terminations at joints, concrete crack treatment, pipe penetration treatment, coating terminations at metal embedments in the concrete substrate, and other details. The CSM's standard detail drawings shall be submitted for all such coating applications. If standard details are not available for a given detail treatment, the CSM shall be required to produce one at no additional cost to the owner, the engineer, or any other party.
	If wet abrasive or water blasting surface preparation methods were used, the concrete substrate shall be allowed to dry under warm conditions (minimum of 75 degrees F) for at least 5 days prior to coating application. Following surface preparation work and dry-out, all surfaces to be coated shall be vacuum cleaned to remove all loose dirt, dust, or other loose materials.
61. Application:	Carefully follow CSM's written instructions regarding mixing, thinning, application, recoat limitations (windows) and curing of coating materials.
62. System Thickness:	125 mils dry film.
63. Coatings:	
a. Primer:	Brush or roller apply at 6.0 – 10.0 mils DFT.
b. Broadcast Applied:	Brush or roller catalyzed resin and broadcast aggregate to rejection (should achieve 100 to 105 mils DFT).
c. Top:	Brush or roller apply at 8.0 – 10.0 mils.
	Install all termination and transition details in accordance with the CSM's detail drawings.
J. Coating System Identification: EF-2	
64. Coating Material:	Epoxy Resin Based Floor Coating
65. Surface:	Concrete Floors
66. Service Condition:	For interior – heavy-duty exposure applications. Frequent, heavy wheeled traffic and moderately corrosive exposure conditions. Mainly for wear resistance, impact resistance, protection of concrete, and aesthetics. Non-slip texture can be varied as needed. Test patches to be installed for deciding on level of non-slip texture required.

67. Surface Preparation:	Concrete floor slabs shall be allowed to age for at least 28 days and must meet a moisture vapor transmission rate of less than 3.0 lbs. of moisture per 24 hours per 1,000 SF in accordance with ASTM F1869. It is also essential that a well-sealed and intact vapor barrier has been installed beneath all slabs on grade to receive this floor coating system. Except as otherwise specified, loose concrete, curing compounds, and laitance shall be removed by abrasive blast cleaning or preferably by shotblasting. Surface preparation shall produce a clean sound concrete substrate with a concrete surface profile of CSP-7 minimum in accordance with ICRI 03732. Surface preparation shall be in accordance with SSPC-SP-13.
	Additionally, all coating termination and transition details shall be prepared in accordance with the CSM's standard detail drawings. This includes coating termination details, coating transitions at vertical and vertical to horizontal corners, coating terminations at joints, concrete crack treatment, pipe penetration treatment, coating terminations at metal embedments in the concrete substrate, and other details. The CSM's standard detail drawings shall be submitted for all such coating applications. If standard details are not available for a given detail treatment, the CSM shall be required to produce one at no additional cost to the owner, the engineer, or any other party.
	If wet abrasive or water blasting surface preparation methods were used, the concrete substrate shall be allowed to dry under warm conditions (minimum of 75 degrees F) for at least 5 days prior to coating application. Following surface preparation work and dry-out, all surfaces to be coated shall be vacuum cleaned to remove all loose dirt, dust, or other loose materials.
68. Application:	Carefully follow CSM's written instructions regarding mixing, thinning, application, recoat limitations (windows) and curing of coating materials.
69. System Thickness:	250 mils dry film.
70. Coatings:	
a. Primer:	Brush or roller apply at 6.0 – 10.0 mils DFT.
b. Trowel Applied:	Trowel apply to 230 – 236 mils.
c. Top:	Brush or roller apply at 8.0 – 10.0 mils. Cumulative dry film thickness.
	Install all termination and transition details in accordance with the CSM's detail drawings.
K. Coating System Identification: EA-1	
71. Coating Material:	Blended Amine Cured Epoxy
72. Surface:	Metal
73. Service Condition:	Immersed, nonpotable; non-immersed, corrosive environment, color not required especially for headspace environments that are corrosive due to biogenic sulfide corrosion.
74. Surface Preparation:	
a. 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 3.02 Metallic Surfaces.
b. 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.

75. Application:	Field
a. 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.
b. 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.
76. System Thickness:	30 to 40 mils dry film.
77. Coatings:	
a. Primer:	One coat at CSM's recommended dry film thickness only if required by special circumstances.
b. Finish:	One or more coats at CSM's recommended dry film thickness per coat to the specified system thickness.
c. Testing:	Holiday detection shall be performed over 100% of the coated surface area to identify any holidays or pinholes that must be repaired.
d. Pinhole and Holiday Repair Procedure:	Pinholes and holidays identified by Holiday Detection shall be repaired as follows:
	• Using a pencil grinder, remove a ½-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 ½-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
L. Coating System Identification: EA-2	
78. Coating Material:	Blended Amine Cured Epoxy
79. Surface:	Concrete or masonry
80. Service Condition:	Immersed, nonpotable; non-immersed, corrosive environment, color not required, new construction especially for headspace environments that are corrosive due to biogenic sulfide corrosion.
81. Surface Preparation:	All coating termination and transition details shall be prepared in accordance with the CSM's standard detail drawings. This includes coating termination details, coating transitions at vertical and vertical to horizontal corners, coating terminations at joints, concrete crack treatment, pipe penetration treatment, coating terminations at metal embedments in the concrete substrate, and other details. The CSM's standard detail drawings shall be submitted for all such coating applications. If standard details are not available for a given detail treatment, the CSM shall be required to produce one at no additional cost to the owner, the engineer, or any other party.
	If wet abrasive or water blasting surface preparation methods were used, the concrete substrate shall be allowed to dry under warm conditions (minimum of 75 degrees F) for at least 5 days prior to coating application. Following surface preparation work and dry-out, all surfaces to be coated shall be vacuum cleaned to remove all loose dirt, dust, or other loose materials.
a. Concrete:	Concrete surfaces shall be allowed to cure 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. Except as otherwise specified, loose concrete, form oils, surface hardeners, curing compounds, and laitance shall be removed from surfaces by abrasive blasting and chipping, and voids and cracks shall be repaired as specified in Section 03 30 00. Surface Preparation must open up all shelled over air voids or bugholes to expose fully the void's depth, width, and length. Concrete shall be abraded to achieve a uniform concrete surface profile of CSP-5 in accordance with ICRI 03732. After surface preparation has been accepted, a complete skim coat of the specified filler surfacer shall be applied over all concrete surfaces and all bugholes (air voids) shall be completely filled using this same material. The filler/surfacer material shall be applied as a complete parge coat of the substrate. If the parge coat (filler/surfacer material) is non-polymer modified, it must be brush blast cleaned following adequate cure per CSM's instructions to produce a uniform anchor pattern of CSP-4 in accordance with ICRI 03732 prior to coating application.
b. Masonry:	Masonry surfaces shall be allowed to cure for at least 28 days. Holes or other joint defects shall be filled with mortar and repointed and allowed to cure for 28 days or shall be filled with a repair material compatible with the coating system that does not require hydration cure time. Loose or splattered mortar shall be removed by scrapping 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 skim coated with a surfacer or block filler compatible with the specified coating system.
82. Application:	Field
a. General:	Surfacer or filler shall be applied per CSM's recommendations prior to application of coating to fill all bugholes and voids and create a complete parge coat of the prepared substrate. This parge coat shall completely fill all bugholes and voids in the substrate, and will also completely cover the substrate unless specified otherwise above such filled voids by 1/8 inch (125 mils) of thickness. 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.
83. System Thickness:	60 mils dry film in addition to the parge coat.
84. Coatings:	
a. Finish:	One or more coats at CSM's recommended dry film thickness per coat to the specified system thickness.
b. Testing:	Holiday detection shall be performed over 100% of the coated surface area to identify any holidays or pinholes, which could compromise coating system performance. Holiday testing to be performed after application and adequate cure of the spray applied epoxy coating material. Holiday detection shall be performed in accordance with NACE RP0188.
c. Pinhole and Holiday Repair Procedure:	Pinholes and holidays identified by Holiday Detection shall be repaired as follows:
	• Using a grinder or other suitable power tool, remove the coating system at all pinholes or holidays in an area at least 2 inches in diameter or in both dimensions around the defect back to the concrete substrate.
	• Chip out and remove the concrete to expose the full dimensions in all three directions of the air void responsible for the defect.
	• Aggressively abrade or sand the intact coating system surface at least 3 inches beyond the removal area in all directions to produce a uniform 6- to 8-mil profile in the intact coating system.
	• Vacuum clean the prepared area to remove all dust, dirt, etc. leaving clean sound surfaces.
	• Tape to mask the periphery of the prepared intact coating area to prevent coating repair application onto the prepared area.
	• Using a putty knife or other suitable tool, fill the opened void with the approved filler/surfacer material completely and strike-off. Allow to cure per CSM's

	recommendations.
	• Apply the coating system in the number of coats necessary to achieve the specified 60 mils DFT over the defect and coating removal area and feather the coating onto the abraded coated surfaces around the removal area to avoid a lip and to achieve a neat repair outline. Allow to cure properly.
M. Coating System Identification: EA-3	
85. Coating Material:	Blended Amine Cured Epoxy
86. Surface:	Concrete or masonry
87. Service Condition:	Immersed, nonpotable; non-immersed, corrosive environment, color not required, new or existing construction, especially for headspace environments that are corrosive due to biogenic sulfide corrosion.
88. Surface Preparation:	All coating termination and transition details shall be prepared in accordance with the CSM's standard detail drawings. This includes coating termination details, coating transitions at vertical and vertical to horizontal corners, coating terminations at joints, concrete crack treatment, pipe penetration treatment, coating terminations at metal embedments in the concrete substrate, and other details. The CSM's standard detail drawings shall be submitted for all such coating applications. If standard details are not available for a given detail treatment, the CSM shall be required to produce one at no additional cost to the owner, the engineer, or any other party.
	If wet abrasive or water blasting surface preparation methods were used, the concrete substrate shall be allowed to dry under warm conditions (minimum of 75 degrees F) for at least 5 days prior to coating application. Following surface preparation work and dry-out, all surfaces to be coated shall be vacuum cleaned to remove all loose dirt, dust, or other loose materials.
a. 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. Except as otherwise specified, loose concrete, form oils, surface hardeners, curing compounds, and laitance shall be removed from surfaces by abrasive blasting and chipping, and voids and cracks shall be repaired as specified in Section 03 30 00. Concrete shall be abraded also to achieve a uniform concrete surface profile of CSP 5 minimum. If the parge coat (filler/surfacer material) is non-polymer modified, it shall be brush blasted following adequate cure per the CSM's instructions to produce a uniform concrete surface profile of CSP-4 in accordance with ICRI 03732 prior to coating application. After cleaning, air voids or bugholes in the concrete shall be filled with a surfacer or block filler. The filler/surfacer material shall be applied as a complete parge coat of the substrate. For existing concrete that has been degraded, apply a skim coat of a surfacer or filler material to restore the substrate to a coatable condition. Be certain the filler surfacer material is compatible with the coating system.
b. 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 scrapping 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 sealed or filled with sealer or block filler compatible with the specified coating system.
89. Application:	Field
a. General:	Surfacer or filler shall be applied and dry per CSM's recommendations prior to application of coating.
	Drying time between filler/surfacer and coating system 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. The parge coat shall completely fill all bugholes and voids in the substrate and it will also completely cover the substrate unless

	specified otherwise above such filled voids by 1/8 inch of thickness.
90. System Thickness:	125 mils dry film (or 1/8 inch) in addition to the parge coat.
91. Coatings:	
a. Primer:	Self-priming.
b. Finish:	One coat at CSM's recommended dry film thickness – trowel applied.
c. Testing:	Holiday detection shall be performed over 100% of the coated surface area to identify any holidays or pinholes that could compromise coating system performance. Holiday detection shall be performed after adequate cure of the spray applied epoxy coating material. Holiday detection shall be performed in accordance with NACE RP0188.
d. Pinhole and Holiday Repair Procedure:	Pinholes and holidays identified by Holiday Detection shall be repaired as follows:
	• Using a grinder or other suitable power tool, remove the coating system at all pinholes or holidays in an area at least 2 inches in diameter or in both dimensions around the defect back to the concrete substrate.
	• Chip out and remove the concrete to expose the full dimensions in all three directions of the air void responsible for the defect.
	• Aggressively abrade or sand the intact coating system surface at least 3-inches beyond the removal area in all directions to produce a uniform 6- to 8-mil profile in the intact coating system.
	• Vacuum clean the prepared area to remove all dust, dirt, etc. leaving clean sound surfaces.
	• Tape to mask the periphery of the prepared intact coating area to prevent coating repair application onto the prepared area.
	• Using a putty knife or other suitable tool, fill the opened void with the approved filler/surfacer material completely and strike-off. Allow to cure per CSM's recommendations.
	• Apply the coating system in the number of coats necessary to achieve the specified 60 mils DFT over the defect and coating removal area and feather the coating onto the abraded coated surfaces around the removal area to avoid a lip and to achieve a neat repair outline. Allow to cure properly.
N. Coating System Identification: EA-4	
92. Coating Material:	Blended Amine Cured Epoxy
93. Surface:	Concrete or masonry
94. Service Condition:	Immersed, nonpotable; non-immersed, very corrosive environment, color not required, new or existing construction, especially for headspace environments that are very corrosive due to biogenic sulfide corrosion.
95. Surface Preparation:	All coating termination and transition details shall be prepared in accordance with the CSM's standard detail drawings. This includes coating termination details, coating transitions at vertical and vertical to horizontal corners, coating terminations at joints, concrete crack treatment, pipe penetration treatment, coating terminations at metal embedments in the concrete substrate, and other details. The CSM's standard detail drawings shall be submitted for all such coating applications. If standard details are not available for a given detail treatment, the CSM shall be required to produce one at no additional cost to the owner, the engineer, or any other party.
	If wet abrasive or water blasting surface preparation methods were used, the concrete substrate shall be allowed to dry under warm conditions (minimum of 75 degrees F) for at least 5 days prior to coating application. Following surface preparation work and dry-out, all surfaces to be coated shall be vacuum cleaned to remove all loose dirt, dust, or other loose materials.
a. 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. Except as otherwise specified, loose concrete, form oils, surface

	hardeners, curing compounds, and laitance shall be removed from surfaces by abrasive blasting and chipping, and voids and cracks shall be repaired as specified in Section 03 30 00. Concrete shall be abraded also to achieve a uniform concrete surface profile of CSP 5 minimum. If the parge coat (filler/surfacer material) is non-polymer modified, it shall be brush blasted following adequate cure per the CSM's instructions to produce a uniform concrete surface profile of CSP-4 in accordance with ICRI 03732 prior to coating application. After cleaning, air voids or bugholes in the concrete shall be filled with a surfacer or block filler. The filler/surfacer material shall be applied as a complete parge coat of the substrate.
	For existing concrete that has been degraded, apply a skim coat of a surfacer or filler material to restore the substrate to a coatable condition. Be certain the filler surfacer material is compatible with the coating system.
b. 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 scrapping 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 sealed or filled with sealer or block filler compatible with the specified coating system.
96. Application:	Field
a. General:	Surfacer or filler shall be applied and dry per CSM's recommendations prior to application of coating.
	Drying time between filler/surfacer and coating system 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. The parge coat shall completely fill all bugholes and voids in the substrate and it will also completely cover the substrate unless specified otherwise above such filled voids by 1/8 inch of thickness.
97. System Thickness:	140 to 145 mils dry film in addition to the parge coat.
98. Coatings:	
a. Primer:	Self-priming.
b. Troweled Coat:	One coat at CSM's recommended dry film thickness – trowel applied. (125 mils)
c. Finish (Glaze Coat):	15 to 20 mils dry.
d. Testing:	Holiday detection shall be performed over 100% of the coated surface area to identify any holidays or pinholes that could compromise coating system performance. Holiday detection shall be performed after application and adequate cure of the spray applied epoxy coating material. Holiday detection shall be performed in accordance with NACE RP0188.
e. Pinhole and Holiday Repair Procedure:	Pinholes and holidays identified by Holiday Detection shall be repaired as follows:
	• Using a grinder or other suitable power tool, remove the coating system at all pinholes or holidays in an area at least 2 inches in diameter or in both dimensions around the defect back to the concrete substrate
	• Chip out and remove the concrete to expose the full dimensions in all three directions of the air void responsible for the defect.
	• Aggressively abrade or sand the intact coating system surface at least 3-inches beyond the removal area in all directions to produce a uniform 6- to 8-mil profile in the intact coating system.
	• Vacuum clean the prepared area to remove all dust, dirt, etc. leaving clean sound surfaces.
	• Tape to mask the periphery of the prepared intact coating area to prevent coating repair application onto the prepared area.
	• Using a putty knife or other suitable tool, fill the opened void with the approved filler/surfacer material completely and strike-off. Allow to cure per CSM's recommendations

	• Apply the coating system in the number of coats necessary to achieve the specified 60 mils DFT over the defect and coating removal area and feather the coating onto the abraded coated surfaces around the removal area to avoid a lip and to achieve a neat repair outline. Allow to cure properly.
O. Coating System Identification: HH-1	
99. Coating Material:	Proprietary Primer plus Silicone Topcoat
100. Surface:	Metal
101. Service Condition:	Temperature to 750 degrees F.
102. Surface Preparation:	Metal surfaces shall be prepared in accordance with SSPC SP-10 (Near White Metal Blast Cleaning) to achieve a uniform surface profile of 2.0 to 2.5 mils.
103. Application:	Field
	Curing as required by CSM.
104. System Thickness:	6.5 to 8.0 mils dry film
105. Coating:	Primer at 5 to 6 mils DFT plus one topcoat at 1.5 to 2.0 mils DFT.
P. Coating System Identification: HH-2	
106. Coating Material:	Proprietary Primer plus Silicone Topcoat (available in black or aluminum only)
107. Surface:	Metal
108. Service Condition:	Temperature to 1200 degrees F.
109. Surface Preparation:	Metal surfaces shall be prepared in accordance with SSPC SP-10 (Near White Metal Blast Cleaning) to achieve a uniform surface profile of 2.0 to 2.5 mils.
110. Application:	Field
	Curing as required by CSM.
111. System Thickness:	6.5 to 8.0 mils dry film
112. Coating:	Primer at 5 to 6 mils DFT plus one topcoat at 1.5 to 2.0 mils DFT.
Q. Coating System Identification: L-1	
113. Coating Material:	Latex
114. Surfaces:	Concrete, masonry, plaster, gypsum board.
115. Service Condition:	Interior and exterior including existing exterior coated concrete.
116. Surface Preparation:	
a. 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 03 30 00.
b. 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.
c. 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.
d. 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.

e. Gypsum Wallboard:	Tape joints and spackled nail heads shall be sanded smooth and dusted. Seal with PVA sealer for interior uses only.
117. Application:	Field
a. General:	Sealer or filler shall dry a minimum of 48 hours prior to primer application.
	Drying time between coats shall be as recommended by CSM.
118. System Thickness:	4 mils dry film.
119. Coatings:	
a. Primer:	One coat at CSM's recommended dry film thickness.
b. Finish:	Two or more coats at CSM's recommended dry film thickness per coat to the specified system thickness.
R. Coating System Identification: M-1	
120. Coating Material:	Petrolatum based mastic or wax based wrapping tapes.
121. Surfaces:	Metal
122. Service Condition:	Below grade (buried) or where little to no surface preparation can be performed on piping or structural steel.
123. Surface Preparation:	Remove loose scale, rust, dirt, excessive moisture, or frost from the surface in accordance with SSPC SP-2 (Hand Tool Cleaning).
124. 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.
	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.
125. System Thickness:	Smooth contours shall have a minimum thickness of 50 mils while nuts, bolts, and sharp projections shall be 100 mils.
126. Tape:	Number and types of tape wraps shall be in accordance with the CSM's written instructions.
S. Coating System Identification: S-1	
127. Coating Material:	Penetrating acrylic stain, color required.
128. Surface:	Concrete
129. Service Condition:	Non-immersed, exposure to moisture and sunlight.
130. Surface Preparation:	Brush-off blast or industry standard acid etch or other preparation as approved by the CSM.
131. Application:	
a. General:	Drying time between coats shall be as specified by the CSM for the site conditions.
b. Coatings:	Minimum of two coats overall (coat as many times as required to achieve desired color).
132. System Thickness:	200 square feet per gallon maximum or as recommended by the CSM.

133. Color Selection:	As approved by the Construction Manager consistent with neighborhood selection. The Contractor to price materials based on custom color.
T. Coating System Identification: S-2	
134. Coating Material:	Penetrating Water Repellent (Clear and Non-Film Building)
135. Surface:	Concrete Floors
136. Service Condition:	Exterior and Interior.
137. Surface Preparation:	Clean surfaces of all traces of dirt, dust, efflorescence, mold, salt, grease, oil, asphalt, laitance, curing compounds, paint, coatings, and other foreign materials by brush-off blast, water blasting, and/or chemical cleaners or other preparation as approved by the CSM.
a. 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 03 30 00.
138. Application:	
a. General:	Drying time before placing into service shall be as recommended by the CSM for site conditions.
139. System Coverage:	Follow CSM's recommendations.
140. Color Selection:	Clear.
U. Coating System Identification: S-3	
141. Coating Material:	Penetrating Water Repellent (Clear & Non-Film Building)
142. Surface:	Concrete and Masonry Walls
143. Service Condition:	Exterior and Interior – For Anti-Graffiti Applications
144. Surface Preparation:	Clean surfaces of all traces of dirt, dust, efflorescence, mold, salt, grease, oil, asphalt, laitance, curing compounds, paint, coatings, and other foreign materials by brush-off blast, water blasting, and/or chemical cleaners or other preparation as approved by the CSM.
a. 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 03 30 00.
b. 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.
145. Application:	
a. General:	Drying time before placing into service shall be as recommended by the CSM for site conditions.
146. System Coverage:	Follow CSM's recommendations.
147. Color Selection:	Clear.
V. Coating System Identification: S-4	
148. Coating Material:	Penetrating Oil and Water Repellent (Non-Film Forming)
149. Surface:	Concrete Floors
150. Service Condition:	Exterior and Interior
151. Surface Preparation:	Clean surfaces of all traces of dirt, dust, efflorescence, mold, salt, grease, oil, asphalt, laitance, curing compounds, paint, coatings, and other foreign materials by brush-off blast, water blasting, and/or chemical cleaners or other preparation as approved by the CSM.
a. 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 03 30 00.
152.	Application:	
a.	General:	Drying time before placing into service shall be as recommended by the CSM for site conditions.
b.	Coatings:	One coat, flood horizontal surface so coating ponds for at least 60 seconds. Broom over all puddles thoroughly until complete penetration is achieved
153.	System Thickness:	Follow CSM's recommendations.
154.	Color Selection:	Clear.

3.06 COATING SYSTEMS SCHEDULE (FINISH SCHEDULE)

A. General:

1. 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.

Coating Systems Schedule (Finish Schedule)

Location/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) Indoors	E-1	FS 25051 Blue
2) Outdoors	EU-1	FS 20040 Brown
b. Equipment, immersed, unless otherwise specified	E-2	Beige
c. High temperature equipment operable at		
1) 200 to 750 degrees F	HH-1	FS 26306 Grey
2) above 750 degrees F to 1200 degrees F	HH-2	Aluminum or Black
d. Existing equipment		
1) Not damaged nor modified by work in this contract	Uncoated	--
2) Damaged, exposed, or modified by work in this contract		
a) Indoors	E-1 (see paragraph 3.02)	Match existing color
b) Outdoors	EU-1 without primer (see paragraph 3.02)	Match existing color
e. Diffusers and grilles on coated surfaces, unless otherwise specified		
1) Indoors	E-1	Match background color
2) Outdoors	EU-1	Match background color
f. Diffusers and grilles on uncoated surfaces, unless otherwise specified		
1) Indoors	E-1	FS 25051 Blue
2) Outdoors	EU-1	FS 20040 Brown
g. Existing diffusers and grilles		
1) Not damaged not modified by work in this contract	Uncoated	--
2) Damaged, exposed, or modified by work in this contract		
a) Indoors	E-1 (see paragraph 3.02 Masonry Surfaces)	Match existing color
b) Outdoors	EU-1 without primer (see paragraph 3.02 Masonry Surfaces)	Match existing color

Coating Systems Schedule (Finish Schedule)

Location/Surface	Coating System Identification	Standard Color
h. Electrical switchgear panels, unit substations, motor control centers, power transformers, distribution centers, and relay panels; indoors and outdoors	See paragraph 3.03 Electrical and Instrumentation Equipment and Materials	ANSI 61 Grey (outside) FS 27880 White (inside)
i. Instrumentation panels, graphic indicating panels, indicating and transmitting field panels, unless otherwise specified		
1) Indoors	See paragraph 3.03 Electrical and Instrumentation Equipment and Materials	FS 26306 Grey (outside) FS 27880 White (inside)
2) Outdoors	See paragraph 3.03 Electrical and Instrumentation Equipment and Materials	FS 27722 White (outside) FS 27880 White (inside)
j. 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		
a) Indoors	E-1 (see paragraph 3.02 Masonry Surfaces)	FS 26306 Grey
b) Outdoors	EU-1 without primer (see paragraph 3.02 Masonry Surfaces)	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) Indoors – noncorrosive	E-1	FS 25051 Blue
2) Outdoors – noncorrosive	EU-1	FS 20040 Brown
3) Indoors – in corrosive environment	EA-1	To be determined
4) Buried piping	M-1 or M-2	Not required
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) Indoors	E-1	Match background color
2) 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) Indoors	E-1	FS 25051 Blue
2) Outdoors	EU-1	FS 20040 Brown

Coating Systems Schedule (Finish Schedule)

Location/Surface	Coating System Identification	Standard Color
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) Indoors	E-1 (see paragraph 3.02 Masonry Surfaces)	Match existing color
b) Outdoors	EU-1 without primer (see paragraph 3.02 Masonry Surfaces)	Match existing color
f. Racked conduits and cable trays	Uncoated	--
g. Insulated pipe jacketing	Uncoated	--
h. Plastic, fiberglass and flexible conduit and piping		
1) Unless otherwise specified	Uncoated	--
2) PVC and CPVC Piping	L-2	FS 25051 Blue
a) Exposed to direct sunlight	L-2	FS 25051 Blue
b) Not exposed to direct sunlight	E-7	FS 25051 Blue
i. High temperature piping operable at		
1) 200 to 750 degrees F	HH-1	FS 26306 Grey
2) Above 750 degrees F to 1,200 degrees F	HH-2	Aluminum or Black
j. Exposed ductwork, unless otherwise specified	Uncoated	--
4. Concrete, Grout, Masonry and Plaster		
a. Immersed tank and channel walls and bottoms unless otherwise specified	Uncoated	--
b. Outside concrete walls below grade common with dry area or room	In accordance with Section 07 10 00	--
c. Walls and ceilings		
1) Precast concrete or colored masonry	Uncoated	--
2) Outdoors, unless otherwise specified	Uncoated	--
3) Indoors, unless otherwise specified	E-4	FS 23617 Beige
d. Concrete equipment bases unless otherwise specified	E-4	Match equipment color
e. Floors unless otherwise specified	S-2	
f. Existing coated surfaces.	L-1	Match existing color
5. Door and Door Frames		
a. Doors unless otherwise specified		
1) Ferrous metal		
a) Indoors	E-1	FS 20040 Brown
b) Outdoors	EU-1	FS 25051 Blue
2) Aluminum	Uncoated	--
3) Other	Plastic laminate	Formica 947 Brown
4) Existing		

Coating Systems Schedule (Finish Schedule)

Location/Surface	Coating System Identification	Standard Color
a) Not damaged by work in this contract	Uncoated	--
b) Damaged, exposed, or modified by work in this contract		
(1) Indoors	E-1 (see paragraph 3.02 Masonry Surfaces)	Match existing color
(2) Outdoors	EU-1 (see paragraph 3.02 Masonry Surfaces)	Match existing color
b. Door frames unless otherwise specified		
1) Adjacent wall coated		
a) Indoors	E-1	Match wall color
b) Outdoors	EU-1	Match wall color
2) Adjacent wall uncoated		
a) Indoors	E-1	FS 20040 Brown
b) Outdoors	EU-1	FS 25051 Blue
3) Aluminum	Uncoated	--
4) Existing		
a) Not damaged by work in this contract	Uncoated	--
b) Damaged, exposed, or modified by work in this contract		
(1) Indoors	E-1 (see paragraph 3.02 Masonry Surfaces)	Match existing color
(2) Outdoors	EU-1 without primer (see paragraph 3.02 Masonry Surfaces)	Match existing color
6. Handrails, Gratings, Floor Plates, Manhole Covers, and Hatches		
a. Unless otherwise specified	Uncoated	
b. Existing		
1) Not damaged by work in this contract	Uncoated	--
2) Damaged, exposed, or modified by work in this contract		
a) Indoors	E-1 (see paragraph 3.02 Masonry Surfaces)	Match existing color
b) Outdoors	EU-1 without primer (see paragraph 3.02 Masonry Surfaces)	Match existing color
7. Metal Stairs, Ladders, Platforms, and Supports Except Tread and Grating		
a. Indoors	E-1	FS 25051 Blue
b. Outdoors	EU-1	FS 20040 Brown
c. Existing		
1) Not damaged nor modified by work in this contract	Uncoated	--
2) Damaged, exposed, or modified by work in this contract		

Coating Systems Schedule (Finish Schedule)

Location/Surface	Coating System Identification	Standard Color
a) Indoors	E-1 (see paragraph 3.02 Masonry Surfaces)	Match existing color
b) Outdoors	EU-1 without primer (see paragraph 3.02 Masonry Surfaces)	Match existing color
8. Aluminum Flashing, Light Standards, Supports, and Louvers		
a. Indoors and outdoors, unless otherwise specified	Uncoated	--
9. Precast Concrete Metalwork		
a. Fasteners, anchors, supports, etc.	EU-1	Match wall
10. Other		
a. Fire hydrants	EU-1	FS 21302 Red
b. Flap gates	EA-1	Beige
c. Aluminum slide gates	Uncoated	--
d. Sluice gates		
1) Gate	--	--
2) Stem, except potable	G	--
3) Operator		
a) Indoors	E-2	FS 25051 Blue
b) Outdoors	EU-1	FS 20040 Brown
e. Tanks		
1) Steel tanks unless otherwise specified		
a) Inside of wash water or similar tanks	E-2	--
b) Inside of sludge (open top) tanks	E-9	--
c) Outside of tank		
(1) Indoors	E-1	FS 25051 Blue
(2) Outdoors	EU-1	FS 25051 Blue
2) Potable steel water storage tanks		
a) Inside of tank	E-5	See Note 1
b) Outside of tank	EU-1	FS 25051 Blue
3) Fiberglass tank	Uncoated	--
f. Pipe, ductwork, equipment and appurtenances made from fiberglass, plastic, rubber, including flexible hose, conduit, and plastic coated tubing, in areas not exposed to view (indoors) (metal hangers and supports are coated with E-1)	Uncoated	--
g. Buried, sleeve-type and flanged pipe, couplings, valves, mechanical and electrical penetrations	M-1 or M-2	Manufacturer's color

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

3.07 INSPECTION AND TESTING BY OWNER

A. General:

1. 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.

2. 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 09 90 00. These inspections may include the following:
    a. Inspect materials upon receipt to ensure that are supplied by the CSM.
    b. Inspect to verify that specified storage conditions for the coating system materials, solvents and abrasives are provided.
    c. Inspect and record findings for the degree of cleanliness of substrates.
    d. Inspect and record the pH of concrete and metal substrates.
    e. Inspect and record substrate profile (anchor pattern)
    f. Measure and record ambient air and substrate temperature.
    g. Measure and record relative humidity.
    h. Check for the presence of substrate moisture in the concrete.
    i. Inspect to verify that correct mixing of coating system materials is performed in accordance with CSM's instructions.
    j. 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.
    k. Perform adhesion testing.
    l. Measure and record the thickness of the coating system.
    m. Inspect to verify proper curing of the coating system in accordance with the CSM's instructions.
    n. 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. General
1. Contractor shall conduct a final inspection to determine whether coating system work meets the requirements of the specifications.
2. 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.
3. Any rework required shall be marked. Such areas shall be recleaned and repaired as specified at no additional cost to the Owner.

END OF SECTION

SECTION 31 10 00

SITE CLEARING

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

NOT USED

PART 3 EXECUTION

3.01 CLEARING AND GRUBBING

A. 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.

B. 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 City 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 plant site as specified.

3.03 UTILITY INTERFERENCE

A. Where existing utilities interfere with the prosecution of the work, the Contractor shall relocate them in accordance with the General Conditions of the Contract Documents.

END OF SECTION

SECTION 31 23 00

EXCAVATION AND FILL

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. 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.
   4. Pipe Zone: The Pipe zone is defined as the area of pipe trench backfill from the top of the bedding material to one foot above the top of pipe. The pipe zone includes the Initial Backfill, which is the area from the bedding to the spring line of the pipe.

1.02 QUALITY ASSURANCE

A. References:
   1. 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.
   2. 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 Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D1556	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	Test Method for Moisture Content of Soil and Soil- Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

B. Tests:

1. The Construction Manager will take samples and perform moisture content, gradation, Atterberg Limits, compaction, and density tests during placement of backfill materials to check compliance with these specifications. 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. Payment for inspection trenches shall be as specified in the General Conditions of the Contract Documents.
2. Tests will be made by the Construction Manager in accordance with the following:

Test	Standard Procedure
Moisture content	ASTM D3017
Gradation	ASTM C136
Atterberg Limits	ASTM D4318
Density in-place	ASTM D1556
Moisture-density relationships	ASTM D1557

1.03 SUBMITTALS

A. Samples of fill 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 PRODUCTS

2.01 FILL MATERIALS

A. Type A:

1. Type A material shall be a clean, fine aggregate mixture, free from organic matter, and having a sand equivalent value determined in accordance with ASTM D2419 of not less than 30, a durability index of not less than 25, and conforming to the following gradation:

U.S. standard sieve size	Percent by weight passing
3/4 inch	100
No. 4	90-100
No. 10	35-95
No. 20	20-80
No. 40	0-55
No. 100	0-2

B. Type B:

1. Type B material shall be a select fill material with low expansion potential, free from organic matter and of such size and gradation that the specified compaction can be readily attained. Material shall have a Liquid Limit of less than 35 and a Plasticity Index of less than 15, and shall conform to the following gradation:

U.S. standard sieve size	Percent by weight passing
3 inch	100
No. 4	35-100
No. 30	20-100
No. 200	10-40

2. The coefficient of uniformity of the sand fraction shall be 3 or greater.
3. The material may be an imported quarry waste, clean natural sand or gravel, select trench excavation or a mixture thereof.

C. Type C:

1. Type C material 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 Type C.

D. Type D:

1. 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

E. Type E:

1. Type E material shall be crushed rock commonly known as drain rock and shall conform to the following gradation:

U.S. standard sieve size	Percent by weight passing
1-1/2 inch	100
3/4 inch	30-75
1/2 inch	15-55
1/4 inch	0-5

2. Type E material shall be composed of hard, durable, sound pieces having a specific gravity of not less than 2.65

PART 3 EXECUTION

3.01 GENERAL

A. Control of Water:

1. The Contractor shall keep excavations reasonably free from water during construction. The static water level shall be drawn down a minimum of 1 foot below

the bottom of excavations to maintain the undisturbed state of natural soils and allow the placement of any fill to the specified density. Disposal of water shall not damage property or create a public nuisance. The Contractor shall have on hand pumping equipment and machinery in good working condition for emergencies and shall have workmen available for its operation. Dewatering systems shall operate continuously until backfill has been completed to 1 foot above the normal static groundwater level.

2. Groundwater shall be controlled to prevent softening of the bottom of excavations, or formation of "quick" conditions. Dewatering systems shall not remove natural soils. The Contractor shall control surface runoff to prevent entry or collection of water in excavations.
3. Release of groundwater to its static level shall be controlled to prevent disturbance of the natural foundation soils or compacted fill and to prevent flotation or movement of structures or pipelines.

B. Fill Moisture Conditioning
   1. The moisture content for imported and low expansion potential on-site soils shall be within plus or minus two percent of optimum moisture when the soil is placed.
   2. Where on-site expansive soils are used as fill in any areas except those that are to be landscaped, the moisture content of the placed material shall be at least four percent above minimum. In landscaped areas, the moisture content shall be at optimum moisture, plus or minus two percent. Existing on-site soils with a plasticity index of 15 or greater are considered to be expansive at this site.

C. Overexcavation:
   1. The existing clay surface soils shall be removed to a depth of at least four feet below the finished grade to remove all existing fill beneath all structures, and exterior slabs, not including sidewalks or pavement. Any structures, foundations and existing piping that can be removed from beneath new buildings shall also be removed.
   2. 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. Soil backfill to replace the removed inadequate backfill soils shall be wrapped in a geotextile filter fabric. The overexcavated space under footings may be filled with concrete. The quantity and placement of such material will be paid for as extra work.

D. Surplus Material:
   1. Unless otherwise specified, surplus excavated material shall be disposed of off-site in accordance with applicable ordinances and environmental requirements.
   2. The Contractor shall satisfy himself that there is sufficient material available for the completion of the on-site earthwork before disposing of any material inside or outside the site. Shortage of material, caused by premature disposal of any material by the Contractor, shall be replaced by the Contractor.
   3. Material shall not be stockpiled to a depth greater than 5 feet above finished grade within 25 feet of any excavation or structure. For these areas, the depth of stockpiled material shall be as specified. The Contractor shall maintain stability of the soil adjacent to any excavation.

E. Borrow Material:
   1. If the quantity of acceptable material from excavation is not sufficient to backfill the structures and construct the embankments required by the work, the quantity of material needed to complete the embankments shall consist of imported borrow conforming to specified requirements.

F. Hauling:
   1. 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.
   2. The Contractor shall construct haul roads required to transport materials on site. Alignment of haul roads shall be selected to avoid interference with plant operations. Haul roads shall be removed after completion of embankment construction.

G. Fill Placement
   1. Select and other imported fill materials shall be placed in 8-inch maximum depth loose lifts. Except in pipe trenches, all areas to receive fill shall be scarified to a depth of 8 inches, moisture conditioned in accordance with paragraph 3.01B, and compacted in accordance with Table A

H. Finish Grading:
   1. Finished surfaces shall be smooth, compacted and free from irregularities. The degree of finish shall be that normally obtainable with a blade-grader.
   2. 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.
   3. 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.
   4. 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.

I. Control Of Erosion:
   1. 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 CLASSIFICATION OF FILL

A. Fill material shall be placed in horizontal layers and compacted with power-operated tampers, rollers, idlers, or vibratory equipment. Material type, maximum layer depth, relative compaction, and general application are specified in Table A. Unless otherwise specified, fill classes shall be used where specified in Table A under general application.

Table A, Fill Classifications

Fill class	Material type	Maximum uncompressed layer depth, inches	Minimum relative compaction, percent	General application
A1	A	8	95	Bedding for pipe, initial pipeline backfill; slabs on grade (other than specified for Class E1)
B1	B	8	95	Structure and subsequent pipeline backfill
B2	B	8	90	Site fill
C1	C	8	95	Subsequent pipeline backfill
D1	D	-	95	Bedding for tanks, initial and subsequent tank and pipeline backfill
E1[a]	E	8	-	Fill under slabs for structures and tank slabs

a. Compaction of layers shall be accomplished in two passes of equipment with complete coverage across the width of the field.

b. Material shall not be used for bedding or initial backfill for plastic pipe.

3.03 EARTHWORK FOR STRUCTURES

A. Structure Excavation:

1. 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.
2. 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.
3. 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. Foundation Treatment:

1. Whenever any structure excavation is substantially completed to grade, the Contractor shall notify the Construction Manager who will make an inspection of the foundation. No concrete or masonry shall be placed until the foundation has been inspected by the Construction Manager. The Contractor shall, if directed by the Construction Manager, dig test pits and make test borings and foundation bearing tests. If the material tested is undisturbed soil, the cost thereof will be paid for as extra work. If the material tested is backfill material, the cost thereof will be paid as specified in the General Conditions of the Contract Documents.

C. Structure Backfill:

1. Unless otherwise specified, structure backfill shall be Class B1.
2. 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.

3. 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.
4. Backfill material shall be placed in uniform layers and shall be brought up uniformly on all sides of the structure.
5. Unless otherwise specified, backfill around and above pipelines within the excavation line of any structure shall be the same as that specified for structures.

3.04 EARTHWORK FOR PIPELINES AND CONDUITS

A. General:
   1. Earthwork for pipelines and conduits is specified in Table A; in the standard details; and in the following paragraphs.

B. Pipeline Excavation:
   1. 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.

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. 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.
   2. Initial Backfill: After the pipe has been laid to alignment and grade, unless otherwise specified, additional material shall be placed in layers the full width of the trench and compacted to the spring line of the pipe. Material 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, compacted and rodded 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.
   3. Pipe Zone Backfill: The remainder of the pipe zone backfill shall be placed after the Initial Backfill has been placed and properly compacted. Fill in the Pipe Zone shall be placed in 8 inch maximum loose lifts and compacted carefully by hand methods to avoid disturbing the pipe and haunch soil support.
   4. Subsequent Backfill:
      a. General: Backfill material, placement and compaction above the pipe zone shall be as specified. Maximum loose lifts of solid for the trench backfill shall be 8 inches. 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 (Class B1 or D1) shall be used under all paved and unpaved roadways and paved and unpaved roadway shoulders 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.. Other surfaces shall be restored, including

compaction, to the condition existing prior to construction including restoration of yard areas.

c. Unimproved Areas: Class C1 backfill shall be used for all trenches in pastureland, cultivated land, undeveloped land, and for other unimproved areas where specified. Trench excavation which meets the requirements of Type C material may be used. The Contractor shall maximize the use of fine-grained materials (e.g., sand, silty sand, sandy silt) as Class C1 backfill.

   1) For Class C1 backfill, the trench above the pipe zone shall be backfilled to within 12 inches of original ground surface. The top 12 inches of soil shall be removed and stored in such a manner that it will not become mixed with unsatisfactory soils. After the trench has been backfilled, the stored topsoil shall be replaced at a uniform depth in its original area compacted to its original condition. The Contractor shall leave the backfilled trench neatly mounded not more than 6 inches above existing grade for the full width of the Class C1 backfill area.

3.05 SUBGRADE FOR SIDEWALKS AND PAVEMENT

A. The prepared subgrade shall be scarified to a depth of at least 12 inches, moisture conditioned, and recompacted to at least 95 percent of the maximum density.

3.06 SITE FILL

A. Unless otherwise specified, site fill shall be Class C1 fill. In landscaped areas the compaction for site fill may be reduced to 85%. 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 40 05 01

PIPING SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies the general requirements for design, selection, and supply of pipe materials, fittings, appurtenances, expansion control, supports, and seismic restraints for process, mechanical, plumbing, utility, odor control ducts, and HVAC piping systems. Installation, inspection, and testing are also specified in this Section.

B. Use the general requirements specified in this section with the more specific requirements listed in the Piping System Schedules (Section 40 05 02.00 through 40 05 02.99) and other referenced sections. Except where referenced specification sections specify alternate provisions, the requirements of this Section apply to all piping systems listed in Section 40 05 02.

C. Provide professional engineering services for a piping system design engineer (hereinafter and in all related and referenced sections the "Design Professional") for the design and inspection of piping systems work. For the scope of the work, defined herein as the “Design Professional’s Scope of Responsibility,” the Design Professional provides the design, final inspection, and certification for the piping supports, seismic restraints, and expansion control as specified in this Section and referenced sections.

1.02 RELATED SECTIONS

A. Section 01 33 00 – Submittal Procedures

B. Section 01 61 45 – Area Exposure Designations

C. Section 01 66 00 – Product Storage and Handling Requirements

D. Section 03 30 00 – Cast-in-Place Concrete

E. Section 31 23 00 – Excavation and Fill

F. Section 40 05 02 – Piping System Schedules

G. Section 40 05 06 – Specialty Couplings and Adapters for Process Piping

H. Section 40 05 07 – Hangers and Supports for Process Piping

I. Section 40 05 07.13 – Seismic Restraints for Piping

J. Section 40 05 07.16 – Expansion Control for Piping

K. Section 40 05 45 – Piping System Identification

L. Section 40 42 00 – Insulation for Exposed Piping and Equipment

1.03 REFERENCES

A. 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 prevail.

Reference	Title
ANSI B16.21	Nonmetallic Flat Gaskets for Pipe Flanges
ANSI B31.1	Power Piping
ANSI B31.3	Process Piping
ANSI B31.9	Building Services Piping
ANSI Z223.1	National Fuel Gas Code
ANSI/ISA-S70.01	Quality Standard for Instrument Air
ASME B1.1	Unified Inch Screw Threads
ASME Section IX	Boiler and Pressure Vessel Code; Welding and Brazing Requirements
ASTM F37	Sealability of Gasket Materials
ASTM F104	Nonmetallic Gasket Materials
ASTM F152	Tension Testing of Nonmetallic Gasket Materials
AWWA C651	Disinfecting Water Mains
CAN/CGA B149.6	Code for Digester Gas and Landfill Gas Installations
EJMA	Expansion Joint Manufacturer's Association
UPC	Uniform Plumbing Code

1.04 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:
   1. Maximum pressure: The greatest continual pressure at which the piping system is designed to operate.
   2. Test pressure: The hydrostatic, air, or gas pressure used to determine system compliance.
   3. Take down coupling: Pipe couplings that facilitate disassembly of piping systems without damage or demolition of piping system components.
   4. Embedded/Encased piping: Piping enveloped in reinforced concrete, typically under structures and under roadways, where specified on the drawings.
   5. Exposed: All area exposures specified in Section 01 61 45 other than buried, submerged, or encased/embedded.

B. Piping System Identification
   1. Process, mechanical, plumbing, utility, odor control, and HVAC piping system piping is identified by a two component alpha-numeric code, (Line Label) as follows:
      a. The first component of the code indicates the nominal line size.
      b. The second component of the code identifies the process Service or fluid being conveyed in the Piping System.
   2. Process Service identifiers for pipelines are specified on the drawings. The Process Service is defined for each Process Service Identifier in Section 40 05 02.

3. Detailed specifications for each Process Service are scheduled in Section 40 05 02.00 through 40 05 02.99.
4. Mark and label Piping Systems as specified in Section 40 05 45.

1.05 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. Qualifications of the Design Professional charged with inspection and certification of pipe hangers and supports and related scope of work; provide educational background, proof of registration, and proof of insurance and previous experience in performing this type of work. No further submittals under this or any related section will be considered until the Design Professional's qualifications have been reviewed and accepted by the Construction Manager.
   3. A copy of this specification section, along with Sections 01 73 24, 40 05 07, 40 05 07.13 and 40 05 07.16, 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.
   4. For each piping system (refer to Piping System Schedules in Section 40 05 02.00 through 40 05 02.99), submit document listing pipe, fittings, linings, coatings, valves, flexible connectors, expansion joints, couplings, bolts, gaskets, restraints, and other items provided for each applicable pipe size and category.
   5. Welding: Prior to commencing any welding of steel or stainless steel pipe, supports, and/or structural attachments, provide a written description of welding techniques, including, but not limited to, materials, methods, and quality control. Identify differences in shop and field techniques. Indicate in the submittal that the welding technique has been reviewed for each piping service and certify that the technique is acceptable for the intended service condition (piping service defined in Section 40 05 02 and area exposure designation specified in Section 01 61 45). Written procedures to be stamped and sealed by a Professional Engineer registered in the State of [Enter State that project is located in] and qualified for welding design.

B. Informational Submittals:
   1. Procedures: Section 01 33 00

2. Pre-Construction Data:
    a. Design drawings and calculations for pipe supports, anchorage, seismic restraints, and expansion control systems as specified in Sections 40 05 07, 40 05 07.13, and 40 05 07.16. Drawings and calculations sealed and submitted by the Design Professional specified in this Section. The Design Professional shall affirm that loads on structures are within any stipulated load limits that may be noted on the contract documents.
    b. Submit piping layout drawings by plant area for all piping systems, including raceway, duct and other specified systems support. Indicate assembly details, location and placement of field welds, unions and flanges, fittings, valves, flushing connections, drains, sample taps, cathodic protection, seismic restraint system, expansion joints, guides, anchors, hangers, supports, and the provisions for thrust restraint, as well as any other pertinent details and appurtenances for all piping, including wall and floor penetrations, where applicable, in that area. Indicate location and clearances from structures and other utilities (ductwork, conduit, electrical tray, etc.). Include details of connections to new and existing equipment, piping and structures. Submit original layouts by the Contractor; photocopies of Contract Drawings are not acceptable. Identify the invert elevation of buried pipe at changes in slope, pipe crossings, and connections to structures on piping layout drawings in addition to providing coordinates for locating changes in horizontal alignment of buried pipe.
    c. Product Samples: Where specified or when directed by the Construction Manager, provide mill test results or product samples.
    d. Prior to the commencement of welding, submit current and complete documentation of the welder's qualifications.
    e. Safety plans for pneumatic pressure testing.
3. Post-Construction Data: Inspection reports, authored, sealed, and signed by the Design Professional retained under the provisions of this Section submitted to the Construction Manager. The Design Professional's final report shall be submitted to the Construction Manager before beneficial occupancy by the Owner.

1.06 QUALITY ASSURANCE

A. Review the drawings prior to installation of piping, conduit services, and fixtures. Identify any conflicts and cooperate with the Construction Manager to determine the adjustments necessary to resolve conflicts.

B. Confirm the routing of each section of pipeline with other services prior to commencement of installation. Advise the Construction Manager of any conflicts with existing services or services yet to be installed. Where necessary, amend the routing of pipework to avoid conflict and confirm with the Construction Manager.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00 for Shipment and Storage.

B. Deliver pipe, fittings, and specials to site using loading methods which do not damage pipe or linings, or coatings.

C. Piping materials delivered to site will be clearly marked to indicate size, type, class/schedule and coatings.

D. Until ready for incorporation in the work, store on site as recommended by the piping materials manufacturer to prevent damage, undue stresses, or weathering.

E. Store materials at least 8 inches above ground. Provide sufficient supports to prevent undue bending.

F. Protect non-UV light inhibited plastic from sunlight.

G. Maintain refrigerant piping factory seals until ready for incorporation into the Work.

H. Cover openings in piping, and temporarily seal to protect from contamination.

I. Protect materials and equipment from damage due to environmental conditions. Use protective cover, and protect from surface water by elevating above floor or surrounding grade.

J. Protect unfinished work at end of each workday from damage, contamination and moisture by use of plugs, caps or covers.

K. Protect piping and valves from damage pending performance of system tests.

L. Use proper implements, tools, and facilities for the proper protection of the pipe. Exercise care in the installation so as to avoid damage to pipe, linings, and coatings.

M. Inspect each pipe and fitting prior to installation. Do not install damaged pipe or pipe with damaged protective coatings or linings.

N. Prevent entry of foreign matter during handling, assembling, and installation. Use compressed air, wire brush, solvent and other acceptable means to remove all foreign matter from inside of pipe prior to installation. Remove residual scale, dirt and other foreign matter from interior of piping before final connections are made.

1.08 PIPING SYSTEM DESIGN

A. Design Professional:
   1. Provide professional engineering services (“Design Professional”) for the design and inspection of piping systems work. The Design Professional must have not less than ten years’ experience in the type of piping support, seismic restraint, and expansion control design work required for this project.
   2. The Design Profession shall be a professional engineer currently licensed to practice in the State of California.
   3. The Design Professional must obtain and maintain professional liability insurance in the amount of $1,000,000 aggregate, to be in effect for the duration of this project plus one year.
   4. The requirements for the Design Professional shall not be construed as relieving the Contractor of overall responsibility for this portion of the work.

B. Piping System Design and Inspection:

1. The Design Professional shall provide the design, inspection, and certification for piping supports (hangers, guides, anchors, structural attachments, etc.), expansion control and seismic restraints as specified in this Section and referenced Sections.
2. The work of the Design Professional is complementary to the design elements specified in the Contract Documents and intended to provide complete piping system designs. The Design Professional's inspection responsibilities also complement inspections by the Construction Manager. The division of responsibility for work is shown in the following table:

Piping System Element (Specification)	Design Professional's Responsibility	Construction Manager's Responsibility
Pipe material and thickness, test pressures and other properties (Section 40 05 02.00 through 40 05 02.99)	(NA)	All piping
Contractor layout drawings (Section 40 05 01)	All piping	(NA)
Support design (Section 40 05 07 and Section 01 73 24, and related sections)	All piping, except as indicated for Construction Manager's Responsibility	Pipe supports specified on the drawings
Seismic bracing (Sections 40 05 07.13 and Section 01 73 24, and related sections)	All piping, except as indicated for Construction Manager's Responsibility	Seismic bracing specified on the drawings
Expansion and Control Design (Section 40 05 07.16 and related sections)	All piping, except as indicated for Construction Manager's Responsibility	Expansion Control provisions specified on the drawings
Inspection – General. For design and specification conformance (Section 40 05 01 and related sections)	All piping	(NA)

3. Acceptable types of supports, guides, saddles, expansion joints, flexible couplings, hangers and structure attachments for general piping support are specified in Section 40 05 07. Seismic restraints are specified in Section 40 05 07.13. Pipe expansion control systems are specified in Section 40 05 07.16. Incorporate these specific elements into the design prepared by the Design Professional.
4. Pipe support and seismic restraint placement is subordinate to the function of anchorage, flexibility, and expansion control provisions. Do not interfere with the function of anchorage, flexibility, and expansion control provisions specified on the drawings.
5. Where pipe anchors are specified, they have been designed for longitudinal (axial) seismic loading, in addition to other longitudinal forces associated with expansion control, and pipe thrust for the associated piping. Rely on the specified anchors for longitudinal seismic bracing of the pipe in these instances.
6. There may be situations where the Construction Manager wants to control where certain anchors are located, the level of forces that can be transmitted to structures, the direction that expansion growth is allowed, or requires use of particular piping elements. In such cases these elements will be specified on the drawings and incorporated into the Design Professional's design. Mandatory anchorage locations identified on the drawings and maximum limitations, if any, for structure loads from the anchor will be as indicated on the drawings, identifying location and the maximum force that can be imposed on the structure. Where structural load would be exceeded, provide piping flexibility or expansion joints to reduce the maximum loading imposed on the structure.

7. For general understanding of intent and bidding purposes, general support locations, arrangements, types and means of attachment may be shown on the drawings. Some of the elements may be specifically designed and detailed. If a particular type of support, anchor, seismic restraint or expansion element is detailed on the drawings, then incorporate those elements into the Contractor's design. Include all elements of the piping system in Piping submittals by the Contractor, including those portions directed by the Construction Manager and complete piping runs.
8. Calculate the structural reaction loads for all fixed supports and indicate the calculated reaction loads on the submitted layout drawings. Notify the Construction Manager if any elements specified on the Drawings are incompatible with the overall piping system and its function.
9. Include consideration of and provisions for:
    a. Support and restrain pipe independent of support or restraint provided by equipment or without equipment supported loads exceeding equipment manufacturer's nozzle loading recommendations. Obtain maximum nozzle loads from the equipment manufacturer.
    b. Routing of pipe to provide access aisles free of obstruction and worker hazards. Unless otherwise specified or approved by the Construction Manager, the minimum clear space between equipment is 36 inches horizontally. Minimum vertical clearance is 7 ft above the floor or local grade at pedestrian access aisles and egress paths. Minimum clearance for equipment access aisles in galleries, tunnels and utilidors is 10 ft by 10 ft.
    c. Electrical bonding for all gas, fuel, and pneumatic conveyance systems.
    d. Dielectric separation, as specified.
10. Include all elements of piping systems required for fabrication and construction in the piping layout submittals. Depict couplings, support, restraint, anchorage, expansion control measures and other elements of the piping system.
11. Depict fitting angles and vertical and horizontal pipe locations, as determined by the Contractor, on piping layout drawings.
12. Do not interfere with maintenance functions and access around equipment, including monorails and hoists.

1.09 COORDINATION

A. Refer to Section 40 05 45 for process piping identification requirements.

B. Pipe Sleeves: Coordinate placement of sleeves and penetrations in cast-in-place concrete with raceway, duct, and pipe penetrations prior to concrete placement. Coordinate placement of sleeves and wall penetration prior to construction of masonry building elements.

PART 2 PRODUCTS

2.01 PIPE MATERIALS - GENERAL

A. All pipe materials to be new, free from defects and conforming to the requirements and standards identified in the Piping System Schedules (Section 40 05 02.00 through 40 05 02.99) and related sections.

B. New and existing piping is designated by process service rather than pipe material. Existing pipe material types may not be the same as material types specified for new piping. Investigate connections to existing piping and provide suitable connections, including electrical isolation, as necessary.

C. Fittings and Coupling Compatibility: To assure uniformity and compatibility of piping components, furnish fittings and couplings for grooved-end or shouldered-end piping systems from the same manufacturer.

D. Buried Piping: Size temporary and/or permanent thrust restraints. Design restraint systems to allow complete piping system disassembly without destruction of any portion of the piping system.

2.02 MATERIAL FOR PIPING SUPPORT, SEISMIC RESTRAINTS AND PIPE ANCHORS

A. This paragraph specifies materials for pipe supports specified in Section 40 05 07, seismic restraints specified in Section 40 05 07.13, pipe anchors, certain expansion control elements specified in Section 40 05 07.16, and all associated appurtenances. Section 01 61 45 defines environmental exposures by physical location. Pipe Support, Seismic Bracing, and Pipe Anchor materials are specified based on the environmental exposure specified in Section 01 61 45. Provide Pipe Support, Seismic Bracing and Pipe Anchor components fabricated from materials as specified in the following table:

Environmental Exposure or Pipe Material	Materials [1]	Nuts, bolts, washers, and fasteners
Outdoor	Steel, hot dip galvanized after fabrication	Type 304/316 stainless steel
Indoor, Dry	Steel, hot dip galvanized after fabrication	Steel, Zinc plated or hot-dip galvanized after fabrication
Indoor, Wet	Type 316 stainless steel or FRP	Type 316 stainless steel
Chemical Corrosive	Fiberglass (FRP)	Type 316 stainless steel
Head Space	Type 316 stainless steel or FRP	Type 316 stainless steel
Submerged	Type 316 stainless steel or FRP	Type 316 stainless steel
Undefined	Type 316 stainless steel or FRP	Type 316 stainless steel
Stainless steel piping	Same type of stainless steel as the pipe or FRP	(per area as defined in this table)

Notes:

1. *Where materials as designated in drawing details or indicated in other specification sections, those requirements govern over the provisions of this table.*

2.03 PIPE AND VALVE COMPATIBILITY

A. Coordinate the selection of pipe materials, linings, and end connections so that valves operate properly over their entire range (e.g., sufficient disk clearance for butterfly valves). Support wafer style valves or spectacle flanges between flanges of equal inside diameter.

2.04 BONDING JUMPERS

A. Provide plated, flexible copper braid jumpers with unplated copper ferrules for attachment to pipe flanges, rated for a 100 amp minimum. Provide Burndy Electrical,

Type B series, or Approved Equal, and sufficient conductive, anti-oxidant compound (Burndy Electrical Penetrox series or Approved Equal) to protect ferrules.

2.05 JOINTS – GENERAL

A. Provide joints for disassembly within 3.0 ft of any connection to equipment, on both sides of structural penetrations, and within 2.0 ft of all threaded end valves.

B. Unless otherwise specified on the drawings or in equipment specifications, adapt all equipment connections to a flanged connection compatible with the connected piping system.

C. Flexible Joints at Structural Joint Crossings: Provide a flexible joint (or joints) on all piping crossing structural joints.

2.06 FLANGES AND OTHER COUPLINGS

A. Pipe connections are specified in the Piping System Schedules in Sections 40 05 02.00 through 40 05 02.99

B. General requirements for flanges are as follows:
   1. Where raised-face and flat flanges are provided for connection, reface the raised-face flanges. Flange face to be flush with flat-faced companion flanges on flat-faced valve or equipment flanges.
   2. Provide flat-faced flanges on each side of butterfly valves.
   3. For steel piping, provide weld neck flanges on both sides of wafer or lug body valves.

C. Slip-on flanges that are attached to a pipe by means of set screws and gaskets (uni-flange, etc.) are not acceptable.

2.07 FITTINGS – GENERAL

A. Fittings are specified in the Piping System Schedules.

B. Provide eccentric reducers in horizontal lines with the flat side on top, unless specified otherwise on the drawings (e.g., flow meters in horizontal runs requiring submergence).

C. Provide concentric reducers in vertical lines, unless otherwise specified on the drawings.

D. Provide reducers upstream and downstream of flow measurement devices to adapt line size to the specified flow measurement device dimension. Coordinate with the specific instrument requirements.

E. Provide long radius (greater than or equal to 1.5 x nominal diameter) elbows unless otherwise specified on the drawings.

2.08 GASKET MATERIALS

A. For flat faced flanges, use full-face gaskets. For raised-face flanges, use ring type gaskets. Conform to ANSI B16.21.

B. Refer to the Piping System Schedule for the specified gasket material. Material designations used in the detailed pipe specification sheets are as follows:
   1. EPDM: ethylene-propylene-diene-terpolymer 70 durometer
   2. Neoprene: neoprene (black) 70 durometer
   3. Nitrile: nitrile (Buna N)
   4. SBR: Styrene-butadiene (red)
   5. Natural rubber: natural rubber
   6. Compressed synthetic fibers (Kevlar): ASTM F104 (F712400), and neoprene binder: 1.7 MPa (ASTM F152), 0.2 mL/h Leakage Fuel A (ASTM F37)
   7. Compressed synthetic fibers (Kevlar): ASTM F104 (F712400) and SBR binder: 1.7 MPa (ASTM F152), 0.1 mL/h Leakage Fuel A (ASTM F37)
   8. Gylon - Type 1: Garlock Style 3500: 1.35 MPa (ASTM F152), 0.22 mL/h Leakage Fuel A (ASTM F37)
   9. Gylon - Type 2: Garlock Style 3510: 1.35 MPa (ASTM F152), 0.04 mL/h Leakage Fuel A (ASTM F37)
   10. CPE - Chlorinated Polyethylene
   11. Spiral-wound: Flexitallic SS316L, graphite impregnated per ASME B16.20
   12. PTFE bonded EPDM, full-face gaskets
   13. Viton/FKM – Fluoroelastomer, 75 Durometer

2.09 DISSIMILAR METAL CONNECTIONS

A. Where dissimilar metals are to be connected, provide dielectric fittings and/or isolating flanges, including bolt sleeves and washers, according to Section 40 05 06.

2.10 CATHODIC PROTECTION

A. Provide cathodic protection of piping, pipe fittings, and appurtenances where specified on the drawings.

2.11 STRUCTURAL ELEMENT PENETRATIONS

A. Penetrations through structural elements are referenced to a custom detail or Standard Detail. Where a penetration detail is not specified, conform to the Standard Detail relevant to the type of structure, exposure, and type of pipe.

B. Provide pipe sleeves capable of supporting the loads applied during placement of concrete or during block work erection.

2.12 PIPE MARKERS, DETECABLE WARNING TAPE, AND TRACER WIRE

A. Pipe marker, detectable warning tape, and tracer wire materials per Section 40 05 45.

PART 3 EXECUTION

3.01 PREPARATION

A. Prior to installation, inspect, and field measure to ensure that previous work is not prejudicial to the proper installation of piping.

B. Pothole existing pipe at connections to new pipe to confirm material and joints prior to submittal of pipe layout drawings.

C. The Drawings are, in part, diagrammatic, make all minor modifications to suit installed equipment and structural element locations and elevations and coordinate with electrical construction.

D. Provide details of connections to new and existing equipment, piping, and structures in piping layout drawing submittals. Unless otherwise specified on Drawings, piping fitting angles and vertical and horizontal pipe locations shall be determined by Contractor.

E. Piping arrangements indicated on the drawings have been estimated from the approximate configuration of the type of equipment listed in the equipment specifications. If the equipment to be provided does not have the same configuration, modify the piping arrangement as necessary. Include any piping modifications in shop drawings submitted prior to fabrication or installation.

3.02 PIPE SUPPORT, ANCHORAGE, AND SEISMIC BRACING

A. Support piping with anchor brackets, guides, saddles, or hangers. Pipe movement due to thermal expansion and internal pressure and dynamic forces shall be accommodated by pipe springing, anchors, expansion joints, and guides selected for the specific purpose by the Design Professional retained under the provisions of this Section. Provide supports on each run at each change of direction.

B. Provide seismic bracing as required to resist seismic loads.

C. Do not use existing pipes and supports to support new piping. Existing tunnel pipe support racks can be used for new pipe if the Design Professional determines that the existing rack components are adequate to support the additional load.

D. Install expansion loops, anchors, expansion joints, and guides where specified on the drawings.

3.03 PIPING CONNECTIONS TO MACHINES

A. Align piping at machine connections 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.

B. Do not force bolts into mating flange bolt holes. Align flange bolt holes to permit insertion of bolts by hand (without tools, hammering, or prying).

C. Use of ‘dutchmen’ mitered sections or similar specials to achieve the required alignment with machine connections are strictly prohibited.

D. Provide equipment connection fittings per Section 40 05 06 as specified on the drawings.

3.04 JOINT AND COUPLING OPTIONS

A. Provide pipe connection (joint and coupling) options as specified in the Piping System Schedule.

B. If a Piping System Schedule lists several connection options, then any of the listed options may be used for a particular pipe material, but the selected option shall be used consistently. For example, if flanged or grooved connections are specified and grooved are represented on the Drawings, then flanged may be installed in lieu of the grooved couplings specified on the drawings.

C. Connecting straight runs of pipe by welding is acceptable only where the individual Piping System Schedule allows welding as a connection option.

D. Where connections other than those indicated on the Piping System Schedule are specified on the Drawings, locate the connection specified on the drawing at the specific location indicated on the drawing.

E. Provide rigid, non-rotating connections at all valves and equipment.

3.05 SMALL BORE UTILITY PIPING

A. Field route small bore (generally less than 3-inch) diameter branch piping for utility services.

B. In general, small bore utility branch piping is not specified on the Drawings unless a specific pipe routing or configuration is to be provided or where necessary to show valves or instrumentation requiring electrical connections.

C. Distribution lines for small bore utility piping are specified on the Drawings along with service connection routes to locations that require utility service piping.

D. Install small bore utility piping that must be drained to provide freeze protection with a continuous slope down to the drain.

3.06 BONDING

A. Bonding jumpers shall be as specified in this Section.

B. Bonding shall be provided for all gas, fuel, and pneumatic conveyance systems to control static electricity. Provide bonding jumpers to the following piping systems: MSG, NG.

C. Construct electrically continuous piping for the process services listed above and connect directly or indirectly to earth ground.

D. Provide bonding jumpers where sections of pipe are interrupted with non-conducting sections, fully lined valves that are not through-bolted or other interruption in continuity.

E. Remove any coatings, dirt, grease or other contaminants from flanges where jumpers are to be installed. Apply sufficient conductive, anti-oxidant compound to protect the entire ferrule from galvanic action and hydrogen sulfide attack.

3.07 SEWER AND DRAIN PIPING

A. Run horizontal drainage piping as straight as practicable and at uniform pitch.

B. Install pipe 3-inch or less in diameter with slope of not less than two percent, unless otherwise specified on the Drawings.

C. Install pipe larger than 3-inch diameter with slope of not less than one percent, unless otherwise specified on the Drawings or required by the Plumbing Code.

3.08 SLEEVES

A. Unless otherwise noted in the specified pipe penetration details or otherwise approved by the Construction Manager, provide sleeves where piping passes through a wall, floor, or ceiling.

B. Locate and place sleeves prior to construction of cast-in-place elements and prior to the construction of concrete and masonry building elements.

3.09 PIPE JOINTS AND CONNECTIONS

A. Field cuts for glass-lined pipe are not permitted.

B. Cut pipe with appropriate tool and deburr.

C. Make joints tight. Test and remake leaking joints with new materials. Do not use thread cement or caulking to remake joints.

D. Do not use sharp toothed wrench in making up brass pipe, or chrome plated items.

E. Provide thread forms and length in accordance with ASME standards. Use lubricant or sealant on male threads suitable for proposed pipe service.

F. Clean joints before soldering. Use flux and alloy appropriate for specified operating temperature and pressure.

G. Welding procedures, welder certification/qualification, and weld testing per ASME Section IX, Boiler and Pressure Vessel Code. Make welds per the specified standard when ASME B31.1 or ASME B31.3 are specified for a Piping System in the Piping System Schedules (Sections 40 05 02.00 through 40 05 02.99.

H. Coat gasket with gasket manufacturer's recommended lubricant between flange faces.

3.10 TAKEDOWN COUPLINGS

A. Takedown Couplings: Provide takedown couplings at the locations specified on the Drawings in accordance with this Section.

B. Provide takedown couplings at changes in piping direction and where specified in the Drawings on straight runs of pipe.

C. Provide screw unions, flanged or grooved end coupling type joints as takedown couplings.

D. Use flanged or grooved end joints on pipelines 1.5-inch diameter and larger.

E. Where piping passes through walls provide takedown couplings within 40 inches of the wall.

F. Provide a union or flanged connection within 24 inches of each threaded end valve.

3.11 INSTALLATION OF BURIED PIPE AND PIPE BELOW STRUCTURES

A. Trenching and backfill for buried pipe: conform to Section 31 23 00.

B. Pipe laying and bedding: conform to Section 31 23 00.

C. Restrain all plugs, caps, tees and bends in buried pressure piping systems by means of restrained joints as specified in the respective Piping System Schedule.

D. In accordance with Section 40 05 06, and where specified on the Drawings, provide flexibility per specified details where buried pipe passes under, through, or is connected to structures. Provide restrained joint connections or provide restraints across each un-restrained joints.

E. Install pipe in straight alignment. Do not exceed 3/8-inch variance over 30 ft from the true alignment in any direction.

F. Slope gravity lines uniformly from point of origin to discharge.

G. Ensure the pipe alignment stays true during and after placement of concrete encasement.

H. Ensure that the method used to prevent pipe uplift during placement of concrete encasement results in an invert and crown true to intended grade.

I. Maintain circular cross section of pipe.

J. Provide lean concrete below the underside of the slab or footing for backfill over pipe laid below structures when pipe is less than 6 inches below the underside of the slab or footing, unless specified otherwise. Place concrete in accordance with Section 03 30 00.

K. Provide Heat-Shrinkable Cross-Linked Polyolefin Coating or Tape Wrap coating on all flanged, grooved, and welded joints that are buried or below structures.

L. Provide Petrolatum Tape wrap on all valves and mechanical pipe couplings that are buried or below structures. Install per manufacturer's recommendations. Candidate Manufacturers:
   1. Denso Densyl Tape
   2. #1 Wax Tape
   3. Approved Equal

M. Use anti-seize compound with all stainless steel nuts and bolts.

N. Provide detectable warning tape for all buried pipe. Provide tracer (locate) wire as specified in Section 40 05 45.

3.12 EXPOSED INSTALLATION

A. Fabricate and install domestic hot and cold water piping, sanitary piping and storm drainage piping in accordance with the Plumbing Code.

B. Provide pipe system layout in accordance with the following criteria:
   1. Drawings show general layout of piping. Exact dimensions determined by Contractor.
   2. Maintain minimum clear areas through tunnels and principal access aisles as specified in this Section.
   3. Expanding or swaging of tubing to fit IPS (Iron Pipe Size) fitting sockets is not permitted.
   4. Use reducing fittings where change in pipe size occurs.
   5. Use couplings only where pipe runs are longer than standard supplied pipe lengths.
   6. Make exposed polished or enameled connections to fixtures or equipment with special care to avoid damage to finished surfaces.
   7. Make changes in direction only with fittings.
   8. Install piping with not less than minimum slope to ensure adequate drainage and venting.
   9. Maintain clear areas around equipment to allow adequate access for maintenance as specified in this Section.
   10. Ensure valve operators are accessible from floor level. Provide chain wheel operators for valves with centerline elevations of 7 feet or above.
   11. Ensure piping ancillaries and in-pipe instrumentation is installed in accessible locations which do not create problems for traffic in the clear areas.

C. Make adequate provision in piping and pipe support systems for expansion, contraction, slope, and anchorage.

D. Install pipe support system to adequately secure the pipe and to prevent undue vibration, sag or stress.

E. Install expansion joints where specified on the Drawings or where required by the Design Professional, to allow for piping expansion and contraction.

F. Install expansion loops or bends where specified, or required by the Design Professional, to allow for proper pipe expansion. Construct expansion loops with long radius welded bends.

G. Provide temporary supports as necessary during construction to prevent overstressing of equipment, valves or pipe.

H. Accurately cut all piping for fabrication to field measurements.

I. Install pipes in straight alignment and parallel to wall. Do not exceed 3/8-in variance over 30 ft from the true alignment, in any direction.

J. Fabricate and assemble pipe runs so that the pipework is not stressed to achieve the desired alignment and that no stresses are transferred to equipment or equipment flanges. Unless stipulated by the Design Professional to address significant thermal strain, and accepted by the Construction Manager, the "springing" of pipe and fittings to ensure alignment is not permitted. Undo and subsequently remake all pipework connections where so instructed by the Construction Manager to ensure that unintended springing does not occur. Take care not to damage equipment, valves, or flanges.

K. Slope instrument air piping to condensate traps.

L. Do not cut or weaken the building structure to facilitate installation of piping.

M. In parallel pipe runs, offset flanges and/or grooved joint fittings by a minimum of 8 inches longitudinally to allow for proper access.

N. In vertical pipe runs of pipe diameter greater than 10 inches, provide 8-inch long spool piece on lower side of each valve.

O. Do not install water piping over electric switchboards, transformers, cable tray or electric motor starters.

P. Provide pipe markers for all exposed pipe.

3.13 THREADED JOINTS

A. Conform to the requirement of ANSI B31.1.

B. Ream the end of all pipes to remove all burrs and cuttings when fabricating threaded joints.

C. Clean out pipe and repair linings and coatings prior to joining.

D. Apply Teflon tape to male threads and join pipe. Use both Teflon tape and Teflon sealing compound on stainless steel pipe threads. Do not apply extra tape to make up for slack in the joint.

3.14 FLANGED JOINTS

A. Maintain consistent flange bolt hole positions along the entire length or run of the pipe.

B. For pipe installed with a horizontal axis, position flange bolt holes so that the vertical centerline of the flange face bisects the arc between flange bolt holes (“Two-Holed”).

C. For pipe installed with a vertical axis, position flange bolt holes so that the horizontal centerline of the flange face bisects the arc between flange bolt holes and is perpendicular to the closest structural wall (“Two-Holed”).

D. Clean flanges and gaskets prior to connection.

E. Lubricate gaskets with gasket manufacturer's recommended lubricant and apply anti-seize compound to all bolts.

F. Bring flanges into close parallel and lateral alignment.

G. Tighten bolts progressively. Proceed from side to side of the flange.

H. Use proper length bolts for each size flange on flanged connections. Washers may not be used to take up excess bolt length. Provide approximately two full threads bolt projection beyond nuts. Bolts with excessive length of exposed threads will not be permitted. All-thread rod is not acceptable for bolting flanges.

I. When joining steel to cast iron flanges, take care to avoid damage to the cast iron flange. Ensure both flanges are flat-faced and use full face gaskets.

J. Align flanges which connect piping to mechanical equipment to close parallel and lateral alignment prior to tightening bolts. Do not place strain on the equipment.

K. Allow a minimum of 6 inches' clearance to face or 8 inches to edge of flange to wall, floor, or ceiling unless otherwise specified.

3.15 INSULATION

A. Insulate piping systems in accordance with the Piping System Schedules (Sections 40 05 02.00 through 40 05 02.99) and Section 40 42 00.

3.16 FLEXIBLE HOSE CONNECTORS

A. Accurately align pipelines to receive flexible connectors before installing the connectors. Do not stretch, compress, misalign or offset the connectors.

B. Align and install each flexible connector in accordance with the manufacturer's instructions.

C. Support, anchor and guide the piping so that the flexible hose connectors are not required to absorb any axial compression or elongation.

D. Do not torque or twist the flexible connectors.

E. Check bolt tightness and tighten where necessary, a maximum of one week after commissioning and periodically thereafter.

3.17 EXPANSION JOINTS

A. Accurately align pipelines to receive expansion joints before installing the joint. Do not stretch, compress or offset the joint to fit the piping. Install expansion joints in accordance with manufacturer's instructions prior to releasing preload.

B. Align and install each expansion joint in accordance with EJMA standards and with the manufacturer's written instruction; properly guide and anchor all expansion joints. No lateral movement is permitted on compensator type expansion joints.

C. On rubber expansion joints, check bolt tightness, and tighten where necessary one week after Commissioning is completed.

3.18 REPAIR/RESTORATION

A. Repair pipe with damaged shop-applied protective linings in accordance in accordance with specified standard (e.g. AWWA C210) or accordance with the lining manufacturer's directions, if no standard is cited.

B. Damaged glass lining cannot be repaired. Replace piping with damaged glass lining.

C. Patching inserts, overlays, or pounding out of dents is not be permitted.

D. Repair pipe with damaged protective coatings and holdback areas for welding and other field fabrication, as follows:
   1. For shop-applied coatings, not subject to Section 09 90 00 requirements, in accordance with specified standard (e.g. AWWA C210) or in accordance with the coating manufacturer's directions, if no standard is cited.
   2. For coatings applied pursuant to Section 09 90 00 requirements, apply repair coatings in conformance with the applicable Section 09 90 00 coating system, including thickness and stipulated preparation of the lowest full thickness coating layer (i.e. exposed metal would require full profile preparation and specified multi-layer coating restoration).
   3. Prepare areas to be repaired not less than 2-inches beyond damaged areas and feather repair coating into adjacent areas.
   4. Repair to provide equivalent protection to undamaged coatings and a uniform appearance when judged from 4 feet away.

E. Other requirements may be stipulated in related piping sections.

3.19 FIELD QUALITY CONTROL

A. Inspections:
   1. Inspect and provide reports as specified in Section 40 05 07, Section 40 05 07.13, and Section 40 05 07.16.
   2. Submit the Design Professional's final report before beneficial occupancy by the Owner.

3.20 TESTING

A. Provide 24 hours notice prior to testing.

B. Do not insulate or conceal work until piping systems are tested and have met all required criteria.

C. Complete any required weld tests.

D. Supply all water, air, and inert gases required for pressure testing.

E. Supply all pumps, compressors, gauges, etc. required for testing.

F. Install air threadolets, air relief valves, and line fitting valves as necessary to complete testing. Remove after testing and plug threadolets.

G. Cap or plug all lines which are normally open ended. Remove on completion of testing.

H. Provide all temporary thrust restraints necessary for testing. Remove upon completion of testing.

I. Test all underground lines prior to backfilling. Do not place concrete encasement until lines are tested and have met all required criteria.

J. Test all existing piping where it connects to new piping to the first valve in the existing piping. Repair any failures in existing piping which occur as a result of the test after informing the Construction Manager of such failure.

K. Isolate all pumps and low pressure equipment and appurtenances during testing so as not to place any excess pressure or thrust forces on the equipment.

L. Where defective material or equipment is identified, repair or replace using new material.

M. Flush and drain liquid pipes after pressure tests. Purge all gas pipes after pressure tests using inert gas.

N. Dispose of flushing water in manner approved by the Construction Manager, which causes no damage to buildings or siteworks.

3.21 HYDROSTATIC PRESSURE TESTING OF LIQUID LINES

A. Hydrostatically test all lines normally used for the conveyance of liquids using water as the test medium, unless otherwise specified in this Section.

B. Test pressures and durations as specified in the Piping System Schedules.

C. Ensure all lines are filled with water. Bleed air from all high spots using the taps provided specifically for that purpose.

D. Lined pipelines: Allow filled pipeline or section thereof to stand under a slight pressure for at least 8 hours (24 hours for cement mortar lining) to allow the lining to absorb water and to allow the escape of air from air pockets.

E. Zero leakage is permitted throughout the specified test period for all exposed piping, buried insulated piping, and any liquid chemical lines.

F. Show evidence of leakage rates below 0.02 gal per hour per inch pipe diameter per 100 ft of pipe length for buried piping, unless otherwise specified.

G. Test drains in accordance with the Plumbing Code.

H. For hydraulic and lube oil systems, test using the medium of service. Provide zero loss of pressure throughout the specified test period.

3.22 PNEUMATIC PRESSURE TESTING

A. Use nitrogen gas or oil free dry air to test piping systems where nitrogen or air is the specified testing medium in the Piping System Schedule.

B. Submit a testing plan and a safety plan for each piping system that will be pressure tested with nitrogen gas or oil free dry air. Do not perform pressure testing with air or nitrogen until a favorable review of the safety plan and testing plan for the piping system has been returned from the Construction Manager. Comply with all workplace safety and pressure vessel safety codes and guidelines.

C. Provide a separate pressure relief valve for pneumatic pressure testing.

D. Locate pressure relief valve within visual range of the test gauge and with exhaust to a safe location.

E. Set relief valve at not more than full test pressure plus 10 percent.

F. Continuously monitor and control testing to assure personnel safety and piping integrity.

G. Remove all personnel from areas where piping will be subjected to pressure tests and prevent entry into testing areas until test pressure has been relieved.

H. Protect installed work from potential damage from pressure testing failures. The Contractor is responsible for any damage or injury resulting from failed pressure testing with air or nitrogen.

I. When using nitrogen or air to test steel or stainless steel pipelines, gradually introduce the test gas up to a pressure of 45 psig or 1/3 of specified test pressure, whichever is less.

J. While maintaining this pressure, test lines for leaks using soapy water.

K. When the line is free from leaks at this pressure, increase by increments of 50 psig or 1/3 of specified test pressure (whichever is less) to the specified test pressure.

L. After each increment, retest using soapy water; take corrective action as necessary.

M. When the system is free from leaks at the test pressure, depressurize the system slowly.

N. To prevent the entrance of water or moisture into the medium source, disconnect the test source from the system and cap.

O. Where specified, maintain nitrogen pad after testing until the line is put into service. Label any piping for which a pad is provided and maintained.

P. Provide high purity nitrogen gas used for testing, in cylinders fitted with pressure regulators for 0 to 300 psig and all necessary fittings and adaptors necessary to complete the connection between the source and the system header. Provide self-relieving type pressure regulator that vents to the atmosphere and include a throttling valve.

Q. Provide oil free air with a relative humidity of zero for testing. Provide all fittings, adaptors, accessories, and the pressure regulator and throttling valve that are suitable for pressure testing with air and rated for 300 psig service.

3.23 PRESSURE TESTING OF GAS, AIR, AND VAPOR LINES

A. Hydrostatically or pneumatically pressure test, as specified in the Piping System Schedules, all lines normally used for the conveyance of gas, air, and/or vapor in accordance with ASME procedures for testing pressure piping and CAN/CGA B149.6 for buried digester gas piping. Pneumatically test all instrument air lines in accordance with ISA-S7.0.01 and digester gas piping in accordance with CAN/CGA B149.6.

B. For gas and air lines to be hydrostatically tested, check support system to ensure it is capable of withstanding loads imparted by test method. Provide any additional supports necessary in a manner acceptable to the Construction Manager. At the Construction Manager's request, provide calculations indicating design of temporary support system.

C. Test pressures are identified in the Piping System Schedule.

D. Zero leakage rate for insulated systems, and systems tested with water is required at the specified test pressure through the test period. Prior to commencing test using air, ensure air will be at ambient temperature and specified test pressure.

E. Do not exceed the maximum specified leakage rate during the test period for all other systems tested with air.

F. Remake all joints which display leakage and retest.

3.24 TESTING OF HAZARDOUS GAS AND LIQUID LINES

A. The following process pipes shall be tested as Hazardous Gas or Liquid lines: MSG, NG.

B. Remove components which may be damaged by test pressures and plug openings. Provide tee in any existing lines to be tested adjacent to the terminal valve.

C. Pressure test after cleaning.

D. Zero leakage at specified test conditions is required. Repair and retest lines until successful test is achieved. Test all digester gas lines in accordance with CAN/CGA B149.6.

E. Plug and/or disconnect all vents to the atmosphere, close all valves to the atmosphere, and open all in-line valves. Return the system to its appropriate operating condition after testing, including resetting of vents and valves.

F. Hydrostatically test PVC and CPVC pipelines using water as the test medium, as specified in the Piping System Schedules. Where support systems are not designed for hydrostatic testing or drying of steel pipelines is impractical, with the Construction Manager's approval, the Contractor may use nitrogen gas or dry air as the test medium, providing the specified safety plan is submitted and necessary safety precautions are implemented to minimize the risk incurred when performing such a test.

G. Replace all moisture absorbing gaskets and valve packing after hydrostatic testing.

H. After testing, dry all lines.

1. Steel or stainless steel Lines: Pass steam through the lines from the high end until all lines are thoroughly heated. Allow condensate and foreign material to drain during steaming. Disconnect and drain lines from all low points. While lines are warm, blow dry, oil-free air with a dew point below -40 degrees F through the system until the existing dew point is the same as the supply air. Fix valves in the half open position during drying. Ensure that valves temporarily removed from the system during drying operations are completely free of moisture prior to reinstallation.
2. PVC Lines: Drying applies solely to vacuum lines. Drain and remove all free water and moisture from the system. Swab the pipe to remove any excess water. Air dry the pipe in the same manner as steel lines, additionally ensuring that the entering air temperature is not greater than 120 degrees F.

I. Fill the line with inert gas if service gas is reactive with air.

J. Introduce service gas immediately after testing and drying and inert gas filling. Test the system for leaks. Allow time for the complete replacement of air or inert gas from the piping with the service gas.

K. Use an appropriate sensing device when testing for leaks.

L. If leaks are detected when the system is tested with service gas, do not implement repairs until all gas has been purged from the system. Repeat the hydrostatic testing and drying sequence prior to retesting the line with service gas.

3.25 CLEANING AND FLUSHING

A. After installation and prior to testing, perform initial cleaning of process and utility lines. Clean piping greater than 6 inches and less than 24 inches by passing a tightly fitting cleaning ball or swab through the pipeline, unless specified otherwise. Lines greater than 24 inches may be cleaned manually or with a cleaning ball or swab. Give lines smaller or equal to 6 inches an initial flush or purge.

B. After initial cleaning, connect the piping systems to related process and mechanical equipment. Insert temporary screens, provided with visible locator tabs, in the suction of pumps and compressors in accordance with the following table:

Suction size, in.	Maximum screen opening, in.
0 – 1	1/16
1-1/4 – 3	1/4
3-1/2 – 6	1/2
Over 6	1

C. Maintain the screens during testing, flushing/purging, initial startup, and the initial operating phases of the commissioning process. In special cases and with the Construction Manager's acceptance, screens may be removed for performance tests. Install screens for clear water testing and initial operation on liquid systems handling solids. Initial operation on solids systems following clear water testing may be without screens.

D. Unless specified otherwise, flush liquid systems after testing, with clean water and screens in place. Maintain flushing for a minimum period of 15 minutes and until no debris is collected in the screens.

E. Remove the screens and make the final connections after the screens have remained clean for a minimum of 24 consecutive hours of operation. Keep screens in place for 24 hours of clean water operation on solids handling systems; remove prior to placing the system into solids handling service.

F. In air or gas systems with pipe sizes less than or equal to 6 inches, purge with air and/or inert gases before testing. Upon completion of testing and cleaning, drain and dry the piping with a dry air stream. Satisfy ANSI/ISA-S7.0.01 standards for instrument air systems.

G. Purge digester gas, natural gas, and propane systems with nitrogen gas and provide a nitrogen pad maintained at 10 psig until put in service. Purge and dry digester gas systems in accordance with CGA B149.6.

H. For hazardous gas and liquid systems, clean interior of the pipelines by drawing a cloth or swab impregnated with an appropriate solvent (carbon tetrachloride or trichloroethylene) through the pipe. Do not clean interior of refrigerant lines. Dismantle valves and hand clean. Plug lines at the end of each day. Properly dispose of all waste solvents.

I. Clean and flush piping connecting to HVAC equipment in accordance with Division 23.

3.26 DISINFECTION

A. Flush and disinfect lines intended for potable water service after testing in accordance with AWWA C651.

END OF SECTION

SECTION 40 05 02

PIPING SYSTEM SCHEDULES

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies a Piping System Schedule for each Process Service. Each Piping System Schedule specifies piping system materials for groups of similar process piping services.

B. The table in paragraph 1.01C lists process services and the corresponding Piping System Schedule that specifies piping system material requirements for the associated process piping service. See Part 4 for Piping System Schedules that define materials for piping services.

C. Piping System Schedule assignments are listed in the following table:

Process Service Identifier	Process Service	Piping System Schedule	Fluid Category	Pipe Marker Background Color
CHWR	Chilled Water Return	40 05 02.25	Solution	Gray
CHWS	Chilled Water Supply	40 05 02.25	Solution	Gray
MSG	Medium Pressure Sludge Gas	40 05 02.11	Flammable	Yellow
NG	Natural Gas	40 05 02.17	Flammable	Yellow

1.02 QUALITY ASSURANCE

A. References:

1. 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 prevail.

Reference	Title
ASME B1.20.1	Pipe Threads, General Purpose
ASME B16.1	Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, and 250
ASME B16.3	Malleable Iron Threaded Fittings Class 150 and 300
ASME B16.5	Pipe Flanges and Flanged Fittings
ASME B16.9	Factory-Made Wrought Steel Butt Welding Fittings
ASME B16.11	Forged Steel Fittings, Socket Welding and Threaded
ASME B16.12	Cast Iron Threaded Drainage Fittings
ASME B16.18	Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.22	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

Reference	Title
ASME B16.26	Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B31.1	Power Piping
ASME B31.3	Process Piping
ASME B31.9	Building Services Piping
ASME B32	Solder Metal
ASME B36.10	Welded and Seamless Wrought Steel Pipe
ASME B36.19	Stainless Steel Pipe
ASME B1.1	Unified Inch Screw Threads
ASME Section IX	Boiler and Pressure Vessel Code; Welding and Brazing Requirements
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	Grey-Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A135	Electric-Resistance-Welded Steel Pipe
ASTM A139	Electric-Fusion (ARC)-Welded Steel Pipe (NPS 4 and Over)
ASTM A167	Stainless Steel and Heat-Resisting Chromium-Nickel Steel Plate
ASTM A181/181M	Forgings, Carbon Steel, for General Purpose Piping
ASTM A182/182M	Forged or Alloy Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A193/193M	Alloy Steel and Stainless Steel Bolting Materials for High Temperature Service High Pressure Service and Other Special Purpose Applications
ASTM A194/194M	Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service or High Temperature Service, or Both
ASTM A197	Cupola Malleable Iron
ASTM A234/A234M	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM A240	Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels
ASTM A269	Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A276	Stainless and Heat-Resisting Steel Bars and Shapes
ASTM A307	Carbon Steel Bolts and Studs, 60 000 psi Tensile Strength
ASTM A312/312M	Seamless and Welded Austenitic Stainless Steel Pipe
ASTM A320/320M	Alloy Steel Bolting Materials for Low-Temperature Service
ASTM A403/A403M	Wrought Austenitic Stainless Steel Piping Fittings
ASTM A409/A409M	Welded Large Diameter Austenitic Steel Pipe for Corrosive or High Temperature Service
ASTM A480/A480M	General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
ASTM A480/A480M	General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
ASTM A536	Ductile Iron Castings
ASTM A563	Carbon and Alloy Steel Nuts
ASTM A774/A774M	As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures
ASTM A778	Welded, Unannealed Austenitic Stainless Steel Tubular Products

Reference	Title
ASTM A1011/A1011M	Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High- Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM B75	Seamless Copper Tube
ASTM B88	Seamless Copper Water Tube
ASTM B584	Copper Alloy Sand Castings for General Applications
ASTM C76	Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C564	Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C361	Reinforced Concrete Low-Head Pressure Pipe
ASTM C443	Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C478	Circular Precast Reinforced Concrete Manhole Sections
ASTM D638	Test Method for Tensile Properties of Plastics
ASTM D792	Test Method for Specific Gravity and Density of Plastics by Displacement
ASTM D1248	Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
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 D2466	Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2467	Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2513	Thermoplastic Gas Pressure Pipe, Tubing, and Fittings
ASTM D2564	Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe 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	Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3212	Joints for Drain and Sewer Plastic Pipes using Flexible Elastomeric Seals
ASTM D3261	Butt Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Fittings
ASTM D3350	Polyethylene Plastics Pipe and Fittings Materials
ASTM D4101	Propylene Plastic Injection and Extrusion Materials
ASTM D4174	Cleaning, Flushing, and Purification of Petroleum Fluid Hydraulic Systems
ASTM D4894	Standard Specification for Polytetrafluoroethylene (PTFE) Granular Molding and Ram Extrusion Materials
ASTM D4895	Standard Specification for Polytetrafluoroethylene (PTFE) Resin Produced from Dispersion
ASTM F441	Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
ASTM F894	Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
AWWA C104	Cement–Mortar Lining for Ductile-Iron Pipe and Fittings
AWWA C105	Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids
AWWA C110	Ductile-Iron and Grey-Iron Fittings, 3 Inch Through 48 Inch, for Water and Other Liquids
AWWA C111	Rubber-Gasket Joints for Ductile-Iron and Grey-Iron Pipe and Fittings
AWWA C115	Flanged Ductile-Iron and Grey-Iron Pipe with Threaded Flanges
AWWA C150	Thickness Design of Ductile-Iron Pipe

Reference	Title
AWWA C151	Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water and Other Liquids
AWWA C153	Ductile-Iron Compact Fittings
AWWA C200	Steel Water Pipe, 6 Inches and Larger
AWWA C203	Coal Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot Applied
AWWA C205	Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 Inches through 144 Inches
AWWA C206	Field Welding of Steel Water Pipe
AWWA C207	Steel Pipe Flanges for Waterworks Services - Sizes 4 Inch Through 144 Inch
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	Coal-Tar Epoxy Coating System for the Interior and Exterior of Steel Water Pipe
AWWA C214	Tape Coating Systems for the Exterior of Steel Water Pipelines
AWWA C222	Polyurethane Coatings for the Interior and Exterior of Steel Water Pipe and Fittings
AWWA C301	Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
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 C606	Grooved and Shouldered Joints
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
EJMA STDS	Standards of Expansion Joint Manufacturers' Association, Edition No. 6
FSA	Fluid Sealing Association Technical Handbook, Rubber Expansion Joint Division
FEDSPEC, L-C-530B(1)	Coating, Pipe, Thermoplastic Resin or Thermosetting Epoxy
MIL-H-13528B	Hydrochloric Acid, Inhibited, Rust Removing
MIL-S-8660C	Silicone Compound
MIL-STD-810C	Environmental Test Methods
MSS SP-25	Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-43	Wrought Stainless Steel Butt Welding Fittings
MSS SP-97	Integrally Reinforced Forged Branch Outlet Fittings – Socket Welding, Threaded, and Buttwelding Ends
MSS SP-114	Corrosion Resistant Pipe Fittings Threaded and Socket Welding Class 150 and 1000
NSF/ANSI 61:	Drinking Water System Components – Health Effects
SSPC	Society for Protective Coatings
SAE J1227	Assessing Cleanliness of Hydraulic Fluid Power Components and Systems
CPC	California Plumbing Code

1.03 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:

B. Pipe Connections and Joints:
   1. BABS – Bell and Ball Spigot
   2. BAS – Bell and Spigot
   3. BFW – Butt Fusion Weld
   4. BSS – Bolted Split Sleeve Coupling
   5. BW – Butt Weld
   6. BSW – Butt-Strap Weld
   7. CGRV – Cut (or Cast) Grooved End Coupling
   8. CPLG – Coupling
   9. CPO – Compression Type Push-On
   10. CPRSN – Compression
   11. DLW – Double Lap Weld (Bell and Spigot)
   12. EFSW - Electro-Fusion Socket Weld
   13. FLG – Flanged
   14. FLRD – Flared
   15. FP – Full Penetration
   16. FSW – Fusion Socket Weld
   17. HAS – Hub and Spigot, Compression (Cast Iron Soil Pipe)
   18. HBLS - Shielded Hubless (Cast Iron Soil Pipe)
   19. HGRV – HDPE Groove Coupling
   20. HLF CPLG – Half Coupling
   21. HPEG – HDPE Plain End with Gripping Teeth
   22. HXGT - HDPE by Grooved End Transition
   23. LR ELL – Long Radius Elbow
   24. MJ – Mechanical Joint
   25. PGRV - Proprietary Groove Coupling
   26. PO – Push-on
   27. RBAS – Restrained (Lap Welded) Bell and Spigot with O-ring rubber gasket
   28. RGRV – Rolled Grooved End Coupling
   29. RJC – Ring Joint Coupling
   30. RMJ – Restrained Mechanical Joint
   31. RPO – Restrained Push-On joint
   32. SLV – Solvent Weld
   33. SLDR – Solder or Brazing
   34. SLW – Single Lap Weld (Bell and Spigot)
   35. SR ELL – Short Radius Elbow
   36. SW – Socket Weld
   37. THD – Threaded

38. UN – Union

B. Flanges:
   1. FF – Full Face
   2. LF – Loose Flange
   3. LJ – Lap Joint
   4. LWN – Long Weld Neck
   5. RF – Raised Face
   6. SO – Slip-On
   7. THD – Threaded
   8. WN – Weld Neck

C. Materials:
   1. DI – Ductile Iron
   2. RCP – Reinforced Concrete Pipe
   3. RCP-LHP – Reinforced Concrete Low Head Pressure Pipe
   4. SS – Stainless Steel
   5. SV – Service (Cast Iron Soil Pipe available with SV rating or XH, extra heavy, rating)

D. Welding:
   1. FP – Full Penetration
   2. SML – Seamless
   3. WLD – Welded

E. Other:
   1. CFT - Cured Film Thickness
   2. DFT – Dry Film Thickness
   3. Dim – Dimensions
   4. M or E Pipe – Matches or exceeds rating of connecting pipe
   5. Thk – Thickness
   6. Sch – Schedule
   7. Std – Standard
   8. STD – Standard Weight or Standard

PART 2 PRODUCTS

2.01 MATERIALS

A. Pipe size (nominal diameter) and the Process Service Identifier for the contents of the pipeline are specified in pipe line labels on the drawings.

B. Provide piping system materials and components per the Piping System Schedule assigned for the specified process service and pipe size.

C. The Rating column in the Piping System Schedule specifies the minimum acceptable pressure rating or wall thickness for the component of the piping system.

PART 3 NOT USED

PART 4 SCHEDULES

4.01 PIPESPEC SYSTEM SHEETS/DETAILED PIPING SPECIFICATION SHEETS.

A. Piping System Schedules follow this Section. Piping System Schedules are assigned a Section number in the range from 40 05 02.00 through 40 05 02.99.

END OF SECTION

SECTION 40 05 02.11

MEDIUM PRESSURE SLUDGE GAS

Process Service	Medium Pressure Sludge Gas				
Process Service Identifier	MSG				

ASME B31.1 Design Conditions

Pressure (psig)	Temp. (°F)	ASME Fluid Service Category	Corrosion Allowance	Joint Efficiency	Test Medium
10	120	Normal	0.08 in.	> 0.85	Air

General Requirements

1. Design, fabricate, inspect, and test in accordance with the ASME B31.1 Power Piping Code.
2. Full-Faced flanges mated with raised face flanges are not permitted.
3. Mating flanges for pipe shall be of the same Standard, Class, and Series. Mating flanges at valves and equipment shall have specified rating and matching drilling pattern.
4. Pipe threads per ASME B1.20.1.
5. Match metal alloy/grade/type for any metal welded to pipe or fittings. (e.g. do not weld carbon steel to stainless steel; weld Type 316L to Type 316L pipe material.)
6. Slope all pipe to low point drain. Sags or slope reversal/inflections are not permitted.
7. Fittings shall match or exceed material, ends, and wall thickness of pipe.

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Notes:

1. Flange bolt length per ASME B16.5 plus three additional threads. Hex head bolt dimensions per ASME B18.2.1 (Heavy Hex). Class 2A standard coarse series threads per ASME B1.1, standard coarse thread series. Hex nut dimensions per ASME B18.2.2 (Heavy Hex). Class 2B standard coarse series threads per ASME B1.1.
2. Apply Anti-seize to stainless steel bolts before turning nut on flange bolts.
3. Provide Long Radius Elbows. Provide full flow fittings. Segmentally welded fittings are not acceptable.
4. Not used.

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5. Stainless steel stub end for use with Lap Joint flanges. Stub end dimensions and materials to match pipe. Fillet radius of stub ends compatible with inner corner radius of backing flange bore.
6. For Headspace, Trench and Submerged area exposure, use stainless steel flanges with stainless steel bolts and nuts.
7. Factory coat carbon steel/ductile iron backing ring flanges with Liquid Epoxy per AWWA C210, 16 mils DFT, minimum.
8. Provide stainless steel flange bolts and nuts with stainless steel flanges.
9. Provide weld neck flanges on both sides of wafer, lug body, and flanged valves ½ thru 24 inch.
10. Provide magnetic tracer tape for buried pipe and valves.
11. Provide extension stem and valve box.
12. Fabricated fittings per ASTM A774 and AWWA C226 are unlisted materials per ASME B31.1. Design and fabricate fittings per requirements for unlisted materials specified in ASME B31.1 Power Piping Code.
13. Provide Concrete Surround for pipe buried below structures.
14. Provide flanged adapters for valves.
15. Pipe provided with co-extruded yellow stripes per manufacturer's standard.
16. Not used.
17. Ductile iron backing flanges are unlisted materials per ASME B31.1. Design and fabricate fittings per requirements for unlisted materials specified in ASME B31.1 Power Piping Code.

Indoor Dry, Indoor Wet, Outdoor, Process Corrosive, Headspace, Submerged – Exposed and Embedded and Encased

Component	Line Size, in	Rating	Conn./Joints	Material	Spec Section	Notes
Pipe	1/8 thru 1/2	Sch. 80S	BW, THD, SW, FLG	Stainless Steel: ASTM A312-TP316L, SML, Dim. Per ASME B36.19.	40 05 23	
	3/4 thru 2-1/2	Sch. 40S	BW, THD, SW, FLG	Stainless Steel: ASTM A312-TP316L, SML, Dim. Per ASME B36.19.	40 05 23	
	3 thru 16	Sch. 10S	BW, FLG	Stainless Steel: ASTM A312-TP316L, SML, Dim. Per ASME B36.19.	40 05 23	
Lining for Pipe & Fittings	All	—	—	None	—	
External Coating	All	—	—	None	—	
	Valves	—	—	Manufacturer's Standard Primer and Finish Coating: Shop or Factory Applied	—	
Fittings	1/8 thru 1/2	Class 3000	BW, SW, THD	Forged Stainless Steel: ASTM A182-F316L, Dim. per ASME B16.11.	40 05 23	
		Class 150	FLG	Forged Stainless Steel: ASTM A182-F316L, Dim. per ASME B16.5.		
		Sch. 80S	BW	Wrought Stainless Steel: ASTM A403-WP316L, Dim. per B16.9.		
	3/4 thru 2-1/2	Class 3000	BW, SW, THD	Forged Stainless Steel: ASTM A182-F316L, Dim. per ASME B16.11.	40 05 23	
		Class 150	FLG	Forged Stainless Steel: ASTM A182-F316L, Dim. per ASME B16.5.		
		Sch. 40S	BW	Wrought Stainless Steel: ASTM A403-WP316L, Dim. per B16.9.		
	3 thru 16	Sch. 10S	BW	Wrought Stainless Steel: ASTM A403-WP316L, Dim. per ASME B16.9.	40 05 23	3
		Sch. 10S	BW	Fabricated Stainless Steel: ASTM A774-TP316L, Dim. per ASME B16.9.		4, 12
Taps	1/8 thru 1/2	Class 3000	THD, SW	Forged Stainless Steel Tee: ASTM A182-F316L, Dim. per ASME B16.11.	40 05 23	
		Sch. 80S	THD, SW	Wrought Stainless Steel Tee: ASTM A403-WP316L, Dim. per ASME B16.9.		
	3/4 thru 2-1/2	Class 3000	THD, SW	Forged Stainless Steel Tee: ASTM A182-F316L, Dim. per ASME B16.11.	40 05 23	
		Sch. 40S	THD, SW	Wrought Stainless Steel Tee: ASTM A403-WP316L, Dim. per ASME B16.9.		
	3 thru 16	Class 3000	FP Beveled Fillet Weld	Forged Stainless Steel Half Coupling: ASTM A182-F316L, Dim. per ASME B16.11.	40 05 23	
		Class 3000	FP Beveled Fillet Weld	Forged Stainless Steel Olet: ASTM A182-F316L, Dim. per MSS SP-97		
Grooved Coupling	All	—	—	None	—	
Flanges	1/2 thru 2-1/2	Class 150	WN, SO, THD	Forged Stainless Steel: ASTM A182-F316L, FF, Dim. per ASME B16.5.	40 05 23	
	3 thru 16	Class 150	LJ, LF	Forged Steel Backing Flange: ASTM A105, Dim. per ASME B16.5 with ASME B16.9 stub end.	40 05 23	5, 6, 7
		Class 150	LJ, LF	Forged Stainless Steel Backing Flange: ASTM A182-F316L, Dim. per ASME B16.5 with ASME B16.9 stub end.		6, 8

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Indoor Dry, Indoor Wet, Outdoor, Process Corrosive, Headspace, Submerged – Exposed and Embedded and Encased

Component	Line Size, in	Rating	Conn./Joints	Material	Spec Section	Notes
		Class 150	WN, SO	Forged Stainless Steel: ASTM A182-F316L, FF, Dim. per ASME B16.5.		6, 8
FLG Bolts, nuts and hardware	All	—	—	Stainless Steel Bolts: ASTM A193 Gr B8M Stainless Steel Nuts: ASTM A194 Gr 8M	—	1, 2, 6, 8
Flange gaskets	3 thru 10	1/16 in Thk.	FLG	Buna-N	40 05 01	
	12 thru 16	1/8 in Thk.	FLG	Buna-N	40 05 01	
Mechanical Coupling Gaskets	None	—	—	None	—	
Compression and Push-On Gaskets	None	—	—	None	—	
Valves	1/8 thru 2-1/2	—	THD	Ball:		
			THD	Swing Check:		
			THD	Globe:		
	3 thru 16		FLG	Butterfly: High Performance, Soft Seat	40 05 64.03	9
			FLG	Plug: Eccentric	40 05 62.05	9
			FLG	Double Disc Check: Split Disc/Double Leaf	40 05 65.12	9
Insulation	All	—	—	None	—	
	Valves					

Buried

Component	Line Size, in	Rating	Conn./Joints	Material	Spec Section	Notes
Pipe	1/2 thru 16	IPS DR 17	FLG, FSW, EFSW, BFW	High Density Polyethylene: ASTM D2513 PE4710, ASTM D3350-445574C, Dim. per ASTM D2513	40 05 33.13	10, 13, 15
Lining for Pipe & Fittings	All	—	—	None	—	
External Coating	All	—	—	None	—	
	Valves	—	—	Coating System M-1: Per specification, Field Applied	09 90 00	
Fittings	1/2 thru 16	IPS SDR 17	FLG, FSW, EFSW, BFW	Molded Fittings: ASTM D 3350-445574C/PE 4710, NSF 61 certified, Dim. per ASTM D3261/ASTM F1055/ASTM D2683	40 05 33.13	10
			FLG, BFW	Long Radius Sweep Bend: ASTM D 3350-445574C/PE 4710, NSF 61 certified, Dim. per ASTM D 3035		3, 10
	14 thru 16	IPS SDR 21	FLG, BFW	Fabricated Fittings: ASTM D 3350-445574C/PE 4710, NSF 61 certified, Dim. per ASTM F2206	40 05 33.13	4, 10
Taps	1/2 thru 3	IPS SDR 17	FLG, FSW, EFSW, BFW,	Molded Tee: ASTM D 3350-445574C/PE 4710, NSF 61 certified, Dim. per ASTM D3261, with reducers and HDPE to 316 Stainless Steel MNPT transition	40 05 33.13	
	4 thru 16	IPS SDR 17	BFW, FSW	Fabricated Reducing Tee: ASTM D 3350-445574C/PE 4710, NSF 61 certified, Dim. per ASTM D3035/AWWA C901, with reducers and HDPE to 316 Stainless Steel MNPT transition	40 05 33.13	
		IPS SDR 17	EFSW, FSW	Branch Saddle Tap: ASTM D 3350-445574C/PE 4710, NSF 61 certified, Dim. per ASTM F1055, with reducers and HDPE to 316 Stainless Steel MNPT transition		
Grooved Coupling	All	—	—	None	—	
Flanges	All	Class 150	BFW x FLG	Ductile Iron Backing Flange: ASTM A536, Polypropylene coated, LJ, Dim. per ANSI B16.5 with stub end flange adapter	40 05 33.13	7, 17
		IPS SDR 17		Stub End Flange Adapters: ASTM D 3350-445574C/PE 4710, NSF 61 certified, Dim. per ASTM D3261		
FLG Bolts, nuts and hardware	All	—	—	Stainless Steel Bolts: ASTM A193 Gr B8M Stainless Steel Nuts: ASTM A194 Gr 8M	—	1
Flange gaskets	1/8 thru 10	1/16 in Thk.	FLG	Nitrile or Neoprene	40 05 01	
	12 thru 16	1/8 in Thk.	FLG	Nitrile or Neoprene	40 05 01	
Mechanical Coupling Gaskets	All	—	—	None	—	
Compression and Push-On Gasket	—	—	—	None	—	
Valves	1/2 thru 2-1/2		THD	Ball:		10, 11

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Buried Component	Line Size, in	Rating	Conn./Joints	Material	Spec Section	Notes
	3 thru 16		FLG	Butterfly: High Performance, Soft Seat	40 05 64.03	10, 11, 14
Insulation	All	—	—	None	—	

END OF SECTION

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SECTION 40 05 02.17

Natural Gas Systems

PIPESPEC System – 5

Process Commodity	Natural Gas						
Process Commodity Abbrev.	NG						

Test Conditions			Maximum Conditions	
Pressure (psig)	Duration (min.)	Medium	Pressure (psig)	Temp. (°F)
225	120	Air	150	120

General Requirements

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 40 05 06.33-3.03.
2. Full-Faced flanges mated with raised face flanges are not permitted.
3. Mating flanges shall be of the same drilling pattern.
4. Threads per ASME B1.20.1.
5. Match metal alloy/grade/type for any metal welded to pipe or fittings. (Do not weld carbon steel to stainless steel. e.g. Weld Type 316L to Type 316L pipe material.)
6. Fittings shall match material, ends and wall thickness of pipe.
7. Omit coating on encased pipe.

Notes:

1. Bolt length per ASME B16.5 plus three additional threads. Hex head bolt dimensions per ASME B18.2.1. Class 2A standard coarse series threads per ASME B1.1, standard coarse thread series. Hex nut dimensions per ASME B18.2.2 (Heavy Hex). Class 2B standard coarse series threads per ASME B1.1.
2. Provide Long Radius Elbows.
3. Provide five-cut long radius mitered elbows.
4. Provide plastic tracer tape.
5. Omit coating on encased pipes.
6. Extension stem and valve box required.

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Indoor Dry, Indoor Wet, Outdoor, Process Corrosive, Headspace, Submerged - Exposed

Component	Line Size, in	Rating	Conn./Joints	Material	Spec Section	Notes
Pipe	1/8 thru 2	Sch. 40	Taper THD	Steel: ASTM A106, Grade B, SML, Dim. Per ASME B36.10.	40 05 24	
	2-1/2 thru 8	Sch. 40	BW, FLG	Steel: ASTM A53, Grade B, SML, Dim. Per ASME B36.10.	40 05 24	
Lining for Pipe & Fittings	All	—	—	None	—	
External Coating	All	—	—	Liquid Epoxy: AWWA C210, 16 mils DFT, including 3-4 mils primer. Factory Applied.	40 05 24	3
	Valves	—	—	Liquid Epoxy: AWWA C210, 16 mils DFT, including 3-4 mils primer. Factory Applied.	40 05 24	3
Fittings	1/8 thru 2	Class 150	SW, THD	Malleable Iron: ASTM A197, Dim. per ANSI B16.3. Ends to match pipe.	40 05 24	
	2-1/2 thru 8	Sch. 40 Class 150	BW FLG	Wrought Steel: ASTM A234-WPB, Dim. per B16.9. Forged Steel: ASTM A234-WPB, Dim. per ASME B16.5.	40 05 24	2
Taps	1/2 thru 2	Class 3000 Sch. 40	THD, SW, BW	Forged Steel: ASTM A105, Dim. per ANSI B16.11 Wrought Steel: ASTM A234-WPB, Dim. per ANSI B16.9. 3/4" FNPT branch	40 05 24	
	2-1/2 thru 8	Class 3000 Class 3000	FP Beveled Fillet Weld	Forged Steel Threadolet or Half Coupling: ASTM A105, Dim. per ANSI B16.11. 3/4" FNPT branch/ tap	40 05 24	
Grooved Coupling	—	—	—	None		
Flanges	1/8 thru 3	Class 150	LWN, WN, SO, THD	Forged Steel: ASTM A105, FF, Dim. per ANSI B16.5	40 05 24	
	4 thru 8	Class 150 Class D	LWN, WN, SO	Forged Steel: ASTM A105, FF, Dim. per ANSI B16.5 Plate Steel: ASTM A36 or ASTM 516-Gr 60, Gr 65 or Gr 70, FF, Dim. per AWWA C207	40 05 24	
FLG Bolts, nuts and hardware	All	All	—	Carbon Steel Bolts: ASTM A193 B7. Carbon Steel Nuts: ASTM A194 2H heavy hex nuts.	—	1
Flange gaskets	1/8 thru 8	1/16 in Thk.	FLG	Neoprene	40 05 01	
Mechanical Coupling Gaskets	—	—	—	None	—	
Compression and Push-On Gaskets	—	—	—	None	—	
Valves	1/8 thru 2			Ball: Globe: Lift Check:		
	2-1/2 thru 8		FLG	Ball: Carbon Steel, Fire Safe	40 05 63.11	
Insulation	—	—	—	None	—	

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SECTION 40 05 02.25

Hot Water and Chilled Water

PIPESPEC System – 8

Process Commodity	Chilled Water Return	Chilled Water Supply						
Process Commodity Abbrev.	CHWR	CHWS						

Test Conditions			Maximum Conditions	
Pressure (psig)	Duration (min.)	Medium	Pressure (psig)	Temp. (°C)
75	120	Water	10	120

General Requirements

1. Manual air vents shall be provided at the high points and drains provided at the low points of each reach of pipeline.
2. Full-Faced flanges mated with raised face flanges are not permitted.
3. Mating flanges shall be of the same drilling pattern.
4. Threads per ASME B1.20.1.
5. Match metal alloy/grade/type for any metal welded to pipe or fittings. (Do not weld carbon steel to stainless steel. e.g. Weld Type 316L to Type 316L pipe material.)
6. Fittings shall match material, ends and wall thickness of pipe.

Notes:

1. Bolt length per ASME B16.5 plus three additional threads. Hex head bolt dimensions per ASME B18.2.1. Class 2A standard coarse series threads per ASME B1.1, standard coarse thread series. Hex nut dimensions per ASME B18.2.2 (Heavy Hex). Class 2B standard coarse series threads per ASME B1.1.
2. Provide Long Radius Elbows.
3. Provide five-cut long radius mitered elbows.
4. Drawn, finished in straight lengths
5. Annealed or Drawn, finished in straight lengths or coils.
6. Exposed pipe, 2-1/2 inches and larger, is designed with butt weld and flange connections. Substitution of rigid grooved end couplings with specified anchors, guides and expansion joints is allowed. Provide Victaulic zero flex, or Approved Equal, and roll grooved piping. Grooved fittings and couplings are to be from the same manufacturer and have the same pressure rating. Provide silicone based gasket lubricant on grooved piping coupling gaskets.
7. Pressure rating is reduced to 150 psi for 30” thru 36” fittings.
8. Provide magnetic tracer tape.

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Indoor Dry, Indoor Wet, Outdoor, Process Corrosive, Headspace, Submerged - Exposed

Component	Line Size, in	Rating	Conn./Joints	Material	Spec Section	Notes
Pipe	1/4 thru 2	Type L	SLDR	Cobber Tube: ASTM B88, drawn.	40 05 17	4
	2-1/2 thru 8	Sch. 40	BW, FLG, RGRV, CGRV	Steel: ASTM A53, Gr B, seamless, Dim per B36.10	40 05 24	
Lining for Pipe & Fittings	All	—	—	None	—	
External Coating	1/4 thru 2	—	—	None		
	2-1/2 thru 8	12 mils DFT Thk. per Std. Thk. per Std. Thk. per Std.	—	Three Coat Zinc/Epoxy/Urethane: Factory Applied Primer, 3-4 mils (AWWA C218), Field Applied Intermediate and Finish Coat, per Spec. Section Cement Mortar: Factory Applied, AWWA C205 Extruded Polyolefin: Factory Applied, AWWA C215 Polyurethane: Factory Applied, AWWA C222.	09 90 00	
	Valves	—	—	Same as pipe		
Fittings	1/4 thru 2	—	SLDR	Wrought Copper or Bronzer: Material and Dim. Per ANSI B16.22	40 05 17	
	2-1/2 thru 8	3000# Sch. 40 Class 150 Sch 40 (STD)	BW, SW, FLG,CGRV, RGRV	Forged Steel: ASTM A105, Dim. per ANSI B16.11. Wrought Steel: ASTM A234-WPB, Dim. per ANSI B16.9. Malleable Iron: ASTM A197, Dim. per ANSI B16.3. Grooved Steel: ASTM A234-WPB, r/D dimensions per ANSI B16.9, groove per manufacturer.	40 05 24 40 05 24 40 05 24 40 05 24	2 2 2 2, 6
Taps	1/4 thru 2	—	SLDR x THD	Wrought Copper or Bronze Tee: Material and Dim. per ANSI B16.22, Reducing bushings to 3/4" FNPT connection as necessary.	40 05 17	
	2-1/2 thru 8	3000#	FP Beveled Fillet Weld	Forged Steel Threadolet or Half Coupling: ASTM A105, Dim. per ANSI B16.11. 3/4" FNPT branch/ tap	40 05 24	
Grooved Coupling	1/4 thru 2	—	—	None	—	
	2-1/2 thru 8					
Flanges	1/4 thru 2	Class 150	SLDR, FLG	Cast Flange Adapter: ASTM B584, Flange Dim. per ANSI B16.5	40 05 17	
	2-1/2 thru 3	Class150	LWN, WN, SO, THD	Forged Steel: ASTM A105, FF, Dim. per ANSI B16.5	40 05 24	
	4 thru 8	Class150 Class D	LWN, WN, SO	Forged Steel: ASTM A105, FF, Dim. per ANSI B16.5 Plate Steel: ASTM A36 or ASTM 516-Gr 60, Gr 65 or Gr 70, FF, Dim. per AWWA C207	40 05 24	
FLG Bolts, nuts and hardware	All	All	—	Carbon Steel Bolts: ASTM A307-Gr A Carbon Steel Nuts: ASTM A563-Gr A hex nuts	—	1
Flange gaskets	1/4 thru 8	1/16 in Thk.	FLG	Nitrile	40 05 01	

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Indoor Dry, Indoor Wet, Outdoor, Process Corrosive, Headspace, Submerged - Exposed

Component	Line Size, in	Rating	Conn./Joints	Material	Spec Section	Notes
Mechanical Coupling Gaskets	1/4 thru 2	—	—	None	—	
	2-1/2 thru 8	All	Mech. CPLG	EPDM	40 05 01	
Compression and Push-On Gaskets	1/4 thru 2	All		EPDM		
	2-1/2 thru 8	All	Mech. CPLG	EPDM	40 05 01	
Valves	1/4 thru 2		THD	Ball Valve: Bronze	40 05 63.01	
	2-1/2 thru 8			Butterfly Valve: Swing Check Valve:		
Insulation	All	CC, EC	—	Cellular glass or fiber: Medium Temperature Class per Spec Section	40 42 00	
	Valves	All				

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SECTION 40 05 06

SPECIALTY COUPLINGS AND ADAPTERS FOR PROCESS PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes specialty couplings and adapters to provide electrical isolation, connect misaligned pipe, provide pipeline flexibility, provide disconnection/dismantling capabilities, and other specialty functions in pipelines.

B. Connections, couplings, and joints used to connect pipe segments and fittings that are not specifically designed to provide the capabilities of a specialty coupling are specified with the pipe materials.

C. Expansion Joints and Flexible Metal Hose for expansion control and pipe flexibility are specified in Section 40 05 06.23

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 40 05 01 – Piping Systems
   2. Section 40 05 02 – Piping System Schedules

1.03 REFERENCES

A. 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 prevail.
   1. ASME B31.1 – Power Piping
   2. ASME Section IX – Boiler and Pressure Vessel Code; Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators Qualifications
   3. ASTM A36 – Standard Specification for Carbon Structural Steel
   4. ASTM A53 – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
   5. ASTM A193 – Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
   6. ASTM A194 – Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
   7. ASTM A536 – Standard Specification for Ductile Iron Castings
   8. ASTM F593 – Stainless Steel Bolts, Hex Cap Screws, and Studs
   9. ASTM F594 – Standard Specification for Stainless Steel Nuts
   10. AWWA C105 – Polyethylene Encasement for Ductile-Iron Pipe Systems
   11. AWWA C111 – Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

12. AWWA C116 – Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings
13. AWWA C153 – Ductile-Iron Compact Fittings
14. AWWA C206 – Field Welding of Steel Water Pipe
15. AWWA C213 - Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines
16. AWWA C219 – Bolted, Sleeve-Type Couplings for Plain-End Pipe
17. AWWA C550 – Protective Epoxy Coatings for Valves and Hydrants
18. AWWA C606 – Grooved and Shouldered Joints
19. AWWA M11 – Steel Pipe-A Guide for Design and Installation
20. NSF 61 – Drinking Water System Components - Health Effects

1.04 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this Section, addendum updates included, with each paragraph check-marked to indicate compliance or marked to indicate requested deviations.
   3. Manufacturers' product data, catalog cuts, typical installation details, and dimensions for each size and type of specialty coupling or adapter furnished for the project.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide new specialty pipe couplings and adapters, free from defects and conforming to the requirements and standards specified in this Section.

B. Provide specialty couplings and adapters at locations indicated on drawings.

2.02 MECHANICAL COUPLINGS

A. Sleeve-Type Couplings:
   1. Candidate manufacturer:
      a. Sleeve-type mechanical pipe couplings:
         1) Rockwell Type 411.
         2) Dresser Style 38.
         3) Approved equal, with the stop removed from the middle ring.
      b. Reducing Sleeve Couplings:
         1) Rockwell Type 415.
         2) Dresser Style 62.
         3) Approved equal.
      c. Sleeve-type Flanged Coupling Adapters:
         1) Romac FCA 501.
         2) Rockwell Type 913.

3) Dresser Style 128.
4) Approved equal.

d. Gaskets: Match gasket material specified for Mechanical Coupling Gaskets in the Piping System Schedule for the associated Process Service.

B. Equipment Connection Fittings:

1. Equipment connection fittings join flanged pipe ends with both lateral and angular misalignment adjustment between the axes of the pipes. In addition, equipment connection fittings provide full pressure thrust restraint between the field piping connection and equipment connection flanges.
   a. Equipment connection fittings consist of two flanged coupling adapters, a plain end section of pipe and thrust restraint tie 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.
   b. Materials and features are to conform to the requirements established in this Section. Standard "dismantling joints" incorporate only one flanged coupling adapter and are not acceptable substitutes.
   c. Candidate manufacturers:
      1) Romac ECF Series
      2) Baker Coupling Company, Los Angeles
      3) Approved equal
2. Single sleeve of plain end piping conforming to the Piping System Schedule for the specified Process Service and of sufficient length to span the gap between the connection at the equipment and the connection at the field piping with Sleeve-type Flange Coupling Adapters at each end.
3. Provide thrust restraint by means of all-thread rod spanning between flanges and male rod nuts and spherical washers to provide a ball-joint type self-aligning feature. Project the all-thread restraint rod through the flange and mating flange coupling adapter bolt holes or through holes in the restraint lug plates that extend above the flanges. Secure all thread restraint rod to the flanges with a minimum of two flange bolts.
4. Where the all-thread rods project through the flange bolt holes, provide ball joint type nut and washer combinations with lock washers at each face and at each end. Where restraint lug plates are employed, provide ball joint type nuts and washers only on the outside faces of the plates with nuts that have a self-locking feature that prevents nut movement due to vibration or other operational or environmental causes. Double nutting with non-locking nuts is not an acceptable method of providing a self-locking feature.
5. Select thrust rod diameter and material 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.
6. Design equipment connection fittings per the requirements of AWWA C219.

7. Provide ASTM A193 grade B7, B8, or B8M thrust rods, ASTM A194 grade 2H, 8, or 8M nuts, with matching washers and lock washers to develop full rated piping system pressure thrust forces. For pump applications, select thrust rod quantities and diameters such that the thrust rod stretch under the piping system's operating pressure does not exceed 2.0 mils.
8. Factory apply dry film molybdenum disulfide anti-galling compound to ends of thrust rods, covering all threads subject to nut travel and tightening.
9. Gaskets:
    a. Flange gaskets: Match gasket material specified for Flange Gaskets in the Piping System Schedule for the associated Process Service.
    b. Follower gaskets: Compression Wedge. Match gasket material specified for Mechanical Coupling Gaskets in the Piping System Schedule for the associated Process Service.
10. Provide schedule 40, ASTM A53, Grade B pipe sleeves with ASTM A536, Grade 65-45-12 or ASTM A36 flange bodies and end rings. The pressure ratings of the flange adapters are to meet or exceed the pressure rating of the mating flanges. Coat and line all metal portions of equipment connection fittings, with the exception of 316 stainless steel components, with fusion bonded epoxy conforming to AWWA C550 and NSF 61.

C. Dismantling Joints:
1. Dismantling joints may be used as takedown couplings in accordance with this Specification.
    a. Dismantling joints: fully restrained double flange fittings consisting of a flange coupling adapter and flanged spool piece that allows for longitudinal adjustment.
    b. Provide thrust restraint by means of all threaded rod spanning between flanges and secured to the flanges with a minimum of two flange bolts.
    c. Design Dismantling Joints in accordance with AWWA C219.
    d. Provide schedule 40 ASTM A53 Grade B pipe sleeves with ASTM A536 Grade 65-45-12 or ASTM A36 flange bodies and end rings. The pressure ratings of the flange adapters are to meet or exceed the pressure rating of the mating flanges. Coat and line all metal portions of the fittings, with the exception of 316 stainless steel components, with fusion bonded epoxy conforming to AWWA C550 and NSF 61.
    e. Candidate manufacturers:
        1) Romac DJ-400
        2) Smith Blair 975
        3) Crane-Viking Johnson Dismantling Joint
        4) Approved equal

D. Force Balanced Double Ball and Single Ball Expansion Joints
1. Install ball expansion joints in the locations specified on the Drawings.
2. Provide foundry certification of material upon request. Materials as follows:
    a. Ductile iron joints conforming to the material requirements of ASTM A536 and AWWA C153.
    b. Type 410 stainless steel lock rings.
    c. EPDM molded watertight construction for ring gasket, casing, ball and cover.

3. Pressure test each expansion joint prior to shipment to a minimum of 250 PSI.
4. Flexible expansion joints consist of an expansion joint designed and cast as an integral part of a ball and socket type flexible joint, providing a minimum deflection of: 25 degrees per ball for 4-inch through 8-inch expansion joints; 20 degrees per ball for 10-inch and 12-inch expansion joints, and 15 degrees per ball for 14-inch and larger expansion joints. Two ball and socket joints required for each Double Ball Expansion Joint.
5. Provide 10 inches minimum axial elongation capability with each single or double ball expansion joint. Furnish additional expansion sections as necessary to provide the specified minimum axial elongation capability.
6. Provide force balance ball expansion joint fittings that do not expand or exert an axial thrust under internal water pressure.
7. Line all metal surfaces, including the stainless steel lock rings, with a minimum of 15 mils of fusion bonded epoxy conforming to the applicable requirements of AWWA C213. Provide EPDM sealing gaskets. Provide NSF 61 compliant coatings and gaskets.
8. Coat exterior surfaces with a minimum of 6 mils of fusion bonded epoxy conforming to AWWA C116.
9. For buried installations, install polyethylene sleeve, meeting per AWWA C105, in accordance with the manufacturer's instructions.
10. Candidate manufacturers:
    a. Romac FJ Restraint
    b. Starflex Series 5000
    c. EBAA Iron, Flex-Tend
    d. Approved equal

2.03 UNIONS

A. 2-inch and Smaller: Ground joint screwed pattern unions.

B. 2 1/2-inch and Larger: Ground joint flange unions.

C. Dielectric Unions: Match the pipe material except bronze may be used with copper piping. Dielectric unions shall be EPCO, Capitol Manufacturing, or approved equal.

2.04 INSULATING FLANGES, COUPLINGS, AND UNIONS

A. Flange Insulating Kits: 2-1/2 inches and larger:
   1. Flanged, complete with bolt insulators, dielectric gasket, bolts, and nuts.
   2. In accordance with applicable piping material specified in Piping System Schedules (Section 40 05 02.00 through 40 05 02.99). Provide insulating flange assemblies per ASME B31.9 or B31.1. Flange assembly pressure/temperature rating equal to or greater than pipeline rating.
   3. Galvanically compatible with piping.
   4. Gaskets: Full-face, Type E, with elastomeric sealing element. Sealing element retained in a groove within retainer portion of gasket.
   5. Insulating Sleeves: Full-length fiberglass reinforced epoxy (NEMA G-10 grade).
   6. Insulating Washers: Fiberglass reinforced epoxy (NEMA G-10 grade).

7. Steel Washers: Plated, hot-rolled steel, 1/8 inch thick.
8. Manufacturers:
   a. Pipeline Seal and Insulator, Houston, TX
   b. Advance Products and Systems, Lafayette, LA
   c. Approved equal

B. Insulating Sleeve Couplings:
1. Rockwell Type 416.
2. Dresser Style 39.
3. Approved equal.

C. Flexible Insulated Couplings:
1. Dresser; STAB-39.
2. Baker Coupling Company, Inc.; Series 216.
3. Approved equal

D. Insulating Unions: Union Type, 2 inches and Smaller:
1. Screwed or solder-joint.
2. O-ring sealed with molded and bonded insulation to body.
3. O-ring sealed with molded and bonded insulating bushing to union body, as manufactured by Central Plastics Co., Shawnee, OK.
4. Approved equal

2.05 COATINGS

A. Field coat mechanical couplings in Buried exposure areas with System M-1 as specified in Section 09 90 00.

B. Field coat mechanical couplings in Indoor Dry, Indoor Wet, Outdoor, Submerged, Chemical Corrosive, Headspace, and Process Corrosive exposure areas as scheduled in Section 09 90 00.

PART 3 EXECUTION

3.01 PIPE WELDING

A. 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 ASME B31.1 for piping specified in Section 40 05 02.25.

B. Welds for piping systems not specified above shall be made in accordance with AWWA C206.

3.02 FLEXIBILITY

A. Unless otherwise specified, pipe passing from concrete to earth shall be provided with two pipe couplings or flexible joints (or a double ball expansion joint) as specified on the Drawings. Locate pipe couplings within 24 inches of the structure for 2-inch through 6-inch diameter pipe; within 40 inches of the structure for 8-inch through 24-inch pipe; and

within one and one-half pipe diameters of the structure for pipe larger than 24-inch. Where required for resistance to pressure, restrain mechanical couplings in accordance with Chapter 13 of AWWA M11, including Tables 13-4, 13-5 and 13-5A, and Figure 13-20.

B. Install Single and Double Ball Expansion Joints with ¼ inch elongation/extension of the of the minimum axial elongation capability specified in this Section.

3.03 DIELECTRIC CONNECTIONS

A. Provide an insulating section of rubber or plastic pipe where a copper pipe is connected to steel or cast iron pipe. The insulating section shall have a minimum length of 12 pipe diameters.

B. Dielectric unions as specified in this Section may be used instead of the specified insulating sections.

END OF SECTION

SECTION 40 05 06.23

EXPANSION JOINTS AND FLEXIBLE METAL HOSE

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies piping expansion joints and flexible metal hose.

1.02 QUALITY ASSURANCE

A. References:

1. 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.
2. 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 A276-90	Stainless and Heat-Resisting Steel Bars and Shapes
EJMA STDS-80	Standards of Expansion Joint Manufacturers' Association, Edition No. 5

B. Performance and Service Conditions:

1. Expansion joints shall be designed in accordance with EJMA Standards for pressure, temperature and service as specified.
2. Flexible metal hose shall be suitable for a line pressure equal to the test pressure listed in the PIPESPEC.

C. Design Requirements:

1. Flexible Metal Hose: Live lengths for flexible metal hose shall be based upon the service conditions listed under paragraphs 1.02 References and 1.02 Performance and Service Conditions and a design life of 1,000,000 full displacement cycles.
2. Expansion Joints: Corrugated type expansion joints shall be suitable for a minimum of 10,000 pressure, temperature and deflection cycles (non-concurrent).

1.03 SUBMITTALS

A. The following submittals shall be provided in accordance with Section 01 33 00:

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. Design and construction details of formed metal bellows type expansion joints.
3. Pressure thrust force and spring rate data for formed metal bellows expansion joints.
4. Materials, design and construction, and temperature and pressure rating for elastomer and fabric expansion joints.
5. Details for installation of all expansion joints.
6. Listing of all flexible metal hose applications.

PART 2 PRODUCTS

2.01 EXPANSION JOINTS

A. Metal Construction:
   1. Formed Bellows Type:
      a. Medium Temperature: Formed bellows type expansion joints for temperatures up to 800 degrees F shall have 300 series stainless steel multi-ply bellows rated for the specified design temperature and pressure. Test pressures are specified in Section 40 05 02. Each expansion joint shall be factory tested at the test pressure. Ductwork expansion joints may be rated at less than 50 psig but must be rated equal to the design pressure and, in no case, less than 2 psig. Engine and gas turbine exhaust expansion joints shall be as specified in paragraph 2.01 High Temperature.
         1) Expansion joint design shall be determined by the amount and kind of movement specified (axial, lateral, angular). Unless otherwise specified, end connections shall be flanged. Formed bellows type expansion joints shall be as manufactured by Flexonics, Inc., Hyspan Precision Products, Inc., American BOA Inc. or equal.
      b. High Temperature: Engine and gas turbine exhaust expansion joints for temperatures up to 1300 degrees F shall be the multi-ply bellows type designed for 15 psig. Bellows shall be constructed of 300 series stainless steel. Unless otherwise specified, end connections shall be either the fixed flange or Vanstone flange configuration. Flange material shall be carbon steel for temperatures up to 1000 degrees F and stainless steel for temperatures 1000-1300 degrees F. Vanstone materials and flow liners, where specified, shall be the same as bellows

material. Exhaust expansion joints shall be Flexonics DEX Series, Hyspan Series 2500, American BOA Series 025E, or equal.

2. Steel Expansion Compensator Type: Steel expansion compensator type expansion joints shall be Flexonics Model H Expansion Compensator, Hyspan Series 8500, Keflex 7Q, or equal. Compensators shall have 2-ply stainless steel bellows and carbon steel shroud and end fittings. Compensators shall be rated for 175 psi maximum working pressure and 750 degrees F.
3. Bronze Expansion Compensator Type: Bronze expansion compensator type expansion joints shall be Flexonic Model HB Expansion Compensator, Hyspan Series 8500, Keflex 7Q, American BOA Inc., or equal. Compensators shall have multi-ply phosphor bronze or stainless steel bellows and copper tube end fittings. Compensators shall be rated for 150 psi maximum working pressure and 400 degrees F.

B. Elastomer and Fabric Construction:

1. General: Elastomer and fabric expansion joints shall be the standard spool arch type or the precision molded spherical design type as indicated or specified. Expansion joint connectors shall have control units (restraints) to prevent excessive axial elongation and to accept the static pressure thrust in the piping system. Number and sizes of control rods or restraints shall be as determined by the manufacturer. Unless otherwise specified, single arch and sphere type expansion joints shall have 6-inch face-to-face dimension for pipe up to 8 inches and 8-inch face-to-face dimension for pipe 10 and 12 inches.
    a. The cover elastomer shall be chlorobutyl, neoprene or EPDM. For temperatures between 180 and 240 degrees F, the tube elastomer shall be chlorobutyl or EPDM. Neoprene or Buna N liners are acceptable for temperatures to 180 degrees F.
2. Spool Type: Spool type expansion joints shall be of the resilient arch type and shall be standard or tapered as specified. Unless otherwise specified, all tapered connectors shall be eccentric.
    a. Spool type expansion joints shall be constructed of multiple plies of woven fabric impregnated with elastomer and reinforced with steel rings or wire embedded in the body. Standard arch type expansion joints suitable for the specified temperature and pressure shall be provided with retaining rings or backup rings. Retaining rings shall be 3/8-inch thick steel, split, either galvanized or zinc shield coated. Expansion joints, single, multiple, or filled arch, shall be Mason Style EJBN, Garlock Style 204, Mercer Style 500, Goodall Style E-1462, General Style 1025, or equal. Filled arch type shall be used on all piping systems carrying fluids containing solids. High pressure couplings suitable for 240 degree F operating temperatures shall be Mason Style EJBN-HD, Mercer Style 510, Garlock Style 204-HP, Goodall Style E-1489, General Style 1015, or equal.
3. Spherical Molded Type: Spherical molded type expansion joints shall be precision molded of multiple plys of nylon tire cord fabric and elastomer suitable for specified temperature and pressure. Spherical molded type expansion joints shall have steel or ductile iron floating flanges, and no metal parts shall come in contact with the fluid. Single sphere molded connectors shall be Mason Type MFNC, Mercer Type 5500, Goodall Type E-611, General Type 1010, Garlock Style 8100, or equal. Double sphere or triple sphere connectors shall be provided where required to provide for the specified movement.

C. Polyvinylchloride Construction: Polyvinylchloride expansion joints shall be Celanese "Chemtrol" CPVC slip type with Teflon impregnated seal rings, Certain-teed Fluid Tite PVC, Johns-Manville PVC double bell expansion joint, or equal.

D. Teflon Construction: Teflon expansion joints shall be molded TFE bellows and shall be Metraflex T-2, Garlock Style 215, Resistoflex R-6905, EGC Style M-150, or equal.

2.02 FLEXIBLE METAL HOSE

A. General:
   1. Flexible metal hose shall be corrugated type 321 stainless steel with stainless steel fittings and shall be provided with stainless steel single braid, unless otherwise specified. End connections shall be attached by the heliarc welding process using stainless steel welding rod. Bronze flexible metal hose shall be provided for copper and brass systems.

B. Braided Type:
   1. Type A: Type A braided flexible metal hose shall be US Hose Flexonics Series 701/702, Flexweld USFWSS-31/32, American BOA Series B, or equal.
   2. Type B: Type B braided flexible metal hose shall be US Hose Flexonics Series 161, Flexweld USFWB-31, American BOA Series B, or equal.

2.03 PRODUCT DATA

A. The following information shall be provided to the Construction Manager in accordance with Section 01 33 00:
   1. Design and construction details of formed metal bellows type expansion joints.
   2. Pressure thrust force and spring rate data for formed metal bellows expansion joints.
   3. Details for installation of all expansion joints.

PART 3 EXECUTION

3.01 INSTALLATION

A. Expansion joints and anchors shall be located as specified. Location and number of guides shall be determined from EJMA Standards.

B. Expansion joints shall not be installed during times of temperature extreme or in a fully compressed or fully expanded condition.

3.02 ALIGNMENT

A. Piping systems shall be aligned prior to installation of expansion joints. Expansion joints shall not be used to correct piping misalignment during installations. Expansion joints normally preset at the factory for rated axial compression and expansion shall be installed in this preset condition.

END OF SECTION

SECTION 40 05 06.33

PIPING APPURTENANCES

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. This section specifies pipeline thermometers, flow and level gages, pressure gages, strainers, steam traps, vents and drains.

B. Exclusions:
   1. Temperature, pressure and flow measuring devices used for instrumentation are specified in Division 40 and are identified in the instrument index in Section 40 06 70.

PART 2 PRODUCTS

2.01 PIPELINE THERMOMETERS

A. General:
   1. Pipeline thermometers shall be suitable for the following temperature range as indicated in the Instrument Index in Section 40 06 70.
   2. Pipeline thermometers shall indicate fluid temperatures within the pipeline to an accuracy of plus or minus 2 percent of thermometer full scale.
   3. Pipeline thermometers shall be provided with threaded thermowell mountings, designed to permit removal of the thermometer without depressurization or loss of process fluid. For insulated pipes a thermowell with a lagging extension shall be provided.

B. Bimetallic Thermometers:
   1. Unless otherwise specified, bimetallic type thermometers shall be of the adjustable angle type mounted for convenient viewing. Bimetallic thermometers shall have type 304 stainless steel case. Thermometer dials shall be a minimum of 5 inches in diameter and shall be equipped with an external adjustment mechanism for zero reset. Bimetallic thermometers shall be Ashcroft Type EH, Marsh Mastertherm, or equal.

C. Filled Thermometers:
   1. Unless otherwise specified, filled type thermometers shall have minimum scale length of 9 inches and shall be of the adjustable angle type mounted for convenient viewing. Filled thermometers shall consist of a type 304 stainless steel frame and a mercury-filled pyrex tube. The thermometer tube shall be recessed into the frame. Filled thermometers shall be Weksler, Taylor, or equal.

2.02 FLOW AND LEVEL GAGES

A. Rotameters:

1. Unless otherwise specified, rotameters for purges and other low capacity services shall be Brooks Sho-Rate "50," Wallace & Tiernan 3-inch purge meter, Schutte & Koerting, or equal, with integral needle valve and flow controller. Meter tubes shall be glass, floats shall be stainless steel, and cases shall be aluminum or stainless steel. Unless otherwise specified, meter sizes shall be selected so that the flow rate recommended by the manufacturer of the purged equipment falls within the middle third of the meter scale. Units shall have a 3-inch minimum scale direct reading in the units of flow.
2. Rotameters for high capacity service shall be glass tube-type with a 5-inch scale and stainless steel frame. Flow range shall be as specified and scales shall indicate the units of flow. Rotameters shall be as manufactured by Brooks, Wallace & Tiernan, Schutte & Koerting, or equal.

B. Sight Gages:
1. Sight gages shall be 3/4-inch Penberthy 205 Series, Lunkenheimer Fig. 589, or equal, automatic water gage complete with pyrex gage glass and gage glass protector. Overall length of gages, type of mounting, and orientation of set shall be as specified.

C. Flow Indicators:
1. Flow indicators shall be provided where specified. Each indicator shall consist of a bronze body with threaded ends and a sight glass with rotary wheel. Pressure ratings for flow indicators shall match pipe pressure ratings. Indicators shall be as manufactured by Jacoby-Tarbox, Schutte & Koerting, Eugene Ernst Products, or equal.

2.03 PRESSURE DEVICES

A. Gage Cocks:
1. 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:
1. 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, 1/2-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.
2. 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.
3. 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 Duragauge Fig. 1279, Ametek 1981L, or equal.

C. Diaphragm Seals:
1. Unless otherwise specified, seals shall be diaphragm type with 1/4-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. Pressure Sensors

1. Unless otherwise specified, pressure sensors (tubular chemical seals) shall be the in-line full stream captive sensing liquid type. Wetted parts shall be 316 stainless steel. Flexible cylinder shall be Buna-N unless otherwise specified. Seals shall be rated for 200 psi with 5-inch SC hysteresis. Seals shall be Ronningen-Petter, Red Valve, or equal.
2. Fill fluid shall be rated for a temperature range of -20 degrees F to 200 degrees F. Capillary tubing shall be armored stainless steel. Fittings shall be provided for vacuum filling of system. Systems that are not factory filled shall be vacuum filled in the field. Filling connections shall be soldered shut after vacuum evacuation and filling.

2.04 STRAINERS

A. Air and Gas Strainers:

1. Unless otherwise specified, air and gas line strainers shall be Y-pattern, cast iron body, with 40 mesh Monel screens packed with Everdur wool. Bronze bodies shall be provided with copper piping. Air line strainers shall be fitted with a brass blowoff cock. Strainers shall be Mueller, Armstrong, or equal.

B. Steam and Water Strainers:

1. Steam and water strainers shall be of Y-pattern, unless otherwise specified. Steam strainers shall have carbon steel body; water strainers shall have cast iron body. Bronze bodies shall be provided with copper piping. Strainers shall have 304 stainless steel screens and tapped and plugged blowoff connections. Screen perforations shall be 0.020 inch for steam service and 0.045 inch for water service. Strainers shall be Mueller, Armstrong, or equal.

C. Fuel Oil Strainers:

1. Fuel oil strainers shall be of the basket type and shall have cast iron body with 304 stainless steel screens. Screen perforation shall be 3/64 inch. Strainers shall be Bailey No. 1, Mueller, or equal.

2.05 NOT USED

2.06 PRODUCT DATA

A. Manufacturer's product data shall be provided in accordance with Section 01 33 00.

PART 3 EXECUTION

3.01 PIPELINE THERMOMETERS

A. Unless otherwise specified, filled thermometers shall be used on all water based services, and bimetallic thermometers shall be used for high temperature (300 degrees F or above) steam or gaseous services. Filled thermometers shall be installed where vibration or unstable mounting conditions exist. Thermometers shall be provided for all water and process stream inlets and outlets at each heat exchanger, heat extractor, and

chiller; where shown, and adjacent to process taps for temperature sensing or transmitting instrumentation. Thermometers for sludge service shall be provided at elbows with the process sensor oriented in the direction of sludge flow.

3.02 GAGE TAPS

A. Gage taps shall be provided on the suction and discharge of pumps, fans, compressors, vacuum pumps and blowers. Gage taps shall consist of a 1/4-inch gage cock attached by a threaded nipple to the pipeline, duct or equipment.

3.03 VENTS AND DRAINS

A. Manual air vents shall be provided at the high points of each reach of pipeline where specified. Air vents shall consist of bronze cock and copper tubing return. Air vents shall be taken to the nearest floor with cock mounted 4 feet above the floor. Vents in piping systems for fluids containing solids shall be 1-inch nonlubricated eccentric plug valves fitted with quick couplers.

B. Drains shall be piped to a sump, gutter, floor drain or other collection point with a valve mounted 4 feet above the floor. Drain valves shall be threaded end gate valves of the size specified. When drains cannot be run to collection points, they shall be routed to a point of easy access and shall have hose gate valves of the size specified.

END OF SECTION

SECTION 40 05 07

HANGERS AND SUPPORTS FOR PROCESS PIPING

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. This section specifies hangers and supports for all piping systems specified in Section 40 05 02. This section does not include pipe supports for fire sprinkler systems, pipe anchors, guides or seismic restraints.
   2. Scope Of Contractor Design: The Contractor shall provide the services of a "Design Professional" as specified in Section 40 05 01 to conduct all necessary piping and support design for exposed piping.
      a. Whether a design or general arrangement is shown or not, Contractor's Design Professional shall design all pipe supports, anchorage, restraints and expansion control within the scope described in Section 40 05 01. Where a conflict arises, Contractor's Design Professional shall present any conflict to City for resolution.
      b. As described in Section 40 05 01, the Design Professional's work shall incorporate design criteria and other conditions as specified herein, in related sections, and as shown on the drawings.
      c. Additional requirements are specified in related sections.
   3. Scope Of Work By Engineer: Engineer has undertaken design details for supports and anchors as shown on the drawings. Contractor's Design Professional shall incorporate these features into the Contractor's design.
      a. Where shown, Engineer has also provided guidance in the form of general arrangements that may include specific types of supports or anchorage details. In addition, allowable anchor points and load capacities for potential support structures are shown or otherwise described herein.

B. Operating Conditions:
   1. 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:
      a. Hot Systems
         1) A - 1. 120 degrees F to 450 degrees F
         2) A - 2. 451 degrees F to 750 degrees F
         3) A - 3. Over 750 degrees F
      b. Ambient Systems
         1) B. 60 degrees F to 119 degrees F
      c. Cold Systems
         1) C - 1. 33 degrees F to 59 degrees F
         2) C - 2. -20 degrees F to 32 degrees F

C. Hanger and Support Selection:

1. 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 40 42 00, and any special requirements which may be specified in the project manual.
2. 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.
3. 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:
    a. Weights of pipe, valves, fittings, insulating materials, suspended hanger components, and normal fluid contents.
    b. Weight of hydrostatic test fluid or cleaning fluid if normal operating fluid contents are lighter.
    c. Reaction forces due to the operation of safety or relief valves.
    d. Wind, snow or ice loadings on outdoor piping.
4. Hangers and supports shall be sized to fit the outside diameter of pipe, tubing, or, where specified, the outside diameter of insulation.
5. 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.
6. 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.
7. 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.
8. 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.
9. 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.
10. Unless otherwise specified, existing pipes and supports shall not be used to support new piping.
11. Unless otherwise specified, pipe support components shall not be attached to pressure vessels.
12. Stock hanger and support components shall be used wherever practical.

1.02 REFERENCES

A. 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.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the

Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, 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

A. 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:
   1. 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, 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 2.02 Steel Pipe (Uninsulated) 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 2.02 Steel Pipe (Uninsulated) 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.

g. 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 2.02 Framing Channel. 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 2.02 Framing Channel. 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 2.02 Type E – Framing Channel Post Base.

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 2.02 Framing Channel. 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 2.02 Framing Channel. 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 2.02 Framing Channel.
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

A. 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 40 42 00. 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.

B. 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.

C. 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

A. Hanger and support locations and components shall be indicated on the piping layout drawings required by Section 40 05 01-1.05.

PART 3 EXECUTION

3.01 HANGER AND SUPPORT LOCATIONS

A. 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.

B. At least one hanger or support shall be located within 2 feet from a pipe change in direction.

C. The Contractor shall locate hangers and supports to ensure that connections to equipment, tanks, etc., are substantially free from loads transmitted by the piping.

D. 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.

E. 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

A. 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.

B. 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.

C. The Contractor shall install items to be embedded before concrete is poured. Fasten embedded items securely to prevent movement when concrete is poured.

D. Embedded anchor bolts shall be used instead of concrete inserts for support installations in areas below water surface or normally subject to submerging.

E. 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.

F. Hanger and support components in contact with plastic pipe shall be free of burrs and sharp edges.

G. Rollers shall roll freely without binding.

H. 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.

I. Baseplates shall be cut and drilled to specified dimensions prior to welding stanchions or other attachments and prior to setting anchor bolts.

J. 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

A. 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 40 05 07.13

SEISMIC RESTRAINTS FOR PIPING

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. This section specifies seismic restraints for bracing all piping systems specified in Section 40 05 02.

B. Definitions:
   1. Longitudinal direction--direction parallel to the pipe axis.
   2. Lateral direction--direction perpendicular to the pipe axis.

C. Operating Conditions:
   1. The seismic restraints specified in this section are provided to resist pipe movements and loads occurring as a result of an earthquake or other seismic event.
   2. Unless otherwise specified, all piping shall have bracing to resist seismic loading caused by forces applied at the individual pipe's center of gravity as defined by the design criteria in Sections 01 88 14 and 01 73 23.

D. Restraint Selection:
   1. Unless otherwise specified, the Contractor shall select, locate and provide seismic restraints for piping in accordance with the project manual.
   2. The Contractor shall review the piping layout in relation to the surrounding structure and adjacent piping and equipment before selecting the restraint to be used at each point.
   3. Seismic restraints may be omitted from the following installations:
      a. Gas piping less than 1-inch inside diameter.
      b. Piping in boiler and mechanical rooms less than 1 1/4-inch inside diameter.
      c. All other piping less than 2 1/2-inch inside diameter.
      d. All piping suspended by individual hangers 12 inches or less in length from the top of the pipe to the bottom of the support for the hanger.
   4. Piping systems shall not be braced to dissimilar parts of a building or to dissimilar building systems that may respond in a different mode during an earthquake. Examples: wall and a roof; solid concrete wall and a metal deck with lightweight concrete fill.
   5. Restraints shall be sized to fit the outside diameter of the pipe, tubing, or, where specified, the outside diameter of insulation.
   6. There shall be no contact between a pipe and restraint component of dissimilar metals. The contractor shall prevent contact between dissimilar metals when restraining copper tubing by the use of copper-plated, rubber, plastic or vinyl coated, or stainless steel restraint components.
   7. Branch lines shall not be used to brace main lines.
   8. Seismic bracing shall not limit the expansion and contraction of the piping system.

1.02 QUALITY ASSURANCE

A. References:

1. 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.
2. 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 A58.1-82	Minimum Design Loads for Buildings and Other Structures
AISC Manual of Steel Construction	American Institute of Steel Construction, Manual of Steel Construction, Allowable Stress Design - 9th Edition
FEDSPEC WW-H-171e-78	Hangers and Supports, Pipe
MFMA-2-91	Metal Framing Standards Publication
MSS SP-58-93	Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-69-91	Pipe Hangers and Supports - Selection and Application
SMACNA, PPIC	Guidelines for Seismic Restraints of Mechanical Systems and Plumbing Piping Systems

B. Approval:

1. Seismic restraint load calculations specified in paragraph 3.01 shall be reviewed and signed by a structural engineer registered in the State of California.

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

A. Standard pipe restraints and components shall be manufactured by Carpenter & Patterson, B-Line, Kin-Line, ITT Grinnell, Michigan, Pipe Shields Incorporated, Superstrut, Unistrut, or equal. Pipe restraint materials shall conform to the requirements of MSS SP-58 and MFMA-1.

2.02 MATERIALS

A. General:

1. Unless otherwise specified, restraints, including braces, pipe and structural attachments, shall be hot-dip galvanized after fabrication. Nuts, bolts and washers, fittings and accessories, may be mechanically zinc-coated except for those subject to moisture or corrosive atmosphere, which shall be type 304 stainless steel.

B. Pipe Attachments:

1. Type 1s: Clevis Restraint Attachment: Clevis attachment shall be Type 1, clevis pipe hanger, as specified in Section 40 05 07-2.02 Pipe Hangers and Supports.
2. Type 3s: Double Bolt Restraint Clamp: Restraint clamp shall be Type 3, double bolt pipe clamp, as specified in Section 40 05 07-2.02 Pipe Hangers and Supports.
3. Type 4s: Roller Restraint Attachment: Roller attachment shall be Type 4, adjustable roller hanger, as specified in Section 40 05 07-2.02 Pipe Hangers and Supports. Hold down strap shall be carbon steel and sized as follows: pipe size 1 inch through 2 inch shall be 1 inch by 1/8 inch thick, pipe sizes 2 1/2-inch through 4 inch shall be 1 1/4-inch by 3/l6 inch thick, 6 inch pipe shall be 2 inch by 3/l6 inch thick, 8 inch pipe shall be 2 1/2-inch by 3/16 inch thick, 10-inch through 16-inch pipe shall be 2 1/2-inch by 1/4 inch thick, 20-inch pipe shall be 3 inch by 1/4 inch thick, and 24-inch pipe shall be 3 inch by 3/8 inch thick.
4. Type 7s: U-Bolt Restraint: U-bolt restraint shall be Type 7, U-bolt, as specified in Section 40 05 07-2.02 Pipe Hangers and Supports.
5. Type 13s: Framing Channel Strap Restraint: Strap restraint shall be Type 13, framing channel pipe strap, as specified in Section 40 05 07-2.02 Pipe Hangers and Supports.
6. Type 14s: Pipe Clamp Restraint: Pipe clamp shall be carbon steel, with configuration and components equivalent to MSS and FEDSPEC Type 4. Rod attachment and longitudinal brace connection stud shall be carbon steel, fabricated and welded by the manufacturer.
    a. Steel pipe (insulated)--shall be Superstrut No. S-720, Kin-Line No. S475, or equal, with insulation shield.
    b. Steel pipe (uninsulated)--shall be Superstrut No. S-720, Kin-Line No. S475, or equal.
    c. Cast and ductile iron pipe--shall be Superstrut No. S-720, Kin-Line No. S475, or equal.
    d. Copper pipe (insulated)--shall be Superstrut No. S-720, Kin-Line No. S475, or equal, with insulation shield.
    e. Copper pipe (uninsulated)--shall be Superstrut No. S-720, Kin-Line No. S475, or equal, with insulation shield or dielectric lining.
    f. Plastic pipe--shall be Superstrut No. S-720, Kin-Line No. S475, or equal.

C. Trapeze Restraints:

1. General: Unless otherwise specified, trapeze members shall have a minimum steel thickness of 12 gage, with a maximum deflection 1/240 of the span.
2. Type 20s: Single Channel Lateral Restraint: Trapeze restraint cross member shall be 1 5/8-inch square carbon steel framing channel, Unistrut P1000, B-Line B22, Superstrut A-1200, or equal. Pipe attachments shall be Type 13s or Type 7s

specified in paragraph 2.02 Pipe Attachments. Rod stiffeners and lateral brace shall be as specified in paragraph 2.02 Braces and Fittings.

3. Type 21s: Double Channel Lateral Restraint: Trapeze restraint cross member shall be a double channel manufactured assembly such as Unistrut P1001, B-Line B22A, Superstrut A-1202, or equal. Pipe attachments shall be Type 13s or Type 7s specified in paragraph 2.02 Pipe Attachments. Rod stiffeners and lateral brace shall be as specified in paragraph 2.02 Braces and Fittings.
4. Type 22s: Double Channel Longitudinal Restraint: Trapeze restraint cross member shall be a double channel manufactured assembly such as Unistrut P1001, B-Line B22A, Superstrut A-1202, or equal. Pipe attachments shall be Type 13s or Type 7s specified in paragraph 2.02 Pipe Attachments. Rod stiffeners, longitudinal and lateral braces shall be as specified in paragraph 2.02 Braces and Fittings.

D. Braces and Fittings:
   1. Seismic Brace Fitting: Seismic brace fitting shall be manufactured for use with industry standard framing channel. The fitting shall be carbon steel, welded construction, two-piece linked fitting. A means to reduce noise and vibration transmission between the linked fitting parts shall be provided. Seismic brace fittings shall be Superstrut C-749N series seismic brace, Kin-Line No. 633 seismic connector fitting, or equal.
   2. Hanger Rod Stiffener Assembly: Rod stiffener channel shall be 1 5/8-inch square carbon steel framing channel, Unistrut P1000, B-Line B22, Superstrut A-1200, or equal. Rod stiffener clamps shall be complete with channel nut and shall be Superstrut ES-142, Kin-Line No. 635, or equal.
   3. Type A1 Seismic Brace: Seismic brace shall be 1 5/8-inch square carbon steel framing channel, Unistrut P1000, B-Line B22, Superstrut A-1200, Kin-Line No. 4112, or equal.
   4. Type A2 Seismic Brace: Seismic brace shall be 1 5/8-inch wide by 3 1/4-inch deep carbon steel framing channel, Unistrut P5000, B-Line B11, Superstrut H-1200, Kin-Line No. 8212, or equal.

E. Structural Attachments:
   1. General: Unless otherwise specified, hanger rod structural attachments shall be as specified in Section 40 05 07. Structural attachments for longitudinal and lateral seismic braces shall be as specified in paragraph 2.02 Structural Attachments.
   2. Type SA-1 Attachment: Brace fitting shall be as specified in paragraph 2.02 Braces and Fittings. Concrete anchors shall be as specified in Section 05 05 20 with embedment and location dimensions as specified.
   3. Type SA-2 Attachment: Brace fitting shall be as specified in paragraph 2.02 Braces and Fittings. Concrete anchors shall be as specified in Section 05 05 20 with embedment and location dimensions as specified. Framing channel shall be as specified in paragraph 2.02 Accessories.
   4. Type SA-3 Attachment: Brace fitting shall be as specified in paragraph 2.02 Braces and Fittings. Cap screw, lockwasher and hex nut materials and finish shall be compatible with structural steel material.
   5. Type SA-4 Attachment: Brace fitting shall be as specified in paragraph 2.02 Braces and Fittings.
   6. Type SA-5 Attachment: Brace fitting shall be as specified in paragraph 2.02 Braces and Fittings. Four-inch x 3-inch x 3/8-inch angle shall be carbon steel.

F. Accessories:
   1. Hanger Rods: Rods shall be carbon steel, threaded on both ends or continuous threaded and sized as specified.
   2. Framing Channel: Framing channel shall conform to the Metal Framing Manufacturers Association standard MFMA-1. Framing channel shall be roll formed, 12-gage carbon steel. Channel shall have a continuous slot along one side with in-turned clamping ridges. Channel shall be Unistrut P1000 series, B-Line B22 series, Superstrut A-1200 series, or equal.
   3. Rod Coupling: Rod coupling shall be carbon steel, with sight hole in center of coupling body, Grinnell Fig. 135, Superstrut H-119, or equal.

2.03 THERMAL PIPE HANGER SHIELD

A. Thermal shields shall be provided at seismic restraint locations on pipe requiring insulation. Thermal pipe hanger shields shall be as specified in Section 40 05 07-2.03. Stainless steel band clamps shall be provided on thermal shields at longitudinal pipe restraint locations.

2.04 PRODUCT DATA

A. The following information shall be provided as specified in Section 01 33 00:
   1. Seismic restraint locations and legend as specified in paragraph 3.01.
   2. Load calculations as specified in paragraph 1.02 Approval.

PART 3 EXECUTION

3.01 PIPE RESTRAINT LOCATIONS

A. The first seismic restraint on a piping system shall be located not more than 10 feet from the main riser, entrance to a building or piece of equipment.

B. Cast iron pipe shall be braced on each side of a change in direction of 90 degrees or more. Joints in risers shall be braced or stabilized between floors.

C. No-hub and bell and spigot cast iron soil pipe shall be braced longitudinally every 20 feet and laterally every 10 feet.

D. Lateral bracing for one pipe section may also act as longitudinal bracing for the pipe section connected perpendicular to it, if the bracing is installed within 24 inches of the elbow or tee of the same size.

E. Seismic restraint locations and components shall be indicated on the piping layout drawings required by Section 40 05 01-1.05. The Contractor shall provide a legend giving load information and restraint component selection at each restraint location.

3.02 INSTALLATION

A. Rod stiffener assemblies shall be used at seismic restraints for hanger rods over 6 inches in length. A minimum of two rod stiffener clamps shall be used on any rod stiffener assembly.

B. Lateral and longitudinal bracing shall be installed between 45 degrees above and 45 degrees below horizontal, inclusive, relative to the horizontal centerline of the pipe.

C. Welded and bolted attachments to the building structural steel shall be in accordance with the requirements of the AISC Manual of Steel Construction. There shall be no drilling or burning of holes in the building structural steel without approval of the Construction Manager.

D. Embedded anchor bolts shall be used instead of concrete inserts for seismic brace installations in areas below water surface or normally subject to submerging.

E. The Contractor shall install thermal pipe hanger shields on insulated piping at required locations during restraint installation. Butt joint connections to pipe insulation shall be made at the time of insulation installation in accordance with the manufacturer's recommendations.

F. Restraint components in contact with plastic pipe shall be free of burrs and sharp edges.

G. Rollers shall roll freely without binding.

H. 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.

END OF SECTION

SECTION 40 05 07.16

EXPANSION CONTROL FOR PIPING

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:

1. This section specifies expansion control for the piping systems specified in paragraph 1.01 Operating Conditions. This section addresses pipe anchorage, pipe guides, and expansion control by either expansion joints or pipe deflection.

B. Definitions:

Term	Definition
Expansion joint	Any device containing one or more bellows used to absorb dimensional changes.
Main anchor	An attachment between a structure and a pipe which must withstand the full pipeline thrust due to pressure, pipe bending, pipe compression, flow, spring forces, pipe and contents weight and other pipe forces.
Intermediate anchor	An attachment between a structure and a pipe which withstands the same forces as a main anchor except the pressure forces.
Sliding anchor	An attachment between a structure and a pipe which absorbs forces in one direction while permitting motion in another.
Pipe guide	A device fastened to a structure, which permits the pipeline to move freely in only one direction, along the axis of the pipe.
Pipe section	That portion of pipe between two anchors.
Planar pipe guide	A device fastened to a structure, which permits transverse movement or bending of the pipeline in one plane.
Lateral direction	Direction perpendicular to the pipe axis
Longitudinal direction	Direction parallel to the pipe axis

C. Operating Conditions:

1. Expansion control as specified in this section shall be provided to control pipe movements and loads occurring as a result of pipeline temperature changes.
2. Those piping systems listed in the following table shall be provided with expansion control conforming to good engineering practice.

Piping system	Minimum temperature, degrees F	Maximum temperature, degrees F
MSG	30	120
CHWR/CHWS	30	100

1.02 QUALITY ASSURANCE

A. References:

1. 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.

2. 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
AISC Manual of Steel Construction	American Institute of Steel Construction, Manual of Steel Construction, Allowable Stress Design - 9th Edition
EJMA-93	Standards of the Expansion Joint Manufacturers Association, Inc., Sixth Edition, 1993
EJMA-85	A Practical Guide to Expansion Joints, Copyright 1985, Expansion Joint Manufacturers Association, Inc.

B. Design:

1. The expansion control system shall be designed by the Contractor's Design Professional selected under Section 40 05 01-1.01 Summary. Expansion control details shall be designed in conjunction with preparation of pipe system hangers and seismic restraint systems drawings specified in Section 40 05 01-1.05. The resulting drawings and work product for the expansion control system shall bear the Design Professional's registration seal and signature. The requirement, however, shall not be construed as relieving the Contractor of responsibility for this portion of the work.

C. Design Guidelines:

1. The Design Professional shall use the following guidelines in preparation of the designs and calculations specified in paragraph 1.02 Design:
   a. The difference between the minimum and maximum temperatures listed in the table in paragraph 1.01 Operating Conditions shall be used for calculating pipe expansion.
   b. Published coefficients of thermal expansion for pipe materials shall be used for the listed temperature range. The source of the coefficients of expansion used in the calculations shall be included with the information provided as Product Data.
   c. Expansion control systems shall be designed for maximum reliability. Unless otherwise indicated on the Drawings, "L", "U", or "Z" bends shall be employed to control expansion in preference over expansion joints.
   d. Expansion control systems using pipe bends shall be designed to limit bending stress in the pipe associated with deflection at the worst case temperature difference. The maximum allowable bending stress shall be 1/3 of the yield stress for the pipe material. If loading conditions or uncertainties warrant, a lower allowable stress value shall be used. A recognized pipe bending stress calculation method and documentation supporting its use shall be provided as Product Data.

e. The requirements set forth in Section 40 05 06.23 shall prevail if expansion joints are used. Expansion control design for expansion joints shall conform to the guidelines given in the Standards of The Expansion Joint Manufacturers Association, Inc. (EJMA).

f. If the Design Professional chooses to use expansion control or pipe support methods that involve higher loadings on the structure than are specified and/or shown on the drawings, the Construction Manager shall be notified in the submittal required in Section 40 05 01-1.05. The requested loads shall be listed and the Construction Manager will redesign the structure as necessary at the Contractor's expense.

g. The test pressures listed in the PIPESPEC sheets shall be used when calculating pressure forces.

h. Pipe guides or planar pipe guides shall be provided to control the movement of pipes when "L", "U", or "Z" bends are used for expansion control. The guides shall be located as indicated in EJMA standards. An alternative recognized standard may be used for this purpose only upon approval by the Construction Manager.

i. For piping systems with potentially large loads, recommended main anchor locations are shown on the drawings. Intermediate anchors shall be provided as needed. Maximum forces that the structure can withstand at the main anchor points are noted on the drawings. Anchors shall be designed to attach to the structure and solidly to the pipe. Pipe clamps or U-bolts are not allowed unless they are designed to withstand the forces imposed upon the anchor and have stops welded to the pipe so that the pipe cannot slip in the anchor.

j. Anchors and guides shall be coordinated with the pipe support systems specified in Section 40 05 07 and seismic restraints specified in Section 40 05 07.13.

k. The design of the expansion control, pipe support and seismic restraints for the listed piping systems shall be integrated to provide maximum flexibility for maintenance access to equipment, appurtenances such as valves etc., and to the pipe itself.

l. The piping layout indicated shall be reviewed in relation to, surrounding structures, adjacent piping and equipment before selecting the anchors, guides, and expansion control method to be used at each point.

m. There shall be no metal-to-metal contact between a pipe and restraint component of dissimilar metals.

n. Branch lines shall not be used to anchor main lines.

o. For elevated pipe sections, fabricated support frames or other appropriate structures shall be designed to withstand the specified loads plus gravity and seismic loads. The supports shall be designed to provide access to equipment, walkways, gates, and other piping.

1.03 SUBMITTALS

A. The following information shall be provided in accordance with Section 01 33 00:
   1. Expansion control schedules as specified in paragraph 3.01.

PART 2 PRODUCTS

2.01 MATERIALS

A. Unless otherwise specified, anchors, and guides shall be manufactured of iron or steel, including braces, pipe and structural attachments, and shall be hot-dip galvanized after fabrication. Supports cast integrally with cast iron fittings are specifically prohibited for use in any application where shear forces may be imposed on the support. Structural anchors may be fabricated from structural steel and coated as specified in Section 09 90 00. Nuts, bolts and washers may be zinc-plated except for those subject to moisture or corrosive atmosphere, which shall be Type 304 stainless steel.

2.02 PRODUCT DATA

A. The following product data shall be provided as specified in Section 01 33 00:
   1. Anchor bolt calculations in accordance with Section 05 05 20 requirements.
   2. The Design Professional's reports and final certification, as specified under paragraph 3.03.

PART 3 EXECUTION

3.01 EXPANSION CONTROL SCHEDULES

A. General: Anchor, guide, and expansion joint locations shall be indicated on the piping layout drawings required by Section 40 05 01-1.05 and paragraph 1.02 Design. In addition, schedules shall be prepared as specified below.

B. Anchors:
   1. The anchor schedule shall list as a minimum:
      a. Anchor Point Label
      b. Pipe Size and Service
      c. Contract Drawing No.
      d. Layout Drawing No.
      e. Forces
      f. Load, pounds
      g. Direction
      h. Anchor Description
      i. Remarks

C. Guides:
   1. The guide schedule shall list as a minimum:
      a. Guide Label
      b. Pipe Size and Service
      c. Contract Drawing No.
      d. Layout Drawing No.
      e. Guide Description
      f. Remarks

D. Expansion Joints:
   1. The expansion joint schedule shall list as a minimum:
      a. Expansion Joint Label
      b. Pipe Size and Service
      c. Contract Drawing No.
      d. Layout Drawing No.
      e. Movement, inches
         1) Lateral movement
         2) Compression movement
         3) Extension movement
         4) Angular movement
      f. Maximum Spring Force, pounds
      g. Test Pressure, PSIG
      h. Pressure Force, pounds
      i. Total Forces
      j. Load, pounds
      k. Direction
      l. Expansion Joint Description
      m. Special Features
      n. Remarks

3.02 INSTALLATION

A. The Contractor shall install the expansion control system in accordance with the drawings required in paragraph 1.02 Design.

B. Welded and bolted attachments to the building structural steel shall be in accordance with the requirements of the AISC Manual of Steel Construction. There shall be no drilling or burning of holes in the building structural steel without approval of the Construction Manager.

C. Unless otherwise specified, embedded anchor bolts shall be used instead of concrete inserts, wedge anchors, expansion anchors, adhesive, or other non-embedded type of anchor for expansion control installations in areas below water surface or normally subject to submerging.

D. The Contractor shall install thermal pipe hanger shields on insulated piping at required locations during guide installation. Butt joint connections to pipe insulation shall be made at the time of insulation installation in accordance with the manufacturer's recommendations. Anchors shall be directly connected to the pipe by welding or another acceptable, positive means.

E. Components in contact with plastic pipe shall be free of burrs and sharp edges.

F. Rollers shall roll freely without binding.

G. 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 INSPECTION AND CERTIFICATION

A. The Design Professional retained by the Contractor under the provisions of Section 40 05 01-1.01 Summary and paragraph 1.02 Design shall inspect the completed expansion control system at not less than bi-weekly intervals during construction and furnish the Construction Manager with monthly reports. The Design Professional shall inspect the completed expansion control system before the Owner assumes beneficial occupancy and provide written certification in accordance with Section 40 05 07 requirements.

END OF SECTION

SECTION 40 05 17

COPPER PROCESS PIPE AND TUBING

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies copper pipe, tube, and fittings.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 33 00 – Submittal Procedures
   2. Section 01 66 00 – Product Storage and Handling Requirements
   3. Section 40 05 01 – Piping Systems
   4. Section 40 05 02 – Piping System Schedules
   5. Section 40 05 06 – Specialty Couplings and Adapters for Process Piping

1.03 REFERENCES

A. 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.

Reference	Title
ASTM B32	Solder Metal
ASTM B88	Seamless Copper Water Tube

1.04 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. 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 (✓) denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager is the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the

specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

3. Manufacturers' product data, catalog cuts, typical installation details, and dimensions demonstrating compliance with the requirements of this Section.
4. Indicate on the submittal each piping system where the product will be used.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00 for Shipment and Storage.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Candidate manufacturers are listed below for double ferrule compression fittings.
   1. Swagelok.
   2. Gyrolok.
   3. Equal.

2.02 MATERIALS

A. All pipe system materials to be new, free from defects and conforming to the requirements and standards identified in the Piping System Schedules specified in Section 40 05 02.00 through Section 40 05 02.99.

B. Couplings and Fittings.
   1. Double ferrule compression fittings capable of holding the full bursting strength of connected tubing.
   2. Provide tapered piping reducers/enlargers. Bushing type adapters are not permitted.

C. Joint Solder
   1. Except where otherwise specified in the Piping System Schedules, use ASTM B32, Alloy Grade Sn95 solder for general use in copper piping.
   2. ASTM B32 Alloy Grade E, or Silvabrite 100, for high pressure and high temperature services, where specified.
   3. Brazing, for saturated steam, AWS Classification BCuP-5 (AWS A5.8/A5.8M) or Sil-Fos® 15, where specified.

PART 3 EXECUTION

3.01 INSTALLATION

A. Cleaning.
   1. Remove foreign material from the pipe interior prior to assembly. Swab the pipe interior.
   2. Deburr pipe end and sand using fine emery cloth.

B. Dielectric protection.

1. Copper tubing or fittings in contact with dissimilar metal piping, reinforcing steel, or other dissimilar metal at any location is not permitted.
2. Make electrical checks to assure no contact is made between copper tubing and ferrous elements.
3. Wherever electrical contact is demonstrated by such tests, provide dielectric protection as specified in Section 40 05 06.

3.02 REPAIR/RESTORATION

A. Per Section 40 05 01.

3.03 COMPONENT TEST PHASE

A. Per Section 40 05 01.

END OF SECTION

SECTION 40 05 23

STAINLESS STEEL PROCESS PIPE AND TUBING

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies stainless steel pipe and fittings.

1.02 RELATED SECTIONS

A. Section 40 05 01 – Piping Systems

B. Section 40 05 02 –Piping System Schedules

1.03 QUALITY ASSURANCE

A. References:
   1. 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.
   2. 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
ASME B31.1	Process Piping
ASME Section IX	Boiler and Pressure Vessel Code; Welding and Brazing Requirements
ASTM A480	General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
AWWA M11	Steel Pipe-A Guide for Design and Installation
AWWA C227	Bolted, Split-Sleeve Restrained and Non-Restrained Couplings for Plain-End Pipe
AWWA C606	Grooved and Shouldered Joints
CSA W48.3	Low Alloy Steel Covered Electrodes for Shielded Metal Arc Welding

1.04 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.

2. 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 CITY 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.
3. Piping layout drawings as specified in Section 40 05 01.
4. Manufacturers' product data, catalog cuts, typical installation details, and dimensions. Indicate on the submittal each piping system where the product will be used.
5. Calculations for fabricated pipe and fittings in accordance with the specified ASME B31 code.
6. Submit calculations for engineered flange face rings in accordance with Appendix D of ASME Section VIII Division 1.

B. Informational Submittals:
1. Procedures: Section 01 33 00.
2. Manufacturers' certificates of compliance with specified industry standards.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00 for Shipment and Storage.

B. Deliver pipe and fittings with end protectors in place. Do not remove protectors until materials are about to be installed.

C. Prevent carbon steel contamination of stainless steel pipe and fittings during storage, handling, fabrication, and installation.

PART 2 PRODUCTS

2.01 MATERIALS

A. All pipe system materials to be new, free from defects and conforming to the requirements and standards specified in Piping System Schedules (Section 40 05 02.00 through Section 40 05 02.99) and this Section.

B. Pipe.
1. Conform to the industry standards listed in the individual pipe systems listed in Sections 40 05 02.
2. For shop-fabricated pipe, use only pickled and annealed sheet or plate.
3. Finish.

a. 8-gage through 16-gage material: No. 1 or 2B per ASTM A480.
b. 3/16-inch and heavier plate material: No. 1 mill finish per ASTM A480, "Hot-Rolled or Cold-Rolled, and Annealed or Heat Treated, and Blast Cleaned or Pickled."

C. Shop-fabricated stainless steel pipe and fittings.
1. Furnished by a single manufacturer who is experienced and qualified in the manufacture and fabrication of the items to be provided.
2. Manufacture using Weld Procedure Specifications (WPS) that have been qualified under ASME Section IX. Document qualifications in Procedure Qualification Reports (PQR). Use only certified welders who have successfully completed performance qualification tests per ASME Section IX for manufacture of stainless steel pipe.

D. Flanges.
1. Forged steel backing flange ring in minimum Class 150 thickness.
2. Where specified, provide ductile iron backing ring flanges with the following thicknesses or greater.

Flange Size, in	Flange Thickness, minimum, in.
3	1/2
4	9/16
6 thru 10	5/8
12 thru 16	3/4
18 thru 22	7/8
24 thru 30	1
36	1-1/8
42	1-1/4
46 to 54	1-3/8
60	1-1/2

3. Stub ends.
a. Wall thickness equal to or greater than pipe or fitting to which it is welded.
b. Lap face/gasket mating surfaces clean, free of debris, with welds ground flush and surface roughness between 3.18 and 12.7 microns RMS.

E. Fittings.
1. Double ferrule compression fittings capable of holding the full bursting pressure of connected tubing.
2. Candidate manufacturers for double ferrule compression fittings.
a. Swagelok.
b. Gyrolok.
c. Approved Equal.
3. Provide straight tapered reducers. Flanged & flued reducers and bushing type adapters are not permitted.
4. Pressure rating and thickness of elbows, tees, crosses, and wyes equal to or greater than connecting pipe.

F. Grooved couplings and fittings.
   1. Flexible and rigid coupling with pipe grooves compliant with AWWA C606.
   2. When pipe wall thickness does not meet the minimum requirements of AWWA C606 for rolled or cut groove joints, provide shoulder ends per the requirements of AWWA C606.
   3. Candidate manufacturers.
      a. Victaulic
      b. Gruvlok
      c. Approved equal.

G. Bolted split sleeve couplings.
   1. AWWA C227 compliant sleeve with single or double arch cross section of the same material as pipe. Body thickness equal to or greater than that of connecting pipe wall thickness.
   2. Provide bolts, nuts and hardware that are of the same stainless steel grade as the coupling body.
   3. Candidate manufacturers.
      a. Victaulic, Style 231S through 234S.
      b. Approved equal.

2.02 SHOP FABRICATION

A. Metal forming processes.
   1. Use pinch rolls with a hard chrome finish to form cylinders. Thoroughly clean the rolls using Avesta BlueOneTM 130 Pickling Paste or approved equal, prior to roll forming the pipe. Alternatively, provide a protective barrier between the stainless steel plate/sheet and the plate rolls during the forming process.
   2. Provide a protective barrier between pipe welding rollers and the stainless steel pipe cylinder. Alternately, new rollers or rollers that have been turned down on a lathe to provide a new and clean working face may be used.

B. All saws, drills, files, wire brushes, grinding wheels, etc. will be free of carbon contamination and designated for stainless steel use only.

C. Provide nonferrous, stainless steel, or rubber-lined pipe storage and fabrication racks.

D. Use nylon slings or straps for handling stainless steel piping.

E. Preparation of surfaces to be welded.
   1. Surfaces of joints to be welded are to be free from mill scale, slag, grease, oil, paint, rust, and other foreign material.
   2. Use only stainless wire wheels and grinding wheels that have not come into contact with carbon steel.
   3. Flame cutting or any use of oxy-acetylene gas cutting tools is prohibited. Use plasma arc torch with a nitrogen or argon-hydrogen carrier gas, laser or waterjet processes for cutting and plate beveling.
   4. Air arc and gas backgouging are prohibited. Use grinding and plasma gouging methods to achieve full penetration welds.

F. Welding.
   1. Welding and production processes are to conform to ASME B31.1 unless otherwise specified in the individual pipe systems listed in Sections 40 05 02.
   2. Use of Solar Flux is prohibited.
   3. Use of FCAW welding is prohibited.
   4. Pipe and fittings with wall thickness up to 11-gage (1/8-inch): weld using the GTAW process.
   5. Pipe and fittings with wall thicknesses greater than 1/4-inch may be welded using an automated SAW process.
   6. Pipe and fittings with wall thickness greater than 11-gage (1/8-inch): Bevel and complete root pass using the GTAW process, followed by subsequent passes with the GTAW, GMAW, or Metallic Arc SMAW process.
   7. Filler material:
      a. Add only ELC wire grades to provide a cross section at the weld equal to or greater than the parent metal.
      b. SMAW electrodes to conform to CSA W48.3.
   8. Make weld deposit smooth and evenly distributed and with a crown of no more than 1/16-inch on the I.D. and 3/32-inch on the O.D. of the piping. Concavity, undercut, cracks, or crevices are not permitted.
   9. Full penetration butt welds: provide inert gas shielding to the interior and exterior of the joint.
   10. Lap joints: provide full thickness seal welds on both joints.

G. Remove excessive weld deposits, slag, spatter, and projections by grinding. Grind welds smooth on gasket surfaces. Tack welds, clips, and other attachments.
   1. Repair nicks, gouges, notches, and depressions in the base metal in the area before the joint weld is made.
   2. Remove tack welds, clips, and other attachments and repair defects, except where the tack welds occur within the weld area and these tack welds do not exceed the size of the completed weld. Remove cracked tack welds.
   3. Grind those areas to be repaired down to clean metal and then repair by building up with weld metal. Grind the repaired areas smooth to form a plane surface with the base metal.

H. Defects and repairs.
   1. Remove welds with cracks, slag inclusions, porosity, undercutting, incomplete penetration, or which are otherwise deficient in quality or made contrary to any provisions of these specifications, by chipping or grinding throughout their depth to clean base metal.
   2. Do not perform calking or peening of welds to correct defects.
   3. Enlarge welds found deficient in dimension but not in quality by additional welding after thoroughly cleaning the surface of previously deposited metal and the adjoining plate.
   4. Remove weld deposits, slag, weld spatter, and projections into the interior of the pipe by grinding.

I. Finish.

1. Treat all welded joints with Avesta BlueOne™ 130 Pickling Paste or approved equal and rinse with clean water.
2. If rusting of embedded iron occurs, pickle the affected surface with Avesta BlueOne™ 130 Pickling Paste or approved equal.
3. Rinse clean using Avesta FinishOne Passivator 630 or approved equal.

PART 3 EXECUTION

3.01 GENERAL

A. Field Installation Weather conditions.
   1. Perform welding only when the surfaces are clean and completely free of any moisture or mineral deposits. Protect pipe and fittings from salt water spray or deposition or clean and protect pipe and fitting joints prior to welding.
   2. Do not weld the pipe during periods of high winds or rain unless the areas being welded are properly shielded.

B. Field welding.
   1. Use couplings and prefabrication of pipe systems at the factory to minimize field welding to the greatest extent possible. Pipe butt welds may be performed at the job site, providing the butt welds are performed only with an inert gas shielded process and that the welding requirements of this Section are rigidly adhered to.
   2. On the interior and exterior of the pipe, remove all residue, oxide, and heat stain from any type of field weld and the affected areas adjacent by the use of stainless steel wire brushes, followed by cleaning with an agent such as Avesta BlueOne™ 130 or approved equal, followed by complete removal of the agent.

C. Use wooden scaffolding and/or ladders if possible to gain access to work areas. If metal scaffolding and/or ladders must be used, tape or otherwise shield the contact points between scaffolding/ladders and the stainless steel.

D. After installation, wash and rinse all foreign matter from the piping surface. Adhere to the passivation manufacturer's recommendations and local regulations for safety and disposal of any waste chemicals.

3.02 REPAIR/RESTORATION

A. Per Section 40 05 01 and as specified herein.

B. Paint all steel or iron flanges, couplings, and appurtenances in accordance with Section 09 90 00. Painting of the stainless steel pipe is not required.

C. Restore areas damaged or discolored by field welding or handling, iron contamination or soiled to a uniform surface finish and consistently clean surface with methods specified for shop fabrication.

D. Identifying spool piece marks shall be removed with paint thinner or solvents and the entire stainless steel surface shall be washed with detergent and hot water and rinsed clean.

3.03 COMPONENT TEST PHASE

A. Per Section 40 05 01.

END OF SECTION

SECTION 40 05 24

STEEL PROCESS PIPE

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies steel pipe and fittings.

1.02 QUALITY ASSURANCE

A. References:

1. 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.
2. 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
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

Reference	Title
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:
   1. Factory testing shall conform to the requirements of ASTM A53, ASTM A106, or AWWA C200 as applicable.

PART 2 PRODUCTS

2.01 PIPE MATERIALS

A. Steel pipe and fittings shall be provided in accordance with ASTM A53, ASTM A106, or AWWA C200 as specified in Section 40 05 02.

B. 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

A. Unless otherwise specified, ASTM A53 pipe shall be Type E, electric resistance welded or Type S, seamless pipe as specified in Section 40 05 02. 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.

B. 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

A. Connections shall be as specified in Section 40 05 02 and shall conform to Section 40 05 06. Coating for buried connections shall be as specified in Section 40 05 06-2.05.

2.04 FITTINGS AND APPURTENANCES

A. Malleable iron threaded fittings and appurtenances shall conform to the requirements of ASTM A47 or ASTM A197, ANSI B16.3.

B. 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.

C. 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.

D. Unless otherwise specified, all fittings shall be rated for pressure and loadings equal to the pipe.

2.05 PIPE LINING

A. Epoxy:
   1. Unless otherwise specified, pipe and fittings shall be lined with a liquid epoxy as specified in AWWA C210 with the following exceptions:
      a. No coal tar products shall be incorporated in the liquid epoxy.
      b. The curing agent may be an amidoamine as well as the other curing agents listed in AWWA C210.
   2. The lining shall be applied to a minimum thickness of 16 mils in not less than two coats.

B. Cement Mortar:
   1. 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:
   1. 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:
   1. 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.
   2. Pipe and fittings shall have all internal welds ground smooth and any voids or slag holes ground out, rewelded and ground smooth.
   3. Glass lining shall be Ferrock MEH-32, Vitco SG-14, or equal.

2.06 PIPE COATING

A. Epoxy:
   1. Unless otherwise specified, pipe and fittings shall be coated with a liquid epoxy as specified in AWWA C210 with the following exceptions:
      a. No coal tar products shall be incorporated in the liquid epoxy.
      b. The curing agent may be an amidoamine as well as the other curing agents listed in AWWA C210.
   2. The coating shall be applied to a minimum thickness of 16 mils in not less than two coats.

B. Polyethylene Tape:
   1. 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

A. 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.

B. 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

A. Joint gaskets shall be as specified in Section 40 05 06.

2.09 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00:
   1. Affidavits of Compliance with AWWA C200, ASTM A53, or ASTM A106 as applicable.
   2. Contractor's layout drawings as specified in Section 40 05 01-1.05.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
   1. Pipe shall be installed in accordance with AWWA M11, Chapter 16. Welded joints shall be in accordance with AWWA C206 and Section 40 05 06.
   2. Sleeve-type mechanical pipe couplings shall be provided in accordance with AWWA M11 and Section 40 05 06-2.02.
   3. Pipe lining and coatings at field joints shall be applied as specified in paragraphs 2.05 and 2.06.

4. Unless otherwise specified, buried mechanical couplings and valves shall be field coated as specified in Section 40 05 06-2.05.

B. Anchorage:

1. Anchorage shall be provided as specified. Calculations and drawings for proposed alternative anchorage shall be submitted in accordance with Section 01 33 00.

3.02 TESTING

A. 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 40 05 02.

END OF SECTION

SECTION 40 05 45

PIPING SYSTEM IDENTIFICATION

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies the supply and installation of permanent identification labels and markers for piping systems.

B. Requirements for the supply and installation of permanent identification tags for valves are specified in Section 40 06 50.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 33 00 – Submittal Procedures
   2. Section 01 61 45 – Area Exposure Designations
   3. Section 40 05 02 – Piping System Schedules
   4. Section 40 06 50 – Valves

1.03 REFERENCES

A. References:
   1. 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.
   2. 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
ASME A13.1	Scheme for the Identification of Piping Systems
ANSI Z535.1	Safety Colors/APWA Uniform Color Code for Marking Underground Utilities

1.04 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:
   1. Embedded/Encased piping: Piping enveloped in concrete, typically under structures or under roadways.

2. Exposed: All area exposures specified in Section 01 61 45 other than buried, submerged, or encased/embedded.
3. Buried: Below grade walls or roofs; locations covered and in contact with earth/soil.

1.05 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. Provide a full line product brochure showing available Piping System Marker and Detectable Warning Tape standard text and color options. Submit all text and colors proposed for use.
   3. Provide manufacturer's recommended installation instructions for Detectable Warning Tape.
   4. Provide product brochures and data sheets for tracer wire and splice kits. Submit all wire insulation colors proposed for use.
   5. Submit proposed tracer wire access box(es) for test leads. Submit electrical continuity test results upon completion.
   6. A copy of this Section, addendum updates included, with each paragraph check-marked to indicate compliance or marked to indicate requested deviations from Section requirements.

B. Informational Submittals:
   1. Procedures: Section 01 33 00
   2. Electrical continuity test results.
   3. Sample of each piping identification plastic marker used.
   4. Sample of each detectable warning tape used.

PART 2 PRODUCTS

2.01 PIPING SYSTEM MARKERS FOR EXPOSED PIPE

A. Identify material contained in exposed piping systems using a colored plastic marker legend system conforming to ASME A13.1.
B. For exposed piping, provide pre-coiled mechanically attached type colored markers that are easily removable. Adhesive type markers are not acceptable.
   1. Resistant to petroleum based oils and grease and meet criteria for humidity, solar radiation, rain, salt, fog, leakage and fungus specified by MIL-STD-810.
   2. Withstand a continuous operating temperature range of -40 to 250 degrees.
   3. Manufactured and applied in one continuous length of plastic including directional arrows. Markers comprised of letters and directional arrows individually applied to the maker are not acceptable. Legends and arrows printed on polyester subsurface and over laminated with Tedlar.
   4. Text size per ASME A13.1.
   5. Marking Services Style MS-995, Brady Style B-689, or approved equal.

C. Each piping system marker to be color coded for identification and labelled with the Process Service Identifier and directional flow arrows indicating the direction of flow in the pipe. Piping System marker background colors are specified in Section 40 05 02 for each process service. Except for piping system markers with an orange, yellow or white background color, provide white text and directional arrows for all piping system markers. Provide black text and directional arrows for pipe markers with an orange, yellow or white background.

2.02 DETECTABLE WARNING TAPE AND TRACER WIRE FOR BURIED PIPE

A. Provide Detectable Warning Tape for all buried piping:
   1. Detectable Warning Tape shall be 6 inches wide, colored per ANSI Z535.1 (APWA Uniform Color Code for Marking Underground Utilities) and made of inert plastic material suitable for direct burial with solid aluminum foil core. Minimum 5 mil laminate thickness. Tin or nickel plated clips for joining sections of tape, as provided by the tape manufacturer.
   2. Allen Systems, W. H. Brady Co., Seton Name Plate Corporation, Marking Services Inc., or approved equal.
   3. Print two messages on buried Detectable Warning Tape. The first message reads **"CAUTION CAUTION CAUTION _____ PIPE BURIED BELOW"** with bold letters approximately 2 inches high. Fill the blank with the Process Service name. The second message reads **"CALL____"** with letters approximately 3/4 inch high. Both messages printed at maximum intervals of 2 feet. Fill the blank with phone number provided by the Construction Manager.

B. Install tracer (locate) wire along the buried portion of pipe alignments for the following piping services: Not Applicable
   1. Direct burial rated, 12 gauge solid copper, 600-volt UF tracer wire with heavy-duty PVC insulation. Tracer wire insulation color-coded to match each utility service as designated in ANSI Z535.1 (APWA Uniform Color Code for Marking Underground Utilities).
   2. SPLICES: Silicone-filled UL-Listed product specifically designed for waterproof direct bury splicing of tracer wire. 3M DBR-6; or approve equal.
   3. WIRE ACCESS BOXES: Cast iron valve box top piece frame and cover set within a concrete ring cast flush with grade, as appropriate for the location in which it will be installed and for the traffic loading it may be subject to, and in accordance with the applicable elements of the Standard Detail for valve box installations. Mark lids in raised or recessed lettering with the word “Test”. Submit all wire access boxes proposed for use to the Construction Manager for review.

PART 3 EXECUTION

3.01 INSTALLATION OF PIPING SYSTEM MARKERS

A. Provide piping system markers and direction arrows at locations conforming to ASME A13.1 and at the following locations:
   1. Apply intermittent markings on straight pipe runs, close to all valves, fittings, and adjacent to all changes in direction.
   2. Where pipes pass through walls, partitions, and floors, apply markings on both sides of walls, partitions, and floors.
   3. At point of entry and leaving each pipe chase and/or confined space, and piping accessible at each access opening.

4. Adjacent to valves and where valves are in series at intervals of no more than 6 feet.
5. At least once in each room and at maximum spacing of 40 feet. Exception: gas piping to be identified at 6-ft intervals in ceiling plenums.
6. Spacing for markings not less than 1 foot.
7. At the beginning and end points of each run; and, at each piece of equipment in each run.

B. Visibility
1. Place identification on the bottom of the piping system for pipe systems located near ceiling or above the normal line of sight.
2. Place identification on the side of the piping systems for pipe systems located at the normal line of sight or below.
3. Place identification at approximate line of sight for vertical pipe systems.

3.02 INSTALLATION OF DETECTABLE WARNING TAPE

A. Install a continuous ribbon of Detectable Warning Tape as specified for ALL buried piping.

B. Multiple pipes less than 4 inches in diameter installed in a common trench may be provided with a single ribbon of tape per trench. If the total width of such utilities within the common trench exceeds 3 feet, provide two parallel ribbons of tape spaced equally.

C. Provide a separate detectable warning tape for each pipe that is 4 inches or greater in size.

D. Install the tape in accordance with manufacturer recommendations.

E. At end-to-end and branch connections, provide electrical continuity connectors for detectable tape to mechanically and electrically connect ends together as recommended by the manufacturer.

F. Provide a single line of tape 2.5 feet above the centerline of buried pipe. For pipelines buried 8 feet or greater below finished grade, provide a second line of tape 12 inches below finished grade, above and parallel to each buried pipe. Spread tape flat with message side up before backfilling.

3.03 INSTALLATION OF TRACER WIRE

A. Tracer wire shall be a continuous, fully functioning, and tested system to include all appurtenances including splices and wire access boxes at grade.

B. Tracer wire laid along the top of the pipe prior to backfilling. Secure in place with tape every 20 feet. Where the pipe is encased or provided with concrete collars or cut-off walls, lay the wire on top of the encasement (do not encase the wire). Do not pull the wire taut; leave sufficient slack to allow for pipe movement and future repairs.

C. Splice tracer wire using the specified silicone-filled splice kits in accordance with manufacturer recommendations. Ensure the silicone fully encapsulates un-insulated wire ends and are made watertight.

D. Pull tracer wire up into all valve boxes, cleanout access boxes, and into all utility cabinets and meter boxes installed on the pipeline. For each wire end, provide an 18-inch long length of extra wire (coiled and tucked out of the way in an accessible location) for connection to utility locating equipment.

E. Where the pipeline enters structures, vaults, tanks, or buildings, provide a wire access box at grade adjacent to the structure or building for termination of the tracer wire. Provide an 18-inch long length of extra wire (coiled and tucked into the box) for connection to utility locating equipment. Also provide boxes at each pipeline branch, cross or tee, and at intermediate spacing along the pipeline not to exceed 1,000 feet (except where pipeline valves with valve boxes provide the required wire access at those locations and intervals).

F. Upon completion and backfill of the pipeline, test and demonstrate electrical continuity of each segment of tracer wire. Submit test results to the Owner indicating the location of the tested segment. Use conductive testing method; inductive test methods are not acceptable. Repair all faulty work at no additional cost to the Owner until the system is functional and approved.

3.04 FIELD QUALITY CONTROL

A. Comply with manufacturer's handling and installation instructions.

B. Provide continuity testing of tracer wire as specified herein.

END OF SECTION

SECTION 40 05 60

VALVES

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies the supply, installation and testing of manually operated valves used for isolation, manual throttling, and bypass.

B. Valve Specification Requirements:
   1. Drawings specify general valve types (gate, plug, butterfly, check, globe, etc.) used in each pipeline.
   2. Piping System Specification Sheets (PIPESPECS in Section 40 05 02) specify piping system materials and components, including valve requirements, for the pipeline or piping system conveying the process fluid indicated on the Drawings.
   3. Piping System Specification Sheets reference the Detailed Valve Specification Sheets that specify detailed valve requirements for each general valve type used in the pipeline or piping system.
   4. Provide valves conforming to the Detailed Valve Specification Sheets listed in the Piping System Specification Sheets consistent with the valve/line size, process service, and valve type specified on the Drawings. Example: The Drawings specify a 1-inch ball valve. The Piping System Specification Sheet for the process service specified on the Drawings lists 40 05 63.01 for 1/2 through 2 1/2 inch ball valves. Provide the subject ball valve per the requirements specified in referenced Section 40 05 63.01.
   5. Detailed Valve Specification Sheets are provided in Sections 40 05 61 through 40 05 65.

C. Section 40 06 20.13 specifies the supply and installation of electric powered and pneumatic powered control valves complete with valve body, actuator, position indicator, and other ancillaries.

1.02 RELATED SECTIONS

A. Section 01 33 00 – Submittal Procedures

B. Section 01 58 01 – Identification Systems

C. Section 01 66 00 – Product Storage and Handling Requirements

D. Section 01 78 23 – Operation and Maintenance Manual

E. Section 40 05 02 – Detailed Piping Specification Sheets

F. Section 40 06 20.13 – Actuated Valve and Gate Schedule

G. Sections 40 05 61 through 40 05 65 – Detailed Valve Specification Sheets

1.03 QUALITY ASSURANCE

A. References:

1. 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.
2. 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 C500	Metal-Seated Gate Valves for Water Supply Service
MSS SP-25	Standard Marking Systems for Valves, Fittings, Flanges and Unions

1.04 SUBMITTALS

A. The following information shall be provided in accordance with Section 01 33 00:

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 CITY 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 and/or shop drawings for each type of valve indicating the valve type (Detailed Valve Specification), materials of construction, dimensions, operating torque, valve end connection configuration, pressure rating, and operating temperature range
3. An amended Detailed Valve Specification Sheet for all valves. Indicate with check marks where the valve supplied meets the requirements specified and with written amendments where the product differs from the specification.
4. Certified Statement of Proof-of-Design testing results.

1.05 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00:
   1. Affidavits as specified.
   2. Operating and Maintenance data for incorporation in operation and maintenance manual, as specified in Section 01 78 23. Include complete description of operation together with detailed drawings, a complete list of replacement and repair parts, and parts manufacturer's identifying numbers.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00.

B. Deliver valves to site in accordance with Section 01 66 00 and using loading methods which do not damage any valve components or coatings.

C. Clearly tag valves in accordance with Section 01 58 01, stating size, type, coatings and mating parts shipped loose or separate.

D. Store on site until ready for incorporation in the work using methods recommended by the manufacturer to prevent damage, undue stresses, or weathering.

PART 2 PRODUCTS

2.01 CONFIGURATION, COMPONENTS, AND FEATURES

A. General
   1. Provide valves of the same type, size range and service from a single manufacturer.
   2. Provide new, unused valves for the work.
   3. Provide valve materials free from defects or flaws, with true alignment and bores.
   4. Provide valves that open counter-clockwise unless otherwise specified in the Valve Specifications Sheets in Sections 40 05 61 through 40 05 65.

B. Provide padlockable lockout feature on all valves where specified in Sections 40 05 61 through 40 05 65.

C. Manual Operators
   1. Provide valves with manual operators as specified in Sections 40 05 61 through 40 05 65, unless specified otherwise on the Drawings, and Section 40 06 20.13.
   2. For hand wheels, clearly show the direction of opening in raised lettering and symbols.
   3. The maximum rim pull on a hand wheel is not to exceed 65 lb when one side of the valve is at test pressure and the other side is at atmospheric pressure. Where a shaft mounted hand wheel would require greater force to operate, provide a gear operator. Unless different operators are scheduled or specified on the Drawings, conform to the following minimum requirements.
   4. Provide 6 (total) eight-point operating wrenches for use on all the valves with square nut operators.

5. Quarter turn lever operators are to be perpendicular to the pipe runs when the valves are closed.
6. Lever operators on ball valves are to be two positions. Provide butterfly valves with 10 position latching levers except where used to balance air flows. Where used to balance air flows provide infinite position, screw down levers.
7. The maximum pull at the end of the lever arm is not to exceed 65 lb when one side of the valve is at test pressure and other side is at atmospheric pressure. Where greater force would be required to operate the valve with a lever, provide a gear operator.
8. Provide grease lubricated, worm gear type operators, equipped with a hand wheel and a visual indicator of the valve position. Provide gear operators with adjustable mechanical stop-limiting devices to prevent over travel of the disc/ball in the open and closed positions and which are self-locking and designed to hold the valve in any intermediate position between full open and full closed. Where gear operators are intended for direct bury or submergence, seal units with long life lubricant.
9. For manual valves on lines 3 inches and greater, mounted over 7.0 ft above the operating floor, provide chain wheel gear operators. Design the operator so that a force of 30 lb is sufficient to open the valve when one side of the valve is at test pressure and the other side is at atmospheric pressure. Provide chain pulley that meshes positively with the chain. The chain will extend from the valve operator to an operating height of 4 ft above the floor or as directed by the CITY. The exact dimensions will be field determined. Provide approved chain hooks where required to prevent chain from hanging within traffic paths.
10. Where manual operators are installed over 7.0 ft above the operating floor and the Drawings specify a vertical shaft, revise the gear operator and/or chain wheel position to provide a horizontal chain wheel shaft. Retain the valve orientation specified on the Drawings.
11. Provide ductile iron chain wheels. Provide galvanized steel operating chains.
12. Valve handwheels and levers shall be coated red per City standard.

D. Valve Stem Extensions and Wrench Nuts
   1. Provide valve stem extensions where additional clearance is required for pipe insulation or where valve operation without the extension is difficult; and in manholes.
   2. Where angle valve stem extensions are employed, they will be angle geared. Universal joint types are not permitted.
   3. Wrench nuts shall comply with AWWA C500. 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.

E. Operator Appurtenances
   1. Valve Boxes: Valve boxes shall be cast iron and shall have suitable base castings to fit properly over the bonnets of their respective valves and heavy top sections with stay-put covers. Covers shall be hot-dip galvanized. Valve boxes extending to finished surfaces shall be provided for buried valves.
   2. Floor Boxes: Floor boxes shall be hot-dip galvanized. Where the operating nut is in the concrete slab, the floor box shall be bronze bushed. Where the operating nut is below slab, the opening in the bottom of the box shall be sufficient for passage of the operating key. Floor boxes shall be provided for wrench operation of valves located

below concrete slabs. Each floor box and cover shall be of the depth required for installation in the slab.

3. Adjustable Shaft Valve Boxes: Adjustable shaft valve boxes shall be concrete or cast iron Brooks No. 3RT, Christie G5, Empire 7-1/2 valve extension box, or equal. Box covers on water lines shall be impressed with the letter "W." Gas line covers shall be impressed with the letter "G."

PART 3 EXECUTION

3.01 PREPARATION

A. The valve and piping arrangement indicated on the Drawings is based on typical dimensions for valves of the specified type. Make the necessary modifications in the piping to allow for discrepancies between the valve dimensions shown and those supplied for the Work.

B. Prior to installation of valves, field measure and check all equipment locations, pipe alignments, and structural installations. Ensure that the valve location and orientation provides suitable access to manual operators and that sufficient space and accessibility is available for pneumatic and electric actuators.

C. Where conflicts are identified, inform the CITY.

3.02 INSTALLATION

A. Install valves in conjunction with the piping described in Sections 40 05 01 and 40 05 02, and with control valves and their appurtenances specified in Section 40 06 20.13.

B. In horizontal pipe runs other than in locations where space does not permit, install all valves, except for butterfly valves and trunnion ball valves, with a vertical operating shaft with the actuator at the top. In no case install a valve with the operator below the valve.

C. Install butterfly valves and trunnion ball valves with the shaft in a horizontal orientation.

D. When joining valves to pipe or fittings, do not over torque bolts to correct for misalignment.

E. Support valves in position using temporary supports until valves are fixed in place.

F. Permanently support valves to prevent transmission of loads to adjacent pipework and/or equipment.

G. Where valves are installed in plastic pipework (PVC, CPVC, HDPE, polypropylene etc.) greater than 4-inch diameter, support valves independent of the piping and brace valves against operating loads and torque to prevent transmission of stresses to the adjacent pipework.

H. Install gate valves in the closed position.

I. Install valves which are bubble tight in one direction to provide bubble tight seal of flow in normal direction of flow unless otherwise noted or directed by the CITY.

J. Unless otherwise specified, install single seated valves with the seat downstream. Install valves at tank connections with seat away from tank. Install valves on pump discharge and suction lines with seat end towards the pump.

K. Install all valves in accordance with the manufacturer's recommendations.

L. Protect valves installed below grade with a shrink sleeve or polyethylene sheath attached to the pipe with tape wrap.

M. 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 so that the nut will be within 6 inches of the valve box cover.

3.03 FIELD QUALITY CONTROL

A. Field or Site Tests and Inspections: Sections 40 05 61 through 40 05 65

B. Pressure test all valves in conjunction with the pipes in which the valves are installed at test pressures specified in PIPESPEC System sheets in Section 40 05 02.

END OF SECTION

SECTION 40 05 62.05

PL05

PL05 – Plug Valve, Digester Gas

GENERAL

LINE SIZE (in)	RATED LIMITS	
	PRESSURE (psi)	TEMP. (°F)
1/2 through 16	200	150

VALVE MATERIALS			**VALVE CONFIGURATION**		
ITEM	MATERIAL	NOTES	ITEM	CONFIGURATION	NOTES
Body	Cast iron, ASTM A126, Class B; or Ductile Iron, ASTM A536, Grade 65-45-12; or Stainless Steel 316, ASTM A743, Grade CF-8M		Valve End/Connections	ANSI B16.1 Class 125# Flange	
Plug	316 Stainless Steel		Shop Painting	Interior surfaces – Epoxy (min 10 mils) Exterior surfaces – Epoxy (min 3 mils)	3
Plug Facing	NBR		Shop Coatings	PPG Amercoat “Amercoat 385 Epoxy”, Carboline “Carboguard 890”, Tnemec “Series N69 Hi-Build Epoxoline II”, Sherwin-Williams "Macropoxy 646" or Carboline “Plasite 7122”.	3
Seating	Welded Nickel overlay		Temperature Limitations	-20 to 150°F	
Packing	Chevron packing for gas service	1	Operator	Handwheel	
Bearings	Sleeve type; Stainless steel	2	Special	See Note	

NOTES

1. Packing shall be self-adjusting chevron type replaceable without disassembling the valve.
2. Upper and lower journal bearings shall be replaceable, sleeve-type, corrosion resistant, and permanently lubricated.
3. All interior and exterior ferrous metal surfaces, except bearing and finished surfaces and stainless steel components of valves and accessories, shall be shop painted for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the specified field painting.

SUBMITTALS

Action Submittals:

1. Manufacturer's catalog information including dimensions, cross-sectional views, details of construction and materials list

Information Submittals:

Closeout Submittals:

CANDIDATE MANUFACTURERS

Clow	DeZurik	Val-Matic

SECTION 40 05 63.01

BV01

BV01 – Ball Valve, Bronze

GENERAL

LINE SIZE (in)	RATED LIMITS	
	PRESSURE (psi)	TEMP. (°F)
1/4 through 2	600	400

VALVE MATERIALS

ITEM	MATERIAL	NOTES
Body	Bronze or Brass	
Ball	Bronze or Chrome-Plated Brass	
Seats	PTFE or RPTFE	
Packing	RPTFE	
Shafts	Bronze, Brass, or Stainless Steel	1

VALVE CONFIGURATION

ITEM	CONFIGURATION	NOTES
Valve End/Connections	Threaded, Female	2
Pattern	2 Piece, Regular Port	
Ball Mount	Floating	
Manual Operator	Lever	
Reference Standard	MSS SP-110	

NOTES

1. Blowout-proof stem.
2. Provide threaded end cap and chain in drain pipes

SUBMITTALS

Action Submittals:

1. Manufacturer's catalog information including dimensions, cross-sectional views, details of construction and materials list

Information Submittals:

Closeout Submittals:

CANDIDATE MANUFACTURERS

Stockham T-285-BR-R	Nibco T-585-70	Apollo 70-100 Series

SECTION 40 05 63.11

BV11

BV11 – Ball Valve, Carbon Steel Flanged, Fire Safe

GENERAL

LINE SIZE (in)	RATED LIMITS	
	PRESSURE (psi)	TEMP. (°F)
2 through 4	150	100

VALVE MATERIALS

ITEM	MATERIAL	NOTES
Body	Forged Steel (ASTM A216 or A351)	
Ball	Stainless Steel (316)	
Seats	Metal + RPTFE/TKM	
Packing/Seal	Graphite	
Stem	Stainless Steel (316)	1

VALVE CONFIGURATION

ITEM	CONFIGURATION	NOTES
Valve End/Connections	Flange, ASME/ANSI 16.5 Class 150	
Pattern	Two-Piece, Full Port	
Ball Mount	Floating	
Manual Operator	Lever/Handwheel	
Standards		2,3

NOTES

1. Blowout-proof stem.
2. Fire safe per API 607.
3. Per ASME B16.34 and AMSE B16.10.
4.

SUBMITTALS

Action Submittals:

1. Manufacturer's catalog information including dimensions, cross-sectional views, details of construction and materials list

Information Submittals:

Closeout Submittals:

CANDIDATE MANUFACTURERS

Apollo 88A-200	Neles XT	Flowtek F15
Sharp FS50		

SECTION 40 05 64.03

BF12

BF12 – Butterfly Valve, Digester Gas

GENERAL

LINE SIZE (in)	RATED LIMITS	
	PRESSURE (psi)	TEMP. (°F)
2-1/2" through 16"	30	0 to 480°F

VALVE MATERIALS

ITEM	MATERIAL	NOTES
Body	ASTM A 351, CF8M, 316 stainless steel	
Disc	ASTM A351, CF8M, 316 stainless steel	
Seats	RTFE or Inconel	
Shaft	17-4 stainless steel	
Packing	TFE or PTFE	
Bearings	Graphite impregnated or PTFE impregnated 316 stainless steel	

VALVE CONFIGURATION

ITEM	CONFIGURATION	NOTES
Valve End/Connections	Lugged body, ASME B16.5, Class 150 diameter and drilling	
Type of Disc	Per Manufacturer	
Manual Operator	Geared Handwheel	

NOTES

1. Length Tolerance. Unless otherwise specified, the actual length of valves shall be within plus or minus 1/16 inch of the specified or theoretical length.
2. Manual actuators of the types listed herein shall be provided by the valve manufacturer.
3. Unless otherwise indicated or specified, each geared manual actuator shall be equipped with an operating hand-wheel.
4. The direction of rotation of the wheel, wrench nut, or lever to open the valve shall be to the left (counterclockwise). Each valve body or actuator shall have cast thereon the word "Open" and an arrow indicating the direction to open.
5. The housing of traveling-nut type actuators shall be fitted with a removable cover which shall permit inspection and maintenance of the operating mechanism without removing the actuator from the valve. Travel limiting devices shall be provided inside the actuator for the open and closed positions. Travel limiting stop nuts or collars installed on the reach rod of traveling-nut type operating mechanisms shall be field adjustable and shall be locked in position by means of a removable roll pin, cotter pin, or other positive locking device. The use of stop nuts or adjustable shaft collars which rely on clamping force or setscrews to prevent rotation of the nut or collar on the reach rod will not be acceptable.
6. Each actuator shall be designed so that shaft seal leakage cannot enter the actuator housing. Valves for throttling service shall be equipped with an infinitely variable locking device or a totally enclosed gear actuator.

Actuators shall produce the required torque with a maximum pull of 80 lbs [356 N] on the lever, hand-wheel, or chain. Actuator components shall withstand, without damage, a pull of 200 lbs [890 N] on the hand-wheel or chain-wheel or an input of 300 foot-lbs [407 J] on the operating nut.

7. Handwheel diameters shall be as recommended by the valve manufacturer.
8. Valves shall have enclosed, geared, hand-wheel or chain-wheel actuators with position indicators as specified herein.

SUBMITTALS

Action Submittals:

1. Manufacturer's catalog information including dimensions, cross-sectional views, details of construction and materials list.

Information Submittals:

Closeout Submittals:

CANDIDATE MANUFACTURERS

Keystone K-LOK High Performance Figure 362-159	Pratt Series 400, Figure 402	Flowserve Durco Max BX2001

SECTION 40 05 65.12

CV17

CV17 – Check valve, Air/gas Service Split Disc

GENERAL

LINE SIZE (in)	RATED LIMITS	
	PRESSURE (psi)	TEMP. (°F)
2 through 12	ASME B16.34	ASME B16.34

VALVE MATERIALS

ITEM	MATERIAL	NOTES
Body	316 Stainless Steel, ASTM A351	
Disc	Stainless Steel (316)	
Seals	Stainless Steel (316), Buna-N or Fluoroelastomer	
Hinge pin	Stainless Steel (316)	
Spring	Stainless Steel (316) or Inconel X-750	3

VALVE CONFIGURATION

ITEM	CONFIGURATION	NOTES
Valve End/Connections	Wafer or Lug, ASME/ANSI B16.5 Class 150	
Check Mechanism	Split disc / double leaf	
Special		1, 2
Standards		4,5,6

NOTES

1. Provide lifting lugs on valves greater than 100 lb.
2. Valves shall open with not more than 0.5 psig differential pressure and be sprung such that the doors shut without slamming.
3. Where service temperature exceeds 250F, use Inconel X-750.
4. Class 150 per ASME B16.34.
5. Valve design per API 594.
6. Testing and inspection per API 598.

SUBMITTALS

Action Submittals:

1. Manufacturer's catalog information including dimensions, cross-sectional views, details of construction and materials list

Information Submittals:

Closeout Submittals:

CANDIDATE MANUFACTURERS

APCO 9000	Gulf Model MB	Crane Duo-Chek

SECTION 40 06 70

SCHEDULES FOR INSTRUMENTATION OF PROCESS SYSTEMS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:

1. This section specifies the Instrument Index and general requirements applicable to process instrumentation and analyzer systems consisting of process sensors, process indicators, signal conditioning module, control and monitoring devices, transmitters, and accessories.
2. The Contractor shall provide, calibrate, and test the complete process instrumentation and analyzer systems and place in operation and test the system. Testing includes tuning loops and making final adjustments to instruments and analyzers during facility start-up.
3. The Contactor shall provide the services of certified instrument technicians for testing and adjustment activities as specified in Section 40 61 13.
4. 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 Section 40 05 01-2.04.

1.02 REFERENCES

A. Refer to Section 40 61 13 – Process Control System General Provisions.

B. Refer to Section 40 61 21 – Process Control System Testing.

1.03 SUBMITTALS

A. Refer to Sections 40 61 13 and 40 61 21.

PART 2 PRODUCTS

2.01 INSTRUMENT INDEX

A. The Instrument Index, paragraph 3.03, lists instruments and analyzers required for the project. Instrument functions specified on this list shall be provided by the Contractor.

B. 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.

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. Materials, equipment, and installation shall be tested and inspected per Sections 40 61 13, 40 61 21, and this section.

B. Provide buffer solutions and reference fluids for analytical equipment test procedures.

3.02 INSTALLED EQUIPMENT - TESTS AND INSPECTION

A. Refer to Section 40 61 21 – Process Control System Testing.

3.03 INSTRUMENT INDEX

A. The following is an index of the instrumentation equipment, analyzers, and devices.

B. Description of Headings:
   1. Tag Number:
      a. 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:
      a. Provides the functional description of the instrument, analyzer, or device.
   3. P&ID Number:
      a. Lists the Process and Instrumentation Diagram on which the instrument, analyzer, or device appears.
   4. Specification:
      a. Provides the specification reference and “INSTRUSPEC” designation for the instrument, analyzer, or device.
   5. Size:
      a. Provides the application data relative to sizing the instrument; flow tube diameter, probe length, associated pipe sizes, etc.
   6. Range:
      a. Provides the calibrated instrument range for each application.
   7. Setpoint:
      a. Provides the calibrated switch setpoint.
   8. Comments:
      a. Provides the features, interlocks, and information applicable to the instrument, analyzer, or device.

Instrument Index

Tag No.	Description	P&ID	Spec	Size	Range	Setpoint	Comments
PIXXXXXX	PRESSURE GAUGE (MSG – UPSTREAM OF HE161533)	I-001	40 73 00 – PG	4”	0 – 10 psig	N/A	
PIXXXXXX	PRESSURE GAUGE (MSG – DOWNSTREAM OF HE161553)	I-001	40 73 00 – PG	6”	0 – 10 psig	N/A	
PIXXXXXX	PRESSURE GAUGE (MSG – UPSTREAM OF HE161534)	I-001	40 73 00 – PG	4”	0 – 10 psig	N/A	
PIXXXXXX	PRESSURE GAUGE (MSG – DOWNSTREAM OF HE161554)	I-001	40 73 00 – PG	6”	0 – 10 psig	N/A	
PIXXXXXX	PRESSURE GAUGE (CHWR – UPSTREAM OF HE161533)	I-001	40 73 00 – PG	2”	0 – 60 psig	N/A	
PIXXXXXX	PRESSURE GAUGE (CHWR – DOWNSTREAM OF HE161533)	I-001	40 73 00 – PG	2”	0 – 60 psig	N/A	
PIXXXXXX	PRESSURE GAUGE (CHWR – UPSTREAM OF HE161534)	I-001	40 73 00 – PG	2”	0 – 60 psig	N/A	
PIXXXXXX	PRESSURE GAUGE (CHWR – DOWNSTREAM OF HE161534)	I-001	40 73 00 – PG	2”	0 – 60 psig	N/A	
TIXXXXXX	TEMPERATURE GAUGE (MSG – UPSTREAM OF HE161533)	I-001	40 74 00 - TI	4”	20 – 200 °F	N/A	
TIXXXXXX	TEMPERATURE GAUGE (MSG – DOWNSTREAM OF HE161553)	I-001	40 74 00 - TI	6”	20 – 200 °F	N/A	
TIXXXXXX	TEMPERATURE GAUGE (MSG – UPSTREAM OF HE161534)	I-001	40 74 00 - TI	4”	20 – 200 °F	N/A	
TIXXXXXX	TEMPERATURE GAUGE (MSG – DOWNSTREAM OF HE161554)	I-001	40 74 00 - TI	6”	20 – 200 °F	N/A	
TIXXXXXX	TEMPERATURE GAUGE (CHWR – UPSTREAM OF HE161533)	I-001	40 74 00 - TI	2”	20 – 60 °F	N/A	
TIXXXXXX	TEMPERATURE GAUGE (CHWR – DOWNSTREAM OF HE161533)	I-001	40 74 00 - TI	2”	20 – 60 °F	N/A	
TIXXXXXX	TEMPERATURE GAUGE (CHWR – UPSTREAM OF HE161534)	I-001	40 74 00 - TI	2”	20 – 60 °F	N/A	
TIXXXXXX	TEMPERATURE GAUGE (CHWR – DOWNSTREAM OF HE161534)	I-001	40 74 00 - TI	2”	20 – 60 °F	N/A	

Instrument Index

Tag No.	Description	P&ID	Spec	Size	Range	Setpoint	Comments
PDIT118705	DIFFERENTIAL PRESSURE TRANSMITTER	I-001	40 73 00 – PDT	6”	0 – 10 psig	N/A	To be provided by Siloxane Removal System supplier, per Section 43 31 13.13
FIT118815	FLOW INDICATING TRANSMITTER	I-002	40 71 00 - FTD	3”	0 – 400 scfm	N/A	
FE118815	FLOW ELEMENT	I-002	40 71 00 - FTD	3”	0 – 400 scfm	N/A	
ZSC118808	POSITION SWITCH CLOSED	I-002	N/A	N/A	N/A	N/A	Position switch manufacturer and model shall match the manufacturer and model of position switches currently installed for the cogeneration system.
ZSO118808	POSITION SWITCH OPEN	I-002	N/A	N/A	N/A	N/A	Position switch manufacturer and model shall match the manufacturer and model of position switches currently installed for the cogeneration system.
ZSC118810	POSITION SWITCH CLOSED	I-002	N/A	N/A	N/A	N/A	Position switch manufacturer and model shall match the manufacturer and model of position switches currently installed for the cogeneration system.
ZSO118810	POSITION SWITCH OPEN	I-002	N/A	N/A	N/A	N/A	Position switch manufacturer and model shall match the manufacturer and model of position switches currently installed for the cogeneration system.

END OF SECTION

SECTION 40 42 00

INSULATION FOR EXPOSED PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies insulation for exposed piping and related equipment and appurtenant surfaces.

1.02 RELATED SECTIONS

A. Section 40 05 02 – Detailed Piping Specification Sheets

B. Section 40 05 07 – Pipe Supports and Hangers

C. Section 40 05 07.13 – Seismic Restraints for Piping

D. Section 40 05 45 – Piping System Identification

1.03 REFERENCES

A. This Section incorporates by reference the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of a listed document, the requirements of this Section prevail.

B. ASTM B209 – Aluminum and Aluminum-Alloy Sheet and Plate

C. ASTM C533 – Calcium Silicate Block and Pipe Thermal Insulation

D. ASTM C534 – Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form

E. ASTM C547 – Standard Specification for Mineral Fiber Pipe Insulation

F. ASTM C553 – Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications

G. ASTM C592 – Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation

H. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials

I. ASTM E96 – Water Vapor Transmission of Materials

J. FEDSPEC L-P-535E -- Plastic Sheet (Sheeting) “Plastic Strip” Poly (Vinyl Chloride) and Poly (Vinyl Chloride-Vinyl Acetate), Rigid

K. ASTM C1729 – Aluminum Jacketing and Insulation

1.04 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:

B. Low-temperature range: operating temperature range of -100 to +100 degrees F.

C. Medium-temperature range: operating temperature range of 100 to 800 degrees F.

D. High-temperature range: operating temperature range of 800 to 1200 degrees F.

E. Very-high-temperature range: operating temperature range of 1200 to 1800 degrees F.

F. Jacket: protective outer layer placed over insulation on straight runs of pipe

G. Cover: protective outer layer placed over insulation on valves, strainers, expansion joints, flanges, pipe fittings, couplings, and equipment.

H. Exposed: All area exposures specified in Section 01 61 45 other than buried, submerged, or encased/embedded.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Sequencing: After installation of insulation for pipe and equipment is complete, provide identification as described in Section 40 05 45.

1.06 SUBMITTALS

A. Procedures: Section 01 33 00

B. Action Submittals:
   1. A copy of this Section, addendum updates included, with each paragraph check-marked to indicate compliance or marked to indicate requested deviations.
   2. Manufacturer's descriptive literature, including insulation and jacket thickness, heat transfer coefficient, and methods of installation.
   3. Certification of jacket ratings for water vapor transmission, puncture and stiffness as specified.

C. Informational Submittals:
   1. Samples of each insulation material type and thickness along with typical jackets and covers for pipe, fittings, valves and appurtenances. Provide a full diameter segment for each insulation sample, 6 inches in length.

D. Closeout Submittals:
   1. Warranty Documentation

1.07 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00

B. Deliver insulation, jackets and covering to site using methods which do not damage the materials.

C. Deliver insulation materials to site clearly identified as to type and temperature rating.

D. Store insulation materials on site as recommended by the manufacturer to prevent damage or and weathering.

E. Replace damaged or weathered insulation materials with new materials.

PART 2 PRODUCTS

2.01 GENERAL

A. Piping insulation shall be tubular type or the flexible blanket type. Insulation for valves, strainers, fittings, expansion joints, flanges and other connections shall be segmented sections, molded, or blanket type coverings of the specified type and thickness of pipe insulation, or the flexible blanket type. Equipment insulation shall be flexible blanket type or rigid board type cut to fit the surface.

2.02 MANUFACTURERS

A. Manufacturers: Candidate manufacturers and models are listed below. The manufacturer's standard product may require modification to conform to specified requirements.

B. Cellular Elastomeric Tube
   1. Armacell, AP Armaflex
   2. K-Flex, Insul-Tube
   3. Approved Equal

C. Mineral Wool
   1. Roxul, ProRox PS960
   2. Johns Manville, Min-Wool 1200
   3. Approved Equal

D. Fiberglass
   1. Johns Manville, Micro-Lok HP
   2. Owens Corning, FIBERGLAS
   3. Approved Equal

E. Calcium Silicate
   1. Johns Manville, Thermo-12 Gold
   2. Approved Equal

F. Cellular Elastomeric Flexible Blanket
   1. Armacell, AP Armaflex
   2. K-flex, Insul-Sheet
   3. Approved Equal

G. Fiberglass Flexible Blanket

1. Amatex, Amamat
2. Lewco, E Glass
3. Approved Equal

H. Mineral Wool Flexible Blanket
1. Johns Manville, Min-Wool 1200
2. Roxul, Enerwrap MA 960
3. Approved Equal

I. Silica or Ceramic Fiber Flexible Blanket (Very High Temperature Range)
1. Morgan Thermal Ceramics, Superwool 607 Blanket AC2
2. Unifrax, Fiberfrax
3. Harbison Walker, Inswool-HP
4. Hitco, Refrasil
5. Approved Equal

2.03 INSULATION SERVICE CONDITIONS

A. Insulation Service Types
1. Insulation service types define the function of the insulation. The extent and location of insulation application is based on the function of the insulation. This Section specifies the following insulation service types: Condensate Control, Personnel Protection, Freeze Protection, and Energy Conservation. Insulation Service Types and insulation materials for piping systems are specified in Piping System Schedules.
2. Condensate Control is specified for piping that is to be insulated for condensate control. Where Condensate Control is specified for a piping service, furnish insulation for all pipe and pipeline appurtenances with a line size of ½-inch and larger that are located in Indoor Dry or Indoor Wet areas.
3. Personnel Protection is specified for piping that is to be insulated to protect personnel from injury related to exposure to extreme temperatures (high and low). Where Personnel Protection is specified for a piping service in the Piping System Schedules, furnish insulation for all pipe and pipeline appurtenances where all of the following conditions are present:
    a. Piping is connected to the discharge or exhaust of equipment (includes equipment and pipeline appurtenances).
    b. Equipment, pipe, or pipeline appurtenances are located within 0.0 to 8.0 feet above a floor, stair, landing, or other type of walkway accessible by plant staff, or within 4.0 feet of a guardrail or ladder cage. Pipe, pipeline appurtenances, joints, flanges, valves, and equipment in vaults, utilidors, and other spaces that are not designed for pedestrian access by plant staff are not insulated for Personnel Protection.
4. Freeze Protection is specified for piping that is to be insulated and heat traced to protect against freezing the contents of the pipe. Where Freeze Protection is specified for a piping service in the Piping System Schedules, furnish insulation for all piping to be freeze protected by electric heat trace tape as specified in Section 40 41 13.13. Coordinate electric heat trace tape installation with specified insulation requirements for freeze protection to provide freeze protection for piping as specified in Section 40 41 13.13.

5. Energy Conservation is specified for piping that is to be insulated to conserve energy. Where Energy Conservation is specified for a piping service in the Piping System Schedules, furnish insulation for all pipe and pipeline appurtenances for the entire portion of the piping system that is exposed.

2.04 MATERIALS

A. General:
   1. Provide materials that are new and undamaged.
   2. Match specified pipe insulation and jacket/cover material for insulation on valves, strainers, fittings, expansion joints, flanges, and other pipe couplings. Furnish flexible blanket insulation and soft covers if insulation on valves, strainers, fittings, expansion joints, flanges, and other pipe couplings is not available in the same materials as the specified pipe insulation and jacket/cover.
   3. Provide rigid insulation and shields at pipe supports for insulated pipe. Match specified jacket/cover material for pipe shields at pipe supports.
   4. Provide insulating and sealing materials, including cements, coverings, etc., that do not contain asbestos, mercury, or lead.
   5. When covering stainless steel pipe, pipeline appurtenances, or equipment, use insulation that complies with ASTM C795 and has less than 600 mg/liter of leachable chlorides, and greater than 20 mg/liter of sodium silicate for each mg/liter of chloride.
   6. Flame spread classification for insulation materials is not to exceed 25 when tested in accordance with ASTM E84.
   7. Use fibrous loose fill insulation for joint filler around insulated expansion joints.

B. Unicellular Elastomeric Thermal Type:
   1. Unicellular elastomeric thermal type insulation shall conform to the requirements of ASTM C534, Type I.

C. Cellular Glass Type:
   1. Cellular glass type insulation shall conform to the requirements of ASTM C552, Type II.

D. Fiberglass Type:
   1. Fiberglass type insulation shall conform to the requirements of ASTM C547, Type I, Grade A.

E. Calcium Silicate Type:
   1. Calcium silicate type insulation shall conform to the requirements of ASTM C533, Type II, Class C.

F. Flexible Blanket Type:
   1. High Temperature Class: High temperature insulation shall be removable 1-inch or 2-inch thick blanket-type insulation designed for continuous 1200 degree F service. The blanket shall be a custom sewn, flexible, reusable jacket, custom designed to closely fit the piping or the equipment housing. Blanket shall be custom fitted to not restrict access to any instrumentation or equipment. Insulation shall not compact or shake down in vibrating service.

2. Very High Temperature Class: Very high temperature insulation shall be removable 1-inch or 2-inch thick blanket-type insulation designed for continuous 1800 degree F service. The blanket shall be a custom sewn, flexible, reusable jacket, custom designed to closely fit the piping or the equipment housing. Blanket shall be custom-fitted to not restrict access to any instrumentation or equipment. Insulation shall not compact or shake down in vibrating service.
3. Fiberglass Flexible Blanket: Flexible fiberglass blanket insulation designed for continuous 1200 degree F service. 8.0 pounds per cubic foot density, minimum. Long fiber, random orientation, needled.
4. Mineral Wool Flexible Blanket: Flexible mineral wool blanket insulation designed for continuous 1200 degree F service.
5. Silica or Ceramic Fiber Flexible Blanket: High purity alumina and silica non-asbestos white ceramic fiber insulation designed for continuous 1800 degree F service.

G. Aluminum Insulation Jackets/Covers
1. Aluminum jackets and covers constructed of smooth finish aluminum sheet conforming to ASTM B209, alloy 3003, or 3105 temper H14, with integral vapor barrier.
2. Pipe Insulation Jacket thickness per ASTM C1729, as follows.

Outer Insulation Diameter (inches)	Aluminum jacket thickness, rigid insulation (inch)	Aluminum jacket thickness, flexible and semi-rigid insulation (inch)
≤ 8	0.016	0.016
8 thru 11	0.016	0.020
11 thru 24	0.016	0.024
24 thru 36	0.020	0.032
≥ 36	0.024	0.040

3. Furnish 0.030 inch, minimum thickness, for aluminum insulation covers at valves, strainers, fittings, expansion joints, flanges, and other pipe couplings.
4. Aluminum or stainless steel sheet metal screws.
5. Jackets secured with 0.020 inch thick by ¾ inch wide Type 304 stainless steel expansion bands.
6. Flashing includes aluminum caps, sealant and reinforcing.
7. Provide aluminum caps, 20 gauge. Cut to completely cover the insulation.
8. Provide sealants as recommended by the insulation manufacturer.
9. Provide wire mesh reinforcement or nylon fabric reinforcement in sealant at jacket and cover joints. Reinforcement material as recommended by the insulation manufacturer.

H. Laminated Jackets:
1. Laminated jackets shall consist of aluminum and white kraft paper. Jackets shall have a perm rating for water vapor transmission of not more than 0.02 in accordance with procedure A of ASTM E96.

I. PVC Insulation Jackets and Covers
1. One piece PVC covers and jackets. 20 mil thickness, minimum.

2. Pre-molded polyvinylchloride conforming to FEDSPEC L-P-535E, Composition A, Type II, Grade E4 or GU.

J. Non-combustible Fabric Cover
   1. Custom fit reusable covers. Sewn or stapled covers encapsulating insulation with stainless steel staples/hog rings. Close fit to the piping, pipeline appurtenance, or equipment housing.
   2. Fabricated from 32 ounce TFE-coated or silicone coated fiberglass cloth with concealed/interior stitching, staples or hog rings (not exposed). For flexible blanket insulation installed for High-Temperature and Very High-Temperature Range applications, eliminate non-combustible fabric material on hot face of covers and provide stainless steel wire mesh on hot face of covers.
   3. Fabric rated for continuous exposure to the temperature range of the insulation (Low, Medium, High, or Very High Temperature Range).
   4. Secured in place with stainless steel lacing hooks, lock washers, and lacing wire.
   5. Stitched or quilted to prevent consolidation, shifting, or settlement of insulation when subjected to vibration.

K. Flashing
   1. Flashing shall include aluminum caps, sealant and reinforcing. Aluminum caps shall be 20 gage thick and shall be cut to completely cover the insulation. Sealants shall be as recommended by the insulation manufacturer.
   2. Reinforcement in flashing heated up to 370 degrees F shall be nylon fabric. Reinforcement in flashing for hotter surfaces shall be wire mesh or as recommended by the insulation manufacturer.

PART 3 EXECUTION

3.01 PREPARATION

A. Apply insulation over clean, dry surfaces.

B. Ensure insulation is dry before and during application.

C. Do not apply protective pipe coatings to outside surface of insulation jackets or covers.

D. Do not paint PVC, aluminum, or fabric covers.

E. Do not install insulation or jackets/covers before piping and equipment has been tested and approved. Thermal shields at pipe hangers and supports may be installed prior to testing.

F. Provide thermal pipe hanger shields at pipe supports and bracing as specified on the Drawings, Details, Section 40 05 07 and Section 40 05 07.13.

3.02 INSTALLATION

A. General
   1. Where double layer insulation is provided to achieve the specified insulation thickness, install with staggered section joints.

2. Supply insulated thermal pipe hanger shields and install during pipe support installation. Where insulated thermal pipe hanger shields are used, apply the following to all butt joints:
    a. For pipe insulation with a medium, high, or very high Operating Temperature Range, apply 3 inch wide vapor barrier tape or band over the butt joints.
    b. For pipe with a low Operating Temperature Range, apply a wet coat of vapor barrier lap cement on all butt joints and seal the joints with a minimum 3 inch wide vapor barrier tape or band.

B. Protect insulation and jackets from crushing, denting, and similar damage during construction. Do not penetrate or otherwise damage vapor barriers. Remove any insulation, jacket, and vapor barriers damaged during construction and install new material.

C. Provide flashing at joints between insulation jackets, between insulation jackets and insulation covers, and at endcaps. Provide flashing around flange sets, pipe couplings/connections, and joint fittings. Allow adequate clearance between insulation rings, jackets and the joint connection for the removal and reinstallation of hardware during inspection and maintenance activities.

D. Piping Insulation
    1. Install uninterrupted (continuous) insulation as indicated for the specified Insulation Service Conditions (Condensation Control, Energy Conservation, Personnel Protection, or Freeze Protection). Insulate over pipe and all in-line devices such as valves, fittings, flanges, couplings, strainers and other piping appurtenances. Butt insulation firmly together and provide jacket laps and joint strips with lap adhesive. Install jackets with their seams located on the underside of pipe.
        a. Unless otherwise specified, piping insulation shall be provided with laminated jackets specified in paragraph 2.04 H Laminated Jackets.
        b. PVC covers specified in paragraph 2.04 I Polyvinylchloride (PVC) Covers shall not be used with medium- or high-temperature class insulation. Removable flexible blanket-type insulation need not be jacketed.
    2. Covers overlap the adjoining pipe insulation and jackets.
    3. Install covers with their seams located on the underside of valves, fittings, flanges, couplings, strainers and other piping appurtenances.
    4. Fittings, Connections, Flanges and Valves: Fitting, connection, flange and valve insulation shall be provided with covers specified in paragraph 2.04. Insulation shall be secured in place with 20-gage wire and a coat of insulating cement. Covers shall overlap the adjoining pipe insulation and jackets. Covers shall be provided with their seams located on the underside of fittings and valves.
    5. Low Operating Temperature Range
        a. Seal off ends of pipe insulation with a vapor barrier coating.
        b. Seal covers at edges with vapor barrier adhesive. Secure the ends of covers with vinyl tape. Overlap the jacket and the cover at least one inch with vinyl tape. Do not penetrate vapor barrier.
        c. Fittings, Connections, Flanges and Valves: Except where soft covers are specified, insulation for pipe sizes 2 inches and less, shall be provided with rigid PVC covers specified in paragraph 2.04 I Polyvinylchloride (PVC) Covers. Covers shall be sealed at edges with vapor barrier adhesive. The ends of covers shall be secured

with vinyl tape. The tape shall overlap the jacket and the cover at least 1 inch. Vapor barrier shall not be penetrated.

d. Except where soft covers are specified, insulation for pipes 2 1/2 inches and larger shall be provided with rigid aluminum covers specified in paragraph 2.04 G Aluminum Covers. Covers shall be mechanically secured by corrosion-resistant tacks pushed into the overlapping throat joint.

6. Medium, High, and Very High Operating Temperature Range

a. Except for flexible blanket type, seal ends of insulation with end joint strips and use waterproof adhesive to hold them in place.

b. Mechanically secure covers using corrosion-resistant tacks pushed into the overlapping throat joint.

c. Fittings, Connections, Flanges and Valves: Except where soft covers are specified, rigid insulation shall be provided with rigid aluminum covers specified in paragraph 2.04 G Aluminum Covers. Covers shall be mechanically secured by corrosion-resistant tacks pushed into the overlapping throat joint.

7. Insulation for Outdoor Piping

a. Pipe: Rigid insulation shall be provided with aluminum jackets specified in paragraph 2.04 G Aluminum Jackets. Flexible blanket-type insulation shall be designed for outdoor, weather-exposed service.

b. Fittings, Connections, Flanges and Valves: Rigid insulation shall be provided with rigid aluminum covers specified in paragraph 2.04 G Aluminum Covers. Flexible blanket type insulation shall be designed for outdoor, weather-exposed service.

c. Where insulated pipe emerges from soil, concrete or asphalt terminate insulation for exposed pipe at the interface with insulation for buried pipe. If buried pipe is not insulated, extend insulation to within an inch above the finished surface. Do not push insulation into contact with soil, finished concrete, or asphalt surface.

d. Provide heat tracing as specified in Section 40 41 13.13. Install insulation over heat tracing according to the specifications of the heat trace tape and insulation manufacturers.

E. Mechanical Equipment Insulation

1. Unless otherwise specified in this Section, fit insulation to the contours of equipment and secure it with 1/2 by 0.015 inch stainless steel bands. Weld pins or stick clips with washers may be used for flat surfaces and spaced a maximum 18 inches apart. Stagger joints and fill voids with insulating cement. Unless otherwise specified, insulation shall be provided with laminated jackets specified in paragraph 2.04 H Laminated Jackets.

a. Unless specifically specified to be uninsulated, equipment connected to insulated piping shall be insulated.

2. Overlap ends of blanket segments to prevent gaps and voids when the piping and equipment are heated.

3. Secure blankets snugly under nuts and bolt heads to assure complete coverage during operation and to prevent vibration-induced gaps or voids.

4. Secure blankets in strict accordance with the manufacturer's instructions.

5. Outdoor Equipment: Insulation shall be provided with a coat of weatherproof mastic and a layer of open-weave glass cloth embedded into a wet tack coat. Seams shall overlap at least 2 inches. A finish coat of weatherproof mastic shall be provided. The total coating thickness shall be a minimum of 1/8 inch.

6. Low Temperature Class: Insulation shall have joints, breaks, and punctures sealed in facing with fire-retardant vapor barrier adhesive reinforced with 4-inch tape.
7. Insulation shall be provided with a layer of open-weave glass cloth embedded into a wet coat of fire-retardant adhesive. Seams shall overlap at least 2 inches. A finish coat of fire-retardant adhesive shall be provided.
8. Medium Temperature Class: Joints shall be covered and cemented in place with 4-inch-wide strips of the same material as the laminated jackets specified in paragraph 2.03 H Laminated Jackets.
9. High and Very High Temperature Class: High and very high temperature equipment shall be covered with custom-fitted removable blanket-type insulation. Blanket-type insulation shall be secured with stainless steel wire lacing and hooks. Ends of blanket segments shall overlap to prevent gaps and voids when the piping and equipment is heated. Blankets shall be snugly secured under nuts and bolt heads to assure complete coverage during operation and to prevent vibration-induced gaps or voids. Blankets shall be secured in strict accordance with the manufacturer's instructions.

F. Flashing
1. Provide flashing at jacket penetrations and terminations. Provide clearance for flashing between insulation system and piping supports.
2. A heavy tack coat of sealant shall be troweled over the insulation, extending over the jacket edge 1 inch and over the pipe or protrusion 2 inches. Reinforcement shall be stretched over the tack coat after clipping to fit over pipe and jacket. Clipped reinforcing shall be strapped with a continuous band of reinforcing to prevent curling. Sealant shall then be troweled over the reinforcement to a minimum thickness of 1/8 inch.
3. Form aluminum caps to fit over the adjacent jacketing and to completely cover coated insulation. Hold cap in place with a jacket strap.

3.03 INSULATION THICKNESS SCHEDULE

A. The insulation dimensional tolerances shall comply with the specified standards. Equipment insulation shall match thickness of attached piping. The minimum insulation thicknesses, exclusive of jacket, shall be as follows:

Piping Service[a]	Fluid Temperature Range, Degrees F	Insulation Thickness in Inches for Nominal Pipe Sizes					
		Runouts up to 2 inches[b]	1 inch and less	1.25 to 2 inches	2.50 to 4 inches	5 and 6 inches	8 inches and larger
Existing Siloxane Removal Vessels	Ambient – 160	2.0	2.0	2.0	2.0	2.0	2.0
New Siloxane Removal Vessel	Ambient – 160	2.0	2.0	2.0	2.0	2.0	2.0
Aftercooler Heat Exchangers	20 - 160	2.0	2.0	2.0	2.0	2.0	2.0
CHWR/CHWS	0 - Ambient	1.0	1.0	1.0	-	-	-

[a]*See specification Section 40 05 02.*

[b]*Runouts to individual terminal units (not exceeding 12 feet in length).*

END OF SECTION

SECTION 40 61 13

PROCESS CONTROL SYSTEM GENERAL PROVISIONS

PART 1 GENERAL

1.01 SUMMARY

A. Scope:
   1. This section specifies general requirements applicable to providing a complete, functional process control, instrumentation, communication, network, and signal systems. This work will be referenced as the Process and Instrumentation Control System (PICS) to be provided by a single Systems Integrator (SI) meeting the qualifications section of this specification.

B. System overview. Detailed requirements are in individual related specification sections.
   1. Field Instrumentation:
      a. New field instruments.
   2. Process Control Hardware:
      a. Integration of new PLC controllers and Remote I/O into the existing SCADA control system.
      b. New control panels.
      c. Modification of existing control panels
   3. Process Control Software, Programming, and Integration:
      a. All necessary software and applications programming to implement the control strategies for the vendor supplied equipment shall be provided by the vendor. The CITY will provide the necessary applications programming for non-vendor supplied equipment. The CITY will provide all programming for the SCADA system.
   4. Communications and Networking
      a. Interface to and expansion of existing Plant network.
      b. Hardwired fiber-optic and copper communications systems.
      c. Device-level communications systems.

C. Definitions:
   1. General:
      a. 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. 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. 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:
    a. 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:
    a. 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. Data Sheets:
    a. Data sheets shall refer to ISA S20 or ISA TR20.00.01.
7. Signal Types:
    a. Used in systems specified in Division 40:
        1) Low-Level Analog:
            a) Signal with full output level of 100 millivolts or less including thermocouples and resistance temperature detectors.
        2) High-Level Analog:
            a) Signals with full output level greater than 100 millivolts but less than 30 volts, including 4 to 20 mA transmission.
        3) Digital Code:
            a) Coded information from the output of an analog to digital converter or digital transmission terminal.
        4) Pulse Frequency:
            a) Counting pulses emitted from speed or flow transmitters.
        5) Modulated Signals:
            a) Signals from modems or low level audio signals. Normal signal level: plus 4 dBm to minus 22 dBm. Frequency range is 300 to 10,000 Hertz.
        6) Discrete Control or Events:
            a) Dry contact closures and signals monitored by solid state equipment, relays, or control circuits.
        7) Low Voltage Discrete Control or Events:
            a) Dry contact closures and signals monitored by solid state equipment, relays, or control circuits operating at less than 30 volts and 250 milliamperes.
        8) High-Level Audio Signals:
            a) Audio signals exceeding plus 4 dBm, including loudspeaker circuits.
        9) Radio Frequency Signals:
            a) Continuous wave alternating current signals with fundamental frequency greater than 10 kilohertz.

8. Systems Integrator:
    a. 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:
    1. 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 prevail.
    2. Unless otherwise specified, references to documents 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).
    3. If referenced documents have been discontinued by the issuing organization, references to those documents 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.
    4. Where document dates are given in the following listing, references to those documents 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 100	Standard Dictionary of Electrical and Electronics Terms
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
NEMA ICS 1	General Standards for Industrial Control and Systems

B. 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 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.

e. The application software packages shall be latest versions available, or compatible with existing software currently in use by the City.

2. Systems Integrator Qualifications:

a. Contractor-proposed 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, General Contractor, and Principal Design Firm.

3) Submit organization chart and resumes for proposed project personnel.

4) Submit Training and Certification information. Completion of the following training courses or appropriate portions thereof or possession of the following certifications included with the Systems Integrator's personnel experience requirements described above:

a) Project manager: Control System Engineer (CSE) registration, Professional Engineer (PE) registration.

b) Systems engineer: Control System Engineer (CSE) registration, Professional Engineer (PE) registration, or completion of the relevant core courses in the Engineering Skills Training program.

c) Programmer: Control System Engineer (CSE) registration, Professional Engineer (PE) registration.

d) Field instrument technician: Certified Control Systems Technician (CCST) registration or completion of the relevant core courses in the Technical Skills Training program.

e) Certified training programs, as offered by ISA.

5) Submit financial data for Systems Integrator division when subsidiary to a parent corporation. Include two years of financial data.

a) Financial Statement.

b) Balance Sheet.

c) Dun & Bradstreet Report.

3. Pre-Submittal Conference:

a. Schedule a pre-submittal conference with the Owner and Construction Manager within 30-calendar days after Contract award to discuss the work, equipment, submittal format, and establish the framework for project coordination and communication.

b. Provide materials 10-days prior to the conference:

1) Instrument Index that lists the devices and instruments specified in Division 40 identify each by tag number, description, function, manufacturer, and model number.

2) Product descriptive literature with a statement that the item is as specified.

3) Proposed equal products with comparative listing of the published specifications for the specified item and the proposed item.

4) Project schedule with deliverables and milestones.
5) Project Control System Block Diagram, when specified.
6) Sample portion of documented PLC and Operator Interface program, when specified.
7) Samples of a typical control panel schematic diagram proposed for this project. Sample can be a copy from a previous project provided that it represents the format being proposed for this project.
8) Sample analog and discrete loop diagrams proposed for this project, when specified. Sample can be a copy from a previous project provided that it represents the format being proposed for this project.
9) 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.

c. The pre-submittal conference will not replace the Product and Shop Drawing Submittal review process.

C. Process Equipment Coordination

1. Division 40 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. 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. Systems Integrator shall coordinate with project subcontractors and equipment suppliers.
5. Systems Integrator shall provide installation supervision for the duration of the project.
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:
   1. Specified data communication and process control equipment shall suitable for operation in indoor locations and in outdoor locations.

1.04 FUNCTIONAL REQUIREMENTS

A. General:
   1. The instrumentation and control system functions are shown on the drawings and specified in subsequent sections of Division 40. The 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:
      a. 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 Systems Integrator shall prepare detailed installation drawings as specified below.
         1) Drawings prepared in AutoCAD version 2015 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".
         2) Diagrams shall carry a uniform and coordinated set of wire numbers and terminal block numbers in compliance with panel wiring
   2. Connection Diagrams:
      a. 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. Interconnection Diagrams:
      a. Show panels, panel devices, and field devices with wire numbers, cable numbers, raceway numbers, terminal box numbers, terminal block numbers, panel numbers, and field device tag numbers.
   4. Elementary or Schematic Diagram:
      a. 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.
   5. Arrangement, Layout, or Outline Drawings:
      a. 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.
   6. Network Block Diagram:
      a. A network block diagram is a diagram of the overall SCADA system, with annotated boxes to show the primary network components (controllers, hubs,

switches, computers, displays), and annotated interconnecting lines that show the system communication media and communication protocols.

1.05 SUBMITTALS

A. The following information shall be provided in accordance with and Section 01 33 00:
   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.
      a. 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.
      b. 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.
      c. 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 1.04 Submittal Drawings.
   5. Nameplate list with material, tag number and description as specified herein.
   6. Systems Integrator Evidence of Experience per paragraph 1.02 Systems Integrator Qualifications.
   7. Data Sheets in accordance with ISA 20 for each instrument. Identical instruments may be submitted with one common ISA Data Sheet and accompanying tag list.

B. Review the submittal requirements specified in other Division 40 sections.

PART 2 PRODUCTS

2.01 GENERAL

A. Materials and Quality:
   1. 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.
   2. Electronic equipment shall be of solid-state construction with printed or etched circuit boards of glass epoxy of sufficient thickness to prevent warping.
   3. Printed circuit boards in field mounted equipment shall be coated with 2 mils of conformal coating in compliance with MILSPEC MIL-I-46058C.

B. Enclosures:
   1. 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
Indoor: Architecturally Finished Area	NEMA 12: mild steel
Indoor: Electrical Room	NEMA 12: mild steel
Indoor: Process Areas	NEMA 4X: 316 Stainless Steel
Indoor: Corrosive Area	NEMA 4X: 316 Stainless Steel
Outdoor: Corrosive Area	NEMA 4X: 316 Stainless Steel
Outdoor: Non-Corrosive Areas	NEMA 4X: 316 Stainless Steel
Corrosive Area (Hypochlorite)	NEMA 4X: Non-metallic
Hazardous Area:	NEMA 7: Galvanized Malleable Iron or Aluminum or NEMA 4X and UL listed or FM Approved for the Hazardous Area.
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

A. Nameplates shall be provided for all field mounted instrument, analyzer, or equipment specified in Division 40. 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 engraved black phenolic with white 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.

B. 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

A. The following Product Data shall be provided in accordance with Section 01 33 00.

1. Record drawings specified by paragraph 1.04 Submittal Drawings and the schedules included in Division 40 shall be provided in the latest AutoCAD format and PDF format on CD.
    a. 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 01 78 23. 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 EXAMINATION

A. Verify field measurements prior to fabrication.

3.02 INSTALLATION

A. General:
    1. 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 CITY.
    2. Installation, calibration, settings, and testing procedures are specified in Section 40 61 21, Section 40 06 70, and subsequent sections of Division 40.

B. Field Equipment:
    1. 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.
    2. 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.
    3. 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.
    4. 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:
   1. Equipment electric power wiring shall comply with Division 26. 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.
   2. 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.
   3. Provide a surge arrestor on each 120 volt AC disconnect switch serving equipment located outdoors. Surge arrestor shall be Telematic, LP Series or equal.

D. Signal Connections:
   1. 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.
   2. 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.

3.03 FIELD QUALITY CONTROL

A. Delivery Inspection:
   1. Notify the Owner's Representative upon arrival of material or equipment to be incorporated into the work. Remove protective covers or otherwise provide access in order that the Owner's Representative may inspect such items.

B. Inspection and Installed Tests:
   1. Refer to Section 40 61 21.

3.04 CLEANING

A. Execute final cleaning prior to final project assessment.

B. Clean surfaces exposed to view, remove temporary labels, stains, and foreign substances.

C. Replace filters of operating equipment.

D. Remove waste and surplus materials, rubbish, and construction facilities from site.

3.05 MAINTENANCE

A. Maintain and service equipment for one (1) year from date of substantial completion.

END OF SECTION

SECTION 40 61 21

PROCESS CONTROL SYSTEM TESTING

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies testing requirements applicable to Sections 40 60 00 through 40 79 00 of these specifications for the process control, instrumentation, communication, network, and signal systems. This work will be referenced as the Process and Instrumentation Control System (PICS) to be provided by a PICS Testing Manager meeting the Qualifications section of this specification. Section includes:
   1. Testing documentation.
   2. Testing organization and sequencing.
   3. Factory Acceptance Testing (FAT)
   4. Performance testing.
   5. Loop testing.
   6. Functional testing.
   7. Operational testing.

B. Related sections:
   1. Section 40 06 70 – Schedules for Instrumentation of Process Systems
   2. Section 40 61 13 – Process Control System General Provisions

1.02 REFERENCES

A. Definitions:
   1. The term “instrumentation” covers field and panel instruments, analyzers, primary sensing elements, transmitters, power supplies, and monitoring devices.

B. Reference Standards:
   1. This section contains references to the following documents with additional references listed in Section 40 61 13.
      a. References are part of this section as specified and modified. In case of conflict between the requirements of this section and those of the referenced documents, the requirements of this section prevail.
      b. Version: Latest 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) unless noted otherwise.
      c. If referenced documents have been discontinued by the issuing organization, use 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.
      d. Where document dates are given in the following listing, reference to those documents means the specific document version associated with that date, whether the document has been superseded by a version with a later date, discontinued, or replaced.

Reference	Title
ISA RP7.1	Pneumatic Control Circuit Pressure Test
ISA S51.1	Process Instrumentation Terminology

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate testing with Section 01 45 20.
   2. Provide notice to the Construction Manager prior to conducting a test.
   3. Provide a detailed step-by-step test procedure, between 60 and 70 days before the commencement of testing activity, complete with forms for the recording of test results, testing equipment used, and a place for identification of the individuals performing and witnessing the test.
   4. Provide detail assistance to the Contractor in generating Section 01 45 20-Form A, customized for this project. Submit detailed form prior to testing per the requirements of Section 01 45 20.
   5. Equipment and System Performance and Operational Testing: Section 01 45 20 specifies testing of the mechanical, electrical, instrumentation, and HVAC systems. Coordinate, manage, and supervise the work with the quality assurance program including:
      a. Testing plan with the sequence for the test work.
      b. Calibration program for instruments and analyzers.
      c. Documentation program that records tests results.
      d. Performance testing program systems.

1.04 SUBMITTALS

A. Procedures: Section 01 33 00.

B. PICS submittal requirements: Section 40 61 13.
   1. Submit process and instrument control system instrumentation, hardware, and software together as an integrated system in staged submittal groupings as defined in Section 40 61 13.

C. Action Submittals:
   1. Quality Assurance submittal:
      a. PICS Testing Manager Qualifications.
      b. Testing Technician Qualifications.
      c. Proposed process area and process system organization.
      d. Submit test procedures and sample forms for approval within 90 days from the date of Notice to Proceed.

2. Testing submittal:
    a. Submit detailed testing plan and proposed testing documentation after review of the Quality Assurance submittal showing conformance with Part 2 of this specification. Obtain approved submittal prior to testing. Obtain approved submittal prior to testing:
        1) I/O interface.
        2) Testing status spreadsheets.
        3) Test procedures.
        4) Proposed test forms per this section, detailed for each test for this project.
        5) Certified Factory Calibration Reports.
    b. Test equipment and test equipment calibration date.
    c. List of factory calibrated items and calibration certificates.
    d. Performance test results.
    e. Loop test results.
    f. Functional test results.
    g. Operational test results.
3. FAT:
    a. FAT schedule and location.
    b. FAT procedures and test forms.

D. Closeout Submittals
    a. Completed test forms
    b. Calibration forms and calibration certificates.
    c. Documentation of all system, instrument, network, and any other device settings.

1.05 QUALITY ASSURANCE

A. Unit Responsibility
1. The Supplier shall accept Unit Responsibility to warrant, design, manufacture, Factory Test (performance and seismic testing), ship, provide coordination of installation, provide all specified Field Testing and Commissioning, Training, and Operations and Maintenance Manuals for all the equipment specified in this Section. A Certificate of Unit Responsibility Form shall be furnished for the equipment specified in this Section.

B. Factory Testing
1. Factory Testing shall be performed by the Supplier prior to delivery in order to verify the accuracy and performance of the systems as specified. Factory Testing need not be witnessed by the Construction Manager, unless a special Witness Testing paragraph is included in this Section. However, the Supplier shall certify and provide copies of the tests and guarantee the equipment's performance as specified in this Section. All certifications of Factory Testing shall be submitted and approved by the Construction Manager, prior to shipping equipment.
2. Factory Testing shall include at the minimum all standard tests recommended by the Supplier and the following:
    a. Factory Test 1

C. Warranty

1. A warranty for the equipment specified under this Section shall be provided in accordance with the General Conditions and Section 01 78 36 – Warranties. The Warranty shall be for one (1) year from the date of the Notice of Substantial Completion certificate issued by the City for the Work.

D. PCS Testing Manager:

1. Appoint a startup engineer or qualified specialist as PCS Testing Manager to manage, coordinate, and supervise the testing work.
2. The quality assurance program includes:
   a. Definition of process areas and systems, with testing executed on an area-by-area basis, based on the P&ID drawings.
   b. Testing for each process area executed in sequential tasks.
   c. Regularly updated testing status tracking by process area, system, and task.
   d. Regularly updated separate testing documentation for each process system.
3. PCS Testing Manager Qualifications:
   a. The PCS Testing Manager shall have at least five (5) years of total experience, or experience on at least five (5) separate projects, in managing the testing and startup of similar electrical and instrumentation control systems.

E. Testing Technician Qualifications:

1. Technicians shall be qualified by completion and certification from training courses offered by the International Society of Automation (ISA), the instrumentation and analyzer manufacturer's training courses, or technician training courses at a recognized trade school that specializes in instrumentation calibration.

PART 2 PRODUCTS

2.01 GENERAL

A. The PICS Testing Manager shall provide test forms, documentation, and records as specified in the following paragraphs.

B. Project Labeling:

1. The items specifying project labeling herein include the following as a minimum: Owner's name, facility name, project name, and project number.

2.02 TESTING DOCUMENTATION

A. Documentation Records:

1. The PICS Testing Manager shall develop a records keeping system to document progress and completion for each task in each process area or system. The following shall be kept current and available for inspection on-site at all times in a location designated by the CITY:
   a. PICS Testing Manager's qualifications, project startup, and testing history, including resume per paragraph PICS Testing Manager.

b. List of names of Contractor's and System Integrator's personnel associated with final construction and testing, and normal and emergency contact telephone numbers
c. Testing Status spreadsheet with breakdown for each process area and process system, with percentage complete on each testing sequence task.
d. Testing status specific to pre-loop test and loop testing status spreadsheet to include the I/O list organized by area and system and loop number. Percent complete of the PICS system will be based on percentage of I/O points tested.
e. Test Report Volumes.

B. Test Report Volumes:
1. Develop and maintain testing documentation for each process area or system in separate volumes. Always keep each volume current and available for inspection on site in a location designated by the Construction Manager. Each volume shall include the following as a minimum:
a. Three-ring binder with front cover and spine labeled: "Testing Documentation for (applicable Process Area / Process System)" including project labeling per paragraph 2.01B Project Labeling.
b. Table of Contents with same labeling as the volume cover with tabs for each section:
c. Section 2: I/O Interface
d. Section 3: Instrument Index
e. Section 4: Test Procedures and Forms
f. Section 5: Certified Factory Calibration Reports
g. Section 6: Test Report

C. I/O Interface:
1. Provide I/O spreadsheets for each process area's system. Spreadsheets are to include the following for each I/O point:
a. Information shown in Section 40 91 01.
b. Signal number/tag.
c. Annotation description that may be logically abbreviated and that is subject to approval.
d. Complete physical I/O channel designation and addressing or communication I/O register designation.
e. True/false status designations for digital I/O.
f. Process range; engineering units and multipliers; and raw signal range count for analog I/O.
g. Signals: Fixed point and scaled at the controller with minimum four significant implied digits of scaling; e.g., 0 to 1,400 at controller for a pH range of 0 to 14 at operator interface.
h. Provide operator interface scaling to display decimal digits required.
i. Indicate pass/fail for each point for both pre-loop test and loop tests.
j. Indicate date of tests and comment for failed points.

D. Instrument Index:

1. Provide a detailed Instrument Index. The Instrument Index from Section 40 06 70 may be used as a basis. Indicate actual calibration ranges, set points, and deadbands.

E. Field Test Procedure Documentation:
   1. Organize and assemble test procedures for each analog and discrete loop in the process control system in separate volumes for each process area or test group. Organize by I/O point. Submit final test records in electronic form by scanning and converting the records and files to Adobe PDF format, to preserve actual signatures and signoffs.
   2. 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.
   3. Include test report forms for each loop, including forms for wiring, piping, and individual component tests, with the test procedure documentation. Record the actual test results on these forms and assemble them into final test reports.
   4. Preprint and populate information in the test report forms to the extent possible prior to commencing testing.
   5. Include on the test report forms:
      a. Project name.
      b. Process area associated with the equipment under test.
      c. Instrument loop description.
      d. Instrument loop identification number.
      e. Instrument nameplate data.
      f. Instrument setup and configuration parameters.
      g. Time and date of test.
      h. Inspection checklist and results.
      i. Reference to applicable test procedure.
      j. Expected and actual test results for each test point in the loop including programmable controller data table or register values.
      k. Test equipment used.
      l. Space for remarks regarding test procedure or results, observations, etc.
      m. Name, date, and signature of testing personnel.
      n. Test witness's name and signature.

PART 3 EXECUTION

3.01 GENERAL

A. General Requirements:
   1. Provide the labor, tools, material, power, and services necessary to provide the process instrumentation and control system inspection and testing specified herein.
   2. Materials, equipment, and construction included under this Specification shall be inspected in accordance with this section and subsequent sections of this division. Perform testing in accordance with this and subsequent sections of this division.

3. A certified instrument technician qualified to calibrate the instrumentation shall calibrate and set up field instruments and analyzers.
4. No required test shall be applied without prior notice to the City. Between sixty (60) and seventy (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.

B. Test Equipment and Materials:
1. 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.
2. Provide a calibration sticker on test instruments showing date of calibration, deviation from standard, name of calibration laboratory and technician, and date recalibration is required. Include certified calibration reports traceable to the National Institute of Standards and Technology with the final test report.
3. Provide a documenting calibration system to conduct process instrumentation calibration activities that consist of a documenting process calibrator and an instrumentation data management software system that captures the calibration results and electronically document instrument data, date of calibration, calibration procedures, and as-found and as-left instrument calibration data.
4. Provide an instrument calibration system such as Fluke 743B with Fluke DPC/Track Instrumentation Management software or similar system. Submit calibration files with the final test report in hard-copy and electronic formats that does not require specialized equipment or software to read and print the files.
5. Provide buffer solutions and reference fluids for tests of analytical equipment.
6. Provide a communications and software package to record final configuration parameters and settings for variable-frequency drives with the parameters acquired by connection to the network that record the configuration settings without manual data entry or transcription of values.
7. Vendor software tools may document the systems where a licensed copy of the identical software including connectors, cables, keys, interface cards, and devices required for operation is submitted with the final documentation files.

C. Performance Deviation Tolerances:
1. Tolerances are specified in individual sections. Where tolerances are not specified, refer to the manufacturer's published performance specifications.
2. Calculate overall accuracy requirements for loops consisting of two or more components, by the root-summation-square (RSS) of the component accuracy specifications. Calculate and record tolerances for each required calibration point on the associated test report form.

D. Witnessing:
1. The Construction Manager reserves the right to observe factory and field instrumentation testing and calibration procedures. Notify the Construction Manager prior to testing, as specified herein.

3.02 FACTORY TEST

A. General Requirements.

1. Sixty days prior to the FAT, the Contractor or Packaged Equipment Vendor will develop and submit a FAT plan for use during test of cabinets, special control systems, flow measuring systems, and other pertinent systems that were factory assembled.
2. The purpose of the FAT is to check the integrity and readiness of each panel prior to delivering it to the site. The FAT, once completed, will ensure the panel will function as designed by the Construction Manager. The FAT is the first step in the testing process and consists of a PRE-FAT and the actual FAT itself. The intent of PRE-FAT is to identify and correct any deficiencies that would cause delays during the FAT.
3. Contractor or Packaged Equipment Vendor will be responsible for covering travel costs for the City and the Construction Manager for all factory acceptance tests. Travel costs covered by the Contractor or Packaged Equipment Vendor include: air travel (round trip), all meals, rental vehicle(s), and lodging for each day of test.
4. Shop drawings will be made available for use by the City and the Construction Manager.
5. The FAT shall include a System Configuration Inventory List to be verified at the Contractor's or Packaged Equipment Vendor's facility. Model and serial numbers of major equipment shall be verified and recorded in the System Configuration Inventory List. This list will be used to confirm receipt of shipped equipment and that only equipment accepted at the FAT is shipped to the site.
6. The Contractor or Packaged Equipment Vendor will resolve any discrepancies found during the FAT and documentation will be corrected. A minimum of 30 working days notification will be provided to the City prior to testing.
7. No shipments will be made without the City approval.

B. Pre-Factory Acceptance Test (Pre-FAT):

1. The Contractor or Packaged Equipment Vendor will conduct a PRE-Factory Acceptance Test (PRE-FAT) to be held at the Contractor's or Packaged Equipment Vendor's facility and must be completed prior to FAT. All trouble-shooting should be done at this phase. This is to ensure that the FAT can be demonstrated according to the approved FAT Plan without unanticipated delays. The PRE-FAT will be a documented test performed by the Contractor or Packaged Equipment Vendor. The PRE-FAT will not be witnessed by the City or its designated Construction Manager. A statement of FAT readiness will be required of the Contractor or Packaged Equipment Vendor.

C. Factory Acceptance Test (FAT):

1. General: Control system equipment shall be subject to a Factory Acceptance Test. Control system panels containing programmable logic controllers shall be loaded with the PLC software at the Contractor's or Packaged Equipment Vendor's facility prior to the FAT.
2. During FAT, the Contractor or Packaged Equipment Vendor will serve as the lead role; while the Construction Manager and City will witness the FAT.
3. Provide written notice to the City thirty (30) working days before the commencement of the FAT activity and shall include:
   a. Schedule for the FAT.

b. Location of the FAT.
c. Testing equipment used.
d. Detailed test procedure with forms for the recording of test results.
e. Sign-off spaces for the individuals performing and witnessing the tests.

4. Factory Acceptance Test procedures: Panels provided shall be interlocked or networked as applicable, operated, and checked-out by the Contractor or Packaged Equipment Vendor prior to the FAT. Submit completed panel checkout forms indicating that the panels are ready for the FAT. The FAT shall include the following:
   a. Visual inspection of equipment, instruments, control panels, and graphic displays.
   b. Validation of each input loop and output loop by simulated signals for analog inputs and by shorting discrete inputs.
   c. Validation shall include:
      1) Monitoring state changes on operator interface screens based on the inputs state change.
      2) Observation of online PLC programming application software with the associated PLC outputs state change.
      3) Outputs triggered by operator interface software devices (pushbuttons, sliders, manually-entered values, etc.)
      4) Calibration and operation of instruments on or in the control panels.
   d. Repair of loops which do not pass validation.
   e. Retest of the FAT at no additional cost.
5. Panels that pass the FAT may be shipped to the site upon shipping schedule and storage accommodation approval by the City.

3.03 PRE-OPERATIONAL PERFORMANCE TESTING

A. General Requirements:
   1. Pre-Operational Performance Testing includes testing of the completed structural, electrical, mechanical, instrumentation, and control systems as required per the specifications. It also demonstrates the hardware and software operating together to verify the PLC control strategies. The following specific tests are included in Pre-Operational Testing as related to automation requirements. This list of tests is not meant to be inclusive of all Pre-Operational Testing that may be required for all aspects of a given project.
   2. In general, tests shall be performed in the following order:

B. Wiring Tests:
   1. Verify that electrical power and signal cable ring-out and resistance testing has been performed as specified in Sections 26 05 00 and 26 08 00. Conduct wiring tests after cables have been properly terminated, tagged, and inspected.
      a. Power and Control: Section 26 08 00.
      b. Signal: Section 40 61 13-Form A.

C. Network and Bus Cable Inspection and Testing:
   1. Inspected and tested by independent industrial network testing firms.

2. Test proprietary bus systems by the manufacturer's qualified field services technician. Manufacturer's sales personnel are not considered to be qualified technicians unless qualifications are documented and certified by the manufacturer.
3. Have a qualified independent network testing service test standardized networks and buses. The following types of cabling and networks shall be tested and certified by the independent industrial network testing firm:
    a. Ethernet system cabling.
    b. Other networks provided as a part of a packaged monitoring or control system.
4. Test and verify control and instrumentation bus cabling using the standards that apply to the specific cable and bus type as follows:
    a. Ethernet Category 5E and Category 6: per TIA/EIA-568B standards.
5. Pre-Active Testing: Inspect and test cables prior to energizing to verify the following:
    a. Media type and specifications.
    b. Physical routing and project-specific cable identification tagging.
    c. Correct termination installation and connection of conductors to pins at terminations.
    d. Record cable run length and compare to the manufacturer or industry standards to verify that lengths are within specifications.
    e. Locations and values of network termination resistance.
    f. Integrity and grounding of cable shields.
    g. Values of transient protection (surge) elements.
    h. Firmware revision level of network devices available prior to energization.
    i. Settings of dip switches and configuration parameters.
6. Active System Testing: After the cable or network system has been activated for testing, provide diagnostic monitoring and signal analysis for the bus network system to evaluate network and bus integrity and data transfer quality. Measure, verify, and record the following parameters:
    a. Node addressing.
    b. Signal attenuation before and after a repeater device and at the farthest point in the network.
    c. Total network trunk voltage and current loading as applicable.
    d. Baud rate, message traffic rate, percent bandwidth used, error rate, and lost packet count.
    e. Firmware revision level of the network devices.
    f. Pre-active and active testing: within the specified range of values established by the referenced standards.
    g. Correct the functionality of networks and devices connected to the network.

D. Piping Tests:
1. Pneumatic Piping Systems: Tested for leaks in compliance with Section 40 79 00. Test pneumatic piping systems for leaks in compliance with ISA RP7.1, except performed at 10 times the normal system operating pressure. Test Section 40 61 13-Form B.
2. Liquid Piping Systems: Tested for leaks in compliance with Section 40 05 01.

E. Instrument and Component Inspection:

1. PICS components inspection activities include the following:
    a. Compare and validate instrument type and nameplate data with the drawings, specifications, and data sheet.
    b. Validate instrument identification tag.
    c. Confirm that instrument installation conforms to drawings, specifications, and manufacturer's instructions.
    d. Verify proper conductor termination and tagging.
    e. Visually check for physical damage, dirt accumulation, and corrosion.
    f. Verify that isolation amplifiers, surge protection, and safety barriers are properly installed.
    g. Report deficiencies identified within 24 hours of discovery. No instrument or system component shall be tested until deficiencies are addressed.

F. Instrumentation Calibration:
1. Calibrate instruments and final elements in accordance with the manufacturer's recommended procedures and tested in accordance with the Contractor's test procedure.
2. Complete and document instruments and component inspections to the satisfaction of the [Engineer][Construction Manager] prior to individual component calibration and testing.
3. Calibrate analog instrument at 0, 10, 50, 90, and 100 percent of the specified full-scale range. Adjust each signal sensing trip and process sensing switch to the required setting. Verify instrument readout matches loop signal. Test data recorded on test forms as specified herein.
4. Test and adjust final element alignment to verify that each final element operates smoothly over the full range in response to the specified process control signals.
5. Enter test data on the applicable test forms at the time of testing: set alarm trips, control trips, and switches to initial values specified in Section 40 06 70 Instrument Index at this time. Check final elements for range, deadband, and speed of response.
6. Have any component repaired or replaced by the manufacturer where the component fails to meet the required tolerances. 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 [Section 40 61 13-Form C through I].
9. 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. Return each instrument that fails to demonstrate proper performance for recalibration or replaced as agreed depending on the impact to the project as determined by the Construction Manager.
    a. Where instrument field calibration is not feasible, certified factory calibration reports may be submitted that include 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
FTD	40 71 00	Thermal dispersion flow metering system

G. 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 CITY.
   2. Each instrument loop shall be tested as an integrated system. Check operation from field instruments to transmitter to receiving components to the vendor panel or the SCADA operator workstation. 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 PLC I/O shall include verification of the input/output assignment and verification of operation of the input/output system and processor. Inspect the data table or register in the PLC 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. The Contractor will submit completed Loop Test Sheets within 15 days after completion of Functional Testing. Any deficiencies will be noted on the Loop Test Sheet. Once the deficiencies are resolved, the CONSTRUCTION MANAGER will initial the note and the Loop Test Sheet will be signed off.

3.04 FUNCTIONAL TESTING

A. General Requirements.
   1. Functional Testing is performed on a completed subsystem to demonstrate that equipment/ system meets manufacturers' calibration and adjustment requirements and other requirements as specified.
   2. Functional Testing includes operating equipment/system manually in local, manually and automatically from the PLC under clean water conditions.
   3. Functional Testing will commence only after the completion of the Pre-Operational Performance Testing.
   4. Functional Testing will demonstrate proper operation of all systems, with the process equipment operating over full operating ranges under conditions as closely resembling actual operating conditions as possible.
   5. Once Functional Testing is completed, the new PCS controls should be fully operational.
   6. The Contractor will deliver an instrumentation and control system Functional Testing Completion Report which will state that all Contract requirements have been met and will include a listing of all instrumentation and control system maintenance and repair activities conducted during the Functional Testing. Acceptance of the instrumentation and control system Functional Testing must be provided in writing to the Construction Manager before the Acceptance Testing may begin. Final

acceptance of the control system will be based upon Substantial Completion as stated in the General Conditions.

7. The Construction Manager is responsible for generating a control strategy validation check list. The check list will include all monitoring, alarming, historical data collection, trending, remote manual control, and automatic control. As each function is verified, it will be signed off by the Contractor and Construction Manager.
8. System Functional Testing activities will include the use of water, where feasible, to establish service conditions that simulate normal final control element operating conditions in terms of applied process loads, operating ranges, and environmental conditions.
9. Final control elements, control panels, and ancillary equipment will be tested under start-up and steady-state operating conditions to verify that proper and stable control is achieved using motor control center and local field mounted control circuits.
10. Initial control loop tuning will take place for modulating control loops.
11. All hardwired and software control circuit interlocks and alarms will be operational. The control of final control elements and ancillary equipment will be tested using both manual and automatic (where provided) control circuits.
12. The Contractor will correct any inconsistent or erroneous equipment and instrument operation within five (5) working days

B. 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 CITY.
   2. Control Strategy Testing is performed by the City in coordination with the Contractor and consist of installing and debugging the PCS control logic program, verifying the interface points between the PCS and field devices and equipment, and exercising the control strategies.
   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.

C. Control System Closed Loop Testing:
   1. Closed-Loop Commissioning shall not commence until the Control Strategy Testing has been successfully completed and documented to the satisfaction of the CITY.
   2. Closed-loop commissioning tests, performed as part of the system tests, shall demonstrate stable operation of each loop under operating conditions. Tests shall include adjustment of loop tuning parameters.
   3. Tuning parameters: gain (or proportional band), integral time constant, and derivative time constant for each control loop, adjusted to provide 1/4-amplitude damping, unless otherwise specified.
   4. The loop response to a step disturbance shall be provided for each loop. Two graphs shall be made for cascaded control loops, one showing the secondary loop response with its set point in manual, and the second showing overall loop response.
   5. Control loops with "batch" features shall be adjusted to provide optimum response following start-up from an integral action saturation condition.

6. Graph recording shall be provided showing the response and made at sufficient speed and amplitude to show 1/4 amplitude damping. Label to show loop number and title, and settings of parameters and set point.
7. Where a loop is controlled under the direction of a programmable logic controller, the City will perform the necessary adjustment of loop tuning parameters and setpoints; Contractor shall record the loop response, adjusting final elements, and assuring total integrated loop performance as specified.

D. Functional Checkout:
1. Conducted to verify the operation of discrete and hardwired control devices, refer to Section 01 45 20. 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

A. System Acceptance Test (SAT) shall be performed after component and subsystem tests have been completed. Perform the test of the completed system in full operation and demonstrate that functional requirements of this specification have been met. The SAT shall demonstrate the following:
1. Each component of the system operates correctly with other components of the system.
2. Analog control loops operate in a stable manner.
3. Hard-wired and software equipment interlocks perform correctly.
4. Process control sequences perform correctly.
5. Application program performs monitoring and control functions correctly.
6. Operator interface graphics represent the monitoring and control functions correctly.

END OF SECTION

SECTION 40 71 00

FLOW MEASUREMENT

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies requirements for instrumentation elements that quantitatively convert the measured variable energy into a form suitable for measurement and process measurement accessories. Application requirements are specified in Section 40 06 70.

B. This section specifies requirements for process parameter transmitters, associated indication devices, and accessories.

C. This section specifies requirements for process activated switches, devices, and accessories.

D. This section specifies requirements for instrumentation elements which form a part of the process control systems specified in Section 40 61 13.

E. Operating Requirements:

1. The devices specified in this section quantitatively convert the measured variable energy into a form suitable for measurement and process measurement accessories.

1.02 REFERENCES

A. References are listed in Section 40 61 13. They are a part of this section as specified and modified.

1.03 QUALITY ASSURANCE

A. Manufacturer:

1. Equipment furnished under this section shall be the products of firms regularly engaged in the design and manufacture of such equipment for a minimum of five years.

B. Installer:

1. Installation, calibration and testing of equipment furnished under this section shall be performed by qualified, skilled, Certified Technicians specified in Section 40 61 13, who are regularly engaged in such activities involving systems of similar complexity.

C. References:

1. References are listed in Section 40 61 13 and are a part of this section as specified and modified.

1.04 ENVIRONMENTAL CONDITIONS

A. Equipment provided under this section shall be suitable for operation under ambient conditions described in Section 40 61 13-1.03.

1.05 SUBMITTALS

A. Submittals shall be provided as specified in Section 40 06 70-1.03.

B. Submittals shall be provided as specified in Sections 01 33 00 and 40 61 13, including:

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 01 79 00 – Demonstration and Training
    b. Section 01 78 23 – Operating and Maintenance Data
    c. Section 40 61 13 – Process Control System General Provisions
    d. Section 40 06 70 – Schedules for Instrumentation of Process Systems
2. 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.
    a. 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.
    b. 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. 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.
4. 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. Marked Contract Document Mechanical and/or Electrical Plan drawings, sections, and details showing sensor installation locations and details. Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
    a. Marked product literature of all equipment and features to be provided.
    b. Installation drawings for only the transmitters, sensors, and mounting accessories to be provided.
    c. Electrical and signal connection drawings for only the transmitters and sensors to be provided.

d. List of miscellaneous items, cables, spare parts, that will be provided in accordance with INSTRUSPEC sheet requirements.

C. Marked product literature of all equipment and features.

D. Installation details for the process switches and mounting accessories.

E. Electrical and signal connection drawings for process switches and devices.

PART 2 PRODUCTS

2.01 INSTRUMENTATION SPECIFICATION SHEETS (INSTRUSPEC)

A. General requirements for instruments specified in this section are specified on the INSTRUSPEC sheets in the Appendix at the end of this section.

B. Application requirements are specified in the Instrument Index, and/or on the drawings.

2.02 SYSTEM EQUIPMENT

A. General:
1. In accordance with Section 01 33 00, the General Conditions of the Contract Documents, drawings, information, and technical data for all equipment as, required in Section 40 61 13 and this section shall be provided. All required product data for this section shall be included in one complete package.

B. Process switches and devices shall comply with the following requirements:
1. Contact outputs used for alarm actuation shall be normally-closed or normally-opened as required by the process condition to open to initiate the alarm.
2. Contact outputs used to control equipment shall be normally-opened and shall close to start the equipment.
3. Contacts monitored by solid state equipment such as programmable controllers or annunciators shall be hermetically sealed and rated for switching currents from 20 to 100 mA at 24 volts DC.
4. Contacts, monitored by electromagnetic devices such as mechanical relays, shall be rated as NEMA ICS 2, designation B300.
5. Double barriers provided between switch elements and process fluids such that failure of one barrier will not permit process fluids into electrical enclosures.
6. Switch electrical enclosures rated as NEMA 250, Type 4 minimum.
7. Switch contacts located in Class I, Division 1 areas and monitored by solid-state circuits shall be made safe by intrinsic safety barriers as specified in paragraph 2.04.
8. Switch range shall be selected so that the specified set point is at least 30 percent but not more than 70 percent of the span, between the upper range limit and the lower range limit.

C. Measuring elements and transmitters shall comply with the following requirements:
   1. Measured parameter output indicators complying with paragraph 2.03 shall be provided with any transmitter that does not include an integral indicator. Indicators, whether integral or separate, shall be calibrated in process units, and engraved on the indicator scale plate.
   2. The two-wire type transmitters shall have operating power derived from the signal transmission circuit.
   3. Transmitters shall meet specified performance requirements with load variations within the range of 0 to 600 with the power supply at a nominal 24 volts DC with the default range of 0 to 100% corresponding to 4 to 20 madc.
   4. Transmitter output shall increase with increasing measurement.
   5. Time constant shall be adjustable from 0.5 to 5.0 seconds for transmitters used for flow, level transmitters used for flow measurement, or pressure measurement.
   6. Transmitter output shall be galvanically isolated via electro-mechanical or optical technology.
   7. Transmitter enclosures shall be rated NEMA 250, Type 4, unless otherwise specified.
   8. Transmitters located outdoors shall be provided with surge protectors:
      a. Signal:
         1) Emerson/Rosemount Model 470 D, Emerson/EDCO SS64-036-2, CCI SPN-42 FS28 Series, or accepted equal.
      b. AC Power:
         1) UL 1449, LED indicator, screw terminal connections, NEMA 4X. EDCO HSP121A or accepted equal.
   9. Two-wire transmitter located in a facility area classified as hazardous per the NFPA and the NEC shall be made safe by means of an intrinsic safety barrier as specified in paragraph 2.04.
   10. Four-wire transmitters shall be isolated from the process and power or provided with a loop-powered signal current isolator as specified in paragraph 2.05 connected in the output signal circuit.

2.03 PROCESS PARAMETER OUTPUT INDICATOR

A. Provide digital LED or LCD indicators that integral to the instrument housing where available from the manufacturer. Displays shall be scaled in engineering units, over the calibrated range of the instrument. Calibrate the indicator scale in process units.

B. Analog output indicators shall be 2.5-inch milli-ammeter with 90-degree movement enclosed in a NEMA 7/9 rated meter case. Provide indicators with accuracy within two percent of span. Provide a diode to maintain loop continuity for indicator removal.

2.04 INTRINSIC SAFETY BARRIERS

A. Intrinsic safety barriers for two-wire transmitters shall be of the active, isolating, loop powered type. Barrier shall be Measurement Technology LTD Type MT3042 or accepted equal.

2.05 SIGNAL CURRENT ISOLATOR

A. 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.

B. 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.

2.06 PRODUCT DATA

A. Additional Information:
   1. The following product data shall be provided:
      a. Flow calculation for each differential-type flow element.
      b. Record documentation shall include the data sheets specified in this section.

B. The following data provided in accordance with Section 01 33 00:
   1. Operating and maintenance information as specified in Section 40 61 13. Include final reviewed submittal and separate record of all final configuration, jumper, and switch settings for each instrument.
   2. Test results as specified in Section 40 61 21.

PART 3 EXECUTION

3.01 INSTALLATION

A. Process Connections:
   1. Process taps shall comply with API RP551. Root valves shall be provided at taps, except temperature taps and pump discharge pressure taps. Process connections shall be arranged such that instruments may be readily removed for maintenance without disruption of process units or draining of large tanks or vessels.
   2. Unions or flange connections shall be provided as necessary to permit removal without rotating equipment. Where process taps are not readily accessible from instrument locations, a block valve shall be provided at the instrument. Block valves shall also be provided for each instrument where multiple instruments are connected to one process tap.

B. Electrical Connections:
   1. Final connections between rigid raceway systems and instruments shall be made with jacketed flexible conduit with a maximum length of 2 feet.

3.02 INSTALLATION

A. General:
   1. General requirements for the installation of primary elements specified in this section are listed on INSTRUSPEC sheets and the specific application specified in Section 40 06 70-2.01.
   2. Installation requirements are specified in paragraph 40 61 13-3.01.

B. Process Connections:
   1. General:
      a. Unless otherwise specified, process taps shall comply with Section 40 05 01. Process connections shall be arranged such that instruments may be readily removed for maintenance without disruption of process units or draining of large tanks or vessels. Unions or flange connections shall be provided as necessary to permit removal without rotating equipment.
         1) Where process taps are not readily accessible from instrument locations, an isolation valve shall be provided at the instrument.
         2) Isolation valves shall be provided for each instrument where multiple instruments are connected to one process tap.
         3) Pipe between the process connection and instruments shall be 1/2-inch stainless steel with treatment material for easy removal, as specified herein.
   2. Safety Instruments:
      a. No valves shall be installed at pressure taps for safety instruments. Safety instruments shall not be connected to the same process tap as instruments used for control, indication, or recording except when annular chemical seals are used.
   3. Root Valves:
      a. Root valves shall be provided at all process taps, except as follows:
         1) Temperature taps, where valves are unnecessary.
         2) Pump discharge pressure taps where no instrument is permanently
         3) installed. Isolation valves shall be provided.
         4) Process taps for safety instruments.
         5) Where gauge valves are provided.
         6) Where chemical seals are used.
   4. Gauge Valves:
      a. Gauge valves shall be provided for each pressure gauge tap except where chemical seals are used.

C. Tubing:
   1. Tubing shall be installed on supports spaced not more than 3 feet apart and shall run parallel of perpendicular to walls structural members, or intersections of vertical planes and the ceiling. Unless otherwise shown, tubing shall follow building surfaces closely or shall be carried in trays or conduit.
   2. Tubing shall not be supported from piping or equipment except at process taps or connections to the device served. Tubes supported directly on concrete surfaces shall be spaced at least 1/8 inch from the concrete. Tubing support shall be one-hole malleable iron clamps with clamp backs as required. Bends shall be formed to uniform radii without flattening.
   3. Ends of tubing shall be square-cut and de-burred before installation in fittings. Fittings shall be used for splices, connections, and turns near final connections. Bulkhead fittings shall be used when tubing enters a panel.

D. Electrical Connections:
   1. Final connections between rigid raceway systems and instruments shall be made with jacketed flexible conduit with a maximum length of 2 feet.

3.03 TESTING

A. Applicable testing requirements are specified in Section 40 06 70.

B. Testing requirements are specified in Section 40 61 21.

3.04 PROCESS CONNECTIONS:

A. Process connection piping and tubing shall be tested in accordance with Section 40 05 01.

PART 4 APPENDIX - INSTRUSPECS

4.01 INSTRUSPECS

A. General requirements for instruments specified in this section are listed on INSTRUSPEC sheets herein. Application requirements are specified in the Instrument Index, and/or on the drawings.

Table A

INSTRUSPEC Symbol	Instrument description	Instrument function
FTD	Thermal Dispersion Flow Transmitter	Flow Measurement

4.02 INSTRUMENT IDENTIFICATION: FTD

A. Instrument Type: Flow Measurement

B. Instrument Description: Thermal Dispersion Flowmeter

C. Power Supply: 120 Vac

D. Signal Input: Process

E. Signal Output: 4 to 20 mADC into 0 to 600 ohms, galvanically isolated

F. Process Connection: 0.75-inch male NPT

G. Product Requirements:

1. Flow indicating transmitter mounted remotely or integral with the flow element, as scheduled in Section 40 06 70-3.03 Instrument Index, with LCD flowrate display and totalized flow display. Provide continuous interconnecting cable and mounting hardware.
2. Convert resistance difference to gas flow rate with a maximum error of ±1 percent of reading + 0.5% of full scale.
3. Transmitter housed in a NEMA 4X enclosure and rated for a minimum temperature range of 0 to 140 degrees F.
4. Sensing element shall consist of two matched platinum resistance temperature elements, one heated and the other passive sheathed in a nickel brazed 316 stainless steel insertion assemblies.

5. Element suitable for gas flow velocities from 0.5 to 100 actual feet per second, gas temperatures of -40 to +350 degrees F, static pressures from full vacuum to 300 psig, process pipes 1-inch diameter and larger.
6. Flow conditioner, flow element, and flow transmitter provided and calibrated as a unit from the manufacturer.
7. Flow conditioner shall match the process piping schedule, material, and end-connection pressure service rating.
8. Manufacturer shall provide NIST testing and certification documentation for 20, 40, 60, 80 and 100% of the expected flow rate, as provided by the Engineer.
9. Thermal dispersion flow transmitter manufacturer:
    a. Fluid Components, Inc., ST98
    b. Endress + Hauser Proline t-mass 65F
    c. Accepted equal.
10. Flow conditioner:
    a. VORTAB VMR
    b. Accepted equal.

H. Execution:
1. Installation: Install flowmeter per manufacturer's instructions and Engineer's installation detail.
2. Install flow conditioners per manufacturer's instructions and piping specifications, including gasket material and bolt torque requirements.
3. Test: In accordance with paragraph 3.03.

END OF SECTION

SECTION 40 73 00

PRESSURE, STRAIN, AND FORCE MEASUREMENT

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies requirements for instrumentation elements that quantitatively convert the measured variable energy into a form suitable for measurement and process measurement accessories. Application requirements are specified in Section 40 06 70.

B. This section specifies requirements for process parameter transmitters, associated indication devices, and accessories.

C. This section specifies requirements for process activated switches, devices, and accessories.

D. This section specifies requirements for instrumentation elements which form a part of the process control systems specified in Section 40 61 13 and Section 40 06 70-3.03. Application requirements are specified in the instrument schedule, Section 40 06 70-3.03.

E. Operating Requirements: The devices specified in this section quantitatively convert the measured variable energy into a form suitable for measurement and process measurement accessories.

1.02 REFERENCES

A. References are listed in Section 40 61 13. They are a part of this section as specified and modified.

1.03 QUALITY ASSURANCE

A. Manufacturer: Equipment furnished under this section shall be the products of firms regularly engaged in the design and manufacture of such equipment for a minimum of five years.

B. Installer: Installation, calibration and testing of equipment furnished under this section shall be performed by qualified, skilled, Certified Technicians specified in Section 40 61 13, who are regularly engaged in such activities involving systems of similar complexity.

C. References: References are listed in Section 40 61 13 and are a part of this section as specified and modified.

1.04 ENVIRONMENTAL CONDITIONS

A. Equipment provided under this section shall be suitable for operation under ambient conditions described in Section 40 61 13-1.03.

1.05 SUBMITTALS

A. Submittals shall be provided as specified in Section 40 06 70-1.03.

B. Submittals shall be provided as specified in Sections 01 33 00 and 40 61 13, including:

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 01 79 00 – Demonstration and Training
    b. Section 01 78 23 – Operating and Maintenance Data
    c. Section 40 61 13 – Process Control System General Provision
    d. Section 40 06 70 – Schedules for Instrumentation of Process Systems
2. 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.
    a. 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.
    b. 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. 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.
4. 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. Marked Contract Document Mechanical and/or Electrical Plan drawings, sections, and details showing sensor installation locations and details. Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
    a. Marked product literature of all equipment and features to be provided.
    b. Installation drawings for only the transmitters, sensors, and mounting accessories to be provided.
    c. Electrical and signal connection drawings for only the transmitters and sensors to be provided.

d. List of miscellaneous items, cables, spare parts, that will be provided in accordance with INSTRUSPEC sheet requirements.

C. Marked product literature of all equipment and features.

D. Installation details for the process switches and mounting accessories.

E. Electrical and signal connection drawings for process switches and devices.

PART 2 PRODUCTS

2.01 INSTRUMENTATION SPECIFICATION SHEETS (INSTRUSPEC)

A. General requirements for instruments specified in this section are specified on the INSTRUSPEC sheets in the Appendix at the end of this section.

B. Application requirements are specified in the Instrument Index, and/or on the drawings.

2.02 EQUIPMENT

A. General:
1. In accordance with Section 01 33 00 the General Conditions of the Contract Documents, drawings, information, and technical data for all equipment as, required in Section 40 61 13 and this section shall be provided. All required product data for this section shall be included in one complete package.

B. Process switches and devices shall comply with the following requirements:
1. Contact outputs used for alarm actuation shall be normally-closed or normally-opened as required by the process condition to open to initiate the alarm.
2. Contact outputs used to control equipment shall be normally-opened and shall close to start the equipment.
3. Contacts monitored by solid state equipment such as programmable controllers or annunciators shall be hermetically sealed and rated for switching currents from 20 to 100 mA at 24 volts DC.
4. Contacts, monitored by electromagnetic devices such as mechanical relays, shall be rated as NEMA ICS 2, designation B300.
5. Double barriers provided between switch elements and process fluids such that failure of one barrier will not permit process fluids into electrical enclosures.
6. Switch electrical enclosures rated as NEMA 250, Type 4 minimum.
7. Switch contacts located in Class I, Division 1 areas and monitored by solid-state circuits shall be made safe by intrinsic safety barriers as specified in paragraph 2.04.
8. Switch range shall be selected so that the specified set point is at least 30 percent but not more than 70 percent of the span, between the upper range limit and the lower range limit.

C. Measuring elements and transmitters shall comply with the following requirements:
   1. Measured parameter output indicators complying with paragraph 2.02 shall be provided with any transmitter that does not include an integral indicator. Indicators, whether integral or separate, shall be calibrated in process units, and engraved on the indicator scale plate.
   2. The two-wire type transmitters shall have operating power derived from the signal transmission circuit.
   3. Transmitters shall meet specified performance requirements with load variations within the range of 0 to 600 with the power supply at a nominal 24 volts DC with the default range of 0 to 100% corresponding to 4 to 20 madc.
   4. Transmitter output shall increase with increasing measurement.
   5. Time constant shall be adjustable from 0.5 to 5.0 seconds for transmitters used for flow, level transmitters used for flow measurement, or pressure measurement.
   6. Transmitter output shall be galvanically isolated via electro-mechanical or optical technology.
   7. Transmitter enclosures shall be rated NEMA 250, Type 4, unless otherwise specified.
   8. 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.
   9. Two-wire transmitter located in a facility area classified as hazardous per the NFPA and the NEC shall be made safe by means of an intrinsic safety barrier as specified in paragraph 2.04.
   10. Four-wire transmitters shall be isolated from the process and power or provided with a loop-powered signal current isolator as specified in paragraph 2.05 connected in the output signal circuit.

2.03 PROCESS PARAMETER OUTPUT INDICATOR

A. Provide digital LED or LCD indicators that integral to the instrument housing where available from the manufacturer. Displays shall be scaled in engineering units, over the calibrated range of the instrument. Calibrate the indicator scale in process units.

B. Analog output indicators shall be 2.5-inch milli-ammeter with 90-degree movement enclosed in a NEMA 7/9 rated meter case. Provide indicators with accuracy within two percent of span. Provide a diode to maintain loop continuity for indicator removal.

2.04 INTRINSIC SAFETY BARRIERS

A. Intrinsic safety barriers for two-wire transmitters shall be of the active, isolating, loop powered type. Barrier shall be Measurement Technology LTD Type MT3042 or accepted equal.

2.05 SIGNAL CURRENT ISOLATOR

A. 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.

B. 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.

2.06 PRODUCT DATA

A. Additional Information: The following product data shall be provided:
   1. Flow calculation for each differential-type flow element.
   2. Record documentation shall include the data sheets specified in this section.

B. The following data provided in accordance with Section 01 33 00:
   1. Operating and maintenance information as specified in Section 40 61 13. Include final reviewed submittal and separate record of all final configuration, jumper, and switch settings for each instrument.
   2. Test results as specified in Section 40 61 21.

PART 3 EXECUTION

3.01 INSTALLATION

A. Process Connections:
   1. Process taps shall comply with API RP551. Root valves shall be provided at taps, except temperature taps and pump discharge pressure taps. Process connections shall be arranged such that instruments may be readily removed for maintenance without disruption of process units or draining of large tanks or vessels.
   2. Unions or flange connections shall be provided as necessary to permit removal without rotating equipment. Where process taps are not readily accessible from instrument locations, a block valve shall be provided at the instrument. Block valves shall also be provided for each instrument where multiple instruments are connected to one process tap.

B. Electrical Connections: Final connections between rigid raceway systems and instruments shall be made with jacketed flexible conduit with a maximum length of 2 feet.

3.02 INSTALLATION

A. General:
   1. General requirements for the installation of primary elements specified in this section are listed on INSTRUSPEC sheets and the specific application specified in Section 40 06 70-3.03.
   2. Installation requirements are specified in Section 40 61 13-3.01.

B. Process Connections:
   1. General: Unless otherwise specified, process taps shall comply with Section 40 05 01. Process connections shall be arranged such that instruments may be readily removed for maintenance without disruption of process units or draining of large tanks or vessels. Unions or flange connections shall be provided as necessary to permit removal without rotating equipment.

a. Where process taps are not readily accessible from instrument locations, an isolation valve shall be provided at the instrument.
b. Isolation valves shall be provided for each instrument where multiple instruments are connected to one process tap.
c. Pipe between the process connection and instruments shall be 1/2-inch stainless steel with treatment material for easy removal, as specified herein.

2. Safety Instruments: No valves shall be installed at pressure taps for safety instruments. Safety instruments shall not be connected to the same process tap as instruments used for control, indication, or recording except when annular chemical seals are used.
3. Root Valves: Root valves shall be provided at all process taps, except as follows:
   a. Temperature taps, where valves are unnecessary.
   b. Pump discharge pressure taps where no instrument is permanently
   c. installed. Isolation valves shall be provided.
   d. Process taps for safety instruments.
   e. Where gauge valves are provided.
   f. Where chemical seals are used.
4. Gauge Valves: Gauge valves shall be provided for each pressure gauge tap except where chemical seals are used.

C. Tubing:
1. Tubing shall be installed on supports spaced not more than 3 feet apart and shall run parallel of perpendicular to walls structural members, or intersections of vertical planes and the ceiling. Unless otherwise shown, tubing shall follow building surfaces closely or shall be carried in trays or conduit.
2. Tubing shall not be supported from piping or equipment except at process taps or connections to the device served. Tubes supported directly on concrete surfaces shall be spaced at least 1/8 inch from the concrete. Tubing support shall be one-hole malleable iron clamps with clamp backs as required. Bends shall be formed to uniform radii without flattening.
3. Ends of tubing shall be square-cut and de-burred before installation in fittings. Fittings shall be used for splices, connections, and turns near final connections. Bulkhead fittings shall be used when tubing enters a panel.

D. Electrical Connections:
1. Final connections between rigid raceway systems and instruments shall be made with jacketed flexible conduit with a maximum length of 2 feet.

3.03 TESTING

A. Applicable testing requirements are specified in Section 40 06 70-3.02.

B. Testing requirements are specified in Section 40 61 21.

3.04 PROCESS CONNECTIONS

A. Process connection piping and tubing shall be tested in accordance with Section 40 05 01.

PART 4 APPENDIX - INSTRUSPECS

4.01 INSTRUSPECS

A. General requirements for instruments specified in this section are listed on INSTRUSPEC sheets herein. Application requirements are specified in the Instrument Index, and/or on the drawings.

Table A

INSTRUSPEC Symbol	Instrument description	Instrument function
PDT	Differential Pressure Transmitter	Pressure Measurement
PG	Pressure gage	Pressure measurement

4.02 INSTRUMENT IDENTIFICATION: PDT

A. Instrument Function: Pressure Measurement

B. Instrument Description: Differential Pressure Transmitter

C. Power Supply: As specified in paragraph 2.02

D. Signal Input: Process

E. Signal Output: Analog transmission signal as specified in paragraph 2.02

F. Process Connection: Two 1/2-inch female NPT flange adapters

G. Product Requirements:
   1. Pressure Transmitter: Capacitance or piezoresistive type.
   2. Wetted Parts: Type 316 stainless steel or as specified in Section 40 06 70-3.03.
   3. Range: 100:1.
   4. HART standard data communication protocol.
   5. Accuracy: 0.075 percent of calibrated span.
   6. Static Pressure Rating: 2,000 psi
   7. Indicator: LCD display.
   8. Acceptable Manufacturer:
      a. Rosemount 3051CD.
      b. Endress + Hauser Deltabar PMD75
      c. Accepted equal.

H. Execution:
   1. Installation: Install in accordance with manufacturer's instructions and the Engineer’s installation detail.
   2. Root valves provided at all process pressure taps.
   3. Gauge valves provided at the instrument where the instrument is not within sight of the root valve or where two or more instruments are connected to a single tap.
   4. Safety instruments shall not be connected to the same process tap as instruments used for control, indication, or recording.

5. Pressure instruments located as close as practical to the process tap and be positioned to permit observation and maintenance.
6. Pressure instruments shall not be supported from process piping.
7. Pressure instruments for use with integral seals, or remote seals and capillary tubing provided by a single manufacturer with components factory-assembled prior to shipping.

I. Seals:
1. Type: Diaphragm
2. Process Connection: 3-1/2 inch saddle style, pancake, or flush flanged as required by the application.
3. Diaphragm and Wetted Parts: Type 316L stainless steel unless otherwise specified in Section 40 06 70.
4. Upper Housing and Mounting Flange: Type 316L stainless steel. Lower Housing: Type 316 stainless steel
5. Temperature Limit, High Side: -40 to 300 degrees F
6. Acceptable Manufacturer:
   a. Rosemount 1199.
   b. Accepted equal.

J. Capillary Option:
1. Seal Location: High pressure side of transmitter, direct mounting
2. Fill Fluid: DC 200 Silicone
3. Capillary Seal Connection Material: Type 316 stainless steel armored sleeving.

4.03 INSTRUMENT IDENTIFICATION: PG

A. Instrument Function: Pressure measurement

B. Instrument Description: Pressure gage

C. Power Supply: N/A

D. Signal Input: N/A

E. Signal Output: N/A

F. Process Connection: 1/2-inch male NPT

G. Product Requirements: Pressure gages shall be 4-1/2-inch premium grade, glycerin filled units with bourdon tube element, 270-degree milled stainless steel movement, phenolic case, and shatterproof glass window. Accuracy shall be 1 percent of span or better. All exposed metal parts shall be stainless steel. Pressure gage manufactures:
1. Ashcroft Duraguage Figure 1279
2. Ametek 1981L
3. or equal.

H. Execution:

1. Installation: Install in accordance with manufacturer's instructions and the recommendations of API RP551 to the specified requirements.

   Root valves shall be provided at all process pressure taps except taps made for safety instruments. Gage valves shall be provided at the instrument where the instrument is not within sight of the root valve or where two or more instruments are connected to a single tap.

   Safety instruments shall not be connected to the same process tap as instruments used for control, indication, or recording. Unless otherwise specified, pressure instruments shall be located as close as practical to the process tap but shall be positioned to permit observation and maintenance. Pressure gages may be supported from the process tap if this location permits observation from the floor or a permanent work platform. Pressure instruments shall be installed in such a manner that blowout discs are not obstructed.
2. Application/Calibration: Application, calibration, and set points shall be as specified in Section 40 06 70-3.03.

END OF SECTION

SECTION 40 74 00

TEMPERATURE MEASUREMENT

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies requirements for instrumentation elements that quantitatively convert the measured variable energy into a form suitable for measurement and process measurement accessories. Application requirements are specified in Section 40 06 70.

B. This section specifies requirements for process parameter transmitters, associated indication devices, and accessories.

C. This section specifies requirements for process activated switches, devices, and accessories.

D. This section specifies requirements for instrumentation elements which form a part of the process control systems specified in Section 40 61 13 and Section 40 06 70-3.03. Application requirements are specified in the instrument schedule, Section 40 06 70-3.03.

E. Operating Requirements: The devices specified in this section quantitatively convert the measured variable energy into a form suitable for measurement and process measurement accessories.

1.02 REFERENCES

A. References are listed in Section 40 61 13. They are a part of this section as specified and modified.

1.03 QUALITY ASSURANCE

A. Manufacturer: Equipment furnished under this section shall be the products of firms regularly engaged in the design and manufacture of such equipment for a minimum of five years.

B. Installer: Installation, calibration and testing of equipment furnished under this section shall be performed by qualified, skilled, Certified Technicians specified in Section 40 61 13, who are regularly engaged in such activities involving systems of similar complexity.

C. References: References are listed in Section 40 61 13 and are a part of this section as specified and modified.

1.04 ENVIRONMENTAL CONDITIONS

A. Equipment provided under this section shall be suitable for operation under ambient conditions described in Section 40 61 13-1.03.

1.05 SUBMITTALS

A. Submittals shall be provided as specified in Section 40 06 70-1.03.

B. Submittals shall be provided as specified in Sections 01 33 00 and 40 61 13, including:
   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 01 79 00 – Demonstration and Training
      b. Section 01 78 23 – Operating and Maintenance Data
      c. Section 40 61 13 – Process Control System General Provisions
      d. Section 40 06 70 – Schedules for Instrumentation of Process Systems
   2. 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.
      a. 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.
      b. 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. 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.
   4. 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. Marked Contract Document Mechanical and/or Electrical Plan drawings, sections, and details showing sensor installation locations and details. Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
      a. Marked product literature of all equipment and features to be provided.
      b. Installation drawings for only the transmitters, sensors, and mounting accessories to be provided.
      c. Electrical and signal connection drawings for only the transmitters and sensors to be provided.
      d. List of miscellaneous items, cables, spare parts, that will be provided in accordance with INSTRUSPEC sheet requirements.

C. Marked product literature of all equipment and features.

D. Installation details for the process switches and mounting accessories.

E. Electrical and signal connection drawings for process switches and devices.

PART 2 PRODUCTS

2.01 INSTRUMENTATION SPECIFICATION SHEETS (INSTRUSPEC)

A. General requirements for instruments specified in this section are specified on the INSTRUSPEC sheets in the Appendix at the end of this section.

B. Application requirements are specified in the Instrument Index, and/or on the drawings.

2.02 PRODUCT DATA

A. General:
   1. In accordance with Section 01 33 00 the General Conditions of the Contract Documents, drawings, information, and technical data for all equipment as, required in Section 40 61 13 and this section shall be provided. All required product data for this section shall be included in one complete package.

B. Process switches and devices shall comply with the following requirements:
   1. Contact outputs used for alarm actuation shall be normally-closed or normally-opened as required by the process condition to open to initiate the alarm.
   2. Contact outputs used to control equipment shall be normally-opened and shall close to start the equipment.
   3. Contacts monitored by solid state equipment such as programmable controllers or annunciators shall be hermetically sealed and rated for switching currents from 20 to 100 mA at 24 volts DC.
   4. Contacts, monitored by electromagnetic devices such as mechanical relays, shall be rated as NEMA ICS 2, designation B300.
   5. Double barriers provided between switch elements and process fluids such that failure of one barrier will not permit process fluids into electrical enclosures.
   6. Switch electrical enclosures rated as NEMA 250, Type 4X minimum.
   7. Switch contacts located in Class I, Division 1 areas and monitored by solid-state circuits shall be made safe by intrinsic safety barriers as specified in paragraph 2.04.
   8. Switch range shall be selected so that the specified set point is at least 30 percent but not more than 70 percent of the span, between the upper range limit and the lower range limit.

C. Measuring elements and transmitters shall comply with the following requirements:
   1. Measured parameter output indicators complying with paragraph 2.02 shall be provided with any transmitter that does not include an integral indicator. Indicators, whether integral or separate, shall be calibrated in process units, and engraved on the indicator scale plate.
   2. The two-wire type transmitters shall have operating power derived from the signal transmission circuit.
   3. Transmitters shall meet specified performance requirements with load variations within the range of 0 to 600 with the power supply at a nominal 24 volts DC with the default range of 0 to 100% corresponding to 4 to 20 madc.
   4. Transmitter output shall increase with increasing measurement.

5. Time constant shall be adjustable from 0.5 to 5.0 seconds for transmitters used for flow, level transmitters used for flow measurement, or pressure measurement.
6. Transmitter output shall be galvanically isolated via electro-mechanical or optical technology.
7. Transmitter enclosures shall be rated NEMA 250, Type 4X, unless otherwise specified.
8. 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.
9. Two-wire transmitter located in a facility area classified as hazardous per the NFPA and the NEC shall be made safe by means of an intrinsic safety barrier as specified in paragraph 2.04.
10. Four-wire transmitters shall be isolated from the process and power or provided with a loop-powered signal current isolator as specified in paragraph 2.05 connected in the output signal circuit.

2.03 PROCESS PARAMETER OUTPUT INDICATOR

A. Provide digital LED or LCD indicators that integral to the instrument housing where available from the manufacturer. Displays shall be scaled in engineering units, over the calibrated range of the instrument. Calibrate the indicator scale in process units.

B. Analog output indicators shall be 2.5-inch milli-ammeter with 90-degree movement enclosed in a NEMA 7/9 rated meter case. Provide indicators with accuracy within two percent of span. Provide a diode to maintain loop continuity for indicator removal.

2.04 INTRINSIC SAFETY BARRIERS

A. Intrinsic safety barriers for two-wire transmitters shall be of the active, isolating, loop powered type. Barrier shall be Measurement Technology LTD Type MT3042 or accepted equal.

2.05 SIGNAL CURRENT ISOLATOR

A. 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.

B. 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.

2.06 PRODUCT DATA

A. Additional Information: The following product data shall be provided:
    1. Flow calculation for each differential-type flow element.
    2. Record documentation shall include the data sheets specified in this section.

B. The following data provided in accordance with Section 01 33 00:
   1. Operating and maintenance information as specified in Section 40 61 13. Include final reviewed submittal and separate record of all final configuration, jumper, and switch settings for each instrument.
   2. Test results as specified in Section 40 61 21.

PART 3 EXECUTION

3.01 INSTALLATION

A. Process Connections:
   1. Process taps shall comply with API RP551. Root valves shall be provided at taps, except temperature taps and pump discharge pressure taps. Process connections shall be arranged such that instruments may be readily removed for maintenance without disruption of process units or draining of large tanks or vessels.
   2. Unions or flange connections shall be provided as necessary to permit removal without rotating equipment. Where process taps are not readily accessible from instrument locations, a block valve shall be provided at the instrument. Block valves shall also be provided for each instrument where multiple instruments are connected to one process tap.

B. Electrical Connections: Final connections between rigid raceway systems and instruments shall be made with jacketed flexible conduit with a maximum length of 2 feet.

3.02 INSTALLATION

A. General:
   1. General requirements for the installation of primary elements specified in this section are listed on INSTRUSPEC sheets and the specific application specified in Section 40 06 70.
   2. Installation requirements are specified in Section 40 61 13-3.01.

B. Process Connections:
   1. General: Unless otherwise specified, process taps shall comply with Section 40 05 01. Process connections shall be arranged such that instruments may be readily removed for maintenance without disruption of process units or draining of large tanks or vessels. Unions or flange connections shall be provided as necessary to permit removal without rotating equipment.
      a. Where process taps are not readily accessible from instrument locations, an isolation valve shall be provided at the instrument.
      b. Isolation valves shall be provided for each instrument where multiple instruments are connected to one process tap.
      c. Pipe between the process connection and instruments shall be 1/2-inch stainless steel with treatment material for easy removal, as specified herein.
   2. Safety Instruments: No valves shall be installed at pressure taps for safety instruments. Safety instruments shall not be connected to the same process tap as instruments used for control, indication, or recording except when annular chemical seals are used.

3. Root Valves: Root valves shall be provided at all process taps, except as follows:
    a. Temperature taps, where valves are unnecessary.
    b. Pump discharge pressure taps where no instrument is permanently installed. Isolation valves shall be provided.
    c. Process taps for safety instruments.
    d. Where gauge valves are provided.
    e. Where chemical seals are used.
4. Gauge Valves: Gauge valves shall be provided for each pressure gauge tap except where chemical seals are used.

C. Tubing:
1. Tubing shall be installed on supports spaced not more than 3 feet apart and shall run parallel of perpendicular to walls structural members, or intersections of vertical planes and the ceiling. Unless otherwise shown, tubing shall follow building surfaces closely or shall be carried in trays or conduit.
2. Tubing shall not be supported from piping or equipment except at process taps or connections to the device served. Tubes supported directly on concrete surfaces shall be spaced at least 1/8 inch from the concrete. Tubing support shall be one-hole malleable iron clamps with clamp backs as required. Bends shall be formed to uniform radii without flattening.
3. Ends of tubing shall be square-cut and de-burred before installation in fittings. Fittings shall be used for splices, connections, and turns near final connections. Bulkhead fittings shall be used when tubing enters a panel.

D. Electrical Connections:
1. Final connections between rigid raceway systems and instruments shall be made with jacketed flexible conduit with a maximum length of 2 feet.

3.03 TESTING

A. Applicable testing requirements are specified in Section 40 06 70-3.02.

B. Testing requirements are specified in Section 40 61 21.

3.04 PROCESS CONNECTIONS:

A. Process connection piping and tubing shall be tested in accordance with Section 40 05 01.

PART 4 APPENDIX - INSTRUSPECS

4.01 INSTRUSPECS

A. General requirements for instruments specified in this section are listed on INSTRUSPEC sheets herein. Application requirements are specified in the Instrument Index, and/or on the drawings.

Table A

INSTRUSPEC Symbol	Instrument description	Instrument function
TI	Temperature indicator	Temperature measurement

4.02 INSTRUMENT IDENTIFICATION: TI

A. Instrument Function: Temperature measurement

B. Instrument Description: Temperature indicator

C. Power Supply: N/A

D. Signal Input: Process

E. Signal Output: N/A

F. Process Connection: 1/2-inch male NPT

G. Product Requirements: Temperature indicators shall be 4-1/2-inch gas pressure operated bourdon tube elements, 270-degree movement, phenolic case, shatterproof glass window, and 1/2-inch NPT process connection.

Bulb shall be 3 inches long by 3/8-inch diameter for all ranges. Stem lengths shall be selected to place bulb in middle third of pipe. Indicator head shall be swivel mounted to the stem.

H. Temperature indicator manufacturer:
1. Ashcroft Duratemp Type 600B, or equal.

I. Execution:
1. Installation: Temperature instruments shall be installed in accordance with the manufacturer's instructions and the recommendations of API RP551 to the specified requirements.
2. For pipelines less than 4-inch diameter, temperature elements shall be installed at a pipeline elbow if possible.
3. Where an elbow is not available, a wye fitting shall be installed in the pipeline for installation of the temperature element at a 45-degree angle with the flow.

END OF SECTION

SECTION 42 13 17

AFTERCOOLER HEAT EXCHANGERS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:

1. This section specifies a corrosion resistant, pressurized heat exchanger for sequentially cooling and reheating medium pressure sludge gas (MSG) produced by the anaerobic digestion of municipal sewage sludge at a wastewater treatment facility.

B. Type:

1. The heat exchanger shall be a dual section unit and include a stainless steel, finned plate type gas-to-gas section for precooling the inlet MSG and reheating the discharge MSG and a liquid cooled plate-fin and tube section for cooling the MSG.

C. Equipment List:

Item	Equipment Number
Aftercooler Heat Exchanger 1	HE161553
Aftercooler Heat Exchanger 2	HE161534

1.02 SYSTEM DESIGN AND PERFORMANCE

A. General:

1. Medium Pressure Sludge Gas (MSG): A water-saturated mixture of several constituents including methane, carbon dioxide, nitrogen, sulfides, siloxanes, and water in vapor phase, produced by the anaerobic digestion of municipal wastewater sludge. MSG is pressurized to approximately 5 psig. As produced in the anaerobic digesters, the raw digester gas evolves under mesophilic conditions at a temperature of about 100 degrees F. The dry digester gas, as determined by laboratory analysis, has the following properties:

Parameter, by volume	Units	Design Value	Range
Methane[1]	Percent	62.0	56 to 68
Carbon Dioxide[1]	Percent	35.5	35 to 44
Nitrogen[1]	Percent	2.0	0 to 2
Oxygen[1]	Percent	0.5	0 to 1
Sulfides[2]	ppm_v	20	2 to 20
Siloxanes[3]	ppm_v	8	6 to 10

Notes:

[1] Methane, carbon dioxide, nitrogen, and oxygen values represent percent by volume as a dry gas.

[2] Sulfides are expected to comprise 90 percent or more hydrogen sulfide.

[3] Siloxanes: Volatile silicon based compounds including hexamethyldisiloxane (L2), octamethylcyclotetrasiloxane (D4), and decamethylcyclopentasiloxane (D5).

2. Flow Range: Size and select the heat exchanger to accommodate the full range of MSG flow expected from the anaerobic digesters and maintain the specified

discharge temperature.

B. Operating Conditions:

1. The raw digester gas, produced at approximately 100 degrees F and fully water saturated, will initially be treated to reduce the hydrogen sulfide concentration. The digester gas will then be cooled for moisture removal. Following the initial cooling process, the digester gas will be pressurized and consequently warmed by the heat of compression. The pressurized digester gas, MSG, will then undergo a final cooling and reheating step via the dual core heat exchangers specified in this section. The heat exchangers specified herein shall be sized and selected for the following conditions:

Process Fluid (digester gas)		
1.	Fluid name	MSG
2.	Fluid flow, design, scfm	365
3.	Fluid flow, minimum, scfm	265
4.	Fluid Cp, approximate, Btu/lb-°F	0.333
5.	Fluid pressure as produced, approximate, psia	15.2
6.	Fluid temperature as produced, approximate, degrees F	100
7.	Fluid pressure following initial cooling, approximate, psia	14.7
8.	Fluid temperature following initial cooling, approximate, degrees F	55
9.	Fluid inlet pressure following pressure boosting, approximate, psia	21.1
10.	Fluid inlet temperature following pressure boosting, approximate, degrees F	160
11.	Fluid internally chilled temperature, degrees F	46
12.	Fluid reheated outlet temperature range, degrees F	70 to 80
13.	Fluid pressure drop allowed, maximum, inches W.C.	9
Cooling Fluid (glycol solution)		
14.	Cooling fluid name	Ethylene Glycol
15.	Cooling fluid glycol concentration, percent	20
16.	Cooling fluid flowrate, approximate, gpm	25
17.	Cooling fluid inlet temperature, degrees F	41
18.	Cooling fluid discharge temperature, approximate, degrees F	46
19.	Cooling fluid pressure drop allowed, maximum, psig	12.5

1.03 QUALITY ASSURANCE

A. References:

1. 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
ANSI B16.5	Pipe Flanges and Flanged Fitting

B. Warranty:

1. A two-year 100 percent parts and labor warranty against manufacturing defects or failure of the equipment specified in this section caused by normal wear and tear

shall be provided. The warranty period shall start from the date of Owner acceptance following startup and testing.

1.04 SUBMITTALS

A. Submittals shall be provided and shall include the following information:

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 or those parts which are to be provided by the manufacturer 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 manufacturer, 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 Owner 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 manufacturer with the specifications. Failure to include a copy of the marked-up specification, along with justification(s) for any requested deviations to the specification requirements shall be cause for rejection of the entire submittal and no further submittal material will be reviewed.
2. A copy of the contract document process and instrumentation diagrams and mechanical layout drawings 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.
3. Predicted performance data, as applicable, developed for the specific application, confirming conformance to specified design and operating requirements and characteristics.
4. Manufacturer and manufacturer's model and type designation. Provide manufacturer's catalog data confirming rated capacity, dimensions, weight, material and equipment requirements, construction, and installation requirements, showing clearance required for maintenance purposes.
5. Manufacturer warranty.
6. Operation and maintenance manual.

1.05 ENVIRONMENTAL CONDITIONS

A. Equipment shall be designed for an outdoor environment at approximately 100 feet above sea level. The location is at a functional municipal wastewater treatment plant with an ambient air environment that is more likely to contain trace amounts of hydrogen sulfide gas than typical.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer provided equipment shall be new, undamaged, and free of rust. Manufacturer shall ship equipment with shipping materials suitable for shipping and storage of equipment to protect all equipment from exposure to rain and direct sunlight except for materials manufactured for exterior locations. Shipping materials shall not

require removal from equipment during unloading.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The following candidate manufacturers are believed to be 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 the named manufacturer's standard equipment or products will comply with the requirements of this section. Candidate manufacturers include Xchanger, Inc., or approved equal.

2.02 MATERIALS

Component	Material
Gas to gas core	Type 304L stainless steel
Tubes, glycol core	Type 304L stainless steel
Fins, glycol core	Type 304 stainless steel
Casing, glycol core	Type 304L stainless steel
Housing	Type 304 stainless steel
Housing mounting legs	Type 304 stainless steel
Gasket material	Teflon (PTFE)

2.03 EQUIPMENT CONSTRUCTION AND FEATURES

A. General:

1. After the MSG is cooled in the liquid-cooled section, a portion of the gas shall be internally returned to the gas-to-gas section to be reheated by the warm inlet MSG prior to discharge. The remainder of the chilled gas shall bypass the gas-to-gas reheat section. The chilled bypass gas and the reheated gas shall be manually mixed in the heat exchanger's discharge piping by throttling the manual bypass valve (bypass valve to be provided by the installation contractor) to achieve the appropriate discharge temperature. Both heat exchanger cores shall be mounted within a gas tight housing. The heat exchanger shall be designed for cooling MSG and with condensing service with appropriately sized and located drains.
2. Heat exchanger core fin spacing shall be as required to meet the requirements specified herein. Provide a flanged, easily removable, fully sealed cover on the housing to allow full access and servicing of each core. All welding shall conform to the latest standards of the American Welding Society.
3. Flanged connections shall be provided for gas flows, oriented for connection to external piping systems. Provide drilled or punched mounting legs for floor installation. Heat exchanger shall be provided with ANSI 150# flanged connections and cut gaskets.

Gas to Gas Heat Exchanger Connections	Pipe Diameter (inches)
1. Process Gas Inlet	4
2. Bypass Gas Outlet	4
3. Final Reheat Gas Outlet	4
4. Chilled Glycol Solution Service Inlet	2
5. Chilled Glycol Solution Service Outlet	2
6. Condensate Drain Connection	1

2.04 ACCESSORIES

A. Heat exchanger shall be provided with the following:
   1. Condensate drain.
   2. Sensing ports for instruments.

B. Nameplates:
   1. A nameplate shall be provided on the heat exchanger and shall contain the specified equipment name or abbreviation and equipment number. The equipment nameplate shall be engraved or stamped stainless steel and fastened to the heat exchanger in an accessible location with stainless steel screws or drive pins.

2.05 PROTECTIVE COATING

A. The heat exchanger shall be uncoated stainless steel, free from grease pen notations or hand applied markings. Heat exchanger's refrigerated cooling section will be field insulated by others.

2.06 SPARE PARTS

A. Provide one complete spare gasket of all unique types.

2.07 PRODUCT DATA

A. The following product data shall be provided:
   1. Manufacturer's recommended storage, installation and start-up procedures.
   2. Applicable operation and maintenance information.

PART 3 EXECUTION

3.01 START-UP

A. Start-up guidelines, instructions and procedures shall be provided with the operation and maintenance manuals specified in Paragraph 1.04.

END OF SECTION

SECTION 43 05 11

GENERAL REQUIREMENTS FOR EQUIPMENT

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:

1. 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:

1. 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:

1. 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:

1. 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.
2. 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:

1. 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 as provided in the General Conditions of the Contract Documents.

D. 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 43 05 11-C specified in Section 01 99 90, 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.

E. Balance:

1. 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:

   a. $U_{per} = 6.015\frac{GW}{N}$

   b. Where:

      1) U_{per} = permissible imbalance, ounce-inches, maximum
      2) G = Balance quality grade, millimeters per second
      3) W = Weight of the balanced assembly, pounds mass
      4) N = Maximum operational speed, rpm

2. 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

A. 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.

B. Threaded flanges shall have a standard taper pipe thread conforming to ANSI B1.20.1. Unless otherwise specified, flanges shall be flat faced.

C. 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

A. 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.

B. 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.

C. 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.

D. 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

A. 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.

B. 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.

C. 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:
   1. 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:
   1. 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.
   2. 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.

3. 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.
4. Candidate seals include:
   a. 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.
   b. AESSEAL RDS seals with Cyclops bushing.
   c. John Crane 3710 seals with Type 24SL bushing.
5. 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.
6. 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:
1. 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 2.04 Mechanical Seals for the applicable pump and operating conditions.
2. 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.
3. 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

A. 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.

B. 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

A. 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

A. 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 fiberglass material, minimum 1/8 inch thick, rigid, suitable for post mounting. Signs shall be 10 inch x 14 inch. Letters shall be white on a red background. Signs shall be installed near guarded moving parts.

2.08 GAGE TAPS, TEST PLUGS AND GAGES

A. 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 Division 40.

2.09 NAMEPLATES

A. 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

A. 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, 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

A. Anchor bolts shall be designed for lateral forces for both pullout and shear in accordance with drawing S-001. Anchor bolt materials shall be stainless steel, type 316.

2.12 SPARE PARTS

A. 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 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. Spare parts with individual weights less than 50 pounds and dimensions less than 2 feet wide, or 18 inches high, or 3 feet in length shall be stored in a wooden box with a hinged wooden cover and locking hasp. Hinges shall be strap type. The box shall be painted and identified with stenciled lettering stating the name of the equipment, equipment numbers, and the words "spare parts." A neatly typed inventory of spare parts shall be taped to the underside of the cover.

PART 3 EXECUTION

3.01 GENERAL

A. 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

43 05 13

Rigid Equipment Mounts

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. This section specifies minimum requirements for rigid equipment mounts (baseplates, soleplates, and mounting blocks) and their installation on equipment pads. Completed equipment supports shall consist of equipment pads, equipment anchors, and rigid equipment mounts (baseplates, soleplates, or mounting blocks) set in grout.
   2. Unless alternate requirements for equipment mounts are specified in the applicable equipment specification, the requirements of this section shall be applied to rigid mounts for all rotating or reciprocating equipment that is used to mix, convey, or pressurize fluids (gases and liquids). The requirements of this section shall also apply whenever referenced in specifications for other types of equipment. If conflict exists between this section and requirements of individual equipment manufacturers, the more restrictive requirements shall prevail.

B. Definitions:
   1. Specific equipment mounting terminology used in this section conforms to the following definitions:
      a. Baseplate:
         1) Fabricated (welded structural steel elements), cast, or plate steel base providing a common mounting element on which the legs, feet, or mounting surfaces of equipment are mounted by means of bolted connections.
      b. Soleplate:
         1) A machined plate, spanning an opening in the floor or equipment pad, providing a common mounting element on which the legs, feet, or mounting surfaces of equipment are mounted by means of bolted connections.
      c. Mounting Blocks:
         1) Multiple smaller baseplates on which individual legs, feet or equipment supports are mounted when equipment or drivers are not fastened to a common baseplate or sole plate.
      d. Equipment Pad:
         1) Concrete foundation (block or slab) supporting and elevating equipment mounts above the supporting structural floor slab or local grade.
      e. Mounting Pads:
         1) Thickened or raised areas of baseplates and soleplates where the feet or mounting surfaces of mounted equipment and drivers are bolted and/or doweled to the baseplate or soleplate.
      f. Leveling Blocks:
         1) Temporary steel blocks placed under baseplates, soleplates, or a mounting block at leveling positions (at equipment anchors) for the purpose of leveling baseplates, soleplates, or mounting blocks prior to grouting.

g. Shims:
    1) Thin stainless steel plates of a uniform thickness installed on top of Leveling Blocks for fine adjustment of level. Shims may also be used between equipment or drivers and baseplates, soleplates, or mounting blocks for equipment alignment purposes specified in Section 43 05 14.
h. Wedges:
    1) Pairs of uniformly tapered metal blocks that are stacked with the tapered surfaces reversed (relative to the other wedge) so that the top and bottom surfaces of the wedges are parallel. Wedges are used between equipment pads and baseplates, soleplates, or mounting blocks for the purpose of leveling baseplates, soleplates, or mounting blocks.
i. Mounting Stud:
    1) Threaded rod or bolts anchored to baseplates, soleplates, or mounting blocks for the purpose of mounting equipment or ancillary devices onto baseplates, soleplates, or mounting blocks.
j. Reinforcement Dowels:
    1) Steel reinforcement rods embedded in concrete, across a cold joint, for the purpose of transferring loads or force across the joint.
k. Machine Alignment Dowels:
    1) Tapered diameter rods inserted in tapered diameter holes for the purpose of aligning machinery. The practice of drilling tapered diameter holes through machinery and baseplates so that Machine Alignment Dowels may be inserted to facilitate alignment of machinery is known as Doweling.
l. Leveling Position:
    1) A location on the top of a concrete equipment pad where leveling tools and equipment will be temporarily installed or used for the purpose of leveling baseplates, soleplates, and mounting blocks prior to grouting.
m. Grout Manufacturer:
    1) Refers to the manufacturer of the epoxy grout system used for installation of rigid equipment mounts.
n. Grout Manufacturer's Technical Representative(s):
    1) Refers to the technical representative(s) of the Grout Manufacturer.

C. Equipment Mounting Requirements:
    1. Unless otherwise specified, equipment and drivers shall be rigidly mounted on a common cast iron or fabricated steel baseplate or soleplate grouted into place on a concrete equipment pad. Under no circumstances shall baseplates, soleplates, or mounting blocks be grouted directly to concrete slabs or floors. Equipment that uses an interdependent equipment and driver mounting configuration (equipment that is bolted onto the driver frame and equipment that supports the driver entirely from the equipment frame) may be bolted directly on concrete or grout surfaces of equipment pads if the driver is less than five horsepower. Bolting equipment directly on concrete or grout surfaces of equipment pads is not acceptable for equipment and drivers that do not have an interdependent equipment and driver mounting configuration.

1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. It is a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed document, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Request for Proposals. 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
ANSI/HI 1.4	Centrifugal Pumps – Installation, Operation and Maintenance
ANSI/HI 2.4	Vertical Pumps – Installation, Operation and Maintenance
API RECOMMENDED PRACTICE 686	Recommended Practices for Machinery Installation and Installation Design
ASTM E329	Inspection and Testing Agencies for Concrete, Steel, and Bituminous Materials as Used in Construction
MIL-PRF-907E	Anti-Seize Thread Compound, High Temperature
SSPC	Society for Protective Coatings Specifications, Vol. 2
IBC	2001 International Building Code (including local amendments)

B. Quality Control By Contractor:
1. To demonstrate conformance with the specified requirements for rigid equipment mounts, the Contractor shall provide the services of an independent testing laboratory that complies with the requirements of ASTM E329. The testing laboratory shall sample and test equipment mount related materials as indicated in this section (43 05 13). Costs of testing laboratory services shall be borne by the Contractor.
2. For equipment with drivers 20 horsepower and greater, the Contractor shall furnish the services of a grout manufacturer's technical representative that has been factory trained by the grout manufacturer. The grout manufacturer's technical representative shall perform training and quality control of epoxy grout installation for rigid equipment mounts as indicated in this section (43 05 13).

1.03 SUBMITTALS

A. The following information shall be provided in accordance with the submittal requirements specified in Section 01 33 00.
1. A copy of this specification section, with addendum updates included, (referenced sections need not be included for Section 43 05 13) 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. Copies of this specification section shall be numbered and marked (specification number and eqiuipment number) for inclusion (filing) with the associated equipment submittal requirements.

2. Schedule of rigid equipment mount installations specified in paragraph 2.01.
3. Name, employer and certificates or other information documenting compliance with the journeyman qualifications requirements for millwrights who will install rigid equipment mounts, as specified in paragraph 3.03 Leveling.
4. Certificates or other documentation issued by the epoxy grout manufacturer that demonstrates that the grout manufacturer's technical representative has been factory trained on installation of epoxy grout for equipment mounts, as specified in paragraph 1.02 Quality Control by Contractor.
5. Shop drawings for all equipment pads, equipment anchors, and baseplate, soleplate or mounting block details. Shop drawings shall depict size and location of equipment pads and reinforcement; equipment drains; equipment anchor, size, location, and projection; 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. Shop drawings for equipment pads, equipment anchors, and baseplate, soleplate, or mounting blocks shall be numbered and marked (specification number and equipment number) for inclusion (filing) with the associated equipment submittal requirements.

PART 2 PRODUCTS

2.01 GENERAL

A. Prior to initiating any installation efforts, the Contractor shall produce a rigid equipment mount installation schedule containing the expected dates for installing equipment anchors and preparation of equipment pads for leveling, grouting, and final equipment anchor clamping for each item of equipment. The schedule shall list the equipment, by equipment tag number, and shall list applicable equipment specification section, motor horsepower, and name of the Contractor's representative responsible for quality control during installation of rigid equipment mounts. The schedule shall be accompanied by written verification of equipment anchor clamping torque from the manufacturer of each item of equipment to be installed with rigid equipment mounts.

2.02 CONCRETE EQUIPMENT PADS

A. Concrete equipment pads shall be as shown in the structural details for equipment pads and equipment anchors for rigid mounted equipment.

B. The Contractor shall submit equipment anchor calculations for all equipment with drivers 20 horsepower and greater. Equipment anchor calculations shall demonstrate that equipment anchor size, embedment, and edge distance comply with the [Local Governing Code] and are sufficient to resist the maximum lateral and vertical forces

specified in Section 43 05 11-2.11. Equipment anchor calculations shall be sealed by a registered structural or civil engineer licensed in the State of California.

2.03 BASEPLATES, SOLEPLATES, AND MOUNTING BLOCKS

A. General:

1. Unless otherwise specified, Type I baseplates, soleplates, and mounting blocks shall be a minimum of 1 inch thick for equipment with drivers 20 horsepower and larger. All Type I baseplates, soleplates, and mounting blocks shall have edges of surfaces bearing on grout rounded to a radius of not less than 0.25 inch. Horizontal corners of Type I baseplates, soleplates, or mounting blocks shall be rounded to a radius of not less than two inches to avoid producing stress risers on the grouted foundation. Grout pouring holes (minimum 4 inches in diameter for epoxy grout, minimum 2 ½ inches in diameter for cementitious nonshrink grout) shall be provided in all baseplates and soleplates and all baseplates and soleplates shall have grout release holes. Mounting blocks may be grouted without grout pouring holes provided that no dimension of the mounting block (width or length) exceeds 18 inches. Grout relief or vent holes (minimum 1 inch in diameter) shall be provided in all baseplates, soleplates, and mounting blocks. Internal stiffeners shall be provided on all cast and fabricated baseplates and shall be designed to allow free flow of grout from one section of the baseplate to another. The minimum acceptable opening in cross bracing and stiffeners shall be 2-inches high by 6-inches in width. All welds shall be continuous and free from skips, blowholes, laps and pockets.
2. Mounting holes for equipment anchors shall be drilled through baseplates, soleplates, and mounting blocks. Mounting holes for equipment anchors shall not be burned out and they shall not be open slots. All mounting studs shall be Type 316 stainless steel. An anti-seize or anti-galling compound, as specified in paragraph 2.06, shall be applied to all mounting stud threads prior to installing nuts on mounting studs. Terminations requiring connections to baseplates, soleplates, or mounting blocks shall be acorn nuts welded to the under side of the baseplate or nuts welded to the underside of the baseplate and plugged with cork, plastic plugs or grease. In no case shall the fastener terminate only into the metal base. Where baseplates, soleplates, or mounting blocks are leveled using jackscrews, jackscrew threads shall be tapped in thickened pads or otherwise in sufficient metal to provide ease in adjusting level.
3. Mounting pads for equipment shall be machined after all welding and stress relieving and shall be coplanar within 0.002 inch per foot in all directions. Mounting pads shall extend not less than 0.5 inch beyond the perimeter of the foot or mounting surface of the mounted equipment, in any direction.
4. Equipment baseplates shall provide common support for the equipment and driver (and flywheel, if one is specified). Baseplates for equipment with drivers 20 horsepower and greater shall be furnished with eight transverse alignment (horizontal) positioning jackscrews for alignment of equipment drivers on horizontal surfaces of baseplates. Two of the eight transverse alignment/positioning jackscrews shall be installed in perpendicular directions in a horizontal plane at the mounting position for each corner or foot of the equipment driver. (Eight additional jackscrews shall be provided for transverse alignment of the flywheel, if flywheels are specified.)

B. Type I Baseplates:

1. Type I baseplates shall be plate or fabricated structural steel baseplates with thickened steel mounting pads for doweling and bolting equipment to the baseplate. The baseplates shall be rectangular in shape for equipment other than centrifugal refrigeration machines and pump baseplates, which may be "T" or "L" shaped to accommodate the equipment drive and accessories. Baseplates for split case pumps shall include supports for suction and discharge elbows, if required by the specified configuration. Perimeter members shall be beams with a minimum depth equal to 1/10th of the longest dimension of the baseplate. Beam depth need not exceed 14 inches provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer.

C. Type II/III Baseplates:
   1. Not Used

D. Type IV Baseplates:
   1. Type IV Baseplates shall be cast iron with thickened mounting pads for doweling and bolting equipment to the baseplate. Cast iron baseplates shall be sealed in accordance with the requirements for bleeding surfaces specified in Section 09 90 00 prior to grouting.

E. Soleplates:
   1. Where soleplates are provided, the underside shall be scribed with the words “This Side Down” using welding rod material prior to milling the mounting pad for each equipment foot or mounting surface. Mounting surfaces and mounting pads on soleplates shall be milled flat to a tolerance of not less than 0.002 inch per foot in all directions. Soleplates shall be machined for an indexed fit to the mounted equipment or driver.

F. Mounting Blocks:
   1. Where equipment is fabricated or cast with feet or mounting surfaces that are not fastened to a common baseplate or soleplate, as in dry-pit bottom suction pumps, the equipment may be supported on individual concrete piers or equipment pads in lieu of a common baseplate or soleplate and equipment pad. In such instances, the equipment shall be supported at the feet or mounting surfaces on individual mounting blocks, which shall be leveled and grouted into place on the individual piers or equipment pads as specified in this section. Vertical volute-type pumps weighing more than 2000 pounds shall be mounted on mounting blocks under each foot or mounting surface for the pump. All mounting blocks shall be furnished with jackscrew threads (three locations, minimum) tapped in the mounting block for the purpose of leveling mounting blocks with jackscrews.

2.04 GROUT FOR EQUIPMENT PADS

A. Epoxy Grout for Equipment Mounting:
   1. Unless otherwise specified, grout for setting bearing surfaces of baseplates, soleplates, and mounting blocks on equipment pads shall be Epoxy Grout for Equipment Mounting as specified in Section 03 60 00. Where the term epoxy grout is used in the context of details and specifications for equipment mounting it shall mean Epoxy Grout for Equipment Mounting.

B. Cementitious Nonshrink Grout:

1. Cementitious Nonshrink Grout, specified in Section 03 60 00, may be used for setting bearing surfaces of baseplates, soleplates, or mounting blocks on equipment pads where equipment drivers are 20 horsepower and smaller and the combined weight of equipment and driver is less than 1000 pounds. Where the term nonshrink grout or cementitious grout is used in the context of details and specifications for equipment mounting it shall mean Cementitious Nonshrink Grout. Training and quality control by the grout manufacturer's technical representative is not required for rigid equipment mounts installed with cementitious non-shrink grout.

2.05 EPOXY PRIMER

A. Epoxy primer shall be a lead free, chrome free, rust inhibitive, two-component epoxy primer specifically designed for use on metal substrates and in conjunction with epoxy grout. The epoxy primer shall be a product of the epoxy grout manufacturer.

2.06 ANTI-SEIZE/ANTI-GALLING COMPOUND

A. Anti-seize or anti-galling compound shall be a molybdenum disulfide and graphite combination in an aluminum complex base grease conforming to MIL-PRF-907E. Acceptable products include Jet Lube 550 by Jet Lube, Inc., E-Z Break by LA-CO, or equal.

2.07 PRODUCT DATA

A. The following information shall be provided in accordance with the product data requirements specified in Section 01 33 00:
   1. Equipment anchor calculations specified in paragraph 2.02.
   2. Results of grout strength tests, as specified in paragraph 3.03 Grouting.
   3. Completed Rigid Equipment Mount Installation Inspection Checklist Forms (Form A), as specified in paragraph 3.02 Epoxy Grout Quality Control.
   4. List of Contractor's equipment installation staff that has completed epoxy grout manufacturer's grout installation training specified in paragraph 3.02 Epoxy Grout Training.

PART 3 EXECUTION

3.01 GENERAL

A. Grouting for installation of equipment on equipment pads shall take place prior to connecting any field piping or electrical and instrumentation systems. Unless the Construction Manager accepts an alternate installation procedure in writing, baseplates, soleplates, and mounting blocks shall be leveled and grouted with the equipment removed. Pumps shall be installed in accordance with this section and ANSI/HI 1.4 or ANSI/HI 2.4, as appropriate for the type of pumping equipment installed.

B. Connecting piping with flexible connections and/or expansion joints shall be anchored such that the intended uses of these joints are maintained in the piping system without imposing strain on the equipment connections.

C. Where an equipment manufacturer's installation requirements include a rigid connection between the machine and connecting piping systems, the Contractor shall delete any

flexible coupling (including equipment connection fittings) shown on the drawings and install the equipment in the following manner, in lieu of installing the flexible coupling:

1. The equipment pad shall be prepared as shown on the details for rigid equipment mounts
2. The baseplate, soleplate, or mounting blocks supporting the equipment shall be installed, leveled, and grouted in place as specified in this section.
3. The equipment shall be installed, aligned and doweled in place as specified in Section 43 05 14.
4. The piping shall be installed and aligned to the equipment connections and the field piping connections without welding one of the joints for one section of pipe between the equipment connection and the field piping and all valving. All flanged joints shall be bolted up and pressure tested.
5. All piping shall be fully supported by supports designed to accept their full weight and thrust forces.
6. The final sections of piping shall be aligned with the equipment and field connections without the use of jacks, chain falls or other devices to force it into alignment.
7. The final piping joints shall be welded only after the previous steps have been completed and accepted by the Construction Manager.

3.02 EPOXY GROUT TRAINING AND QUALITY CONTROL

A. Epoxy Grout Training:

1. Prior to commencing rigid equipment mount installation work on equipment pads, the Contractor shall furnish the services of a grout manufacturer's technical representative to conduct a training school for the workers that will be using the epoxy grout for rigid equipment mount installations. The school shall be not less than 4 hours in length and shall cover all aspects of using the products, from mixing to application. This requirement, however, shall not be construed as relieving the Contractor of overall responsibility for this portion of the work. The epoxy grout manufacturer shall furnish a list of school attendees that have been satisfactorily trained to perform epoxy grout installation for equipment mounting.

B. Epoxy Grout Quality Control:

1. For equipment with drivers 20 horsepower and greater, the epoxy grout manufacturer's technical representative shall provide quality control services for epoxy grout installation in rigid equipment mounts. The epoxy grout manufacturer's technical representative shall be on site to inspect and verify that the application personnel have successfully performed surface preparation, epoxy grout application, and Quality Control Inspection in accordance with these specifications for a representative portion of the epoxy grout installation work.
    a. Specifically, the epoxy grout manufacturer's technical representative shall perform the following services for at least one rigid equipment mount installation for each equipment type and size:
        1) Inspect ambient conditions during various phases of epoxy grouting installation for conformance with the epoxy grout manufacturer's requirements.
        2) Inspect the surface preparation of concrete substrates onto which epoxy grout materials are to be applied, for conformance to the specified

application criteria, including but not limited to substrate profile, degree of cleanliness, and moisture.

3) Inspect the surface preparation of the metallic substrates onto which the epoxy primer is to be applied.
4) Inspect the epoxy-primed metallic substrate for coverage and adhesion.
5) Inspect preparation and application of epoxy grout form work for conformance to the specifications.
6) Inspect and record that the "pot life" of epoxy grout materials is not exceeded during installation.
7) Inspect epoxy grout for cure.
8) Inspect and record that localized repairs made to grout voids are in conformance with the specification requirements.
9) Conduct a final review of completed epoxy grout installation for conformance to these specifications.
10) Attest to conformance of the Contractor's work by signing appropriate entries in the "Rigid Equipment Mount Inspection Checklist," Form 43 05 13-A in Section 01 99 90.

3.03 INSTALLATION

A. Concrete Equipment Pad Preparation:

1. After the concrete is fully cured, the top of the equipment pad shall be roughened by chipping the surface. Chipping shall remove all laitance and defective or weak concrete and result in a rough surface profile with a 0.25 inch minimum amplitude. Chipping shall expose broken aggregate without dislodging unbroken aggregate from the cement matrix and shall not cause fractures below the concrete surface. Leveling surfaces of the concrete that have been finished smooth and level for baseplate, soleplate, or mounting block leveling at equipment anchors shall be protected from damage during chipping. A light duty, hand held pneumatic chipper with a chisel type tool shall be used for chipping the equipment pad concrete surface. Abrasive blast, bush-hammer, jack hammers with sharp chisels, heavy chipping tools, or needle gun preparation of concrete surfaces to be grouted is not acceptable.
2. Prior to leveling activities, satisfactory removal of defective or weak concrete shall be demonstrated in the presence of the Construction Manager by operating the chipper on the chipped concrete surface at locations identified by the Construction Manager. The chipped surface of the concrete shall be such that the final baseplate, soleplate, or mounting block elevation results in the grout manufacturer's recommended grout thickness between the surface of the equipment pad and the lower baseplate flange, underside of the soleplate or underside of mounting block.
3. All dust, dirt, chips, oil, water, and any other contaminants shall be removed and the surface protected with plastic sheeting until grout is installed.
4. Concrete equipment pad surfaces that have been finished smooth and level for use as leveling positions shall be protected from damage during chipping activities. Alternatively, leveling positions may be restored on chipped surfaces. Leveling positions shall be restored by installing leveling blocks or leveling plates for jackscrews on a high compressive strength epoxy putty (Philadelphia Resins, Phillybond Blue 6A, or equal). Leveling blocks and leveling plates shall be installed level on the epoxy putty.

B. Baseplates, Soleplates, and Mounting Blocks:

1. All surfaces of baseplates, soleplates, and mounting blocks to be in contact with epoxy grout shall be cleaned to SSPC SP-6 and shall be primed with epoxy primer within 8 hours of cleaning.

C. Leveling:

1. All machinery shall be mounted and leveled by journeyman millwrights. Precision surveying equipment shall be used for leveling. Machinists' spirit levels will not be permitted for leveling purposes for any baseplate, soleplate, or mounting block with a plan dimension greater than 4 feet. Baseplates and mounting blocks shall be leveled to a maximum tolerance of 0.002 inch per foot or as otherwise required by the equipment manufacturer, if more stringent. Soleplates shall be leveled to 0.0005 inch per foot or as otherwise required by the equipment manufacturer, if more stringent. An anti-seize or anti-galling compound specified in paragraph 2.06 shall be applied to all equipment anchor threads prior to beginning baseplate, soleplate, or mounting block leveling.
2. All baseplates, soleplates, and mounting blocks shall be leveled against steel surfaces (jackscrew plates, leveling blocks, leveling nuts, support plates, or other steel surfaces). Use of other materials for leveling purposes is strictly and specifically prohibited. Unless otherwise specified, baseplates, mounting blocks, and soleplates shall be leveled as indicated in the leveling details. Leveling equipment and tools shall be stainless steel leveling blocks and shims, steel wedges, or jackscrews bearing on leveling plates. Leveling nuts may be used for leveling baseplates and soleplates weighing less than 200 pounds. The use of leveling nuts for leveling mounting blocks is not permitted.
3. After baseplates, soleplates, or mounting blocks have been leveled on the leveling equipment, the Contractor shall clamp the baseplates, soleplates, or mounting blocks in position by installing the equipment anchor nuts and washers. Clamping torque shall be less than the final clamping torque specified in paragraph 2.01, but sufficient to hold the baseplate, soleplate, or mounting block in position. The Contractor shall verify that the correct level and position of the baseplate, soleplate, or mounting block has been maintained after clamping on the leveling equipment.
4. Leveling blocks shall be stainless steel, four inches square and 1-1/2 inches thick with an open-ended slot terminating in the center for the equipment anchor. Leveling blocks shall be machined flat on all horizontal surfaces and placed under the baseplate or soleplate at each equipment anchor. Shims shall be pre-cut stainless steel, slotted for removal after grouting, and shall extend not less than three inches beyond the baseplate, soleplate or mounting block. Leveling blocks and shims shall be coated with a light oil just prior to beginning the leveling and grouting work. Shims shall be placed so the tabs on the shims are easily accessible.

D. Grouting:

1. Grout forms shall be built of minimum 0.75 inch thick waterproof plywood and shall be securely braced (minimum brace size shall be two-by-four lumber). Forms shall be designed for a minimum of 6 inches hydrostatic head above the final elevation of the grout, to assist in flow during installation. Equipment mounting grout shall be furnished with expansion joints installed at four to six foot intervals, perpendicular to the centerline of baseplates.
2. Forms shall be coated with three coats of paste wax on all areas that will come in contact with the grout to prevent the grout from bonding to the forms. Forms shall be

waxed before assembly to prevent accidental application of wax to surfaces where the grout is to bond. Before any forms are installed, all concrete surfaces that will contact epoxy grout shall be free from any foreign material, such as oil, sand, water, wax, grease, etc. Forms shall be liquid-tight. Any open spaces or cracks in forms, or at the joint between forms and the foundation, shall be sealed off, using sealant, putty, or caulking compound. All outside vertical and horizontal edges of the grout shall have 45-degree chamfers as indicated in the equipment anchor details for rigid equipment mounts. Match chamfers in concrete portions of the equipment pad. Block outs shall be provided at all shimming and leveling positions to allow removal of leveling equipment and tools after the grout has cured. Jackscrews shall be coated with a light oil or other acceptable bond-breaking compound prior to grouting.

3. The 45-degree perimeter chamfer strip shall be located at the final elevation of the grout. The final elevation of the grout on baseplates with exposed I-beam or C-channel supports shall be at the top of the lower support flange. The top of the grout, on all other baseplates soleplates, and mounting blocks, shall be at least 1.0 inch above the bottom or underside of the baseplate, soleplate, or mounting block and shall not be higher than the top of the baseplate, soleplate, or mounting block. The grout's final elevation shall not be so high as to bond the equipment anchor nut and washer.
4. The resin and hardener for epoxy grout for equipment mounting shall be mixed in accordance with the epoxy grout manufacturer's recommendations. Epoxy grout shall be placed at the center of one end of the baseplate or soleplate and worked toward the ends in such a manner as to force the air out from beneath the baseplate or soleplate and out the vent holes, to eliminate voids. Epoxy grout shall be placed in a manner that avoids air entrapment, using a head box to pour grout into the grout holes. When the head box is moved to the next grout hole, a 6-inch high standpipe shall be placed over the grout hole and filled with grout. Use of vibrating tools and/or jarring (rapping or tapping) forms to facilitate grout flow is not permitted during placement of epoxy grout.
5. The Contractor shall exercise care to never allow the grout to fall below the baseplate level once the grout has made contact with the baseplate. Grout placement shall be continuous until all portions of the space beneath the baseplate, soleplate, or mounting block have been filled. Subsequent batches of grout shall be prepared so as to be ready when the preceding batch has been placed. Under no circumstances shall the grouting operation be halted because of lack of grout mix. After the entire baseplate is full, 6-inch high standpipes shall be maintained over each grout hole, to continue purging of air. When the grout has started to take an initial set (typically this is determined by a noticeable increase in temperature and no flow of grout at the vent holes) the standpipes shall be removed and excess grout cleaned from all surfaces.
6. Where the cavity under a baseplate or mounting block extends above the elevation of the top of the bolting flange for the baseplate or mounting block, grouting may be completed in two pours. Under these circumstances, the first grout pour shall be continuous until the lower face of the bolting flange for the baseplate or mounting block is submerged in grout a minimum of one inch. The second grout pour shall be completed with standpipes and air purges as specified in the previous paragraph.
7. Grout forms shall be checked for leaks throughout grout pours. Leaks shall be repaired immediately to prevent formation of voids. A final check of baseplate, soleplate, or mounting block level and elevation shall be performed before the grout sets.

8. A grout sample shall be taken for each equipment pad that has a baseplate, soleplate, or mounting block set in grout. The sample shall be placed in a cylinder of sufficient size to yield three two-inch cubes as test samples. The samples shall be tagged with project name, date, time, the equipment number and ambient temperature at the time of placement. Once the epoxy grout cylinder has been completely filled, it shall be placed next to the foundation of the equipment being grouted and allowed to cure for 48 hours. After 48 hours, the test cylinder shall be tested in accordance with the grout manufacturer's recommendations by the independent testing laboratory specified in paragraph 1.02 Quality Control by Contractor. The results shall be reported directly to the Construction Manager. Forms shall be removed only after the grout has cured sufficiently and upon specific permission from the Construction Manager.

E. Completion:
   1. Upon acceptance by the Construction Manager and the equipment manufacturer's representative and after the grout has reached sufficient strength, grout forms and block outs at leveling positions shall be removed. Leveling blocks and shims or wedges and support plates shall be removed, leveling nuts and jack screws shall be backed off to allow the grout to fully support the baseplate, mounting block, or soleplate. Take care not to damage the grout during removal of extended shimming material or leveling equipment and tools.
   2. The equipment anchor nuts shall be tightened, using calibrated indicating torque wrenches, to develop the full clamping force required by the equipment manufacturer.
   3. Equipment anchor nuts shall be tightened in increments of not more than 25 percent of the final torque value in an alternating pattern to avoid stress concentration on the grout surface. After tightening equipment anchor nuts to final values, apply additional wax, grease, or mastic to all exposed portions of the equipment anchor beneath the baseplate, soleplate, or mounting block.
   4. After applying additional wax or mastic to exposed portions of equipment anchors, block outs (pockets) for access to leveling nuts, leveling blocks and shims, or wedges shall be filled with the grout material installed under baseplates, soleplates, or mounting blocks and pointed after the equipment anchor nuts have been tightened to final values. Jackscrews shall be removed and holes in the baseplate, soleplate, or mounting blocks filled with a flexible sealant (silicone rubber) or a short cap screw.
   5. Check for baseplate, soleplate, or mounting block movement (soft foot) by individually loosening and re-tightening each equipment anchor. Vertical movement at each equipment anchor shall be measured and recorded during loosening and retightening and shall not exceed 20 micrometers (0.001 inch). Vertical movement shall be measured using a magnetic-based dial indicator on the baseplate, soleplate, or mounting block referenced to the epoxy grout surface of the equipment pad or other approved method. Soft foot conditions shall be sufficient cause for removal and reinstallation of grout and baseplates, soleplates, or mounting blocks.
   6. Check for grout voids by tapping along the upper surfaces of the baseplate, soleplate, or mounting block. Grout voids shall be sufficient cause for removal and reinstallation of grout and baseplates, soleplates, or mounting blocks. Grout voids shall be marked. At the discretion of the Construction Manager, grout voids may be repaired as specified in Chapter 5, Section 3.16 of API 686.

3.04 FINAL INSPECTION

A. The Construction Manager will conduct a final inspection with the Contractor for conformance to requirements of the contract documents.

END OF SECTION

SECTION 43 13 46

LOW PRESSURE GAS DRIP TRAPS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. This section specifies drip traps for collection of condensate for use in sludge gas systems at pressures below 10 psig.

B. Type:
   1. Drip traps shall be the rotating disc, manually operated type specially designed for use in sludge gas service.

1.02 QUALITY ASSURANCE

A. Performance and Design Requirements:
   1. General: Drip traps shall be suitable for continuous exposure to gas derived from the anaerobic digestion process.
   2. Operating Requirements: Drip traps shall be rated for a minimum working pressure of 10 psig and have a storage capacity of 6 quarts.

1.03 SUBMITTALS

A. The following information shall be provided in accordance with Section 01 33 00:
   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 CITY 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 information, calculations, charts or graphs to verify that the product provided meets the requirements set forth in this specification.
   3. Operation and maintenance information, as specified in Section 01 78 23.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00.

B. Deliver drip traps to site in accordance with Section 01 66 00 and using loading methods which do not damage any drip trap components or coatings.

C. Clearly tag drip traps in accordance with Section 01 58 01, stating size, type, coatings and mating parts shipped loose or separate.

D. Store on site until ready for incorporation in the work using methods recommended by the manufacturer to prevent damage, undue stresses, or weathering.

PART 2 PRODUCTS

2.01 MATERIALS

A. Construction of the body shall be anodized cast aluminum throughout except for stainless steel shaft and spring. The drip traps shall be suitable for use in a Class I, Division 1, Group D hazardous location.

2.02 EQUIPMENT

A. All drip traps shall be provided with 1 inch NPT female inlet and outlet connections. They shall have an air inlet port to permit free flow of the condensate from the bowl when draining. All ports shall be O ring sealed and gas shall not escape while draining or when the operating handle is moved from the fill to the drain position.

PART 3 EXECUTION

3.01 INSTALLATION

A. Each drip trap shall be aligned, connected, and installed at the location specified and in accordance with the manufacturer's written recommendations. The installation and initial operation of all components shall be certified on Form 01 45 20-A as specified in Section 01 99 90.

3.02 FIELD TESTING

A. After completion of installation, each drip trap shall be completely field tested to demonstrate compliance with the performance requirements as specified. Inspection, testing, and certification shall be provided, and testing procedures and forms shall be submitted and used, as specified in Section 01 45 20.

B. Testing procedures shall duplicate as nearly as possible the conditions of operation and shall be selected to demonstrate that the equipment is operational and free from damage.

END OF SECTION

SECTION 43 31 13.13

SILOXANE REMOVAL SYSTEM

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:

1. This section specifies a single self-supporting siloxane removal vessel. The vessel will be supplied with and filled with activated carbon. The vessel will be piped and operated in series with two existing vessels. Provide interconnecting piping and all specified valves, appurtenances, related shipping, technical support during installation and startup and training services.

B. Type:

1. Siloxane removal vessel shall be of the vertical arrangement, upward flow type. The vessel shall be the freestanding type specifically designed for removal of gaseous siloxanes (organic silicon) from municipal anaerobic medium pressure sludge gas (MSG).

C. Equipment List:

Item	Equipment Number
Carbon Vessel 3	FTL161553

1.02 SYSTEM DESIGN AND PERFORMANCE

A. General:

1. Medium Pressure Sludge Gas (MSG): A water-saturated mixture of several constituents including methane, carbon dioxide, nitrogen, sulfides, siloxanes, and water in vapor phase, produced by the anaerobic digestion of municipal wastewater sludge. MSG will be pressurized to approximately 6 psig. As produced, the raw digester gas is expected to contain small amounts of fine particulate matter and approximately 6 percent water vapor, by volume. The dry gas, as determined by laboratory analysis, has the following properties:

Parameter	Units	Value	Range
Methane[1]	Percent	62.0	56 to 68
Carbon Dioxide[1]	Percent	35.5	35 to 44
Nitrogen[1]	Percent	2.0	0 to 2
Oxygen[1]	Percent	0.5	0 to 1
Sulfides[2]	ppm_v	20	2 to 20
Siloxanes[3]	ppm_v	8	6 to 10

Notes:

[1] Methane, carbon dioxide, and nitrogen values represent percent by volume as a dry gas.

[2] Sulfides are expected to comprise 90 percent or more hydrogen sulfide.

[3] Siloxanes: Volatile silicon based compounds including hexamethyldisiloxane (L2), octamethylcyclotetrasiloxane (D4), and decamethylcyclopentasiloxane (D5).

B. Performance and Design Requirements:

1. Siloxane removal vessel will be located outdoors and shall be specifically designed and selected for continuous duty treatment of MSG. Prior to treatment in the siloxane removal vessels, digester gas will sequentially undergo treatment to remove hydrogen sulfide, pressurization, mechanical chilling for dehydration and finally reheating. System performance and design requirements and expected digester gas conditions entering the siloxane removal vessels are as follows:

Item	Value
Digester gas flow rate, design, scfm	365
Inlet hydrogen sulfide concentration, maximum, ppm	20
Inlet gas temperature, approximate, degrees F	70 to 80
Operating digester gas pressure, maximum, psig	6.0
Siloxane removal efficiency, percent	98
Inlet connection pipe, diameter, inches	6
Outlet connection pipe, diameter, inches	6
Inlet/outlet piping connection type	150# ANSI flange
Vessel side wall depth, feet	12
Vessel diameter, feet	4.5
Gas pressure drop per vessel, clean, maximum, inches W.C.	6
Design pressure, maximum, psig	15
Design pressure, minimum, psig	-3 (vacuum)

1.03 QUALITY ASSURANCE

A. References:

1. 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 case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. 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 or not the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI B16.5	Pipe Flanges and Flanged Fittings
IBC	2015 International Building Code
OSHA 1910	Occupational Safety and Health Standards

B. Supplier Experience and Qualifications:

1. The siloxane removal vessels shall be the product of manufacturers having a minimum of 5 years experience in the design and construction of this type equipment. The siloxane removal system manufacturer shall have successfully completed at least 5 similar siloxane removal systems treating municipal wastewater digester gas and or municipal landfill gas for siloxane removal.

C. Warranty:

1. A two year 100 percent parts and labor warranty against manufacturing defects or failure of the equipment specified in this section caused by normal wear and tear shall be provided. The warranty period shall start from the date of final acceptance following startup and testing.

1.04 SUBMITTALS

A. Submittals shall be provided and shall include the following information:

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 or those parts which are to be provided by the manufacturer 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 manufacturer, 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 Owner 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 manufacturer with the specifications. Failure to include a copy of the marked-up specification, along with justification(s) for any requested deviations to the specification requirements shall be cause for rejection of the entire submittal and no further submittal material will be reviewed.
2. A copy of the contract document process and instrumentation diagrams and mechanical layout drawings 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.
3. Predicted performance data, as applicable, developed for the specific application, confirming conformance to specified design and operating requirements and characteristics.
4. Manufacturer and manufacturer's model and type designation. Provide manufacturer's catalog data confirming rated capacity, dimensions, weight, material and equipment requirements, construction, and installation requirements, showing clearance required for maintenance purposes.
5. Details and catalog data for all accessories.
6. Recommended spare parts list.
7. Manufacturer warranty.
8. Operation and Maintenance Manuals:

a. No less than one week before equipment start-up, manufacturer shall submit staff training plans and three hardcopies of completed, tabbed, and bounded operation and maintenance manuals. Operation and maintenance manual shall include at minimum: table of contents; as constructed record drawings including piping and instrumentation diagrams; manufacturer cutsheets and operational and maintenance instructions for all provided equipment; and instructions for recommended routine maintenance activities.

1.05 ENVIRONMENTAL CONDITIONS

A. Equipment shall be designed for continuous outdoor duty in a weather-exposed, environment at approximately 100 feet above sea level. Outside air temperature ranges from minus 3 degrees F to 100 degrees F. The location is at a functional municipal wastewater treatment plant with an ambient air environment that is likely to contain trace amounts of hydrogen sulfide gas.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer provided equipment shall be new, undamaged, and free of rust. Manufacturer shall ship equipment with shipping materials suitable for shipping and storage of equipment to protect all equipment from exposure to rain and direct sunlight except for materials manufactured for exterior locations. Shipping materials shall not require removal from equipment during unloading.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The following candidate manufacturers are believed to be 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 the named manufacturer's standard equipment or products will comply with the requirements of this section. Candidate manufacturers include Unison Solutions, Venture Engineering, Willexa Energy or approved equal.

2.02 MATERIALS

Component	Material
Siloxane removal vessel	Type 304L stainless steel, passivated
Hand hole gaskets	Buna-N
Drain and instrument couplings	Type 304L stainless steel
Isolation valves	Type 304 stainless steel
Inlet/outlet piping	ASTM, A778, Sch 10S, Type 316L stainless steel

2.03 EQUIPMENT CONSTRUCTION

A. General:

1. Siloxane removal vessel shall be a custom fabricated, high-performance device that is designed for maximum siloxane removal at low digester gas pressure drops. The

unit shall be designed so that the removal effectiveness does not vary across the specified gas flow range.

B. Siloxane Removal Vessels:
   1. Siloxane removal vessel shall be welded fabrication constructed of minimum 10 gauge stainless steel. Siloxane removal vessel shall have dished top head and straight sides.
   2. Siloxane removal vessel shall have 150-pound ANSI B16.5 flanges for direct connections to gas piping.
   3. Siloxane removal vessel shall have hinged 16-inch hand hole with bolted access covers supplied with easy-open swing bolts, toggle bolts, or similar latches for carbon fill and chained to the tank to prevent the cover from falling into the tank. Siloxane removal vessel shall have a 20-inch diameter flanged side connection for accessing and removing the carbon.
   4. Siloxane removal vessel shall be provided with a 1-inch stainless steel condensate drain and stainless steel ball valve on the vessel bottom.
   5. Siloxane removal vessel shall be provided with two instrument couplings and attached differential pressure gauge located upstream and downstream of the siloxane removal vessel. One 1/2-inch coupling and valved sample tap shall be located upstream and downstream of the siloxane removal vessel. A 1-inch coupling with full port stainless steel ball valve shall be located on the top of the vessel to purge the methane during the carbon replacement procedure.
   6. Siloxane removal vessel shall include a pressure relief valve and be equipped with flanged connection and all accessories for mounting the pressure relief valve.
   7. Siloxane removal vessel shall be equipped with stainless steel carbon media retention screens. These screens shall be located at gas pipe inlet, gas pipe outlet, and condensate drain outlet. Screens shall be removable to accommodate vessel servicing.

2.04 SUPPORTS AND BRACES

A. Siloxane removal vessel shall be freestanding and shall include four or more fabricated stainless steel mounting legs with bolt plates, and anchor bolt holes, constructed and braced suitable for 2015 IBC seismic installation.

B. All carbon steel, including accessories, shall be electrically isolated and carefully protected from direct contact with the stainless steel vessels and piping.

2.05 VESSEL ACCESSORIES

A. Interconnecting Piping:
   1. Provide the gas inlet and outlet gas piping manifolds. Piping shall include butt welded joints and ANSI flange connections.

B. Isolation Valves:
   1. Provide full size (6-inch), ANSI flanged, Type 304 stainless steel butterfly valves on the inlet and on the outlet piping to the siloxane removal vessel. Butterfly valves shall be Jamesbury “high performance” wafer type valves with Teflon seats and stainless steel discs or approved equal.

C. Pressure relief valve:
   1. Provide one pressure relief valve on the top of the vessel. The pressure relief valve shall be rated for 8 psig and shall be designed for very low leakage.

D. Carbon Discharge Valve:
   1. Provide 6-inch, ANSI flanged, Type 304 or 316 stainless steel full port ball valves on bottom of each siloxane removal vessel. Ball valves shall be as manufacturer by Apollo Valves, Jamesbury, or NIBCO, Inc. and shall be provided with PTFE seats, PTFE or Viton stem seals, self-lubricated bearings, and be safe for combustible fluid applications (digester gas, natural gas, fuel oil, etc.) and high temperature applications.

E. Drain Valves:
   1. Provide Type 304 or 316 stainless steel full port ball valves on inlet and outlet piping, drain piping, and pressure gauge isolation as shown to facility draining and isolation of the piping and vessels. Ball valves shall be as manufacturer by Apollo Valves, Jamesbury, or NIBCO, Inc. and shall be provided with PTFE seats, PTFE or Viton Stem Seals, Self-lubricated bearings, and safe for combustible fluid applications (digester gas, natural gas, fuel oil, etc.) and high temperature applications.

F. Differential Pressure Gauge:
   1. Manufacturer shall provide a differential pressure gauge on the inlet and outlet piping of the vessel as shown on the drawings.
   2. Gauge valves shall be provided for each tap.
   3. Differential pressure gauge shall be located as close as practical to the process taps but shall be positioned to permit observation and maintenance. Differential pressure gauge may be supported from the process taps if this location permits observation from the ground or a permanent work platform. Pressure instruments shall be installed in such a manner that blowout discs are not obstructed.

2.06 ACTIVATED CARBON MEDIA

A. The vessel supplier shall select and shall provide the initial charge of virgin activated carbon. Activated carbon shall be supplied in Supersack containers and shall be protected from moisture or damage during shipment.

B. Activated carbon shall have a hardness greater than 98 percent, shall have moisture content less than 3 percent, shall have a carbon tetrachloride (CCl4) adsorption greater than 75 percent, and shall have a total ash level less than 10 percent. Nominal particle diameter shall be 4 mm.

2.07 PROTECTIVE COATINGS

A. The stainless steel vessel shall be shop passivated and need not be painted. After vessel installation, any passivation nicks or scratches shall be touched up. The completed vessel shall be cleaned of any grease pencil marks or field notations.

B. Siloxane vessel shall be field insulated by others per Section 40 42 00.

2.08 SPARE PARTS

A. Provide one complete spare gasket plus any other spare parts recommended by the manufacturer. Spare parts shall be carefully packaged or boxed for protection from the elements during storage and shall include all necessary identification materials, labels, and installation instructions.

2.09 PRODUCT DATA

A. The following product data shall be submitted:
   1. Applicable operating and maintenance material.
   2. Activated carbon product specification, fill, removal, and disposal instructions.
   3. Potential suppliers of replacement activated carbon media, including at least two local media suppliers.
   4. Seismic support calculations.
   5. Proposed field testing guidelines, parameters, and test procedures.

PART 3 EXECUTION

3.01 START-UP

A. The equipment manufacturer shall provide a factory-trained representative for up to one day (8 hours) at the Owner's request. The factory representative shall start up and calibrate the equipment, and train plant personnel on operating and maintenance requirements.

3.02 TRAINING

A. Staff training plans and operation and maintenance manuals specified in Paragraph 1.04 shall be provided to the Owner before staff training.

END OF SECTION

CITY OF SANTA ROSA

STATE OF CALIFORNIA

LAGUNA TREATMENT PLANT
DIGESTER GAS CONDITIONING IMPROVEMENTS

The work to be performed and referred to herein is in the City of Santa Rosa, California and consists of improvements to be constructed in accordance with the provisions of the Invitation for Bids, containing the Notice to Bidders, the Special Provisions, the Project Plan(s), the Bid Forms and the Contract, all of which are by reference incorporated herein, and each Addendum, if any is issued, to any of the above which is also incorporated by reference herein.

TO THE AWARD AUTHORITY OF THE CITY OF SANTA ROSA

The undersigned, as bidder, declares that the only person or parties interested in this bid as principals are those named herein; that this bid is made without collusion with any other person, firm, or corporation; that Contractor has carefully examined the Project Plans, Invitation for Bids and conditions therefor, and is familiar with all bid requirements, that Contractor has examined this Contract and the provisions incorporated by reference herein, and Contractor hereby proposes, and agrees that if its bid is accepted by the City, Contractor will provide all necessary machinery, tools, apparatuses, and other means of construction, and to do all the work and furnish all the materials and services required to complete the construction in accordance with the Contract, the Special Provisions, the Project Plan(s), and Addenda to any of the above as incorporated by reference, in the time stated herein, for the unit prices and/or lump sum prices as follows:

CITY OF SANTA ROSA
UNIT PRICE SCHEDULE
LAGUNA TREATMENT PLANT DIGESTER GAS CONDITIONING IMPROVEMENTS

NAME OF BIDDER: _____

No.	Item	Quantity	Units	Unit Price	Total Price
1	LAGUNA TREATMENT PLANT DIGESTER GAS CONDITIONING IMPROVEMENTS	1	LS	$_____	$_____
	GRAND TOTAL BID				$_____

In the case of any discrepancy between the unit price and the total set forth for the item, the unit price shall prevail; provided, however, that if the amount set forth as a unit price is ambiguous, unintelligible or uncertain for any reason, or is omitted, or in the case of lump sum items, is not the same amount as the entry in the "Total" column, then the amount set forth in the "Total" column for the item shall prevail in accordance with the following:

1. As to lump sum items, the amount set forth in the "Total" column shall be the unit price;

2. As to unit basis items, the amount set forth in the "Total" column shall be divided by the estimated quantity for the item and the price thus obtained shall be the unit price.

The Total Base Bid shall be the sum of the "Total" column. In case of discrepancy between the sum of the "Total" column and the amount entered as Total Base Bid, the sum of the "Total" column shall prevail. The bid comparison will be based on the sum of the "Total" column for each bidder.

If this Contract Bid is accepted by the City and the undersigned fails to execute the Contract and to give all the bonds required under the Contract, with a surety satisfactory to the Award Authority of the City of Santa Rosa, within ten calendar days after bidder has received the Notice of Award from the Engineer, then the Award Authority may, at its option, determine that the bidder has abandoned the Contract, and thereupon this bid and the acceptance thereof shall be null and void, and the forfeiture of the security accompanying this bid shall be in accordance with California Public Contract Code section 20172.

The undersigned understands and agrees that the City is not responsible for any error or omissions on the part of the undersigned in making this bid.

The bidder to whom the Contract is awarded agrees to execute the Contract in favor of the City, in the form attached, and to deliver any and all required bond(s) and insurance certificates within ten calendar days from the date of Contractor’s receipt of the Notice of Award. Following the award of the Contract, Contractor shall commence work within ten calendar days from the day authorized in the Notice to Proceed and diligently prosecute the same to completion in accordance with Section 8-1.04.

LIST OF SUBCONTRACTORS

NAME OF BIDDER: _____

The following is a list of each subcontractor who will perform work or labor or render services to the undersigned for the construction of the project in an amount in excess of ½ of 1% of the total amount of this bid.

The undersigned agrees that any portion of the work in excess of ½ of 1% of the total amount of this bid and for which no subcontractor is designated herein will be performed by the undersigned.

SUBCONTRACTOR NAME	SUBCONTRACTOR LICENSE NUMBER	SUBCONTRACTOR DIR REGISTRATION NUMBER	SUBCONTRACTOR BUSINESS ADDRESS	DESCRIPTION OF WORK (ITEM NO.)

LIST OF PREVIOUS SIMILAR JOBS

NAME OF BIDDER: _____

NONCOLLUSION DECLARATION
TO BE EXECUTED BY BIDDER AND SUBMITTED WITH BID

The undersigned declares:

I am the _____ of _____, the party making the foregoing bid. The bid is not made in the interest of, or on behalf of, any undisclosed person, partnership, company, association, organization, or corporation. The bid is genuine and not collusive or sham. The bidder has not directly or indirectly induced or solicited any other bidder to put in a false or sham bid. The bidder has not directly or indirectly colluded, conspired, connived, or agreed with any bidder or anyone else to put in a sham bid, or to refrain from bidding. The bidder has not in any manner, directly or indirectly, sought by agreement, communication, or conference with anyone to fix the bid price of the bidder or any other bidder, or to fix any overhead, profit, or cost element of the bid price, or of that of any other bidder. All statements contained in the bid are true. The bidder has not, directly or indirectly, submitted his or her bid price or any breakdown thereof, or the contents thereof, or divulged information or data relative thereto, to any corporation, partnership, company, association, organization, bid depository, or to any member or agent thereof, to effectuate a collusive or sham bid, and has not paid, and will not pay, any person or entity for such purpose.

Any person executing this declaration on behalf of a bidder that is a corporation, partnership, joint venture, limited liability company, limited liability partnership, or any other entity, hereby represents that he or she has full power to execute, and does execute, this declaration on behalf of the bidder.

I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct and that this declaration is executed on _____ [date], at _____ [city], _____ [state].

NOTE: The above Noncollusion Declaration is part of the Contract Bid. Signing this Bid on the signature portion thereof shall also constitute signature of this Noncollusion Declaration.

BID BOND AFFIDAVIT AND BIDDER'S SIGNATURE PAGE

Accompanying this bid is a guaranty in the form of (Notice: Insert the words "cash $," "Cashier's Check," "Certified Check," or "Bidder's Bond" as the case may be):

_____

in an amount equal to at least ten percent of the total of this bid.

The undersigned further agrees that if Contractor does not execute the Contract and deliver the necessary bonds to the City within the period of time specified in this Invitation for Bids, the proceeds of the security accompanying this bid shall become the property of the City of Santa Rosa, California, and this bid and the acceptance thereof may, at the option of the City, be considered null and void.

The undersigned is licensed in accordance with an act providing for the registration of Contractors, License No. _____, Class _____, expiration date _____.

The undersigned in registered with the Department of Industrial Relations, Registration No. _____.

IMPORTANT NOTICE: If bidder or other interested person is a corporation, state legal name of corporation, also names of the president, secretary, treasurer, and manager of the corporation; if a partnership, state true name of partnership, also the names of all partners in the partnership; if the bidder is a sole proprietor, state the business name and the proprietor's name in full.

Secretary of State Business Entity Number: _____.

_____

_____

_____

_____

Business Address

_____

Telephone Number

I declare under penalty of perjury that the foregoing is true and correct.

BIDDER'S SIGNATURE: _____

TITLE: _____

DATE: _____

CONTRACT

CITY OF SANTA ROSA

CALIFORNIA

CONTRACT NO. C02101
LAGUNA TREATMENT PLANT
DIGESTER GAS CONDITIONING IMPROVEMENTS

This Contract is made and entered into as of date to be added upon award at Santa Rosa, California, between the City of Santa Rosa (“City") and _____ of _____ ("Contractor").

ARTICLE I - For and in consideration of the payment and agreement hereinafter mentioned, to be made and performed by City, and under the conditions expressed in the required bonds hereunto annexed, Contractor agrees that for the benefit of City, at its own cost and expense, to do all the work and furnish all the materials, except such as are mentioned in the Special Provisions to be furnished by City, necessary to construct and complete the work herein described in a good, workmanlike, and substantial manner. The work embraced herein shall be done in accordance with the Standard Specifications of the State of California Department of Transportation, dated 2010, insofar as the same may apply (Standard Specifications); in accordance with the City of Santa Rosa Construction Specifications for Public Improvements (City Specifications); in accordance with the City of Santa Rosa Design and Construction Standards, (City Standards); in accordance with the State of California Department of Transportation Standard Plans, dated 2010 (Standard Plans), (collectively, “Contract Documents”) and in accordance with the Special Provisions hereinabove set forth, all of which are hereby incorporated into and made part of this Contract.

The work to be performed is further shown upon a plan consisting of 40 sheets entitled, Laguna Treatment Plant Digester Gas Conditioning Improvements, File Number 2018-0018, approved by the Deputy Director of Transportation and Public Works, hereinafter referred to as the Project Plan(s).

ARTICLE II - Contractor agrees to receive and accept the following prices as full compensation for furnishing all materials and doing all the work contemplated and embraced in this Contract; also for all loss or damages arising out of the nature of the work aforesaid, or from the acts of the elements, or from any unforeseen difficulties or obstructions which may arise or be encountered in the prosecution of the work until its acceptance by City and for all expenses incurred by or in consequence of the suspension or discontinuance of work, and for well and faithfully completing the work, and the whole thereof in the manner and according to the Project Plans and Invitation for Bids therefor, and the requirements of the Engineer under them to wit:

ITEM NUMBER	QUANTITY	DESCRIPTION	UNIT PRICE	TOTAL
			$ _____	$ _____

TOTAL BASE BID (SUM OF "TOTAL" COLUMN) $ _____

BID ITEMS IN THIS SECTION WILL BE INSERTED UPON AWARD OF THE CONTRACT AND SHALL BE THE SAME AS THOSE BID UPON.

ARTICLE III - City and Contractor hereby promise and agree that Contractor shall provide the materials and do the work according to the terms and conditions herein contained and referred to, for the prices aforesaid, and City hereby agrees to pay for the same at the time, in the manner, and upon the conditions set forth; and the parties for themselves, their heirs, executors, administrators, successors, and assigns, do hereby agree to full performance of the covenants herein stated.

ARTICLE IV - By execution of this Contract, Contractor hereby represents and certifies that Contractor is aware of the provisions of Labor Code section 3700 which require every employer to be insured against liability for Workers' Compensation or to undertake self-insurance in accordance with the provisions of that Code, and Contractor hereby agrees to comply with such provisions before commencing the performance of the work of this Contract.

ARTICLE V - It is further expressly agreed by and between the parties hereto that the Invitation for Bids, containing the Notice to Bidders including any required Bonds, the Contract Documents, and any Addenda are all essential parts of this Contract and are specially referred to and by such reference made a part hereof. In the event of any conflict in the provisions thereof, the terms of said documents shall control each over the other, in the following order:

1. Special Provisions
2. Project Plans
3. City Standards
4. City Specifications
5. Standard Specifications
6. Standard Plans

ARTICLE VI - Contractor agrees to commence work pursuant to this Contract within ten calendar days from the date authorized in the Notice to Proceed and to diligently prosecute the same to completion in accordance with Section 8-1.04C of the Special Provisions.

This Contract shall not be transferred or assigned without the prior written consent of City, which may be withheld by City in its sole and absolute discretion.

If Contractor is a corporation, two corporate officers of Contractor, one from each of the following two groups shall execute this Contract: a) the chairman of the board, president or any vice-president; b) the secretary, any assistant secretary, chief financial officer, or any assistant treasurer. The name and title of the corporate officers shall be printed under the signature.

In witness whereof, the parties hereto have executed this Contract as of the date first written above.

City:	**Contractor:**
City of Santa Rosa, a Municipal corporation	Name of Contractor, Type of entity
By: _____	By: _____
Title: _____	Name: _____
ATTEST: By: _____	Title: _____
Title: _____	By: _____
Approved as to form:	Name: _____
By: _____ Office of City Attorney	Title: _____