State of Hawai‘i
DEPARTMENT OF AGRICULTURE & BIOSECURITY
AGRICULTURAL RESOURCE MANAGEMENT DIVISION
Honolulu, Hawai‘i

DEPARTMENT OF AGRICULTURE & BIOSECURITY

Sharon Hurd
Chairperson

INVITATION FOR BIDS

Job No. DOAM10
Moloka‘i Irrigation System Improvements – Well Nos. 5 and 6
Moloka‘i, Hawai‘i

4

Advertise:	March 6, 2026
Bid Open:	April 9, 2026 02:00 PM
IFB No.:	26001111
Bid Location:	HiePro – Electronic Procurement System
Contact:	Bryce Yoshimori; email: bryce.e.yoshimori@hawaii.gov

Prime/Mechanical/ Electrical Engineer:	Brown and Caldwell

March 2026

State of Hawai'i
DEPARTMENT OF AGRICULTURE & BIOSECURITY
AGRICULTURAL RESOURCE MANAGEMENT DIVISION
Honolulu, Hawai'i

CONTRACT SPECIFICATIONS AND PLANS

Job No. DOAM10
Moloka'i Irrigation System Improvements – Well Nos. 5 and 6
Moloka'i, Hawai'i

Approved: _____

Brian Kau, P.E.
Administrator and Chief Engineer
Agricultural Resource Management Division

March 2026

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NOTICE TO BIDDERS
(Chapter 103D, HRS)

COMPETITIVE BIDS for Job No. DOAM10; Molokai Irrigation System Improvements – Well Nos. 5 and 6 (Molokai, Hawaii) shall be submitted to the Department of Agriculture & Biosecurity, Agricultural Resource Management Division on the specified date and time through the State of Hawaii e-Procurement system (HIePRO). HIePRO is accessible through the State Procurement Office website at www.spo.hawaii.gov.

The Department of Land and Natural Resources Interim General Conditions, dated October 1994, as amended, and the General Conditions – AG008, latest revision shall be made a part of the specifications.

The work shall generally consist of the installation of: mechanical, electrical, incidental, and related improvements.

Due to the nature of work contemplated, bidders must possess a valid State Contractor's license, Classification "A".

A pre-bid conference will be held by video conference, on March 12, 2026 at 2:00 PM. Interested parties shall email Bryce Yoshimori Bryce.e.yoshimori@hawaii.gov, by March 11, 2026 at 4:00 PM.

All interested parties are strongly encouraged to attend a State conducted site visit including a walkthrough on March 25, 2026. Because of the remoteness and difficulty in accessing the site, it is imperative that prospective bidders familiarize themselves with the limitations in accessibility, resources, and conditions. The site visit will begin at the Department of Agriculture & Biosecurity, Molokai Office, at 801 Puupeelua Avenue. Interested parties shall email Bryce Yoshimori Bryce.e.yoshimori@hawaii.gov, by March 13, 2026 at 4:00 PM. Attendance will be limited to one representative per company. Weather conditions at the time may require rescheduling.

The estimated cost of construction for the BASE BID is $2,300,000.

The award of the Contract, if it be awarded, will be subject to the availability of funds.

Because the estimated cost of construction exceeds $250,000, the apprenticeship agreement preference pursuant to Hawaii Revised Statues §103-55.6 (ACT 17, SLH 2009) shall apply.

Should there be any questions, please refer to the HIePRO solicitation.

Non-Discrimination Notice

The Hawai‘i Department of Agriculture & Biosecurity does not discriminate on the basis of race, color, sex, national origin, age, or disability, or any other class as protected under applicable federal or state law, in administration of its programs, or activities, and, the Department of Agriculture & Biosecurity does not intimidate or retaliate against any individual or group because they have exercised their rights to participate in actions protected, or oppose action prohibited, by 40 C.F.R. Parts 5 and 7, or for the purpose of interfering with such rights.

If you have any questions about this notice or any of the Department's non-discrimination programs, policies, or procedures, you may contact:

Rae Gee, Non-Discrimination Coordinator
Hawai‘i Department of Agriculture & Biosecurity
1428 S. King Street
Honolulu, HI 96814
(808) 973-9560
hdoa.titlevi@hawaii.gov

If you believe that you have been discriminated against with respect to a Department of Agriculture & Biosecurity program or activity receiving federal assistance, please contact the DAB Non-Discrimination Coordinator identified above or visit our website at https://dab.hawaii.gov/grievance-procedures/ to learn how and where to file a complaint of discrimination.

The Hawai'i Department of Agriculture & Biosecurity does not intimidate, threaten, coerce, or discriminate against any individual or group for the purpose of interfering with any right or privilege guaranteed under federal anti-discrimination laws, or because an individual has filed a complaint or has testified, assisted, or participated in any way in an investigation, proceeding, or hearing related to federal anti-discrimination laws, or has opposed any practice made unlawful by federal anti-discrimination laws.

To request translation, interpretation, modifications, accommodations, or other auxiliary aids or services, contact the HDOA Office of the Chairperson at (808) 973-9560 or email hdoa.info@hawaii.gov. Please allow sufficient time for HDOA to meet accommodation requests.

INFORMATION AND INSTRUCTIONS TO BIDDERS

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INFORMATION AND INSTRUCTIONS TO BIDDERS

A. PROJECT LOCATION AND SCOPE OF WORK: The project location and scope of work shall be as generally described in the Notice to Bidders.

B. PROPOSALS**:** Bidders shall submit their bid, including the completed proposal form, bid bond, and any other documents required by the solicitation as part of their bid through the State of Hawaii e-Procurement System (HIePRO). See Item D, PROPOSAL FORM.

C. GENERAL CONDITIONS: The Department of Land and Natural Resources Interim General Conditions dated October 1994, as amended, shall be made a part of these contract specifications and are referred to hereafter as the General Conditions.

D. PROPOSAL FORM: The Bidders shall fill out and upload the electronic copy of the proposal form to the HIePRO website when submitting the bid. Bid Proposals shall not be mailed, faxed or delivered to the State, unless requested to do so after the designated closing date. The successful Bidder shall fill out and print a hard copy of the proposal form, sign and submit the form with the contract award package.

E. OMISSIONS OR ERASURES: Any proposal which contains any omission or erasure or alteration not properly initialed, or conditional bid, or other irregularity may be rejected by the Board of Agriculture & Biosecurity (Board).

F. NOTICE OF INTENT TO BID AND QUESTIONNAIRE:
A Notice of Intent to Bid is not required for this project. In compliance with HRS Section 103D-310, the lowest responsive and responsible bidder may be required to complete a questionnaire. When requested by the State, the completed questionnaire shall be submitted to the Chief Engineer for evaluation. Failure to furnish the requested information within the time allowed may be grounds for a determination of non-responsibility, in accordance with HRS Section 103D-310 and HAR Section 3-122-108.

G. BID SECURITY: A bid security will be furnished by each bidder as provided in sub-section 2.7 of the General Conditions. The successful bidder's bid security will be retained until Contract execution and furnished a performance and payment bond in an amount equal to one hundred percent (100%) of the total Contract price, including an amount estimated to be required for extra work, is furnished.

The Board reserves the right to hold the bid securities of the four lowest bidders until the successful bidder has entered into a contract and has furnished the required performance bond. All bid securities will be returned in accordance with sub-section 3.5 of the General Conditions.

Should the successful bidder fail to enter into a contract and furnish a satisfactory performance bond within the time stated in the proposal, the bid security shall be forfeited as required by law.

H. CONTRACTOR'S LICENSE REQUIRED: The Board will reject all bids received from contractors who have not been licensed by the State Contractors License Board in accordance

with Chapter 444, HRS; Title 16, Chapter 77, Hawaii Administrative Rules; and statutes amendatory thereto.

I. IRREGULAR BIDS: No irregular bids or propositions for doing the work will be considered by the Board.

J. WITHDRAWAL OF BIDS: No bidder may withdraw his bid between the time of the opening thereof and the award of contract.

K. SUCCESSFUL BIDDER TO FILE PERFORMANCE AND PAYMENT BONDS: The successful bidder will be required to file performance and payment bonds each; in the amount equal to the total contract price, including amounts estimated to be required for extra work, as provided in sub-section 3.6 of the General Conditions.

L. NUMBER OF EXECUTED ORIGINAL COUNTERPARTS OF CONTRACT DOCUMENTS: If requested by the Board, six copies of the Contract, performance and payment bonds shall be executed.

M. CHANGE ORDERS: No work of any kind in connection with the work covered by the plans and specifications shall be considered as change order work, or entitle the Contractor to extra compensation, except when the work has been ordered in writing by the Chief Engineer (Engineer) and in accordance with sub-section 4.2 of the General Conditions.

The Contractor shall clearly identify and inform the Engineer in writing of any deviations from the contract documents at the time of submission and shall obtain the Engineer's written approval to the specified deviation prior to proceeding with any work.

N. WAGES AND HOURS: In accordance with sub-sections 7.3 to 7.9 of the General Conditions relative to hours of labor, minimum wages and overtime pay, the current minimum wage rates promulgated by the Department of Labor and Industrial Relations (DLIR) shall be paid to the various classes of laborers and mechanics engaged in the performance of this contract on the job site. The minimum wages shall be increased during the performance of the contract in an amount equal to the increase in the prevailing wages for those kinds of work as periodically determined by the DLIR.

The State will not recognize any claim for additional compensation because of the payment by the Contractor of any wage rate in excess of the said minimum wage rates. The possibility of wage increase is one of the elements to be considered by the Contractor in determining his bid, and will not, under any circumstances, be considered as the basis of a claim against the Department under this Contract.

No work shall be done on Saturdays, Sundays, legal State holidays, and/or in excess of eight (8) hours each day without the prior written consent of the Engineer. Should permission be granted to work at such times, the Contractor shall pay for all inspection administrative costs thereof. No work shall be done at night unless pre-authorized by the Engineer.

O. PERMITS: The State will process permit applications whenever possible, and the Contractor shall procure the pre-approved permits and pay the required fees. If permit applications are not processed by the State, the Contractor shall complete and acquire appropriate regulatory agency approval for permit applications, permits and licenses, and pay all charges and fees. In all cases, the Contractor shall give all notices necessary and incident to the due and lawful prosecution of the work.

P. PROPERTY DAMAGE: It shall be the responsibility of the Contractor to protect State property and to prevent damage to existing facilities, structures, and improvements. The Contractor will be responsible for any and all damages resulting from construction operations. Immediately upon discovery, the Contractor shall repair such damage to the satisfaction of the Engineer.

All trees and shrubbery outside the excavation, embankment or construction limits shall be fully protected from damage.

Q. TIME: The time of completion is specified in the Proposal. It is the Board's intention to insist the Contractor diligently prosecute the work to completion within the specified time.

Prospective bidders are reminded that the State has the option to proceed with or abandon a project depending on whether the project can be completed for occupancy in the specified time.

It is the bidder's responsibility to check the availability of all materials before bidding. The bidder shall select sub-contractors and suppliers who can warrant availability and delivery of all specified or qualified materials to assure project completion within the specified time.

The successful bidder must assume all risks for completing the project by the specified date. There shall be no extension of time for any reason except for delays caused by acts of God, labor disputes involving unions, or actions of the State. If for any reason the project falls behind schedule, the Contractor shall at its own cost, take necessary remedial measures to get the project back on schedule, i.e., working overtime, air freighting all materials, etc. In addition, if the Contractor fails to fully complete the project by the completion date, Contractor will be required to make the facility usable at its own cost.

R. BIDDER'S RESPONSIBILITY TO PROVIDE PROPER SUPERINTENDENCE: The successful low bidder shall designate in writing to the Engineer the name of its authorized superintendent (Superintendent), who will be present at the job site whenever any work is in progress. The Superintendent shall be responsible for all work, receiving and implementing instructions from the Engineer in a timely manner. The cost for superintendence shall be considered incidental to the project.

If the Superintendent is not present at the site of work, the Engineer shall have the right to suspend the work as described under sub-section 5.5 c. and 7.20 - Suspension of Work of the General Conditions.

S. LIQUIDATED DAMAGES: Liquidated damages in the amount specified in the Proposal will be assessed for each and every calendar day from and after the expiration of the time period stated in the Contract for the completion of the project.

T. HIRING OF HAWAII RESIDENTS: The Contractor shall comply with Act 68, SLH 2010, in the performance and for the duration of this contract. The Contractor shall ensure that Hawaii residents compose not less than eighty percent of the workforce employed to perform the contract work on the project. The eighty percent requirement shall be determined by dividing the total number of hours worked on the contract by Hawaii residents, by the total number of hours worked on the contract by all employees of the Contractor in the performance of the contract. The hours worked by any Subcontractor of the Contractor shall count towards the calculation for this section. The hours worked by employees with shortage trades, as determined by the Department of Labor and Industrial Relations (DLIR), shall not be included in the calculation for this section.

The requirements shall apply to any subcontract of $50,000 or more in connection with the Contractor, that is, such Subcontractors must also ensure that Hawaii residents compose not less than eighty percent of the Subcontractor's workforce used to perform the subcontract.

U. WATER AND ELECTRICITY: The Contractor shall make all necessary arrangements and pay all expenses for water and electricity used in the construction of this project.

V. PUBLIC CONVENIENCE AND SAFETY: The Contractor shall conduct construction operations with due regard to the convenience and safety of the public at all times. No materials or equipment shall be stored where it will interfere with the safe passage of public traffic. The Contractor shall provide, install, and maintain in satisfactory condition, all necessary signs, flares and other protective facilities and shall take all necessary precautions for the protection of the work and the convenience and safety of the public. The Engineer shall have the right to suspend the performance of the work in accordance with sub-section 7.20 - Suspension of Work of the General Conditions.

W. WORK TO BE DONE WITHOUT DIRECT PAYMENT: Whenever the contract that the Contractor is to perform work or furnish materials of any kind for which no price is fixed in the contract, it shall be understood that the Contractor shall perform such work or furnish said materials without extra charge or allowance or direct payment of any sort. The cost of performing such work or furnishing said material is to be included by the Contractor in a unit price for the appropriate item unless it is expressly specified that such work or material is to be paid for as extra work.

X. AS-BUILT DRAWINGS: As-built drawings, the intent of which is to record the actual in-place construction so that any future renovations or tie-ins can be anticipated accurately, shall be required. All authorizations given by the Engineer to deviate from the plans shall be drawn on the job site plans. All deviations from alignments, elevations and dimensions which are stipulated on the plans shall be recorded on the as-built drawings. Final as-built drawings shall be submitted to the Engineer for review and approval. After the Engineer approves the as-built drawings, the contractor shall submit an electronic copy in Adobe PDF format on CD ROM.

Y. ASBESTOS CONTAINING MATERIALS: The use of asbestos containing materials or equipment is prohibited. The Contractor shall insure that all materials and equipment incorporated in the project are asbestos-free

Z WORKER SAFETY: The Contractor shall provide, install and maintain in satisfactory condition all necessary protective facilities and shall take all necessary precautions for the protection and safety of its workers in accordance with the Occupational Safety and Health Standards for the State of Hawaii. The Engineer shall have the right to suspend the performance of the work in accordance with sub-section 7.20 - Suspension of Work of the General Conditions.

AA. TOILET FACILITIES: All toilet facilities constructed at the project site shall be in accordance with the Public Health Regulations of the State Department of Health (DOH). All necessary precautions shall be observed at the project site. The use of sanitary facilities shall be strictly enforced and workers violating these provisions shall be promptly discharged.

BB. SIGNS: Whenever the project involves closing or obstructing any public thoroughfare, the Contractor shall provide traffic signs conforming to the applicable provisions of the current edition of the "Manual on Uniform Traffic Control Devices for Streets and Highways", published by the Federal Highway Administration as directed by the Engineer for the purpose of diverting

or warning traffic prior to the construction area. All traffic signs shall bear proper wording stating thereon the necessary information as to diverting or warning traffic.

When indicated in the Proposal, the Contractor shall provide a project sign, size 4'-0" x 7'-0" to be placed as directed by the Engineer. The sign shall be constructed in accordance with Section 01581 - Project Sign of these specifications and approved by the Engineer. All wording, type and size of lettering and color selection shall be as specified in these specifications or as approved by the Engineer.

All signs shall be kept neat and clean, and properly erected at all times.

CC. FIELD OFFICE AREA FOR DEPARTMENT: The Contractor shall provide a housed working area of at least 100 square feet adjacent to the Contractor's office for the Department's use. This area will be used by the Engineer to perform tests and to store equipment. As a minimum, the field office shall include the following: standard sized office desk and chair, lighting, ventilation, window-type air conditioning rated at 5,000 BTU, door and window with locking hardware, electrical outlets, and working communications facilities (a cellular telephone is acceptable). The Department will pay for all long distance toll charges made by the Engineer.

DD. QUANTITIES: All bids will be compared on the basis of quantities of work to be done as shown in the Proposal; the quantities shown in the Unit Price items are estimated, being given as a basis for comparison of bids. The Board reserves the right to increase or decrease the quantities given under the items or delete items entirely as may be required during the progress of the work.

EE. OTHER HEALTH MEASURES: Forms of work site exposure or conditions which may be detrimental to the health or welfare of workers or of the general public shall be eliminated or reduced to safe levels as required by the DOH codes, standards, and regulations. Suitable first aid kits and a person qualified to render first aid, as specified in the DOH regulations, shall be provided at all times when work is scheduled.

FF. HAWAII BUSINESS OR COMPLIANT NON-HAWAII BUSINESS REQUIREMENT: Bidders (Contractors) shall be incorporated or organized under the laws of the State or be registered to do business in the State as a separate branch or division that is capable of fully performing under the contract, as stipulated in §3-122-112 HAR.

GG. COMPLIANCE WITH §3-122-112 HAR:
As a condition for award of the contract and as proof of compliance with the requirements of 103D-310(c) HRS, the apparent low bidder shall furnish the required documents to the Department. If the valid required certificates are not submitted on a timely basis for award of a contract, a bidder otherwise responsive and responsible may not receive the award. Bidder is responsible to apply for and submit the following documents to the Department.

A. TAX CLEARANCE REQUIREMENTS (HRS Chapter 237): Bidder shall obtain a tax clearance certificate from the Hawaii State Department of Taxation (DOTAX) and the Internal Revenue Service (IRS). The certificate is valid for six months from the most recently approved stamp date on the certificate; the certificate must be valid on the date received by the Department.

B. Department of Labor (DLIR) "**Certificate of Compliance**". (HRS Chapter 383 - Unemployment Insurance, Chapter 386 - Workers' Compensation, Chapter 392 - Temporary Disability Insurance, and 393 – Prepaid Health Care): Bidder shall obtain a certificate of compliance from the Hawaii State Department of Labor and Industrial

relations (DLIR). The certificate is valid for six months from the date of issue; certificates must be valid on the date received by the Department.

C. Department of Commerce and Consumer Affairs (DCCA), Business Registration Division (BREG) "**Certificate of Good Standing**". Bidder shall obtain a certificate of good standing issued by the Department of Commerce and Consumer Affairs (DCCA), Business Registration Division (BREG). The certificate of good standing is valid for six months from the date of issue; certificates must be valid on the date received by the Department.

Alternately, instead of separately applying for these certificates at the various state agencies, bidder may choose to use the Hawaii Compliance Express (HCE), which allows businesses to register online through a simple wizard interface at http://vendors.ehawaii.gov to acquire a "Certificate of Vendor Compliance" indicating the bidder's status is compliant with the requirements of §103D-310(c), HRS, and shall be accepted for contracting and final payment purposes. Bidders that elect to use the new HCE services will be required to pay an annual fee of $15.00 to the Hawaii Information Consortium, LLC (HIC). Bidders choosing not to participate in the HCE program will be required to provide the paper certificates as instructed in the previous paragraphs.

PROPOSAL

FOR

State of Hawaii
DEPARTMENT OF AGRICULTURE & BIOSECURITY
AGRICULTURAL RESOURCE MANAGEMENT DIVISION

JOB NO. DOAM10
MOLOKAI IRRIGATION SYSTEM IMPROVEMENTS – WELL NOS. 5 AND 6
MOLOKAI, HAWAII

_____, 2026

Chief Engineer
Agricultural Resource Management Division
Department of Agriculture & Biosecurity
State of Hawaii
Honolulu, Hawaii

Dear Sir:

The undersigned, having carefully examined the local conditions and all available records and information covering conditions which may affect the cost of the work to be performed, and having carefully examined the Plans and Specifications, and other contract documents, hereby proposes to furnish and pay for all materials, tools, equipment, labor, and other incidental work necessary to construct improvements for the Molokai Irrigation System Improvements – Well Nos. 5 and 6 project, and related work as required or called for in this Proposal, all according to the true intent and meaning of the Notice to Bidders, Information and Instructions to Bidders, Proposal, Detailed Specifications, Interim General Conditions, Plans, and any and all addenda for:

JOB NO. DOAM10
MOLOKAI IRRIGATION SYSTEM IMPROVEMENTS – WELL NOS. 5 AND 6
MOLOKAI, HAWAII

on file in the office of the Agricultural Resource Management Division for the TOTAL BASE BID (Items 1 to 9) of:

_____
_____ Dollars ($ _____)

and will fully complete all work under this contract within 450 consecutive calendar days from the date of written notice to proceed, including date of said order, and total sum being itemized on the following pages.

Item No.	Quantity	Unit	Description	Unit Price	Total
BASE BID – WELL NO. 5					
1.	1	LS	Mobilization, (not to exceed 6% of Base Bid total, excluding bid price for mobilization, allowance items; cost of demobilization shall be considered incidental to mobilization cost), per Section 01 15 00.	Lump Sum	$
2.	1	LS	Pre- and post-construction surveys, per Section 01 45 21.	Lump Sum	$
3.	1	LS	Erosion, sedimentation, and dust control, per Section 31 35 00.	Lump Sum	$
4.	1	LS	Well No. 5 well depth measurement and pre-rehabilitation and post-rehabilitation inspections and surveys, per Sections 13 10 00 and 13 20 00.	Lump Sum	$
5.		Vertical feet	Well No. 5 well fill removal, per Section 13 10 00. Cost per vertical feet: $_____	*Allowance	$ 20,000
6.	1	LS	Well No. 5 rehabilitation, per Section 13 30 00.	Lump Sum	$
7.	1	LS	Well No. 5 mechanical improvements, including demolition, pump, piping, fittings, valves, supports, coating systems, testing, and all other incidentals, in place complete.	Lump Sum	$
8.	1	LS	Well No. 5 electrical improvements, including demolition, instrumentation, local disconnect switch, conduit, junction boxes, wire between Well No. 5 and Surface Water Pump Building, testing, and all other incidentals, in place complete.	Lump Sum	$
9.	1	LS	Performance and operational testing of Well No. 5, per Section 01 45 20; commissioning of Well No. 5, per Section 01 91 00.	Lump Sum	$
			TOTAL – BASE BID (ITEMS 1 TO 9)		$
ADDITIVE ALTERNATE 1 – HANDHOLE REPAIR					
10.	1	LS	Handhole repair (south of Surface Water Pump Building), including backfill over existing ductbank concrete, cover replacement, interior handhole cleaning (removal of debris/soil), and handhole structural repair, in place complete.	Lump Sum	$
			TOTAL – ADDITIVE ALTERNATE 1 (ITEM 10)		$

ADDITIVE ALTERNATE 2 – WELL NO. 6					
11.	1	LS	Additional mobilization, (not to exceed 6% of Additive Alternative 2 total, excluding bid price for mobilization, allowance items; cost of demobilization shall be considered incidental to mobilization cost), per Section 01 15 00.	Lump Sum	$
12.	1	LS	Additional pre- and post-construction surveys, per Section 01 45 21.	Lump Sum	$
13.	1	LS	Additional erosion, sedimentation, and dust control, per Section 31 35 00.	Lump Sum	$
14.	1	LS	Well No. 6 well depth measurement and pre-rehabilitation and post-rehabilitation inspections and surveys, per Sections 13 10 00 and 13 20 00.	Lump Sum	$
15.		Vertical feet	Well No. 6 well fill removal, per Section 13 10 00. Cost per vertical feet: $_____	*Allowance	$ 20,000
16.	1	LS	Well No. 6 rehabilitation, per Section 13 30 00.	Lump Sum	$
17.	1	LS	Well No. 6 mechanical improvements, including demolition, pump, piping, fittings, valves, supports, coating systems, testing, and all other incidentals, in place complete.	Lump Sum	$
18.	1	LS	Well No. 6 electrical improvements, including demolition, instrumentation, local disconnect switch, conduits, junction boxes, wire between Well No. 6 and Surface Water Pump Building, testing, and all other incidentals, in place complete.	Lump Sum	$
19.	1	LS	Performance and operational testing of Well No. 6, per Section 01 45 20; commissioning of Well No. 6, per Section 01 91 00.	Lump Sum	$
			TOTAL – ADDITIVE ALTERNATE 2 (ITEMS 11 TO 19)		$

RECAPITULATION

TOTAL BASE BID (ITEMS 1 - 9) $ _____

TOTAL ADDITIVE ALTERNATE 1 (ITEM 10) $ _____

TOTAL ADDITIVE ALTERNATE 2 (ITEMS 11 - 19) $ _____

TOTAL SUM BID (ITEMS 1 - 19) $ _____

*Use of and payment for this item authorized only when written approval for its use is given. Any unused Allowance monies shall remain with the State upon completion of the project. Contractor shall not make a claim in the event the State chooses to delete any Allowance monies from the Contract.

RECYCLED PRODUCTS PREFERENCE

This project allows a 10% price preference for recycled products in accordance with HRS 103D-1005. Please indicate your recycled or non-recycled product by indicating its cost FOB jobsite unloaded in the schedule below, including applicable General Excise & Use Taxes.

DESCRIPTION	RECYCLED PRODUCT COST	NONRECYCLED PRODUCT COST
_____	$_____	$_____
_____	$_____	$_____
_____	$_____	$_____
_____	$_____	$_____

The bidder requesting a recycled product preference shall also complete and submit the form "CERTIFICATION OF RECYCLED CONTENT" as shown in the Interim General Conditions and provide all supporting information with this proposal. Additional information may be requested to qualify a product.

The following definitions are applicable to the CERTIFICATION OF RECYCLED CONTENT form:

"Post-consumer recovered material" means any product used by a consumer, including a business that purchases the material, that has served its intended end use, and that has been separated or diverted from the solid waste stream for the purpose of use, reuse, or recycling.

"Product" includes materials, manufactures, supplies, merchandise, goods, wares, and foodstuffs.

"Recovered material" means waste material and by-products that have been separated, diverted, or removed from the solid waste stream after a manufacturing process for the purpose of use, reuse, or recycling. Recovered material does not include those materials and by-products that are generated and normally reused on-site or within original manufacturing processes (such as mill broke, in the case of paper products).

"Recycled content" means the percentage of a product composed of recovered material, or postconsumer recovered material, or both.

"Recycled product" means a product containing recovered material, or post-consumer recovered material, or both.

The bidder agrees that preference for recycled products shall be taken into consideration to determine the low bidder in accordance with said Section and the rules promulgated, however, the award of contract will be in the amount of the bid offered exclusive any preference.

APPRENTICESHIP AGREEMENT PREFERENCE

1. If applicable to this project, any bidder seeking the preference must be a party to an apprenticeship agreement registered with the State Department of Labor and Industrial Relations (DLIR) at the time the bid is submitted for each apprenticeable trade the bidder will employ to construct the project. "Employ" means the employment of a person in an employer-employee relationship.

    a. The apprenticeship agreement shall be registered with the DLIR and conform to the requirements of Hawaii Revised Statutes Chapter 372.

    b. Subcontractors do not have to be a party to an apprenticeship agreement for the bidder to obtain preference.

    c. The bidder is not required to have apprentices in its employ at the time the bid is submitted to qualify for the preference.

2. A bidder seeking the preference must state the apprenticeable trade the bidder will employ for each trade to be employed to perform the work by submitting a completed signed original Certification Form 1 verifying participation in an apprenticeship program registered with DLIR. "Apprenticeable trade" shall have the same meaning as "apprenticeable occupation" pursuant to Hawaii Administrative Rules (HAR) §12-30-5.

    a. The Certification Form 1 shall be authorized by an apprenticeship sponsor listed on the DLIR list of registered apprenticeship programs. "Sponsor" means an operator of an apprenticeship program and in whose name the program is approved and registered with the DLIR pursuant to HAR §12-30-1.

    b. The authorization shall be an original signature by an authorized official of the apprenticeship sponsor.

    c. The completed signed original Certification Form 1 for each trade must be submitted with the bid. Previous certifications shall not apply.

    d. When filling out the Certification Form 1, the name of Apprenticeable Trade and Apprenticeship Sponsor must be the same as recorded in the List of Construction Trades in Registered Apprenticeship Programs that is posted on the DLIR website. "Registered apprenticeship program" means a construction trade program approved by the DLIR pursuant to HAR §12-301 and §12-30-4.

    e. The Certificate Form 1 and the List of Construction Trades in Registered Apprenticeship Programs is available on the DLIR website at: http://hawaii.gov/labor/wdd.

3. Upon receiving the Certification Form 1, the Procurement Officer will verify that the apprenticeship program is on the List of Construction Trades in Registered Apprenticeship Programs and that the form is signed by an authorized official of the Apprenticeship Program Sponsor. If the programs and signature are not confirmed by the DLIR, the bidder will not qualify for the preference.

4. If the bidder is certified to participate in an apprenticeship program for each trade which will be employed by the bidder for the project, a preference will be applied to decrease the bidder's bid amount by five percent (5%) for evaluation purposes.

5. Should the bidder qualify for other preferences (e.g. Hawaii Products), all applicable preferences shall be applied to the bid price.

CONTRIBUTIONS BY STATE AND COUNTY CONTRACTORS PROHIBITED

Contractors are hereby notified of the applicability of Section 11-355, HRS, which states that campaign contributions are prohibited from specified State or county government contractors during the term of the contract if the contractors are paid with funds appropriated by a legislative body.

CONDITION OF AWARD

It is understood that the award of the contract will be made on the basis of the lowest responsible total Base Bid (Items 1 to 9) selected by the Department of Agriculture & Biosecurity. Write the total of Bid Items 1 to 9 on page P-3.

In the event the low bid is below the available funds certified by the appropriate fiscal officer, the head of the purchasing agency responsible for the procurement in question is authorized to award Additives to the lowest bidder. The award of Additives may be in any order or combination such that the Base Bid plus Additives do not exceed the available funds.

It is understood and agreed that the Department of Agriculture & Biosecurity reserves the right to reject any and/or all bids and waive any defects when, in DAB's opinion, such rejection or waiver will be for the best interest of the State of Hawaii.

In the event all bids exceed available funds certified by the appropriate fiscal officer, the head of the purchasing agency responsible for the procurement in question is authorized in situations where time or economic considerations preclude resolicitation of work of a reduced scope to negotiate an adjustment of the bid price, including changes in the bid requirements, with the low responsible and responsive bidder, in order to bring the bid within the amount of available funds. It is understood and agreed upon that the head of the purchasing agency may delete a portion or all of any item(s) in the proposal at the stated unit or lump sum price as necessary to stay within the available funding. The bidder is responsible to make an earnest effort to represent the actual cost of each item, including all materials, labor, equipment, overhead and profit in their bid proposal to preclude claims of anticipated profit or loss of profit because of an unbalanced bid proposal.

It is also understood that if a mutually agreeable cost for the reduced scope of work necessitated by a lack of available funds cannot be agreed upon between the bidder and the head of the purchasing agency within 14 calendar days after the bid opening, then the bid may be rejected in the best interest of the purchasing agency, and the head of the purchasing agency may negotiate in progressive order (lowest to highest) with the next lowest responsible and responsive bidder.

It is also understood and agreed that the award of the contract shall be conditioned upon funds being made available for this project and further upon the right of the Department of Agriculture & Biosecurity to hold all bids received for a period of sixty (60) days from the date of the opening thereof, unless otherwise required by law, during which time no bid may be withdrawn.

It is also understood that Notice to Proceed may be delayed up to one (1) year after the bid opening date, and that no additional compensation will be provided for any claim for escalation or delay for issuance of Notice to Proceed on or before that date.

It is also understood and agreed that the quantities given herewith are approximate only and are subject to increase or decrease, and that the undersigned will perform all quantities of work as either increased or decreased, in accordance with the provisions of the Contract Specifications.

It is also understood and agreed that the estimated quantities shown for the items for which a UNIT PRICE is asked in this Proposal are only for the purpose of comparing on a uniform basis, bids offered for the work under this contract, and the undersigned agrees that he is satisfied with and will at no time, dispute said estimated quantities as a means of claims for anticipated profit or loss of profit, because of a difference between the quantities of the various classes of work done or the materials and equipment installed, and the said estimated quantities. On UNIT PRICE bids, payment will be made only for the actual number of units incorporated into the finished project at the contract UNIT PRICE.

After the proposals are opened and read, the figures will be extended and/or totaled in accordance with the bid prices of the acceptable proposals and the totals will be compared. In the comparison of bids, words written in the proposal shall govern over figures and unit prices will govern over totals. Until the award of the contract, however, the right will be reserved to reject any and all proposals and to waive any defects or technicalities as may be deemed best for the interest of the State.

It is also understood and agreed that liquidated damages in the amount of FIVE HUNDRED and No/100 Dollars ($500.00) for each and every calendar day in excess thereof prior to completion of the contract shall be withheld from payments due to the Contractor.

It is also understood and agreed that if this bid is accepted, the successful bidder must enter into and execute a contract with the Department of Agriculture & Biosecurity and furnish a Performance and Payment Bond, as required by law. These bonds shall conform to provisions of Section 103D-324 and 325, Hawaii Revised Statutes and any law applicable hereto.

It is also understood and agreed that the successful bidder will provide all necessary labor, materials, tools, equipment, and other incidentals necessary to do all the work and furnish all the materials specified in the contract in the manner and time herein prescribed, and according to the requirements of the Engineer as therein set forth.

It is understood that by submitting this proposal, the undersigned is declaring that his firm has not been assisted or represented on this matter by an individual who has, in a State capacity, been involved in the subject matter of this contract in the past two years.

It is understood that by submitting this proposal in accordance with HAR 3-122-192, the undersigned is declaring that the price submitted is independently arrived without collusion.

It is also understood that by submitting this proposal, a Certification for Safety and Health Programs for bids in excess of $100,000 (in accordance with HRS 396-18), the undersigned certifies that his organization will have a written safety and health plan for this project that will be available and implemented by the Notice to Proceed date of this project. Details of the requirements of this plan may be obtained from the Department of Labor and Industrial Relations, Occupational, Safety and Health Division (HIOSH).

It is further understood and agreed that the successful bidder shall comply with paragraph 3.1.a "SUBCONTRACTING" of the General Provisions which requires that the contractor shall perform with his own organization and with the assistance of workmen under his immediate superintendence, work of a value not less than twenty percent (20%) of the value of all work embraced in the Contract, except that certain contract items of work, if specifically referred to in the special provisions, will be exempted from said twenty percent requirement.

Compliance with §103-310 HRS. As a condition of award all bidders shall comply with all laws governing entities doing business in the State, including Chapter 237 HRS (general excise tax); Chapter 383 HRS (employment security – unemployment insurance); Chapter 386 HRS (workers compensation); Chapter 392 HRS (temporary disability insurance); and Chapter 393 HRS (pre-paid health care), and shall produce all documents to the State (DLNR, Engineering Division) required to demonstrate compliance with these subsections. Any bidder making a false affirmation or certification under this subsection shall be suspended and may be debarred from further offerings or awards pursuant to §103D-702 HRS.

RECEIPT OF ADDENDA

The bidder also acknowledges receipt of any and all addenda issued by the Engineering Division, by recording the date of receipt of the respective addenda in the space provided below:

Addendum	Date Received	Addendum	Date Received
No. 1	_____	No. 5	_____
No. 2	_____	No. 6	_____
No. 3	_____	No. 7	_____
No. 4	_____	No. 8	_____

It is understood that failure to receive any such addendum shall not relieve the Contractor from any obligation under this Proposal as submitted.

It is also understood and agreed that if this Proposal is accepted and the undersigned should fail or neglect to contract as aforesaid, the State may determine that the bidder has abandoned the Contract, and thereupon, forfeiture of the security accompanying his proposal shall operate and the same shall become the property of the State.

JOINT CONTRACTORS OR SUBCONTRACTORS TO BE ENGAGED ON THIS PROJECT

The Bidder agrees that the following is a complete listing of all joint contractors or subcontractors covered under Chapter 444, Hawaii Revised Statutes (HRS), who will be engaged by the Bidder on this project to perform the required work indicated pursuant to Section 103D-302, HRS. It is the sole responsibility of the contractor to review the requirements of this Project and determine the appropriate licenses that are required to complete the Project. The Bidder certifies that the completed listing of joint contractors or subcontractors fulfills the requirements for the project and the Bidder, together with the listed subcontractors or joint contractors have all the specialty contractor's licenses to complete the work, except as provided for in HRS §103D-302(b). Failure of the Bidder to comply with this requirement may be just cause for rejection of the bid.

"A" General Engineering Contractors and "B" General Building Contractors are reminded that due to the Hawaii Supreme Court's January 28, 2002 decision in Okada Trucking Co., Ltd. v. Board of Water Supply, et al., 97 Haw. 450 (2002), they are prohibited from undertaking any work, solely or as part of a larger project, which would require the general contractor to act as a specialty contractor in any area in which the general contractor has no license. Although the "A" and "B" contractor may still bid on and act as the "prime" contractor on an "A" or "B" project (See, *HRS §444-7 for the definitions of an "A" and "B" project.*), respectively, the "A" and "B" contractor may only perform work in the areas in which they have the appropriate contractor's license *(An "A" or "B" contractor obtains "C" specialty contractor's licenses either on its own, or automatically under HAR § 16-7732).* The remaining work must be performed by appropriately licensed entities.

General Engineering "A" Contractors automatically have these "C" specialty contractor's licenses: C-3, C9, C-10, C-17, C-24, C-31a, C-32, C-35, C-37a, C-37b, C-38, C-43, C-49, C-56, C-57a, C-57b and C-61.

General Building "B" Contractors automatically have these "C" specialty contractor's licenses: C-5, C-6, C-10, C-12, C-24, C-25, C-31a, C-32a, C-42a and C-42b.

In completing the Joint Contractors or Subcontractors List, describe the specialty contractor's nature and scope of work to be performed for this project and provide the complete firm name of the joint contractor or subcontractor in the respective columns. If the Bidder is a general contractor providing the work of a required specialty contractor, whose license is not automatically held pursuant to HAR 16-77-32, fill in the Bidder's (general contractor's) name and nature and scope of work to be performed on this project.

List only one joint contractor or subcontractor per required specialty contractor's classification, unless within the same specialty, the work of each joint contractor or subcontractor can be described so that there is no overlap in work descriptions.

If a contractor's license is required by law for the performance of the work which is called for in this bid, the bidder and all subcontractors must have the required license before the submission of the bidder's proposal in the case of a non-federal aid project, and for federal-aid projects, the bidder must have the required license prior to the award of the project and all subcontractors prior to the start of the subcontracted work.

COMPLETE FIRM NAME OF JOINT CONTRACTOR OR SUBCONTRACTOR	NATURE AND SCOPE OF WORK TO BE PERFORMED

Enclosed herewith is a:

1. Surety Bond (*1)	)	
2. Legal Tender (*2)	)	
3. Cashier's Check (*3)	)	
4. Certificate of Deposit (*3)	)	in the
5. Certified Check (*3)	)	amount
6. Official Check (*3)	)	of
7. Share Certificate (*3)	)	
8. Teller's Check (*3)	)	
9. Treasurer's Check (*3)	)	

(Cross Out Those Not Applicable)

_____

_____Dollars ($_____)

as required by law.

Respectfully submitted,

_____
Name of Company, Joint Venture
or Partnership

_____
Contractor's License No.

By _____
Signature (*4)

Title _____
Print Name _____
Date _____
Address _____
_____
Telephone No. _____

E-Mail Address _____

NOTES:

1. Surety bond underwritten by a company licensed to issue bonds in this State;

2. Legal tender; or

3. A certificate of deposit; share certificate; or cashier's, treasurer's, teller's, or official check drawn by, or a certified check accepted by, and payable on demand to the State by a bank, a savings institution, or credit union insured by the Federal Deposit Insurance Corporation or the National Credit Union Administration.

   A. These instruments may be utilized only to a maximum of $100,000.

   B. If the required security or bond amount totals over $100,000, more than one instrument not exceeding $100,000 each and issued by different financial institutions shall be accepted.

4. Please attach to this page evidence of the authority of this officer to submit bids on behalf of the Company and also the names and residence addresses of all officers of the Company.

5. Fill in all blank spaces with information asked for or bid may be invalidated. PROPOSAL MUST BE INTACT, MISSING PAGES MAY INVALIDATE YOUR BID.

END OF PROPOSAL

MOLOKAI IRRIGATION SYSTEM IMPROVEMENTS – WELL NOS. 5 AND 6

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SECTION 01 01 90

GENERAL SPECIFICATIONS

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies general requirements of the project, which shall consist of furnishing all labor, tools, materials and equipment necessary and required to construct, in place complete, all work as indicated on the drawings and as specified herein.

1.02 GENERAL

A. "OFFICER-IN-CHARGE" shall refer to an authorized representative of the Department of Agriculture & Security to be identified at project initiation.

B. Examination of Premises: The Contractor shall contact the Officer-in-Charge and obtain permission before visiting the project sites.

C. All lines and grades shall be established by a licensed surveyor, or licensed Civil Engineer, registered in the State of Hawaii. The Contractor shall submit evidence of current and valid registration.

D. Notices: The Contractor shall notify the Officer-in-Charge and give at least three (3) working days' notice before starting any work.

E. Disruption of Utility Services: All work related to the temporary disconnection of electrical system shall be prearranged with the Officer-in-Charge so that any disruption of such services will be kept to a minimum. In the event temporary power hook-up is required, the Contractor shall provide the necessary services.

F. Permits and Regulations: The Contractor shall obtain and pay for all permits and licenses, give all notices and comply with all laws, ordinances, rules and regulations bearing on the conduct of the work as drawn and specified.

G. Existing Utilities: The Contractor shall be responsible for the protection of existing surface and subsurface utilities and poles within and abutting the project sites, trench excavations, borrow sites, and other work areas. Any utility that the Contractor encounters during the progress of the work, such as telephone poles, electric poles, water lines, sewer lines, electric lines, and drainage lines, whether or not shown on the plans, shall not be disturbed or damaged unless otherwise instructed in the plans and specifications. The Contractor shall notify the Officer-in-Charge and the affected utility company immediately of any damaged or disturbed utility.

H. Contractor's Operations: The Contractor must employ, insofar as possible, such methods and means of carrying out the work so as not to cause any interruption or interference to existing operations of any landowners and their facilities. Where the Contractor's operations would result in interruptions which would hamper the operations of the facilities, the Contractor shall rearrange the schedule of work accordingly. The Contractor shall maintain safe passageway to and from the facility for the user agency personnel and the public at all times.

I. Lead Paint: When the project includes paint to be disturbed that was applied prior to 1980, it shall be assumed to contain lead. The Contractor shall inform its employees, subcontractors, and all other persons engaged in the project that lead containing paints are present in the existing bridge structure at the job site and to follow the requirements of the Department of Labor and Industrial Relations, Division of Occupational Safety and

Health, Title 12, Subtitle 8, Chapter 148, Lead Exposure in Construction, Hawaii Administrative Rules (Chapter 12-148, HAR).

J. Standard Specifications

1. The work embraced herein shall be done in accordance with the following documents as amended:
    a. "DLNR INTERIM GENERAL CONDITIONS" October 1994
    b. "STANDARD SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION, City and County of Honolulu, 1986
    c. "2005 STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION", Department of Transportation, Highways Division.
    d. "WATER SYSTEM STANDARDS", Board of Water Supply, City and County of Honolulu, 2002
2. The terms hereinafter are as follows:
    a. "GENERAL CONDITIONS" shall refer to the "DLNR INTERIM GENERAL CONDITIONS" October 1994
    b. "STANDARD SPECIFICATIONS" shall refer to the "STANDARD SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION, City and County of Honolulu, 1986
    c. "2005 STANDARD SPECIFICATIONS" shall refer to the "2005 STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION", Department of Transportation, Highways Division.
    d. "BWS STANDARDS" shall refer to the "WATER SYSTEM STANDARDS", Board of Water Supply, City and County of Honolulu, 2002
3. The DETAILED SPECIFICATIONS supplement and modify the Standard Specifications.

K. Existing Site Conditions: Every person bidding upon the work is expected to visit the site and examine the site conditions and satisfy himself as to the character and amount of work to be performed as indicated on the plans and called for by these specifications. No additional payment will be granted because of lack of knowledge of such conditions

L. Parking Policy for Contractor: Areas to be used by the Contractor shall be as designated by the Officer-in-Charge. Any site damage by the Contractor shall be restored as instructed by the Officer-in-Charge at no cost to DAB.

M. Toilet Accommodations: The Contractor shall be responsible for providing and maintaining his own toilet facilities for his use.

N. Telephone, Water, and Electricity: The Contractor shall make all necessary arrangements and connections for temporary use of telephone, water, and electricity for construction and shall pay all expenses.

O. Protection of Property: The Contractor shall continually maintain adequate protection of all its work from damage and shall protect all property, including but not limited to buildings, equipment, furniture, grounds, vegetation, material, utility systems located at and adjoining the job site. The Contractor shall repair, replace or pay the expense of repair of damages resulting from its operations.

P. Use of Power Driven Equipment: The Contractor is cautioned to take all necessary safety precautions to protect the facility personnel, and the public whenever power driven equipment is used.

Q. Safety: The Contractor shall carefully read and strictly comply with the requirements of the Hawaii Occupational Safety and Health Law, Chapter 396, Hawaii Revised Statutes, as amended, is applicable and made a part of the Contract.

R. Clean Up Premises: The Contractor shall clean up and remove from premises all debris accumulated from operations as necessary or as directed. The Contractor shall keep the project and surrounding areas neat and free from dust nuisance. See also Section 7.25 of the General Conditions.

S. Completion of Work: Upon completion of work, the Contractor shall remove all equipment, signs, and unused materials provided for the work and shall restore the project sites to a neat and clean condition.

T. Responsibility:

1. The State will hold the Contractor liable for all the acts of Subcontractors and shall deal only with the prime Contractor in matters pertaining to other trades employed on the job. The Contractor shall be responsible for coordinating the work of all trades on the job.
2. Should the Contractor discover any discrepancy in the plans or specifications, the Contractor shall immediately notify the Engineer before proceeding any further with the work, otherwise, the Contractor will be held responsible for any cost involved in correction of work placed due to such discrepancy.

U. Cooperation with Other Contractors: The State reserves the right at any time to contract for or otherwise perform other or additional work within the contract zone limits of this Contract. The Contractor of this project shall, to the extent ordered by the State, conduct its work so as not to interfere with or hinder the progress or completion of the work performed by other contractors.

V. Division of the Work: The Divisions and Sections into which these Specifications are divided shall not be considered an accurate or complete segregation of work by trades. This also applies to all work specified within each Section.

W. Drawings and Specifications:

1. The Contractor shall not make alterations in the drawings and specifications. In the event the Contractor discovers any errors or discrepancies, the Contractor shall immediately notify the Officer-in-Charge in accordance with the General Conditions.
2. Where devices, or items, or parts thereof are referred to in the singular, it is intended that such reference shall apply to as many such devices, items or parts as are required to properly complete the work.
3. Specifications and drawings are prepared in abbreviated form and include incomplete sentences. Omission of words or phrases such as "the Contractor shall", "as shown on the drawings", "a", "an", and "the" are intentional. Omitted words and phrases shall be provided by inference to form complete sentences.

X. Required Submittals

1. Required submittals as specified in the Technical Sections of these specifications include one or more of the following: Shop drawings; color samples; material samples; technical data; schedules of materials; schedules of operations; guarantees; operating and maintenance manuals; and as-built drawings.
2. The Contractor shall make a comprehensive list of the required submittals, by Specification Section, and submit this list to the Officer-in-Charge within 15 days after notice to proceed.
3. As-Built Drawings: When as-built drawings are required for submittal, the following shall apply:
   a) As-built drawings, the intent of which is to record the actual in-place construction so that any future renovations or tie-ins can be anticipated accurately, shall be required.

b) All deviations from alignments, elevations and dimensions which are stipulated on the plans shall be recorded in red on the as-built drawings.

c) The following procedure shall be followed:

   1) Immediately after these changes are constructed in place, the Contractor shall record them on the field office plans.

   2) Within two weeks after final inspection of the project, the Contractor shall transfer the changes marked on the field office plans onto a clean copy of plans using a red pencil. Any deletions shall be so noted and redrawn as necessary. The Contractor shall stamp or mark the tracings "AS-BUILT", and also sign and date each drawing so marked.

   3) The Contractor shall submit the as-built drawings to the Officer-in-Charge for review and approval. After the Officer-in-Charge approves the as-built drawings, the Contractor shall submit an electronic copy in Adobe PDF format on DVD.

   4) Any as-built drawing which the Officer-in-Charge determines does not accurately record the deviation shall be corrected by the State, and the Contractor shall be charged for the services.

END OF SECTION

SECTION 01 09 00

STANDARD REFERENCES

PART 1 GENERAL

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

Abbreviation	Company
AA	Aluminum Association Incorporated 818 Connecticut Avenue, N.W. Washington, D.C. 20006
AASHTO	American Association of State Highway and Transportation Officials 444 North Capitol Street, N.W., Suite 225 Washington, D.C. 20001
ACI	American Concrete Institute P.O. Box 19150 Detroit, MI
AEIC	Association of Edison Illuminating Companies 51 East 42nd Street New York, NY 10017
AFBMA	Anti-Friction Bearing Manufacturer's Association 60 East 42nd Street New York, NY 10017
AGA	American Gas Association 8501 East Pleasant Valley Road Cleveland, OH 44131
AGMA	American Gear Manufacturer's Association 1330 Massachusetts Avenue, N.W. Washington, D.C.
AISC	American Institute of Steel Construction 101 Park Avenue New York, NY 10017
AISI	American Iron and Steel Institute 1000 16th Street, N.W. Washington, D.C. 20036

Abbreviation	Company
AITC	American Institute of Timber Construction 333 West Hampden Avenue Englewood, CO 80110
AMCA	Air Moving and Conditioning Association, Inc. 30 West University Drive Arlington Heights, IL 60004
ANSI	American National Standards Institute, Inc. 1430 Broadway New York, NY 10018
APA	American Plywood Association 1119 A Street Tacoma, WA 98401
API	American Petroleum Institute 1801 K Street N.W. Washington, DC 20006
ARI	Air-Conditioning and Refrigeration Institute 1814 North Fort Myer Drive Arlington, VA 22209
ASCE	American Society of Civil Engineers 345 East 47th Street New York, NY 10017
ASCII	American Standard Code for Information Interchange United States of America Standards Institute 1430 Broadway New York, NY 10018
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 United Engineering Center 345 East 47th Street New York, NY 10017

Abbreviation	Company
ASME	American Society of Mechanical Engineers 345 East 47th Street New York, NY 10017
ASTM	American Society for Testing and Materials 1916 Race Street Philadelphia, PA 19103
AWPA	American Wood Preservers Association 1625 Eye Street Washington, DC 20006
AWS	American Welding Society 2501 N.W. 7th Street Miami, FL 33125
AWWA	American Water Works Association 6666 West Quincy Avenue Denver, CO 80235
CBM	Certified Ballast Manufacturers 2120 Keith Building Cleveland, OH 44115
CMAA	Crane Manufacturers Association of America, Inc. (Formerly called: Overhead Electrical Crane Institute - OECI) 1326 Freeport Road Pittsburgh, PA 15238
CRSI	Concrete Reinforcing Steel Institute 180 North La Salle Street Chicago, IL 60601
CSA	Canadian Standards Association 178 Rexdale Boulevard Rexdale, Ontario, M9W IR3, Canada
DEMA	Diesel Engine Manufacturer's Association 122 East 42nd Street New York, NY 10017
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

Abbreviation	Company
EIA	Electronic Industries Association 2001 Eye Street N.W. Washington, DC 20006
EJMA	Expansion Joint Manufacturer's Association 331 Madison Avenue New York, NY 10017
ESO	Electrical Safety Orders, California Administrative Code, Title 8, Chap. 4, Subarticle 5 Office of Procurement, Publications Section P.O. Box 20191 8141 Elder Creek Road Sacramento, CA 95820
FEDSPEC	Federal Specifications General Services Administration Specification and Consumer Information Distribution Branch Washington Navy Yard, Bldg. 197 Washington, DC 20407
FEDSTDS	Federal Standards (see FEDSPECS)
FM	Factory Mutual Research 1151 Boston-Providence Turnpike Norwood, MA 02062
HEI	Heat Exchange Institute 122 East 42nd Street New York, NY 10017
HI	Hydraulic Institute 1230 Keith Building Cleveland, OH 44115
IAPMO	International Association of Plumbing and Mechanical Officials 5032 Alhambra Avenue Los Angeles, CA 90032
ICBO	International Conference of Building Officials 5360 South Workman Mill Road Whittier, CA 90601
ICEA	Insulated Cable Engineers Association P.O. Box P South Yarmouth, MA 02664

Abbreviation	Company
IEEE	Institute of Electrical and Electronics Engineers, Inc. 345 East 47th Street New York, NY 10017
IES	Illuminating Engineering Society C/O United Engineering Center 345 East 47th Street New York, NY 10017
ISA	Instrument Society of America 400 Stanwix Street Pittsburgh, PA 15222
JIC	Joint Industrial Council 7901 Westpark Drive McLean, VA 22101
MILSPEC	Military Specifications Naval Publications and Forms Center 5801 Tabor Avenue Philadelphia, PA 19120
MSS	Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. 127 Park Street, N.E. Vienna, VA 22180
NAAMM	National Association of Architectural Metal Manufacturers 100 South Marion Street Oak Park, IL 60302
NACE	National Association of Corrosion Engineers P.O. Box 986 Katy, TX 77450
NESC	National Electric Safety Code American National Standards Institute 1430 Broadway New York, NY 10018
OSHA	Occupational Safety and Health Act U.S. Department of Labor San Francisco Regional Office 450 Golden Gate Avenue, Box 36017 San Francisco, CA 94102
PPIC	The Plumbing & Piping Industry Council, Inc. Suite 402 510 Shatto Place Los Angeles, CA 90020

Abbreviation	Company
SAE	Society of Automotive Engineers 2 Pennsylvania Street New York, NY 10001
SAMA	Scientific Apparatus Makers Association One Thomas Circle Washington, DC 20005
SMACNA	Sheet Metal and Air Conditioning Contractors National Association, Inc. 8224 Old Courthouse Road Tysons Corner Vienna, VA 22180
SSPWC	Standard Specifications for Public Works Construction Building News, Inc. 3055 Overland Avenue Los Angeles, CA 90034
TEMA	Tubular Exchanger Manufacturer's Association 331 Madison Avenue New York, NY 10017
UBC	Uniform Building Code Published by ICBO
UL	Underwriters Laboratories Inc. 207 East Ohio Street Chicago, IL 60611
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

END OF SECTION

SECTION 01 11 00

SUMMARY OF WORK AND CONTRACT TIME

PART 1 GENERAL

1.01 SUMMARY

A. This Section summarizes the work covered under this contract, which will be performed in Waikolu Valley on Molokai. The work includes construction, installation, testing, and commissioning of new irrigation water system improvements.

B. This Section also specifies the contract completion time from the Notice to Proceed (NTP) date.

1.02 DESCRIPTION OF OWNER'S PROJECT

A. The Molokai Irrigation System (MIS), originally constructed in 1962, services Department of Hawaiian Home Lands and agricultural lands in the Manawainui, Hoolehua, and Kualapuu sub-aquifers of the Molokai Central aquifer. The Waikolu Valley Watershed, the sole water source for the MIS, conveys water by gravity from Waikolu Valley through the five-mile long Molokai Irrigation Tunnel (Tunnel) to central Molokai farms. The tunnel is also the only vehicular access into Waikolu Valley. Water is supplied by both surface water from Waikolu Stream and groundwater in Waikolu Valley. Three intakes divert flow from Waikolu Stream into the Tunnel, and the Surface Water Pump Station conveys stream flow into the Tunnel. Five wells supply groundwater from Waikolu Valley, while a sixth well is used for groundwater level monitoring purposes.

B. Due to the age of the system, select improvements are being implemented to restore reliability and service life of the MIS. This project includes improvements at Well Nos. 5 and 6, in addition to select work at the Surface Water Pump Building.

1.03 WORK OF THIS CONTRACT

A. The work to be performed under this contract includes:

1. Well depth measurement
2. Well fill removal, if required (allowance)
3. Well inspection and survey (pre- and post-rehabilitation activities)
4. Well rehabilitation, if required (allowance)

<u>Mechanical</u>

5. Lineshaft pump replacement
6. Valve replacement (check valves, isolation valves, air release valves, solenoid valves)
7. Piping and fitting replacement
8. Concrete pump and pipe support refurbishment

<u>Electrical/Instrumentation</u>

9. Instrumentation replacement
10. Level monitor access point addition
11. Local disconnect switch addition
12. Replacement of above grade conduit and junction boxes at well site
13. Replacement of wire between wells and Surface Water Pump Building

14. Handhole refurbishment near Surface Water Pump Building

1.04 CONTRACT TIME

A. Time for completion of the work described in the Base Bid in the Proposal Schedule as specified and accepted shall be 450 calendar days from the NTP.

END OF SECTION

SECTION 01 11 80

ENVIRONMENTAL CONDITIONS

PART 1 GENERAL

1.01 SUMMARY

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. Climate conditions are described as follows:

Description	Range of Conditions
Winter	Cloudy, frequent passing showers with winter storms; ENE winds 10 to 15 mph
Summer	Mostly sunny, drier conditions but with some passing showers; ENE winds 10 to 15 mph
Relative humidity, percent	
• Indoors	30 to 60
• Average outdoors	55 to 80
Air temperature, degrees F	
• Outdoors	55 to 90
• Indoors	55 to 85
Barometric pressure, inches, mercury	27 to 31

1.03 ADDITIONAL CONDITIONS

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

END OF SECTION

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SECTION 01 12 16

WORK SEQUENCE

PART 1 GENERAL

1.01 SUMMARY

A. This Section summarizes work sequence and outage requirements.

1.02 CONTINUITY OF OPERATIONS

A. The Molokai Irrigation System (MIS) is currently used to pump and convey irrigation water from Waikolu Valley through the Molokai Irrigation Tunnel. This function shall not be interrupted except as specified herein. The Contractor shall coordinate the work to avoid any interference with normal operation of the MIS and irrigation water being conveyed through the Tunnel.

1.03 DEWATERING

A. Dewatering/discharge of construction process water to surface waters (Waikolu Stream) or drainage courses is prohibited during construction.

B. Penalties imposed on the Department of Agriculture & Biosecurity as a result of any dewatering/discharge 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 Department of Agriculture & Biosecurity resulting directly or indirectly from the dewatering/discharge.

1.04 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 – Submittals

1.05 SUBMITTALS

A. Action Submittals:
   1. 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 Section 01 32 16 and 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 prohibited bypassing or discharges, the length of time required to complete said operation, and equipment which the Contractor shall provide in order to prevent prohibited bypassing or discharges.

1.06 OUTAGE RESTRICTIONS

A. Systems or individual equipment items shall be isolated, dewatered, decommissioned, deenergized, or depressurized in accordance with the detailed outage plan and schedule.

B. The Officer-in-Charge shall be notified in writing at least two weeks in advance of the planned operation.

1.07 WORK SEQUENCE AND SCHEDULE CONSTRAINTS

A. To minimize disruptions to any existing operations or facilities, the construction schedule required in Section 01 32 16 and the General Conditions of the Contract Documents shall provide for the following specific conditions:
   1. Prior to any work at Well No. 5, the Officer-in-Charge shall confirm that a sufficient number of existing wells are in operating condition and can provide sufficient irrigation flow while Well No. 5 is out of service. Contractor shall also field locate existing pipes and conduits prior to taking Well No. 5 out of service.
   2. Conduct Well No. 5 inspection and survey per Section 13 20 00 after Well Pump No. 5 has been removed.
   3. Conduct Well No. 5 rehabilitation per Section 13 30 00 after approval by Officer-in-Charge to proceed with planned rehabilitation method.
   4. Conduct Well No. 5 inspection and survey per Section 13 00 00 after rehabilitation activities have been completed.
   5. Perform Well Pump No. 5 replacement.
   6. Prior to any work at Well No. 6, the Officer-in-Charge shall confirm that a sufficient number of existing wells are in operating condition and can provide sufficient irrigation flow while Well No. 6 is out of service. Contractor shall also field locate existing pipes and conduits prior to taking Well No. 6 out of service.
   7. Conduct Well No. 6 inspection and survey per Section 13 20 00 after Well Pump No. 5 has been removed.
   8. Conduct Well No. 6 rehabilitation per Section 13 30 00 after approval by Officer-in-Charge to proceed with planned rehabilitation method, if required.
   9. Conduct Well No. 6 inspection and survey per Section 13 00 00 after rehabilitation activities have been completed.
   10. Perform Well Pump No. 6 replacement.

PART 2 (NOT USED)

PART 3 EXECUTION

3.01 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be considered incidental and included in the lump sum bids for the respective items in the Proposal Schedule.

END OF SECTION

SECTION 01 14 19

CONTRACTOR'S ACCESS AND USE OF PREMISES

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies Contractor's access and use of the various properties that are part of the work, including State, County, and private properties. This includes staging areas, personnel vehicle parking, construction equipment parking, traffic control, temporary roads, and haul routes. This Section supplements the requirements and notes in the Drawings.

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 12 16 – Work Sequence
   2. Section 01 30 00 – Permits

1.03 WAIKOLU VALLEY ACCESS

A. The work site is remote and only accessible by driving an unpaved road for approximately 3 miles, then through the approximately 5-mile long Molokai Irrigation Tunnel (with limited head and side clearances and about 6 to 10 inches of flowing irrigation water), then another approximately 1 mile of unpaved path with several stream crossings. See site map in the Drawings.

B. For access between Kaunakakai and Waikolu Valley, an all-terrain vehicle (ATV) is required to go between the West and East Portals through the Molokai Irrigation Tunnel, and to access the well sites. Care shall be taken when transporting fuel or hazardous materials through the Tunnel because the Tunnel conveys irrigation water. Daily access through Waikolu Valley shall be coordinated directly with the Officer-in-Charge. Vehicles are not able to utilize the Molokai Irrigation Tunnel during moderate or heavy rains at the discretion of the Officer-in-Charge.

C. Construction equipment/tools or well equipment may need to be conveyed to the site(s) by helicopter. There are no landing zones in Waikolu Valley, but helicopter may lower equipment loads near the Surface Water Pump Building. Helicopter activity shall be coordinated directly with the Officer-in-Charge.

D. Contractor is not allowed to camp in Waikolu Valley.

E. Contractor is not allowed to harvest plants or animals from Waikolu Valley. If a violation of this policy occurs, DAB will suspend the project, at no cost to the State, until a remedy is reached to the satisfaction of the Officer-in-Charge.

1.04 MOLOKAI IRRIGATION SYSTEM

A. The Department of Agriculture & Biosecurity's operating personnel will be responsible for operating the existing irrigation and well system throughout the execution of this contract. Equipment presently installed in and access to the wells and Surface Water Pump Station must be available to personnel at all times for use, maintenance, and repair. If it is necessary in the course of operating the irrigation system 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 irrigation system operation. The Contractor shall not adjust or operate serviceable or functioning equipment or systems except as specifically required by this Contract.

B. The existing irrigation system will remain in operation throughout the execution of this contract, but an individual well site can be removed from service. The Contractor shall schedule and conduct his work to minimize necessary shutdowns and interference with normal irrigation system operations, maintenance, and access.

C. The Contractor shall notify the Officer-in-Charge, in accordance with Section 01 12 16, 14 calendar days in advance of the time it is necessary to take out of service any existing tank, pipeline, channel, electrical circuit, equipment or structure. The Contractor shall be responsible for providing whatever temporary piping, pumping, power, and control facilities as are required to maintain continuous irrigation system operation.

1.05 CITY AND STATE/DOT PROPERTY AND RIGHT-OF-WAY

A. Coordinate directly with the respective agencies for approval, access, and use of property and right-of-way. Existing utility and access easements and temporary construction easements are as noted in the drawings.

1.06 PRIVATE PROPERTY

A. Coordinate directly with the respective private property owners for approval, access, and use of property and right-of-way.

PART 2 (NOT USED)

PART 3 EXECUTION

3.01 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be considered incidental and included in the lump sum bids for the respective items in the Proposal Schedule.

END OF SECTION

SECTION 01 15 00

MOBILIZATION AND DEMOBILIZATION

PART 1 GENERAL

1.01 SUMMARY

A. This Section covers the requirements for mobilization and demobilization.

1.02 MOBILIZATION

A. Mobilization shall consist of the transporting, assembling, constructing, installing, and making ready for use at the job sites, all the equipment, machinery, structures, utilities, materials, labor, project signs, and incidentals necessary to do the work covered by this contract. Temporary erosion, sediment, and dust control measures shall be completely installed and fully functional prior to mobilization. Mobilization shall also consist of obtaining all required permits, insurance, and bonds.

B. Site accessibility limitations are noted in Section 01 14 19.

1.03 DEMOBILIZATION

A. Demobilization shall consist of the dismantling and removal of the above-mentioned equipment, machinery, structures, utilities, materials, and incidentals, and the cleaning up of the site. Permanent best management practices shall be completely installed, established, and functional prior to the commencement of demobilization. Additionally, temporary erosion, sediment, and dust control measures shall be fully installed, functional, and maintained until their removal as the last activity of demobilization.

PART 2 (NOT USED)

PART 3 EXECUTION

3.01 GUIDELINES

A. If the Contractor utilizes private lands other than the sites provided by the State for mobilization purposes, the provisions of this Section shall apply, and the mobilization and demobilization work on said private lands shall be in accordance with the agreement between the Contractor and the landowner.

B. Any and all additional mobilization or demobilization costs in excess of the maximum amounts specified in the Proposal shall be included in the appropriate unit prices bid in the Proposal. The Contractor shall not receive any compensation for mobilization and demobilization in addition to those specified in the Proposal.

C. All equipment, machinery, buildings, utilities, and incidentals mobilized and demobilized under this Section shall remain the property of the Contractor.

3.02 MEASUREMENT AND PAYMENT

A. The work of this Section shall be paid for per the specified line item in the Proposal Schedule.

END OF SECTION

SECTION 01 15 20

WORK HOURS

PART 1 GENERAL

1.01 SUMMARY

A. This Section covers the requirements for permitted work hours.

1.02 NORMAL WORK HOURS

A. The Contractor shall work from 7:00 a.m. to 3:30 p.m., Monday through Friday, INCLUSIVE of commute time through the Molokai Irrigation Tunnel which may take approximately 45 minutes in each direction.

1.03 EXTENDED WORK HOURS

A. No extended work hours are allowed unless approved by the Officer-in-Charge at least two weeks in advance. No claim for financial compensation or claim for lost time in the project schedule shall be made by the Contractor, should any of the extended hours be reduced or denied. Work on weekends or County/State holidays is not allowed without the approval of the Officer-in-Charge.

PART 2 (NOT USED)

PART 3 (NOT USED)

END OF SECTION

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SECTION 01 15 67

POLLUTION CONTROL

PART 1 GENERAL

1.01 SUMMARY

A. This Section describes pollution control measures and requirements.

1.02 RUBBISH DISPOSAL

A. No burning of debris and/or waste materials shall be permitted on the project sites.

B. No burying of debris and/or waste material, except for materials which are specifically indicated elsewhere in these specifications as suitable for backfill, shall be permitted on the project sites.

C. All unusable debris and waste material shall be hauled away to an appropriate off-site dump area. During loading operations, debris and waste materials shall be watered down to allay dust. No dumping in Waikolu Valley or Stream is permitted.

D. No dry sweeping shall be permitted in cleaning rubbish and dirt/debris, which could generate airborne dust nuisance from floors or other paved areas. Vacuuming, wet mopping, or wet/damp sweeping is permissible.

E. Enclosed chutes and/or containers shall be used for conveying debris from above to ground floor level.

F. Clean-up shall include the collection of all waste paper and wrapping materials, cans, bottles, construction waste materials and other objectionable materials, and removal as required. Frequency of clean-up shall coincide with rubbish producing events.

1.03 DUST

A. The Contractor shall minimize dust generation including non-working hours, weekends, and holidays in conformance with the State Department of Health, Administrative Rules, Title 11, Chapter 60 – "Air Pollution Control."

B. The method of dust control and costs shall be the responsibility of the Contractor. Methods of dust control may possibly include the use of water, chemicals, covers/mats, screens, mulch/hydromulch, or asphalt over surfaces which may create airborne dust.

1.04 SUSPENSION OF WORK

A. Violations of any of the above requirements or any other pollution control requirements which may be specified in the Detailed Specifications herein shall be cause for suspension of the work creating such violation. No additional compensation shall be due the Contractor for remedial measures to correct the offense. Also, no extension of time will be granted for delays caused by such suspensions.

B. If no corrective action is taken by the Contractor within 72 hours after a suspension is ordered by the Officer-in-Charge, the State reserves the right to take whatever action is necessary to correct the situation and to deduct all costs incurred by the State in taking such action from monies due the Contractor.

PART 2 (NOT USED)

PART 3 EXECUTION

3.01 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be considered incidental and included in the lump sum bids for the respective items in the Proposal Schedule.

END OF SECTION

SECTION 01 18 00

EXISTING UTILITIES

PART 1 GENERAL

1.01 SUMMARY

A. This Section describes requirements for protection and maintenance of all existing utilities and services that may be impacted by the project.

B. The Contractor shall be responsible for the protection and maintenance of all existing utilities and services in full operation at all times. Such utilities and services shall include but not be limited to sewer, water, drainage, electrical, gas, telephone, and cable television utilities and services.

1.02 LOCATIONS

A. All underground pipes, cables or duct lines known to exist by the Owner within the areas of underground work from the search of records are indicated on the plans. The Contractor shall verify the locations and depths of the facilities and exercise proper care in excavating in the area.

B. Whether or not existing underground and surface improvements are shown on the plans, the Contractor shall make an independent check of the ground prior to the start of construction to ascertain the existence and the exact location of all utility facilities. All existing utility facilities and improvements shall be protected from damage, and if damaged, shall be repaired by the Contractor at his own expense.

C. Wherever connections of new utilities to existing utilities are shown on the plans, the Contractor shall expose the existing lines at the proposed connection to verify their locations and depths prior to excavation for new lines.

1.03 PROTECTION

A. All existing utilities to remain in use, whether or not shown on the Contract Drawings, shall be protected at all times by the Contractor during construction unless indicated on the Contract Drawings to be abandoned. The Contractor shall not interrupt the service function or disturb the support of any utility, such as the base and thrust blocks, without authority from the Department of Agriculture & Biosecurity. All valves, switches, vaults, and meters shall be maintained readily accessible for emergency shut off.

1.04 RELOCATION

A. All utility relocations indicated on the Contract Drawings shall be included in the various bid item prices for shaft and pipeline excavations. The Contractor shall arrange and pay for all temporary relocation of utilities required to complete the work. These payments shall be included in the price bid for the various items of work.

1.05 DELAYS

A. The Contractor shall notify the Officer-in-Charge of its construction schedule insofar as it affects the protection, removal, or relocation of utilities. Said notification shall be in writing and shall be included as a part of the construction schedule. The Contractor shall notify the Officer-in-Charge in writing of any subsequent changes in the construction schedule which will affect the time available for protection, removal, or relocation of utilities.

B. The Contractor will not be entitled to damages or additional payment for delays attributable to utility relocations or alterations if correctly located, noted, and completed in accordance with this section.

PART 2 (NOT USED)

PART 3 EXECUTION

3.01 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be considered incidental and included in the lump sum bids for the respective items in the Proposal Schedule.

B. The Contractor shall bear all costs for relocations of utilities done for his convenience, including all labor, materials, equipment, incidental, and utility company reimbursement costs.

C. Payment for protection of existing utilities located adjacent to proposed Project improvements and all temporary utility relocations shall not be paid for directly but shall be considered incidental and included in the lump sum bids for the respective items in the Proposal Schedule.

END OF SECTION

SECTION 01 20 00

PROJECT MEETINGS

PART 1 GENERAL

1.01 SUMMARY

A. This Section summarizes project meetings.

1.02 MEETINGS

A. Preconstruction Conference
   1. The Officer-in-Charge will schedule and conduct one preconstruction conference prior to the commencement of any work at the site, to which all interested agencies and utility companies will be invited to discuss their interests and requirements relating to the project. Contractor and all subcontractor representatives shall attend.

B. Construction Period Meetings
   1. Construction period meetings will be conducted at weekly intervals or at some other frequency if approved by the Contractor and Officer-in-Charge. These meetings shall be attended by the Officer-in-Charge and the Contractor's Project Manager and any others that are invited by these people.
   2. The agenda of these project meetings will include reports on construction progress, the status of submittal reviews, the status of information requests, and any general business. The meetings will be conducted by the Officer-in-Charge. Officer-in-Charge shall keep minutes of the proceedings. The minutes shall be typed and distributed to all attendees within 48 hours of each meeting.

PART 2 (NOT USED)

PART 3 EXECUTION

3.01 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be considered incidental and included in the lump sum bids for the respective items in the Proposal Schedule.

END OF SECTION

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SECTION 01 30 00

PERMITS

PART 1 GENERAL

1.01 SUMMARY

A. This Section describes permits required for the project and shall supplement the General Conditions.

1.02 REQUIREMENTS

A. The Contractor shall consult with all appropriate City, State, and other governmental agencies to determine the applicable permits, charges and fees required for the Project. Unless otherwise specified in the Contract, two (2) copies of all permits required for the Project shall be submitted to the Officer-in-Charge.

B. The Contractor shall be responsible for complying with all permit requirements for the project. The Contractor shall ensure that all permits remain valid and that all permits are renewed in a timely manner, throughout the duration of the project.

1.03 PERMITS, CHARGES, AND FEES

A. Permits, charges, and fees required for the project may include, but are not limited to the following:

1. Dumping Charges.
2. NPDES: Chapter 55 Water Pollution Control, Hawaii Administrative Rules, Title 11, State Department of Health, for discharges of storm water runoff associated with construction, discharges of hydrotesting waters, discharges associated with construction activity dewatering, etc.
3. Storm Water Pollution Prevention Plan. In accordance with Federal and State Phase II Storm Water regulations and Rules Replating to Water Quality of the Administrative Rules, Title 20, Department of Planning and Permitting, Chapter 3, as amended, the Contractor shall develop and implement a Storm Water Pollution Prevention Plan (SWPPP) to reduce pollutants that may result from land disturbance activities.

1.04 NOISE VARIANCE

A. A noise variance is not anticipated for this project.

B. If the Contractor opts to obtain a noise variance for additional work hours or noise, the Contractor shall first obtain approval from the Owner and respective property owner and comply with all requirements set forth by the State Department of Health and in Hawaii Administrative Rules Title 11, Chapter 11-46, Section 11-46-8. Costs for application for a noise variance shall be borne by the Contractor.

C. If a project noise variance is revoked because of complaints from the public because of excessive noise from the Contractor's work, the Contractor shall reapply and reobtain necessary approvals for the noise variance with additional noise mitigation measures as required at no additional cost to the City and no additional contract time.

1.05 NPDES PERMIT

A. An NPDES Permit has not been applied for by the Owner. If Contractor activities trigger an NPDES Permit, the Contractor shall contact the State Department of Health and retain responsibility for the permit, fees, and compliance.

B. Construction dewatering is not anticipated for the Project.

C. In accordance with State law, all discharges related to project construction or operations are required to comply with State Water Quality Standards (Hawaii Administrative Rules, Chapter 11-54). Best Management Practices shall be used to minimize or prevent the discharge of sediment, debris, and other pollutants to State waters.

1.06 TIME

A. Time required to obtain all permits is considered part of the construction period of this Contract.

B. The Contractor shall not be entitled to additional contract time or compensation in its efforts to complete work within the hours allowed.

PART 2 (NOT USED)

PART 3 EXECUTION

3.01 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be considered incidental and included in the lump sum bids for the respective items in the Proposal Schedule.

END OF SECTION

SECTION 01 32 16

PAYMENT AND PERFORMANCE SCHEDULE

PART 1 GENERAL

1.01 SUMMARY

A. This Section addresses scheduling requirements, including the requirements for the Contractor to prepare and submit the following:
   1. Baseline Critical Path Method (CPM) schedule.
   2. Schedule of Values
   3. Monthly CPM schedule updates.

   At all times, the Payment and Performance schedule shall represent the Contractor's plan for orderly completion of the work. The Contractor shall submit a revised performance schedule whenever construction progress falls behind by 5% or is ahead by 10% by duration.

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 12 16 – Work Sequence
   2. Section 01 33 00 – Submittals

1.03 SUBMITTALS

A. Action Submittals
B. Procedure: Section 01 33 00.
   1. Within 14 calendar days following the Notice To Proceed, the Contractor shall furnish one (1) electronic pdf copy that can be distributed by email, and one (1) editable version of the Baseline CPM Schedule and Summary Schedule. The Officer-in-Charge will not process any progress payments until the required schedule is submitted and approved.
   2. Within 14 calendar days following Notice To Proceed, the Contractor shall submit a detailed cost breakdown of each of the lump sum Items in the Proposal Schedule. This breakdown shall be referred to as the Schedule of Values and shall serve as the basis for progress payments for lump sum items. No progress payments will be made on account of lump sum items until the Officer-in-Charge has reviewed and accepted the Contractor's Schedule of Values.
   3. By the third Thursday of the following month, the Contractor shall submit its Monthly Progress Schedule Update. The Monthly Progress Schedule Update shall include the required submittals of the accepted Baseline Schedule and Monthly Schedule Update.
   4. The Monthly Schedule Update and updated Schedule of Values shall be submitted with the Contractor's monthly payment application request showing all work in progress and completed as of the status date.

5. Submit all Revised Schedules to the Officer-in-Charge including a schedule narrative describing the revised schedule 30 calendar days before the Revised Schedule is implemented.
6. The Contractor shall submit an electronic pdf copy of each preliminary or revised performance schedule to the Officer-in-Charge containing all data comprising the schedule in pdf format that can be distributed by email.
7. Contractor Daily Progress Reports shall be submitted weekly.

1.04 GENERAL PERFORMANCE SCHEDULE REQUIREMENTS

A. The Contractor shall include input from its subcontractors and suppliers in the preparation of the schedule.

B. The schedule shall include proper logic and adequate durations for all activities including mobilization, submittals, procurement/fabrication, installation, system shutdowns, key milestones, cleanup, remedial and restoration work, testing and start-up, submittal of closeout documentation, and demobilization.

C. No activity duration shall be in excess of 20 working days (28 calendar days) unless it is approved by the Officer-in-Charge. Each activity shall be for a definable scope of work and address all Specification milestones, scheduling constraints, and permits.

D. The Officer-in-Charge will not process any applications for payment until the required CPM Schedule is submitted and accepted. Delay in submitting any of the required Schedules will be cause for withholding all progress payments otherwise due under the Contract.

E. The Contractor's schedule shall begin with the date the Officer-in-Charge issues the NTP and conclude with the date of Final Completion of the Contract. The schedule shall use the full Contract Time. If the critical path work is shown to be completed before the expiration of the Contract, refer to Early Completion Schedule.

F. All costs for the preparation and submittal of the required Schedules as well as updated schedules and requested revisions shall be borne by the Contractor.

G. The Contractor shall develop the schedule to an appropriate level of detail as determined by the Officer-in-Charge. The schedule shall enable the Officer-in-Charge to perceive the Contractor's plan to execute the work, track variances, and forecast events. The Contractor shall accommodate any request by the Officer-in-Charge to add specific schedule features such as milestones or summary activities to facilitate reporting.

H. The Contractor shall not be allowed to start construction until the Baseline CPM Schedule has been approved by the Officer-in-Charge.

I. All schedule construction, management, and control processes shall be consistent with all relevant and applicable recommended procedures published by the Association for the Advancement of Cost Engineering International (AACEI).

1.05 BASELINE CPM SCHEDULE

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

B. The Officer-in-Charge's review and comment or acceptance shall occur within 30 calendar days after submittal of the Baseline CPM Schedule. If resubmittal is required, the Contractor shall resubmit within 7 calendar days. When accepted the schedule shall become the "Accepted Baseline CPM Schedule" for the project and shall be the basis for monthly updated schedules, for progressing the activities, for updating the Schedule of Values, and for measuring any impacts or delays to the project.

C. The Baseline CPM Schedule shall utilize the Gantt method of diagraming and show a single critical path. The Contractor shall provide the native schedule electronic export file for all schedule submissions and upon request by the Officer-in-Charge. The Contractor's original native working schedule file shall at all times be accessible to the Officer-in-Charge for the purposes of networking, publishing, auditing, or assessment of real-time progress. Each electronic schedule file submission shall be given a file name that will enable it to be uniquely identified.

D. The schedule and network diagram(s) shall show activities for:

1. Submittal and review of alternative construction methods or designs including all supporting data thereto, if applicable.
2. Adequate time to receive permits and agency approvals. Each permit and approval shall be identified in the construction schedule.
3. Order, shop drawing review, fabrication, and delivery of materials and equipment.
4. Coordination of staging areas, fencing, and traffic concerns.
5. Detailed construction items.
6. Milestones and construction and scheduling constraints.
7. All submittals required in the contract and their review by the Officer-in-Charge within the time limits noted in Section 01 33 00. The key submittals should allow a minimum of one resubmittal cycle in the activity duration.
8. Delivery of operation and maintenance manuals to the Officer-in-Charge in accordance with the requirements of Section 01 78 23.
9. Adequate time for system shutdowns, acceptance testing, and start-up of major systems and equipment.
10. Adequate time for punch list work completion and closeout activities.
11. Training of Owner personnel.
12. Cleaning, flushing, and disinfection.

E. Each activity in the CPM Schedule shall correspond to an item in the Schedule of Bid Prices, whether unit price or lump sum. Each activity may be subdivided into subactivities as required for proper planning and monitoring. Activities corresponding to lump sum items shall be subdivided based on their Schedule of Values.

F. All schedule activity time durations shall specify what calendar the Contractor is using for each activity. All nonwork days shall be explained for each calendar used, and the application of each calendar shall be annotated.

G. The Baseline CPM Schedule shall reflect any limitations on work hours required by the Contract and any permit restrictions and conditions that are required.

H. Activities by the Owner and other agencies that could impact progress shall be shown. These activities include but are not limited to approvals, inspections, utility tie-ins, and Owner-furnished equipment/material.

I. All activities shall be identified in the Baseline CPM Schedule by the party responsible for performing the work. Activity responsibilities include subcontracting firms, contractor workforces (electrical, mechanical, civil, architectural, landscape), or Owner performing a given task. Activities shall not belong to more than one responsible party. The responsible party shall be identified by a responsible code.

J. The schedule should include all key milestones such as installation of equipment, completion of tasks leading up to shutdowns, etc.

K. Any activity that is added or changed by a contract modification or by a change order, or is used to justify claimed time shall be identified by reference to the changed document.

L. The Baseline CPM Schedule shall represent the Contractor's plan of operation performed within the specified Contract Completion Time and within the Contract Bid Price.

M. A schedule extending beyond the Contract Completion Time will not be accepted.

N. All activities shall be identified in the project schedule according to the category of work that best describes this activity. Category of work refers but is not limited to submittals, approvals, procurement, fabrication, delivery installation, shutdown, start-up and testing, and closeout. The category of work for each activity shall be identified by a category of work code.

O. Schedules exhibiting front-loaded costs are unacceptable. All schedule values shall be reasonable as determined by the Officer-in-Charge.

P. The use of float suppression techniques—such as preferential sequencing (arranging critical path through activities more susceptible to owner-caused delay), special lead/lag logic restraints, zero total or free float constraints, extended activity times, or imposing of constraint dates other than required by Contract—shall be cause for rejection of the Progress Schedule(s). The use of Resource Leveling (or similar software features) used for the purpose of artificially adjusting activity durations to consume float and influence the critical path shall also be cause for rejection.

Q. Acceptance of the schedule by the Officer-in-Charge is of a general nature only. The acceptance shall not relieve the Contractor from responsibility to do all work as specified by the Contract Drawings and Specifications. The Contractor has sole responsibility for means and methods of executing the Work. Items missing from the schedule are assumed to be incidental work and not critical activities. If activities are found to be missing from the schedule after the Officer-in-Charge's acceptance, the Contractor may submit a revised schedule including these items. A revised schedule is subject to the review and acceptance of the Officer-in-Charge, as described below in this Section. No time extensions will be granted because of errors or omissions on the schedule. It is the Contractor's responsibility to incorporate all necessary activities to cover the entire work scope.

R. The value of punchlist correction, final inspection, and project closeout activities shall not be less than 10 percent of the total contract value. The Contractor shall evenly disperse overhead and profit to each activity over the duration of the project.

S. The schedule's task precedence logic shall clearly demonstrate the Contractor's intent. The use of lags are not permitted unless it can be shown that the lag duration cannot be modeled using a schedule activity. Lag durations contained in the Project Schedule shall not have a negative value. The use of Start-to-Finish (SF) relationships is not permitted.

T. Failure to provide an acceptable baseline schedule could result in withholding of some or all of contractor monthly progress payment.

1.06 REVISED SCHEDULE

A. The Contractor shall submit to the Officer-in-Charge a revised critical path analysis with the Contractor's evaluation and narrative whenever a Schedule revision is requested or any of the following occur:
   1. A change order affects the completion date or the sequence of activities.
   2. Progress of any critical activity falls significantly behind schedule (critical path activity is late by two weeks or more) as determined by the Officer-in-Charge. The Contractor shall demonstrate how the Contract Time will be achieved.
   3. Delay on a noncritical activity changes the course of the critical path.
   4. The Contractor elects to change any sequence of activities affecting the critical path or the project completion date.

B. Schedule revisions are not permitted on the Monthly Schedule Update. If the Contractor during the course of the construction desires to make any changes in methods of operating or scheduling, or make any changes to the logic or durations of any activities, the Contractor shall notify the Officer-in-Charge in writing stating the reasons for the change. Any change to the Schedule in logic, order or sequence of work, duration of activities, etc., shall be discussed in the schedule narrative before it is implemented as a Revised Schedule. A Revised Schedule will not become effective until accepted by the Officer-in-Charge.

C. All revisions to the Schedule shall comply with the requirements of this section.

D. A revised narrative describing the remaining work as reflected in the Revised Schedule shall be included.

E. A separate listing of all activities deleted, changed, or added shall accompany the Revised Baseline CPM Schedule.

F. All schedule revisions are subject to review and approval by the Officer-in-Charge.

G. Failure to provide acceptable schedule revisions as required in this Section could result in withholding of some or all of contractor monthly progress payment. Contractor is responsible to progress work.

1.07 SCHEDULE OF VALUES

A. Coordinate the preparation of the Schedule of Values with Contractor's Progress Schedule and application for payment.

B. The format, detail, and submittal requirements for the Schedule of Values shall be as directed by the Officer-in-Charge to facilitate and clarify progress payments to the Contractor for completed work.

C. The sum of the individual costs listed in the Schedule of Values for each lump sum item shall equal the lump sum price bid therefor under the Bid Item named in the Proposal Schedule. Unless otherwise provided in the Contract Documents, Contractor's overhead, profit, insurance, bonds, and other similar costs, shall be prorated through all items so that the sum of the cost for all items shall equal Contractor's Total Bid Price.

D. The Officer-in-Charge will review and return Contractor's schedule of values with comments. Contractor shall make all corrections requested by the Officer-in-Charge and resubmit for approval.
   1. The Officer-in-Charge shall be the sole judge of the sufficiency in detail and proper proportioning of Contractor's schedule of values.

2. Contractor's schedule of values will be acceptable to the Officer-in-Charge as to form and substance if it provides reasonable allocation of Contractor's Bid amount to component parts of the Work.

E. Upon concurrence by the Officer-in-Charge a written formal approval of Contractor's schedule of values will be issued. If the Officer-in-Charge later determines that the schedule of values is insufficient or incorrect, an adjustment shall be made as specified in subparagraph.

1.08 MONTHLY SCHEDULE UPDATE

A. The Baseline CPM Schedule shall be updated monthly by the Contractor and submitted to the Officer-in-Charge for review. These updates shall be referred to as the "Monthly Schedule Update."

B. Monthly Schedule Update: The Monthly Schedule Update shall follow the requirements of the Baseline CPM Schedule and shall include the following:

1. Calculations of the schedule starting from the date specified below and ending at project completion. Completed activities shall be listed with their actual start and finish dates.
2. Schedule narrative describing conformance or nonconformance to the schedule, reasons for schedule slippage, and proposed corrective actions.
3. Approved Contract Time extensions properly incorporated into schedule updates.

C. Actual start and finish dates and work in progress shall not be automatically updated by default mechanisms that may be included in CPM scheduling software systems. Actual start and finish dates shall be updated manually and shall match daily reports.

D. Computer calculations of the Monthly Schedule Update will be made starting from the current status or data date to the completion of the project. Work completed shall be shown with the actual start and finish dates for each activity. Work in progress shall be shown with the actual start date and the percentage completed for each activity.

E. The CPM network diagram shall at all times represent the actual history of accomplishment of all activities as well as the Contractor's current projected plan for orderly completion of the work. The Contractor shall, at monthly intervals, evaluate work progress with the Officer-in-Charge by reviewing actual accomplishments since the previous update.

F. Monthly Schedule Updates shall be consistent with actual information reported on daily production reports and are limited to the following attributes: 1) Actual Start Dates, 2) Actual Finish Dates, 3) Remaining Durations, and 4) Physical Percentage Completions. Changes to all other schedule activity attributes including Activity IDs, Activity names, Activity Types, Original Durations, Constraints, Budgeted Total Costs, Relationships, Lags, Calendars, et al. are not permitted on the Monthly Schedule Update.

G. The basis for payment shall be based on the Physical Percentage Complete of an activity. The Officer-in-Charge shall not consider the Duration Percentage Complete nor Cost Percentage Complete as a basis for payment.

H. All Monthly Schedule Updates are subject to review and approval by the Officer-in-Charge.

I. Failure to provide acceptable schedule updates could result in withholding of some or all of contractor monthly progress payment. Contractor is responsible to progress work.

1.09 CONTRACTOR DAILY PROGRESS REPORTS

A. The General Contractor and all subcontractors shall keep a daily report of events, including photos.

B. Contractor Daily Progress Report form shall be as directed by the Officer-in-Charge.

C. Submit copies of the previous week's reports on Monday morning at 10:00 am.

D. Submit copies of the reports with the monthly payment request for the whole period since the last payment request submittal.

E. Deliver reports in hard copy, by email, or web based construction management software as directed by the Officer-in-Charge.

1.10 ADJUSTMENT OF THE CONTRACT TIME AND CHANGE ORDERS

A. Adjustments of the Contract Time due to weather delays, extra work, or any other cause will only be issued through a Contract Change Order or time extension letter and only for causes specified in the Contract Documents. Negative float will not be a basis for requesting time extensions.

B. In the event the Contractor submits a claim for an adjustment of the Contract Time, the Contractor shall furnish such schedule justification, as the Officer-in-Charge may deem necessary for a determination as to whether or not the Contractor is entitled to an adjustment of time under the provisions of the Contract.

C. The Progress Schedule shall clearly indicate that the Contractor has used, in full, all the float time available for the work involved in the request.

D. The Contractor shall not be entitled to additional compensation because of schedule impacts for change order work that extends the Contract beyond the scheduled completion date, but not beyond the Contract Completion Date as specified in the Contract Documents.

E. The Officer-in-Charge's determination as to the adjustment of the Contract Time will take into account the latest version of the Progress Schedule accepted at the time of the alleged delay, the Contractor's written time impact, and all other relevant information.

F. Actual delays in activities, which according to the Progress Schedule do not affect the critical path work, shall not be the basis for an adjustment to the Contract Time.

G. The Contractor shall submit, as part of each Change Order Request or proposed quotation for a Change Order or time extension letter for which the Contractor is requesting an adjustment in the Contract Time, a written time impact analysis showing activity logic revisions and duration changes for the work in question and that work's relationship to other activities on the construction schedule.

H. The new progress schedule, if accepted by the Officer-in-Charge, shall be in compliance with the requirements of this section.

I. Where the Officer-in-Charge has not yet made a final determination as to the adjustment of the Contract Time, and the parties are unable to agree as to the amount of the adjustment to be reflected in the Progress Schedule, the current schedule will be in effect and will be updated regularly every month until a Revised Schedule is agreed upon and accepted by the Officer-in-Charge.

PART 2 (NOT USED)

PART 3 EXECUTION

3.01 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be considered incidental and included in the lump sum bids for the respective items in the Proposal Schedule.

END OF SECTION

SECTION 01 33 00

SUBMITTAL PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes administrative and procedural requirements for submittals.

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 32 16 – Payment and Performance Schedule
   2. Section 01 78 23 – Operation and Maintenance Information
   3. Section 01 99 90 – Reference Forms

1.03 DEFINITIONS

A. Action Submittals
   1. Action Submittals content requires review and response by the Officer-in-Charge before proceeding with incorporating the subject equipment, materials, or procedure into the work.
   2. Review comments on Action Submittals, and perform subsequent actions based on the REVIEW ACTION requirements specified below.

B. Informational Submittals
   1. Informational Submittals are examined to verify that the specified submittal contents have been furnished as specified.
   2. The Contractor's actions are not contingent on the disposition of review comments on Informational Submittals.
   3. Review comments on Informational Submittals, and perform subsequent actions based on the REVIEW ACTION requirements specified below.

C. Closeout Submittals
   1. Closeout Submittals consist of documentation that is not available for review at the time Action Submittals are submitted for review or documentation that is typically generated or furnished following incorporation of the equipment, materials, or procedure into the work. Closeout submittals include spare parts inventory listing, spare parts, extra stock materials, special tools and other materials or components that are furnished separate from the installed and completed work.
   2. Review comments on Closeout Submittals, and perform the subsequent actions based on the REVIEW ACTION requirements specified below.

D. Samples
   1. Samples include partial sections of components, cuts, or containers of materials, color range sets, and swatches showing color, texture, and pattern.
   2. Samples may be Action or Informational submittals.

E. Review Actions:

1. The following definitions and actions are associated with the REVIEW ACTIONS DEFINED below:
    a. NO EXEPTIONS TAKEN: If the review indicates that the material, equipment, or work method complies with the Contract Documents, submittal will be marked "NO EXCEPTIONS TAKEN." Implement the work method or incorporate the material or equipment covered by the submittal.
    b. MAKE CORRECTIONS NOTED: If the review indicates limited corrections are required, submittals will be marked "MAKE CORRECTIONS NOTED." Implement the work method or incorporate the material and equipment covered by the submittal in accordance with the noted corrections. Where submittal information will be incorporated in O&M data, provide a corrected copy.
    c. AMEND AND RESUBMIT: If the review reveals that the submittal is insufficient or contains incorrect data, submittals will be marked "AMEND AND RESUBMIT." Do not undertake work until the submittal has been revised, resubmitted, and returned marked either "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED".
    d. REJECTED – SEE REMARKS: If the review indicates that the material, equipment, or work method does not comply with Contract Documents, the submittal will be marked "REJECTED - SEE REMARKS." Do 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" except at your own risk.
    e. RECEIPT ACKNOWLEDGED: For informational submittals, if no review response is required, this review action indicates receipt of the submittal for documentation purposes.

1.04 ADMINISTRATIVE REQUIREMENTS

A. General:

1. Furnish submittal items as specified in the contract documents.
2. Review submittal information to verify it is accurate and fulfills specified submittal requirements before submitting for review and comment.
3. Edit submittal content to clearly indicate only those items, models, or series of equipment, which are being submitted for review. Cross out or otherwise obliterate extraneous materials.
4. Ensure there is no conflict with other submittals and notify the Officer-in-Charge in each case where the submittal may affect the work of another contractor.
5. Coordinate submittals among subcontractors and suppliers including those submittals complying with unit responsibility requirements specified in the contract documents.
6. For each submittal, certify field conditions, compliance with the Contract Documents, and review of the submittal prior to submitting for review.
7. Designate the installation location within the facility, application, or intended purpose for each submittal item. Review comments are solely applicable to the circumstances designated in the submittal.
8. Coordinate submittals with the work so that work will not be delayed. Coordinate and schedule different categories of submittals, so that one will not be delayed for lack of coordination with others.

9. No extension of time will be allowed because of failure to properly schedule, coordinate or compile submittals.
10. Submittals will be rejected for lack of legibility, lack of coordination, ambiguity, or are incomplete. Incomplete submittals will be returned without review.
11. Do not proceed with work related to a submittal until the submittal process is complete. This requires that submittals for review and comment be returned to the Contractor stamped "No Exceptions Taken" or "Make Corrections Noted."
12. If desired, authorize material or equipment suppliers to deal directly with the Officer-in-Charge regarding a submittal. Such dealings require written authorization from the Contractor and are limited to contract interpretations to clarify and expedite the work.

1.05 SUBMITTAL SCHEDULE

A. A Submittal Schedule is provided in Part 4 of this Section. The Submittal Schedule is provided for Contractor convenience and shall not be relied upon as the complete list of sections requiring submittals.
B. Within 14 days after Notice to Proceed, the Contractor shall provide the Submittal Schedule to the Officer-in-Charge listing submittals for the Contract.
C. Contractor shall update the list as submittals are completed and transmitted to the Officer-in-Charge. Contractor shall provide an updated list to Officer-in-Charge monthly.
D. Include the following as a minimum in the updated list:
    1. Submittal number.
    2. Date submitted.
    3. Requested time for return of comments.
    4. Special requests, if any, for that particular submittal.

1.06 SUBMITTALS

A. Action Submittals:
    1. Procedures: Section 01 33 00.
    2. Submittal Schedule per Para 1.05.

PART 2 (NOT USED)

PART 3 EXECUTION

3.01 SUBMITTAL PROCEDURES

A. General
    1. Officer-in-Charge will review submittal information and indicate a REVIEW ACTION. Review of submittals does not relieve the Contractor of responsibility for performance of the work according to the Contract Documents.
    2. Coordinate submittal transmittal for related elements of work to ensure the submittals are processed as needed to meet the intent of the work and that delays are minimized.
    3. Submittal review activity will be prioritized based on the order received unless otherwise requested by the Contractor.

4. Submittal sequencing should coincide with the Construction Schedule in Section 01 32 16.
5. A review duration of 35 calendar days is allotted for each submittal, from the date of receipt by the Officer-in-Charge to the date of return to the Contractor.

B. Submittal Preparation:
1. Excepting, mock-ups, spare parts, physical samples, and other items that cannot be converted to electronic media, furnish submittal contents electronically in a searchable pdf format.
a. Include a table of contents and labeled divider sheets that are coordinated with the table of contents.
b. Diagrams, drawings, pictures, and illustrations presented with a consistent orientation.
2. If electronic submittals are NOT possible, place a permanent label or title block on each hard copy submittal for identification and submit the following:
a. Action and Closeout Submittals: six (6) copies of submitted information plus one reproducible original.
b. Informational Submittals: six (6) copies of submitted information.
3. Shop Drawings, Samples and Mock-ups:
a. Submit one reproducible electronic pdf copy per the requirements described above and the following:
1) Samples: two (2) samples
2) Mock-up: As required by individual specification
3) Demonstrations: As required to facilitate installation and inspection
b. Reference applicable specifications for additional requirements

C. Submittal Completeness:
1. Submittals without all required information are not acceptable and may be marked "REJECTED" and returned without review.
2. For a submittal to be deemed complete, provide the information required below and specified in specification sections, including those elements in the special transmittal procedures where required.

D. In the event of the need to "revise and resubmit", provide a complete stand-alone submittal with corrections, revisions, and new information clearly identified.

E. Resubmit changes to submittals that require a stamp and signature by a licensed engineer or other certification with the requisite stamp and signature or certifications.

3.02 TRANSMITTAL PROCEDURE

A. General:
1. Include the following information on the submittal transmittal form:
a. Project name and date, including Project Number
b. Name of Contractor and Subcontractor
c. Name of supplier and name of manufacturer
d. Number and title of appropriate specification section
e. Drawing number and detail references, as appropriate

2. Equipment and Material Submittals: Unless otherwise specified, complete the Transmittal Form 01 33 00-A specified in Section 01 99 90.
3. Operation and maintenance manuals, information, and data Submittals: Complete the Transmittal Form 01 78 23-A specified in Section 01 99 90.
4. Use a separate form for each specific item, class of material, equipment, and items specified in separate, discrete sections, for which a submittal is required. Identify the appropriate equipment numbers for submittal documents common to more than one piece of equipment. Submit a single form for multiple items, if the items taken together constitute a manufacturer's package or are functionally related, to facilitate checking or reviewing the group or package as a whole.
5. Assign a unique sequential number to each transmittal form accompanying each item submitted.
    a. Format submittal numbers as follows: "XXX"; where "XXX" is the sequential number assigned to the original submittal.
    b. Format resubmittals as follows: "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.
6. Deviation from contract: If deviations from the material, equipment or method of work are proposed, describe the proposed deviation and explain the reason for proposing the deviation under "deviations" on the transmittal form accompanying the submittal copies.

B. Check Marked Specification Transmittal Procedures
1. When submittal requirements require a "marked" copy of the specification, provide a copy of the specification marked as indicated below. Provide the following when transmitting the submittal:
    a. Provide a copy of the specification section(s) that specifies a marked copy of the specification. Include addendum updates and referenced specification sections, with addendum updates. Complete the following:
        1) Check-mark each paragraph to indicate submittal compliance with that specification requirement. Check marks (✓) shall denote full compliance with that paragraph as a whole.
        2) Mark paragraphs where deviations are proposed by underlining text that is the subject of the proposed deviation. Denoting each proposed deviation with a number in the margin to the right of the identified paragraph and provide a detailed written explanation for each numbered deviation. The remaining portions of the paragraph not underlined signify compliance with specified requirements.
        3) The Officer-in-Charge is the final authority for determining acceptability of requested deviations.
    b. For equipment specifications, provide a copy of the control diagrams and process and instrumentation diagrams relating to the submitted equipment, with addendum updates that apply to the subject equipment. Complete the following:
        1) Mark drawings or diagrams to show specific changes necessary for the equipment proposed in the submittal.
        2) If no changes are required, mark the drawings or diagrams with "no changes required".

C. Provide a Certificate of Unit Responsibility assigning unit responsibility in accordance with the requirements of the specification Section. No other submittal material will be reviewed until the certificate has been received and found to be in conformance with the Specifications.

D. Samples:

1. Submit samples in accordance with the Contract Documents. Package samples to facilitate review. Include the following with the Submittal Transmittal Form:
    a. Generic description of the sample
    b. Sample source
    c. Product name and name of manufacturer
    d. Compliance with recognized standards
    e. Submittal Number
    f. Availability and delivery time
    g. Specification Section
2. Submit samples before installation. Where variation in color, pattern, texture, or other characteristics are inherent in the material, submit four units to show variation range.
3. Where samples are for selection of appearance characteristics from a range of standard choices, submit a full set of choices for the material or products.
4. Maintain sets of approved samples at the Project Site, for quality comparisons throughout the course of construction.
5. Demolish and remove all samples prior to substantial completion.

3.03 REVIEW PROCEDURE

A. General:

1. Officer-in-Charge will review each submittal, indicate a REVIEW ACTION, and return to the Contractor.
2. Returned submittals indicate one of the following REVIEW ACTIONS: NO EXEMPTIONS TAKEN, MAKE CORRECTIONS NOTED, AMEND AND RESUBMIT, REJECTED – SEE REMARKS, or RECEIPT ACKNOWLEDGED.

3.04 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, does not relieve the Contractor of responsibility for errors therein and is not regarded as an assumption of risks or liability by the Officer-in-Charge, or by any officer or employee thereof, and the Contractor has no claim under the contract on account of the failure, or partial failure, of the method of work, material, or equipment reviewed. A mark of "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED" means that the Officer-in-Charge 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.

3.05 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be considered incidental and included in the lump sum bids for the respective items in the Proposal Schedule.

PART 4 SUBMITTAL SCHEDULE

Section	Description	Action	Informational	Closeout
01 12 16	Work Sequence	X	-	-
01 32 16	Payment and Performance Schedule	X	-	-
01 33 00	Submittal Procedures	X	-	-
01 35 29	Safety and Health	X	-	-
01 45 20	Equipment and System Performance and Operational Testing	X	X	-
01 45 21	Pre and Post-Construction Surveys	X	-	-
01 45 23	Testing and Inspection Services	X	-	-
01 73 24	Design Requirements for Non-Structural Components and Non-Building Structures	X	-	-
01 78 23	Operation and Maintenance Information	X	-	-
01 78 39	Record Drawings	X	-	-
01 79 00	Training	X	-	-
01 91 00	Commissioning	X	-	-
02 41 00	Demolition	X	-	-
03 11 00	Concrete Forming	X	X	-
03 20 00	Concrete Reinforcing	X	-	-
03 30 00	Cast-in-Place Concrete	X	-	-
03 60 00	Grouting	X	-	-
05 05 20	Anchor Bolts	X	-	-
05 50 00	Metal Fabrications	X	-	-
09 90 00	Painting and Coating	X	-	-
13 10 00	Well Depth Measurement and Fill Removal	X	-	-
13 20 00	Well Inspection and Survey	X	-	-
13 30 00	Well Rehabilitation	X	-	-
26 05 00	Common Work Results for Electrical for Small Projects	X	-	-
26 05 05	Selective Demolition for Electrical	X	-	-
26 08 00	Acceptance of Electrical Systems	X	-	-
26 09 16	Electrical Controls and Relays	X	-	-
31 10 00	Site Preparation	X	-	-
31 25 00	Erosion, Sediment, and Dust Control	X	-	-
40 05 01	Piping Systems	X	X	-
40 05 02.29	Irrigation Water	X	X	
40 05 06	Specialty Couplings and Adapters for Process Piping	X	X	-

Section	Description	Action	Informational	Closeout
40 05 06.16	Piping Connections	X	X	-
40 05 06.33	Piping Appurtenances	X	X	-
40 05 07	Hangers and Supports for Process Piping	X	-	-
40 05 07.13	Seismic Restraints for Piping	X	X	-
40 05 19	Ductile Iron Pipe	X	X	-
40 05 23	Stainless Steel Pipe	X	X	-
40 05 45	Piping System Identification	X	X	-
40 05 60	Valves	X	X	-
40 05 61.17	Gate Valves, Solid Wedge Ductile Iron AWWA C500	X	X	-
40 05 63.01	Bronze/Brass Ball Valves	X	X	-
40 05 66.01	Bronze Globe Valves	X	X	-
40 05 67.36	Pressure-Regulating Valves	X	X	-
40 05 78.13	Air Release Valves	X	X	-
40 05 82.01	Solenoid Valves, 2-way, 2-position	X	X	-
40 05 83.03	Solenoid Valves, 3-way, 2-position	X	X	
40 06 20.13	Power Actuated Valve and Gate Schedule for Process Services	X	-	X
40 61 13	Process Control System General Provisions	X	X	X
43 05 13	Rigid Equipment Mounts	X	X	X
43 05 14	Machine Alignment	X	-	-
43 05 21	Common Motor Requirements for Equipment	-	X	X
43 23 73	Vertical Lineshaft Deep Well Pumps	X	X	-

END OF SECTION

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SECTION 01 35 29

SAFETY AND HEALTH

PART 1 GENERAL

1.01 SUMMARY

A. This Section describes safety and health requirements, and supplements the General Conditions.

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.

B. The Contractor shall also comply with the provisions of the Federal Occupational Safety and Health Act, as amended.

1.03 SUBMITTALS

A. Health and Safety Plan:

Submit a Health and Safety Plan (HASP) for approval by the Officer-in-Charge within 30 days of NTP. No work shall start at any site prior to approval of the Health and Safety Plan and Safety Officers. The plan shall define the appropriate engineering control methods and personal protection equipment for the health and safety of the Contractor's workers and to mitigate potential environmental hazards. The HASP shall:

1. Establish, in detail, the protocols necessary for the recognition, evaluation, and control of all hazards associated with each task performed by the Contractor.
2. Include the organizational structure that sets forth the lines of authority, responsibility, and communication, including a description of this organization and responsibilities of each key personnel.
3. Describe the emergency and first aid equipment to be utilized for the project.
4. Include example permits and safety inspection forms.
5. Include Emergency Response and Contingency Planning procedures to address potential emergencies that may occur during a task, relative to the Contractor's work.
6. Include the following information:
    a. Confined Space Entry Plan.
    b. Fall Protection and Prevention Plan.
    c. Written Hazard Communication Plan for workplace chemicals brought to the site.
    d. Emergency Response Plan.
    e. Misting or water spray program for dust control.
    f. Provisions for an industrial hygienist to monitor exposure of works and make recommendations for dust mask or respirator use.

B. Submit copies of all safety records along with all safety inspection reports and certifications from regulating agencies and insurance companies, including the following:

1. Daily health and safety inspections performed by the Contractor's Safety Officer(s), submitted in a weekly summary report.

2. Safety meeting attendance sheet ("toolbox" meetings), as requested by the Officer-in-Charge.
3. Monthly Field Project Report, including man-hours, incident/injury and property damage reports, submitted within five days of the last working day of the month.
4. Incident Investigation Reports, submitted within 24 hours of the incident.
5. Air monitoring results/reports.
6. Critical Lift Plans. A critical lift is a lift that exceeds 90 percent of the crane's chart capacity, any multiple crane lift, any lift near power lines, or a lift requiring complex rigging.
7. Heavy Equipment Inspection forms

1.04 CONTRACTOR'S SAFETY OFFICER

A. The Contractor shall be responsible for the safety of the Contractor's employees, Owner's personnel, and all other personnel at the sites of the Work. The Contractor shall designate a competent Safety Officer(s) who shall be responsible for the supervision of the project safety requirements. The Safety Officer(s) shall be on the job at all times while work is in progress. The Safety Officer(s) shall be provided with an appropriate office at the Contractor's office facility to maintain and keep available safety records and up-to-date copies of all pertinent safety rules and regulations, and to maintain adequate supplies of safety equipment.

B. The Safety Officer shall be trained in accident prevention and first aid, and certified in cardiopulmonary resuscitation (CPR).

C. The Contractor's Safety Officer shall:
   1. Be completely familiar with all applicable health and safety requirements of all governing legislation, and ensure compliance with same.
   2. Be experienced in wastewater facility and trenchless pipe construction on similar projects.
   3. Schedule and conduct safety meetings and safety training programs as required by law for all personnel engaged in the Work.
   4. Post all appropriate notices regarding safety and health regulations at locations that afford maximum exposure to all personnel at the job site.
   5. Post the name, address, and hours of the nearest medical doctor; name and address of nearby clinics and hospitals; and the telephone numbers of the fire and police departments.
   6. Post appropriate instructions and warning signs with regard to all hazardous areas or conditions.
   7. Have proper safety and rescue equipment adequately maintained at the job site and readily available for any contingency.
      a. This equipment shall include such applicable items as: proper fire extinguishers, first aid kits, safety ropes and harnesses, stretchers, life savers, oxygen breathing apparatus, resuscitators, gas detectors, oxygen deficiency indicators, explosion meters, and any other equipment mandated by law.
      b. This equipment shall be maintained at the Contractor Safety Officer's office at the job site, or in the actual Work areas, or at both locations as determined most appropriate in the judgment of the Safety Officer.

c. Make inspections at least once daily to ensure that all machines, tools, and equipment are in safe operating condition, and that all work methods are free of hazards.

1.05 CONTRACTOR FURNISHED SAFETY EQUIPMENT AND TRAINING

A. Furnish all safety equipment required by the Health and Safety Plan for the exclusive and permanent use of the Officer-in-Charge and his/her representatives. If the equipment becomes damaged or inoperable, the Contractor shall repair or replace the equipment.

B. Provide training for the Officer-in-Charge and his/her representatives as required by the Health and Safety Plan.

PART 2 (NOT USED)

PART 3 EXECUTION

3.01 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be considered incidental and included in the lump sum bids for the respective items in the Proposal Schedule.

END OF SECTION

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SECTION 01 45 20

EQUIPMENT AND SYSTEM PERFORMANCE AND OPERATIONAL TESTING

PART 1 GENERAL

1.01 SUMMARY

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, and instrumentation 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 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 32 16 – Payment and Performance Schedule
   2. Section 01 33 00 – Submittal Procedures
   3. Section 01 78 39 – Record Drawings
   4. Section 01 91 00 – Commissioning
   5. Section 01 99 90 – Reference Documents

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. 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,

Reference	Title
	Flow Measurement in Sewer Lines by the Dye Dilution Method, Journal of the Water Pollution Control Federation, Vol. 55, Number 5, May 1983, pg. 531
	Flow Measurement in Open Channels and Closed Conduits, Vol 1, U.S. Department of Commerce, National Bureau of Standards, pg. 361
	Techniques of Water-Resources Investigations of the United States Geological Survey, Chapter 16, Measurement of Discharge Using Tracers

1.04 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A complete description of the Contractor's plan for documenting the results from the test program in conformance with the requirements of this Section, 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.
   3. The credentials and certification of the testing laboratory proposed by the Contractor for calibration of all test equipment.
   4. Preoperational check-out procedures, reviewed and approved by the respective equipment manufacturers.
   5. 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.
   6. A schedule and subsequent updates, presenting the Contractor's plan for testing the equipment and systems installed under this contract.
   7. 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.
   8. A summary of the Quality Assurance Manager's qualifications, showing conformance to this Section.

B. Informational Submittals:
   1. Procedures: Section 01 33 00.

      Product Data, shall be the original and three copies of all records produced during the testing program.

1.05 QUALITY ASSURANCE

A. Contractor's Quality Assurance Manager:
   1. The Contractor shall appoint an operations engineer or equally qualified operations specialist as Quality Assurance Manager to manage, coordinate, and supervise the Contractor's quality assurance program. The Quality Assurance Manager shall have at least 5 years of total experience, or experience on at least five separate projects, in managing the startup commissioning of mechanical, electrical, instrumentation, and piping systems. Operations engineers shall be graduates from a minimum 4-year course in mechanical or civil engineering. Operations specialists shall have equivalent experience in plant operation and maintenance. The quality assurance program shall include:
      a. A testing plan setting forth the sequence in which all testing work required under this project manual will be implemented.
      b. A documentation program to record the results of all equipment and system tests.
      c. An installed performance testing program for all mechanical, electrical, and instrumentation, equipment and systems installed under this contract.
      d. A calibration program for all instruments, meters, monitors, gages, and thermometers installed under this contract.
      e. A calibration program for all instruments, gages, meters, and thermometers used for determining the performance of equipment and systems installed under this contract.
      f. A testing schedule conforming to the requirements specified in this Section.
   2. For the purposes of this section, a system shall include all items of equipment, devices and appurtenances connected in such a fashion as their operation or function complements, protects, or controls the operation or function of the others. The Quality Assurance Manager shall coordinate the activities of all subcontractors and suppliers to implement the requirements of this section.

B. 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.

PART 2 PRODUCTS

2.01 GENERAL

A. The Contractor shall prepare test plans and documentation plans as specified in the following paragraphs. The Officer-in-Charge 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 Officer-in-Charge'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 Officer-in-Charge as a condition precedent to the Contractor's receipt of progress payments in excess of 50 percent of the contract amount. Once the Officer-in-Charge 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.

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

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' Officer-in-Charges to be present and expected test duration. As a minimum, the test plans shall include the following features:
    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 56 calendar days 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 Officer-in-Charge 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 Officer-in-Charge. No test work shall begin until the Contractor has delivered the specified number of final test plans to the Officer-in-Charge.

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 28 calendar days in advance of the date testing is to begin. The Officer-in-Charge will not witness any testing work for the purpose of acceptance until the Contractor has submitted a schedule to which the Officer-in-Charge takes no exception. The test schedule shall be updated every 7 calendar days, 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, and instrumentation equipment installed under this contract shall be tested to demonstrate compliance with the performance requirements of this project manual. Each electrical, instrumentation, mechanical, and piping 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 with water.

After filling operations of the pipelines have been completed, the Contractor shall operate all systems for a continuous period of not less than 72 hours (or as directed by the Officer-in-Charge), 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 Quality Assurance Manager and testing team shall monitor the characteristics of each piece of equipment and system and report any unusual conditions to the Officer-in-Charge.

PART 3 EXECUTION

3.01 GENERAL

A. The Contractor's quality control manager shall organize teams made up of qualified Officer-in-Charges 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 Officer-in-Charge'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 Officer-in-Charge.

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 equipment. Preoperational check-out procedures shall be reviewed and approved by the respective equipment manufacturers.
      e. Initial operation tests of all mechanical, electrical, 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 Officer-in-Charge 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 Officer-in-Charge. Evidence of successful completion of the pressure and leakage tests shall be the Officer-in-Charge's signature on the test forms prepared by the Contractor.
   2. Leakage tests for the 14-MG reservoir shall be as described in Section 32 05 19.

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 Officer-in-Charge 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. Irrigation water from the Owner shall be employed as the test medium for leakage testing of the 14-MG reservoir. Potable water shall be employed as the test medium for pipelines and other systems.
    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 Officer-in-Charge and the Contractor regarding the test results or the methods or equipment used in the performance of such test, then the Officer-in-Charge may order the test to be repeated. If the repeat test, using such modified methods or equipment as the Officer-in-Charge 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 Officer-in-Charge, 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 Officer-in-Charge, as a result of repeating such tests.
3. Post-test Inspection: Once functional testing has been completed, 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 Officer-in-Charge. 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 Officer-in-Charge 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 Officer-in-Charge that all equipment and systems comply with the requirements of the specifications, the Contractor shall fill all process units and process systems, and those employing domestic water, oil, air, or chemicals, with water. All domestic water, oil, air, and chemical systems shall be filled with the specified fluid.

B. Irrigation water shall be employed as the test medium for operational testing. When ready to initiate operational testing, the Contractor shall coordinate with the Officer-in-Charge to convey irrigation water through the completed system for a period of not less than 72 hours during a dry weather period (no more than 0.5-inches of rain predicted for a 24-hour period), during which all parts of the system shall be operated as a complete facility at various loading conditions, as directed by the Officer-in-Charge. 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. Record drawing 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.

3.05 MEASUREMENT AND PAYMENT

A. The work of this Section shall be paid for per the specified line item in the Proposal Schedule.

END OF SECTION

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SECTION 01 45 21

PRE AND POST-CONSTRUCTION SURVEYS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes requirements for surveys to document existing conditions prior to construction, and surveys to document conditions following construction. These surveys will be used by the Officer-in-Charge in evaluating any damage to existing facilities as a result of construction activities performed under this Contract. The pre-and post-construction surveys are required for this project.

1.02 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. Pre and Post-Construction Survey Work Plan: Prior to conducting the pre-construction survey, submit a written plan summarizing the procedures to be employed in performing the survey, including the personnel and the specific equipment and methods that are proposed.
   3. Pre-Construction Survey: At least 14 calendar days prior to beginning any construction work, submit documentation of pre-construction surveys, including copies of field notebooks, sketches, inspection reports, map showing where photos were taken and location of features documented in the survey, and two CD or DVD copies of annotated photographs and videos.
   4. Post-Construction Survey: Submit documentation of post-construction surveys, including copies of field notebooks, sketches, inspection reports, map showing where photos were taken and location of features documented in the survey, and two CD or DVD copies of annotated photographs and videos, upon its completion.

1.03 NOTIFICATION

A. Notify the Officer-in-Charge at least 7 calendar days prior to conducting each survey. The Officer-in-Charge shall be allowed to accompany the Contractor on both the pre-and post-construction surveys.

1.04 SURVEY OF PRE-CONSTRUCTION CONDITIONS

A. Prior to the start of construction on the Project, the Contractor shall thoroughly survey the conditions of all existing improvements which are located at the project site. The survey shall include recording observations in the field notebook, taking photographs, making sketches, and video recording buildings, structures, and other improvements along the pipe alignments. Existing conditions shall be documented in detail and, where applicable, quantified (measurement of lengths, widths, and depths of cracks in structures and pavements, etc.). Information obtained from this pre-construction survey shall be used by the Contractor to develop his plans for repair, restoration, or replacement of existing improvements that will be affected by his construction activities, to develop and control his construction methods, and as a base line against which post-construction conditions may be compared should claims against the Contractor from owners arise.

B. Documentation of pre-construction survey information shall include the following:

1. Pre-Construction Survey Report - a comprehensive report presenting detailed descriptions of existing improvements, including special features of note, defects (cracks and other damages), locations, dimensions, sketches, and other pertinent observations and measurements. Information shall be organized in a logical sequence. The report shall be typewritten on 8-1/2" x 11" bond paper, neatly bound with front and back covers.
2. Pre-Construction Photo Survey - a photo log which provides visual confirmation of the information presented in the Survey Report. Photographs shall be 4" x 6" color prints from a minimum 10-megapixels for digital cameras, shall be taken by a proficient photographer, and shall be camera date-imprinted. Multiple photographs of each improvement and defect shall be taken to provide sufficient detail (i.e. different angles, close-up, and panoramic views). Photograph subjects shall be properly focused and lighted. Photographs shall be inserted into clear plastic filler sheets made specifically for such purposes and shall be arranged to present information in a sequence similar to the Survey Report. Identifying information (i.e. brief description of each improvement, unique identifying number) shall be written in indelible ink on the back of each photograph. The filler sheets shall be bound in three-ring binder photo album(s). A reference site map shall be provided with the approximate location of every photograph identified by each photograph's unique number and direction that the photograph taken shown by an arrow.
3. Pre-Construction Video Survey – a videotape log which provides additional visual confirmation of the information presented in the Survey Report. Video recordings shall be recorded on DVD-format videotapes or electronic media approved by the Officer-in-Charge, shall be taken by a proficient video cameraperson, and shall be camera date-imprinted. Multiple view angles and close-up and panoramic views shall be utilized similar to the Photo Survey to provide sufficient detail. Videos shall be made of the exteriors of buildings and if possible, interiors, and other improvements along the pipe alignment showing their general appearance, noting any areas where existing cracks, distress or damage is present. Video subjects shall be properly focused and lighted. The videos shall include audio narrative (i.e. detailed description, features of note, TMK number, address). Video segments shall be arranged to present information in a sequence similar to the Survey Report.
4. Videotapes or approved electronic media shall be individually labeled and shall be accompanied by a detailed typewritten log listing the information presented on each video.

C. Two (2) copies each of the Pre-Construction Survey Report, Photo Survey, and Video Survey documents shall be submitted for the Officer-in-Charge's files within thirty (30) calendar days after the Notice to Proceed date. Such submittals shall be duplicate copies of the Contractor's original documents (i.e. photographs shall be reprinted from the original negatives; videos shall be professionally reproduced from originals; bindings, covers, labeling, and other presentation materials shall be identical). Under no conditions will the Contractor be allowed to start any construction on the Project until the Pre-Construction Survey has been satisfactorily completed and the documents submitted to the Officer-in-Charge.

1.05 SURVEY OF POST-CONSTRUCTION CONDITIONS

A. After construction is completed, including all restoration work, but prior to final acceptance of the Project by the Owner, the Contractor shall perform a thorough survey to document the post-construction conditions of all existing improvements which are located within one hundred (100) feet of the centerline of the pipelines being installed under the Project. The Contractor shall also survey those existing improvements which are otherwise located but which may have been affected by the Contractor's work which include, but is not limited to, buildings and structures. The post-construction survey shall meet all the requirements of the pre-construction survey described hereinbefore, including the required submittals.

B. Two (2) copies each of the Post-Construction Survey Report, Photo Survey, and Video Survey documents shall be submitted for the Officer-in-Charge's files within thirty (30) calendar days after the commencement date specified by the Officer-in-Charge for this work. Such submittals shall be duplicate copies of the original documents (i.e. photographs shall be reprinted from original negatives; videotapes or electronic media shall be professionally reproduced from originals; bindings, covers, labeling, and other presentation materials shall be identical).

PART 2 (NOT USED)

PART 3 EXECUTION

3.01 MEASUREMENT AND PAYMENT

A. The work of this Section shall be paid as a lump sum per the specified line item in the Proposal Schedule and shall be full compensation for furnishing all labor, materials, equipment, and incidentals necessary to complete both pre-construction and post-construction surveys. Payment for pre-construction survey will be made upon approval of survey at 50% of the total lump sum bid. The remainder will be paid upon approval of post-construction survey.

END OF SECTION

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SECTION 01 45 23

TESTING AND INSPECTION SERVICES

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies administrative and procedural requirements for quality assurance and control services, special inspections, field testing and structural observations required for this project. This Section is supplementary to the applicable testing and inspection program elsewhere in the Contract, and describes the responsibilities of all parties pertaining to testing and inspections.

B. This section covers requirements for structural tests and inspection required in accordance with the latest version of the International Building Code and is in addition to and supplements the quality assurance requirements contained on the Contract Drawings.

C. The Contractor is responsible for providing quality workmanship and materials for the construction of this project in accordance with the Contract Documents.

D. The Contractor shall provide special inspection sampling and testing in accordance with Chapter 17 of the International Building Code (IBC).

1.02 DEFINITIONS

A. Approved Agency: An agency approved by the Building Official to engage in furnishing testing or inspection services.

B. Officer-in-Charge: Entity approved to represent and act on the Owner's behalf.

C. Certificate of Compliance: A certificate stating that materials and products meet specified standards or that work was performed in compliance with approved construction documents.

D. Registered Design Professional in Responsible Charge: An architect or engineer, licensed to practice in the State of Hawaii, acting as the Owner's agent.

E. Special Inspection: Inspection of materials, installation, fabrication, erection, or placement of components and connections requiring special expertise to ensure compliance with approved construction documents and referenced standards.

F. Special Inspection, Continuous: The full-time observation of work requiring special inspection by an approved Special Inspector who is present in the area where the work is being performed.

G. Special Inspection, Periodic: The part-time or intermittent observation of work requiring special inspection by an approved Special Inspector who is present in the area where the work is being performed and at the completion of the work.

H. Special Inspector: A qualified person who has demonstrated competence, to the satisfaction of the Building Official, to perform inspection of the particular type of construction or operation requiring special inspection.

I. Statement of Special Inspections: The quality assurance plan contained on the contract drawings establishing the systems and components subject to special inspection and testing, as well as the frequency of testing and extent and duration of the special inspection.

J. Structural Observation: The visual observation of the structural system by a registered design professional for general conformance to the approved construction documents at significant construction stages and at completion of the structural system.

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
ASCE 7-10	Minimum Design Loads for Buildings and Other Structures
ASTM C1093	Practice for Accreditation of Testing Agencies for Unit Masonry
ASTM E329	Practice for Use in Evaluation of Inspection and Testing Agencies as Used in Construction
AWS D1.1	Structural Welding Code – Steel
AWS D1.2	Structural Welding Code – Aluminum
AWS D1.3	Structural Welding Code – Sheet Steel
AWS D1.4	Structural Welding Code – Reinforcing Steel
AWS D1.6	Structural Welding Code – Stainless Steel
AWS QC 1	Standard for AWS Certification of Welding Inspectors
IBC	2012 International Building Code
ICC-ES	International Code Council – Evaluation Service Reports and Legacy Reports

1.04 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. Certificates of Compliance: Certificates of compliance shall be submitted stating that materials and products meet specified standards.
   3. Contractor Statement: Prior to start of construction, Contractor shall submit statement of responsibility containing the following:
      a. Acknowledgement of awareness of special inspection requirements.
      b. Acknowledgement that control will be exercised to obtain conformance with documents approved by the Building Official.
      c. Procedures for exercising control within the Contractor's organization.
      d. Identification and qualifications of persons exercising control.
   4. Testing Laboratory Qualifications: Prior to start of construction, submit latest inspection report of testing laboratory facilities indicating current accreditation by the accreditation authority.

1.05 STRUCTURAL OBSERVATION (FOR REFERENCE)

A. A licensed engineer acting as the Owner's agent shall make visual observations of the work to assess general conformance with the Contract Documents at significant construction stages and at completion of the structural system.

1.06 INSPECTION AND TESTING

A. The Officer-in-Charge shall throughout the duration of construction, inspect construction and witness required testing to assure Contractor conformance with these specifications. Testing to be witnessed shall include special inspections and associated testing, as specified in this Section and as shown on the drawings for compliance with IBC Chapter 17, in addition to testing required of the Contractor in this and other specification sections.

1.07 COSTS PAID BY THE CONTRACTOR

A. Special inspection sampling and testing for compliance with IBC Chapter 17, and as specified in this Section.
B. Testing to demonstrate and document conformance with the Contract Documents and applicable permits and codes.
C. Retesting and re-inspections required due to defective work.
D. Testing performed for the convenience of the Contractor.
E. Mechanical and electrical component testing and certification.

1.08 CONTRACTOR'S RESPONSIBILITIES

A. Contractor shall cooperate with inspection personnel. Contractor shall provide access to the work and supplier's operations.
B. Contractor shall deliver adequate samples of materials proposed to be used and which require testing to the Testing Laboratory or as otherwise directed by the Officer-in-Charge.
C. Contractor shall furnish casual labor and facilities, including but not limited to obtaining and handling samples, repairing of test areas to match original conditions, storage, and curing of samples, etc.
D. Contractor shall provide all testing required to demonstrate compliance with the Contract Documents. Additional testing requirements are specified in the technical specification sections.
E. For all Contractor-required testing, the Contractor shall provide the services of an independent testing laboratory which complies with the requirements of ASTM E329.
F. Contractor shall provide testing compliance records for special inspection sampling and testing.

1.09 SPECIAL INSPECTOR'S RESPONSIBILITIES

A. Special Inspector shall keep records of inspections.
B. Special Inspector shall provide inspection reports to the Officer-in-Charge, Engineer of Record, Contractor, and the Building Official.
C. Special Inspector shall provide a final report documenting special inspections and correction of any discrepancies noted in the inspections to the Officer-in-Charge, Engineer of Record, Contractor, and the Building Official.
D. Special Inspector shall attend pre-construction conferences and construction progress meetings if requested by the Officer-in-Charge.

1.10 APPROVED AGENCY'S RESPONSIBILITIES (FOR REFERENCE)

A. The Approved Agency shall employ personnel experienced and trained to perform the types of tests or inspections required for this project.

B. The Approved Agency personnel performing testing of welds shall be certified in accordance with AWS QC 1.

1.11 SPECIAL INSPECTION AND TESTING REPORTS

A. Report Contents: At a minimum, Special Inspection and Testing Reports shall include the following:

1. Project name and date of report.
2. Testing laboratory name, address, telephone number, name of laboratory field sampling personnel, and name of lab testing personnel, as applicable.
3. Date, time, and location of sampling, testing, and inspecting.
4. Ambient temperature and weather conditions at the site or shop and curing conditions of samples.
5. Product identification and referenced specification section number.
6. Type of sample, test, and inspection and industry standard for sampling and testing.
7. Results of sample, test, and inspection.
8. Evaluation of compliance with requirements in Contract Documents.

B. Distribution of Reports: Test and Inspection reports shall be submitted to the Officer-in-Charge and distributed by the Testing Laboratory to Engineer of Record, Contractor, Building Official and as directed by the Officer-in-Charge. Draft field test and inspection reports shall be submitted to the Officer-in-Charge prior to the Special Inspector departing the project site. Final test and inspection reports shall be submitted not more than three days after completion of required tests and inspections. Inspection reports shall be submitted immediately to the Officer-in-Charge if deficiencies or significant irregularities are noted. Provide two legible reproducible copies of all draft field reports and one copy of all final reports.

1.12 TESTING AND INSPECTION PLANS

A. The Contractor shall develop testing and inspection plans detailing the coordinated, sequential testing or inspection 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. Testing and inspection plans shall identify by specific equipment or tag number each device or control station to be manipulated or observed during the test procedure and the specific results to be observed or obtained. Test plans shall also be specific as to support systems required to complete the test work, temporary systems required during the test work, subcontractors' and manufacturers' representatives to be present and expected test duration. As a minimum, the test plans shall include the following features:

1. Step-by-step proving procedure for all control and electrical circuits by imposing low voltage currents and using appropriate indicators to affirm that the circuit is properly identified and connected to the proper device.
2. Calibration of all analysis process instruments and control sensors.

3. Performance testing of each individual item of mechanical, electrical, and instrumentation equipment. Performance tests shall be selected to duplicate the operating conditions described in the project manual.
4. System tests designed to duplicate, as closely as possible, operating conditions.
5. Test plans shall contain a complete description of the procedures to be employed to achieve the desired test environment.
6. Testing forms as recommended by the Manufacturer.

1.13 TESTING AND INSPECTION SCHEDULE

A. The Contractor shall produce a testing and inspection schedule setting forth the sequence contemplated for performing the test or inspection 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 testing and inspection schedule shall be submitted no later than 28 calendar days in advance of the date testing or inspection is to begin. The Officer-in-Charge will not witness any testing or inspection work for the purpose of acceptance until the Contractor has submitted a schedule to which the Officer-in-Charge takes no exception. The testing and inspection 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.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. The Contractor shall furnish access to the Work as required for special inspections, testing and structural observations.
B. The Contractor shall notify the Officer-in-Charge in advance of required special inspections and structural observation no later than seven (7) calendar days prior to the date of the inspection.
C. Contractor shall correct defective work at no additional cost to the Owner.
D. Structural observation will be performed by a registered professional engineer.

3.02 TESTING

A. Component and attachment testing shall be required of component manufacturers for mechanical and electrical components subject to special inspections for seismic resistance. The Contractor shall submit a certificate of compliance prepared by the component manufacturer.
B. Certificates of Compliance shall include the manufacturer’s name and address; applicable Drawing and Detail number, products, units and assemblies, and system equipment identification.

3.03 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be considered included in the lump sum bids for the respective line items in the Proposal Schedule.

END OF SECTION

SECTION 01 66 00

SHIPMENT, PROTECTION, AND STORAGE

PART 1 GENERAL

1.01 SUMMARY

A. This Section describes requirements for shipment, protection, and storage of equipment, products, and materials for the project. 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 Officer-in-Charge.

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 09 90 00 – Painting and Coating Systems

PART 2 PRODUCTS

2.01 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.

PART 3 EXECUTION

3.01 PACKAGE AND MARKING

A. 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.

B. 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.

3.02 IDENTIFICATION

A. Each item of equipment and valve shall have permanently affixed to it a label or tag with its equipment or valve number designated in this contract. Marker shall be of stainless steel. Location of label will be easily visible.

3.03 SHIPPING

A. Bearing housings, vents and other types of openings shall be wrapped or otherwise sealed to prevent contamination by grit and dirt.

B. 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.

3.04 FACTORY APPLIED COATINGS

A. Unless otherwise specified, each item of equipment shall be shipped to the site of the work with the manufacturer's shop applied epoxy prime coating as specified in Section 09 90 00. The prime coating shall be applied over clean dry surfaces in accordance with the coating manufacturer's recommendations. The prime coating will serve as a base for field applied finish coats. Electrical equipment and materials shall be painted by manufacturer as specified in Section 09 90 00.

3.05 STORAGE

A. 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.

B. 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.

3.06 PROTECTION OF EQUIPMENT AFTER INSTALLATION

A. After installation, all equipment shall be protected from damage from, including but not limited to, dust, abrasive particles, debris, and dirt generated by the placement, chipping, sandblasting, cutting, finishing, and grinding of new or existing concrete 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.

3.07 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be considered incidental and included in the lump sum bids for the respective items in the Proposal Schedule.

END OF SECTION

SECTION 01 73 24

DESIGN REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS AND NON-BUILDING STRUCTURES

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes minimum structural requirements for the design, anchorage, and bracing of non-structural components such as architectural/mechanical/HVAC/electrical components, equipment, or systems, and non-building structures such as tanks.

B. The requirements of this Section apply to design of the structural elements and features of equipment and to platforms/walkways that are provided with equipment or non-building structures.

C. This Section applies to non-building structures and non-structural components that are permanently attached to structures as defined below and in ASCE 7.

D. Design and conform to criteria and 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 specific technical specification sections.

E. The following non-structural components are exempt from seismic design loading requirements of this section.

1. Mechanical and electrical components in Seismic Design Categories D, E, or F where all of the following apply:
    a. The component importance factor, I_p, is equal to 1.0;
    b. The component is positively attached to the structure;
    c. Flexible connections are provided between the component and associated ductwork, piping, and conduit;
    d. And either:
        1) the component weighs 400 lb or less and has a center of mass located 4 ft or less above the adjacent floor level; or
        2) the component weighs 20 lb or less, or in the case of a distributed systems, 5 lb/ft or less.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related section. Additional related sections may apply that are not specifically listed below.

1. Section 01 11 80 - Environmental Conditions
2. Section 01 33 00 - Submittals
3. Section 05 05 20 - Anchor Bolts

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	Aluminum Association, Aluminum Design Manual with Specifications and Guidelines for Aluminum Structures
ACI 318	Building Code Requirements for Structural Concrete
ACI 350	Code Requirements for Environmental Engineering Concrete Structures
ACI 350.3	Seismic Design of Liquid-Containing Concrete Structures
AISC 341	Seismic Provisions for Structural Steel Buildings
ACI 360	Specification for Structural Steel Buildings
ASCE 7	Minimum Design Loads for Buildings and Other Structures
AWS D1.1	Structural Welding Code – Steel
AWS D1.2	Structural Welding Code - Aluminum
AWS D1.6	Structural Welding Code – Stainless Steel
AWS D1.8	Structural Welding Code – Seismic Supplement
IBC	International Building Code with local amendments
OSHA	U.S. Dept. of Labor, Occupational Safety and Health Administration
SMACNA	Seismic Restraint Manual Guidelines for Mechanical Systems

1.04 DEFINITIONS

A. Structure: 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.

B. Non-structural Components: Non-structural 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 effects of wind, snow, impact, temperature, and seismic loads. Non-structural components include, but are not limited to, ceilings, partitions, windows, equipment, piping, ductwork, furnishings, lights, etc.

C. Non-building Structures: 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. Non-building structures include, but are not limited to, pipe racks, storage racks, stacks, tanks, vessels, and structural towers that support tanks and vessels.

1.05 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 requested deviations to specification requirements, with the submittal is sufficient cause for rejection of the entire submittal with no further consideration.
4. For structural elements of non-structural components and non-building structures required to be designed per this section, provide Drawings and design calculations stamped by a licensed professional engineer registered in the State of Hawaii qualified to perform structural engineering.
5. List of non-structural components and non-building structures requiring wind and seismic design and anchorage.
6. Shop drawings showing details of complete wind and seismic bracing and anchorage attachment assemblies including connection hardware, and embedment into concrete.
7. Shop drawings showing plans, elevations, sections, and details of equipment support structures and non-building structures, including anchor bolts, structural members, platforms, stairs, ladders, and related attachments.
8. Identify interface points with supporting structures or foundations, as well as size, location, and grip of 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.
9. Calculations for supports, bracing, and attachments shall clearly indicate design criteria applied. Coordinate concrete embedment calculations 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 design calculations.

1.06 QUALITY ASSURANCE

A. Quality Control:
   1. Special Inspection of non-structural components and non-building structures, and their anchorages shall be performed by the Special Inspector in conformance with IBC Chapter 17. Special Inspector(s) and laboratory shall be acceptable to the Owner in their sole discretion. Special Inspection is in addition to, but not replacing, other inspections and quality control requirements. Where sampling and testing required conforms to Special Inspection standards, such sampling and testing need not be duplicated.
   2. The Officer-in-Charge shall throughout the duration of construction, inspect construction and witness required testing to assure Contractor conformance with these specifications. Testing to be witnessed shall include special inspections and associated testing, as specified in this Section and as shown on the drawings for compliance with IBC Chapter 17, in addition to testing required of the Contractor in this and other specification sections.
   3. Refer to Section 01 45 00 Contractor Quality Control and Section 01 45 23 Testing and Inspection Services.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide materials in conformance with information shown on the Drawings and in other technical specification sections. See individual component and equipment specifications for additional requirements.

2.02 DESIGN CRITERIA

A. Design Codes

Design	Code
Buildings/Structures:	International Building Code 2018, Hawaii State Building Code 2018, and ASCE 7-10
Reinforced concrete:	ACI 350-06 and ACI 350.3-06 for Concrete Liquid Containing Structures, 318-11 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:	OSHA

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

B. Design Loads
   1. Design non-structural components and non-building structures for the following minimum loads: (Do not apply wind and snow loads to non-structural components and non-building structures that are located inside buildings.)
   2. Dead Loads:
      a. Add an additional allowance for piping and conduit when supported and hung from the underside of equipment and platforms.
      b. Typical allowance for piping and conduit: 20 psf
   3. Uniform Live Loads:

Elevated grating floors:	100 psf
Columns:	No column live load reduction allowed
Exitways, stairs and landings:	100 psf
Equipment platforms, walkways/catwalks (other than exitways):	60 psf

4. Wind Loads:

Code:	IBC 2018 & ASCE 7-10
Risk Category:	III
Basic Wind Speed (Ultimate, 3-second gust) for Risk Category Shown Above:	140 mph
Exposure:	C
Topographic Factor (K_{zt})	1.6

Note: Design exterior non-structural components and non-building structures, unless located in a pit or basin, to withstand design wind loads without consideration of shielding effects by other structures.

5. Seismic Loads:

Code:	IBC 2018 & ASCE 7-22
Risk Category:	II
0.2 Sec. Mapped Spectral Response, S_S:	0.66 g
1.0 Sec. Mapped Spectral Response, S_1:	0.19 g
Site Class:	D
0.2 Sec. Design Spectral Response, S_{DS}:	0.53 g
1.0 Sec. Design Spectral Response, S_{D1}:	0.33 g
Importance Factor (I_e):	1.25
Component Importance Factor (I_p):	1.0, except I_p=1.5 for components identified in Section 13.1.3 of ASCE 7
Seismic Design Category	D

Notes:

1. *Calculate seismic loads on the basis of governing building code. Include equipment operating loads in structure dead load.*
2. *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.*

6. Impact Loads:
   a. Consider impact loads in design of support systems.
   b. Use the following impact load factors 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
Hangers supporting floors and platforms:	33% of live and dead load

7. Temperature:
   a. Include effects of temperature in design where non-structural components and non-building structures are exposed to differential climatic conditions. See climatic conditions below for temperature extremes.

C. Load Combinations

1. Design non-structural components and non-building structures to withstand 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, ignore the load when evaluating that member.

D. Design Considerations
    1. Design non-structural components and non-building structures for the following conditions:
    2. Climatic Conditions:
        a. Refer to Specification 01 11 80

E. Column Base Fixity
    1. Design column bases as pinned connections. No moments shall be assumed to be transferred to foundations.
    2. Where significant shear loads (greater than 5,000 lb. per anchor bolt) are transferred at column base plates, provide a shear key designed to transfer shear load.

F. Deflection
    1. Maximum beam deflection as a fraction of span for walkways and platforms: L/240 for total load and L/360 for live load.
    2. Maximum total load deflection for equipment support: L/450.

PART 3 EXECUTION

3.01 GENERAL

A. Make attachments and braces in such a manner that component force is transferred to the lateral force-resisting system of the structure. Base attachment requirements and size and number of braces per calculations submitted by Contractor.

B. 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 is responsible for 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 Owner.

C. Provide anchor bolts in accordance with Section 05 05 20. Base size of anchor bolts and embedment on submitted calculations.

D. Submit details of and calculations for anchorages 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. Contractor is responsible for revisions to anchorages and/or strengthening of structural support so that there is no overstress condition, at no additional cost to Owner.

3.02 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be considered incidental and included in the lump sum bids for the respective items in the Proposal Schedule.

END OF SECTION

SECTION 01 78 23

OPERATION AND MAINTENANCE INFORMATION

PART 1 GENERAL

1.01 SUMMARY

A. This Section describes Operation and maintenance (O&M) instructions that shall be provided in accordance with this section and as required in the technical sections of this Contract Documents. 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 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 – Submittals
2. Section 01 99 90 – Reference Forms

1.03 SUBMITTALS

A. Action Submittals:

1. Procedures: Section 01 33 00.
2. 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 Post-shutdown 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 this Section.

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.

1.04 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. Six (6) 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 Contract Documents. The information shall be organized in the binders in numerical order by the equipment numbers assigned in the Contract Documents. The binders shall be provided with a table of contents and tab sheets to permit easy location of desired information.

C. An electronic pdf copy shall also be provided with the same organization as the hardcopies.

D. 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.

1.05 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.

PART 2 (NOT USED)

PART 3 EXECUTION

3.01 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be considered incidental and included in the lump sum bids for the respective items in the Proposal Schedule.

B. Acceptable O&M information for the project shall be delivered to the Officer-in-Charge 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 Officer-in-Charge.

END OF SECTION

SECTION 01 78 39

RECORD DRAWINGS

PART 1 GENERAL

1.01 SUMMARY

A. This Section describes requirements for record drawing preparation.

1.02 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. Record drawings refer to those documents maintained and annotated by the Contractor during construction and are defined as:
      a. a neatly and legibly marked set of contract drawings showing the final location of piping, equipment, electrical conduits, outlet boxes and cables;
      b. additional documents such as schedules, lists, photos, drawings, and electrical and instrumentation diagrams included in the specifications; and
      c. Contractor layout and installation drawings.
      d. For buried pipelines, provide stationing and location of pipe appurtenances, fittings, couplings, adapters, and changes in horizontal or vertical direction.
   3. 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 Officer-in-Charge 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 Officer-in-Charge.
   4. 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:
      a. Additions - Red
      b. Deletions - Green
      c. Comments - Blue
      d. Dimensions - Graphite*

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

PART 2 (NOT USED)

PART 3 EXECUTION

3.01 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be considered incidental and included in the lump sum bids for the respective items in the Proposal Schedule.

END OF SECTION

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SECTION 01 79 00

TRAINING

PART 1 GENERAL

1.01 SUMMARY

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 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 99 90 – Reference Forms

1.03 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. The following material shall be reviewed and accepted by the Officer-in-Charge as a condition precedent to receiving progress payments in excess of 50 percent of the contract amount and not less than 21 calendar days prior to the provision of training.
      a. 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.
      b. Subject of each training session, identity, and qualifications of individuals to be conducting the training, and tentative date and time of each training session.

1.04 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.

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 calendar 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, or as coordinated with the Officer-in-Charge.

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 7 days 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.

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.

B. Acceptable operation and maintenance manuals for the specific equipment shall be provided to the Owner prior to the start of any training. Videotaping 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 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.
5. Perform Owner-approved practice maintenance and repair job(s), including mechanical and electrical adjustments and calibration and troubleshooting equipment problems.

3.02 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be considered incidental and included in the lump sum bids for the respective items in the Proposal Schedule.

END OF SECTION

SECTION 01 91 00

COMMISSIONING

PART 1 GENERAL

1.01 SUMMARY

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 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

1.03 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. Detailed plans for commissioning each process unit and each system constructed or modified as a part of the work performed under this contract.
   3. The Contractor's plan for providing a commissioning team conforming to the requirements of this Section 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.

1.04 QUALITY ASSURANCE

A. 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 Officer-in-Charge or, through the Officer-in-Charge, 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.

PART 2 PRODUCTS

2.01 SUMMARY

A. Working with representatives of the Owner and the Officer-in-Charge, 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 Officer-in-Charge, shall serve as the guidance manual for the commissioning process.

PART 3 EXECUTION

3.01 SUMMARY

A. The commissioning period shall be 14 calendar days. 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 Officer-in-Charge 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 Officer-in-Charge to assure a reliable and completely operational facility are complete, the Officer-in-Charge 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 system being commissioned, operational.

3.02 MEASUREMENT AND PAYMENT

A. The work of this Section shall be paid for per the specified line item in the Proposal Schedule.

END OF SECTION

SECTION 01 99 90

REFERENCE FORMS

PART 1 GENERAL

1.01 SUMMARY

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

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
09 90 00-A	Coating System Inspection Checklist
26 05 00-A	Wire and Cable Resistance Test Data Form
26 05 00-B	Installed Motor Test Data Form
40 61 13-A	Loop Wiring and Insulation Resistance Test Data Form
40 61 13-G	Field Switch Calibration Test Data Form
40 61 13-H	Transmitter Calibration 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
43 05 21-A	Motor Data Form

END OF SECTION

01 33 00-A. SUBMITTAL TRANSMITTAL FORM

Submittal Transmittal (Form shall comply with requirements of Section 01 33 00)

Submittal Description:	Submittal No:1	Spec Section:

	Routing	Sent	Received
Officer-in-Charge:	Contractor/CM		
Project:	CM/Engineer		
Contract No.:	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: _____

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		Officer-in-Charge	
	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		Officer-in-Charge	
	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:

Officer-in-Charge	Date

ACCEPTED FOR BENEFICIAL OCCUPANCY

City's Representative	Date

01 78 23-A. OPERATION AND MAINTENANCE TRANSMITTAL FORM

Date:	Submittal No:1
To:	Contract No:
	Spec. Section:
	Submittal Description:
Attention:	From:

Checklist	Contractor		Officer-in-Charge	
	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 :

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

09 90 00-A. COATING SYSTEM INSPECTION CHECKLIST

09 90 00-A Coating System Inspection Checklist			
Project Name			
Owner		Coating System Manufacturer (CSM)	
General Contractor (GC)		Coating System Applicator (CSA)	
Area or Structure		Location within Structure	
Coating System (e.g. E-1)		Coating Type (e.g. Epoxy, etc.)	

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

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

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

26 05 00-A. WIRE AND CABLE RESISTANCE TEST DATA FORM

Wire or Cable No.:_____ Temperature, °F: _____

Location of Test	Insulation resistance, megohms
1.	
2.	
3.	
4.	
5.	
6.	
7.	

.

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Officer-in-Charge's Representative

26 05 00-B. INSTALLED MOTOR TEST DATA FORM

Motor Equipment Number: _____ Date of test: _____

Equipment Driven: _____

MCC Location: _____

				Ambient temp	°F
Resistance:					
Insulation resistance phase-to-ground megohms:					
Phase A		Phase B		Phase C	
Current at Full Load:					
Phase		Current, amps			
Phase		Current, amps			
Phase		Current, amps			
Thermal Overload Device:	Manufacturer/catalog #		Amperes		
Circuit breaker (MCP) setting:					

Motor Nameplate Markings:

Mfr		Mfr Model		Frame		HP	
Volts		Phase		RPM		Service factor**	
Amps		Freq		Ambient temp rating		°C	
Time rating			Design letter**				
	(NEMA 1-10.35)			(NEMA MG-1.16)			
Code letter			Insulation class				

**Required for 3-phase squirrel cage induction motors only.

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Officer-in-Charge's Representative

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 _____

Officer-in-Charge'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 _____

Officer-in-Charge'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 _____

Officer-in-Charge'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

WAHIAWA WWTP RECYCLED WATER SYSTEM IMPROVEMENTS

CERTIFICATE OF UNIT RESPONSIBILITY

FOR SPECIFICATION SECTION _____

_____

[SECTION TITLE]

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 sections 43 05 11 and 43 23 03 where applicable) and all sections referencing this (these) section(s), including but not limited to drivers, supports for driving and driven equipment and all other specified appurtenances to be furnished to the Project by manufacturer. And, we have further reviewed, and modified as necessary, the requirements for associated variable speed drives and motor control centers. We hereby certify that all specified components are compatible and comprise a functional unit suitable for the specified performance and design requirements whether or not the equipment was furnished by us. We will make no claim nor establish any condition that problems in operation for the product provided under this specification Section _____ are due to incompatibility of any components covered by this Certificate of Unit Responsibility. Nor will we condition or void any warranty for the performance of the product of this specification Section _____ due to incompatibility of any components covered under this Certificate of Unit Responsibility.

Our signature on this Certificate of Unit Responsibility does not obligate us to take responsibility for, nor to warrant the workmanship, quality, or performance of related equipment provided by others under specification sections _____, _____, and _____. Our obligation to warranty all equipment provided by us shall remain unaffected.

Notary Public	Name of Corporation
Commission expiration date	Address
Seal:	By:
	Duly Authorized Official
	Legal Title of Official
	Date

43 05 13-A. RIGID EQUIPMENT MOUNT INSTALLATION CHECKLIST

CITY AND COUNTY OF HONOLULU, WAHIAWA WWTP RECYLCED WATER SYSTEM IMPROVEMENTS

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: Officer-in-Charge		Date
Name: Millwright		Date
Step 2: Completion of Cleaning and Concrete Substrate Preparation Prior to Grouting		
Name: Contractor Rep.		Date
Name: Officer-in-Charge		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date
Step 3: Equipment Leveling		
Name: Contractor Rep.		Date
Name: Officer-in-Charge		Date
Name: Millwright		Date
Step 4: Installation of Protection of Adjacent Surfaces or Structures NOT TO BE GROUTED		
Name: Contractor Rep.		Date
Name: Officer-in-Charge		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: Officer-in-Charge		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: Officer-in-Charge		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date
Step 7: Epoxy Grout Installation		
Name: Contractor Rep.		Date
Name: Officer-in-Charge		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: Officer-in-Charge		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: Officer-in-Charge		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: Officer-in-Charge		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

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies demolition and removal of site material, building elements, mechanical and electrical equipment, utilities, and related appurtenances from the site as specified in the Drawings.

B. This item of work shall include the furnishing of all labor, materials, tools, and equipment necessary for completing this item of work as specified in the following document (as modified or supplemented hereinafter, and as applicable to this project):
   1. Standard Specifications
   2. Standard Details

C. Definitions:
   1. Demolish: Remove and legally dispose of material and equipment as specified off-site unless indicated by Contract Document or the Officer-in-Charge to be removed and salvaged. Upon removal from site, Contractor shall have the rights of salvage of materials.
   2. Salvage: Carefully remove or detached from its existing condition, in a manner to prevent damage to associated elements, and deliver to Officer-in-Charge or reinstall or reuse as described on the Drawings. Contractor shall protect salvaged equipment and materials from weathering, staining, construction damage, theft, and vandalism. Arrange storage to facilitate inspection by Officer-in-Charge.

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.

B. Protection of Existing Facilities:
   1. The Contractor shall diligently protect existing structures and property of the Owner while proceeding with Work of this section and the entire Contract. All damage shall be repaired at once to the satisfaction of the Owner. All such repairs shall be at the expense of the Contractor and no claims for additional payment will be accepted.
   2. When removing materials or portions of existing structures and when making openings in walls and partitions, the Contractor shall provide barriers, dust screens, and other protective devices so as not to damage the structures beyond the limits necessary for the new Work, nor to damage the structures or contents by falling or flying debris nor to transfer any heavy shocks and vibrations to structures to remain. Swinging weights shall not be used to demolish structures.

3. Remove masonry or concrete in small sections.
4. Provide shoring, bracing, and other supports to prevent movement, settlement, or collapse of remaining or adjacent wall areas, structure, or facilities. Arrange shoring, bracing, and supports to prevent overloading of structure.
5. Take all precautions necessary to prevent damage to existing remaining work or to adjacent facilities. Execute work using methods which will prevent interference with use of remaining and adjacent facilities by the Owner.
6. Electrical equipment removal shall be staged as specified in the Contract Documents.

1.03 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 – Submittals
   2. Section 01 45 21 – Pre and Post-Construction Surveys

1.04 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. 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.
   3. Schedule of Demolition Activities:
      a. Detailed sequence of demolition and removal work, with starting and ending dates for each activity. Ensure Officer-in-Charge's on-site operations are uninterrupted.
      b. Interruption of utility services. Indicate how long utility services will be interrupted and when they will be interrupted. Coordinate with the Officer-in-Charge a minimum of 14 calendar days (10 working days) in advance of interruptions.
      c. Coordination for shutoff, capping, and continuation of utility services.
   4. Coordination of Officer-in-Charge's continuing occupancy of portions of existing building and of Officer-in-Charge's partial occupancy of completed Work.
   5. Pre-demolition Photographs or Video in accordance with Section 01 45 21 to be submitted before Work begins.
   6. Landfill Disposal Receipts: Submit copies of receipts issued by a landfill facility. Include receipts with Contractor Daily Reports.

PART 2 PRODUCTS

2.01 REPAIR AND RESTORATION

A. General: The Contractor shall alter, or rework existing structures as shown and specified. Generally, when items of equipment, conduit, and piping are removed, the areas and surfaces from which items were removed shall be left with a neat appearance and finish compatible with surrounding areas, colors, and surfaces. The Contractor shall do all painting, sanding, grouting, sacking, resurfacing, and other Work as necessary to comply with the above requirements. Prior to structural modifications, all surfaces shall be subject to inspection by the Officer-in-Charge. Colors shall match existing colors as closely as possible. For replacement, repair of restoration of Work removed, comply with the specifications for the type of Work to be done.

B. Penetrations: Where holes in existing masonry or concrete are required to be sealed, unless otherwise specified, they shall be sealed with cement mortar or concrete. The sides of the openings shall be provided with keyed joints and shall be suitably roughened to furnish a good bond and make a watertight joint. All loose or unsound material adjacent to the opening shall be removed and, if necessary, replaced with new material. The method of placing the mortar seal shall provide a suitable means of releasing entrapped air.

C. Modifications of Existing Structures:
   1. Where only a portion of the existing structure is to be removed, the existing concrete shall be sawed to neat lines as shown on the plans or as established by the Officer-in-Charge. Reinforcing steel shall be removed to a depth of two inches from the finished surface. Anchor bolts for equipment and structural steel removed shall be cut off 1 inch below the concrete surface.
   2. When connections are to be made to existing concrete structures, the existing reinforcing steel shall be exposed to a depth of 12 inches and all bars spliced to the new reinforcing steel.

D. Piping Modifications:
   1. Where necessary or required for making piping connections, cut existing pipelines and provide suitable plugs, bulkheads, or other means to hold back the flow of water or other liquids, all as required in the performance of the Work under this Contract. The remaining open ends of all piping, valves, fittings, and appurtenances that are removed shall be plugged with standard pipe plugs or closed with flanges so that there will be no leakage through the closure.
   2. Contractor shall coordinate with Officer-in-Charge and Plant Operations at least 14 calendar days (10 working days) in advance for any interruption of active utilities, including temporary shutdown or rerouting. No lines should be active and full of liquid when cut and plugged.
   3. Thoroughly clean any piping, valves, equipment, or other appurtenances will be re-used after demolition of connecting features.

E. Raceway and Junction Box Modifications: Where necessary or required for making circuit raceway terminations, cut existing raceways and provide suitable caps or other means to abandon below grade raceways not used for new circuits or identified as spare raceways. Below grade raceways shall be concealed as required in the performance of the Work under this Contract. The Contractor shall reuse existing raceways once thoroughly cleaned for new circuits. Exterior raceways that enter manholes and handholes via exterior junction boxes shall be identified as spares where the Contractor does not use the raceways for new circuits. See Drawings for existing raceway usage.

PART 3 EXECUTION

3.01 GENERAL

A. Demolition extents are shown on the Drawings. The Drawings were prepared using facility record drawings and could be diagrammatical in nature. Exact location of the Work may vary from what is shown. Field verify all existing conditions prior to starting the Work.

B. Major obstructions encountered that are not shown or indicated on the Drawings or could not have been foreseen by visual inspection of the site prior to bidding, should immediately be brought to the attention of the Officer-in-Charge, who will make a determination for proceeding with the Work.

C. If saw cuts or breaks are made exceeding limits shown on the Drawings beyond adjustments made after initial field verification prior to the start of work, repair the cuts or breaks back to the dimensions shown on Drawings at the Contractor's expense. Submit repair procedures for Officer-in-Charge's review. Provide saw cut at all pavement surface and pad, apron, header and curb removal limits and where neat connection lines are required.

D. Protect structures and equipment to remain from damage during demolition work.

E. Trash and debris shall be disposed of legally, off site, by the Contractor. Remove and transport materials in a manner that will prevent spillage on adjacent surfaces and areas. Do not allow demolished materials to accumulate on-site.

3.02 SAFETY REQUIREMENTS

A. All debris, materials, piping, and miscellaneous waste products from the demolition process shall be removed safely from the project site as soon as possible. Dispose of in accordance with applicable federal, state and local regulations. Contractor is responsible for determining these regulations and shall bear all costs associated with disposal of these items. Burning of demolished materials is not allowed.

B. Hazardous Materials:
   1. Existing facilities, or portions thereof, to be demolished may contain hazardous materials such as:
      a. Asbestos cement piping.
      b. Asbestos-containing pipe insulation.
      c. Residual chemicals in existing or abandoned piping.
      d. Lead-based paint.

e. Or other unknown hazardous materials.

2. Take all necessary precautions when handling these materials. Protect work area always until hazardous materials are stored in specially treated containers and the area has been cleaned.
3. Remove and dispose of hazardous materials in accordance with federal, state and local regulations.
4. Obtain all permits necessary to perform demolition work on hazardous materials.

C. 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.

D. The use of explosives or fires is prohibited.

E. Post "No Smoking" signs in all interior spaces and in hazardous or confined spaces where dismantling operations are to be carried on. Strictly enforce "No Smoking" restrictions among all personnel employed on the Work.

3.03 DEMOLITION OF EXISTING STRUCTURES

A. Execute work to protect occupants from injury and discomfort. Provide protection to persons and property. Conduct operations to ensure minimum interference with roads, walks, entrances, exits, and other adjacent occupied facilities.

B. Structures that are in the way of new construction shall be removed completely, regardless if they are above or below existing or proposed ground or grade. This Work may be done in any manner selected by the Contractor, and reviewed by the Officer-in-Charge, that does not endanger adjacent structures and property. The use of explosives will not be permitted for any purposes.

C. Structures not in the way of proposed construction but designated to be demolished or removed shall be removed, to a point 3 feet below existing or proposed grade, whichever is lower. That portion that will remain below grade shall be cleaned of rubble and debris including exposed reinforcing steel, backfilled with the appropriate material.

D. Structural steel members shall be cut into sections of such weight and size as will permit convenient handling, hauling, and storage. Concrete to be demolished and removed shall be broken into pieces not greater than 24 inches in any dimension by methods reviewed by the Officer-in-Charge.

3.04 DEMOLITION OF SITE ELEMENTS

A. Where portions of asphalt pavements, concrete pads, headers, curbs, and gutters 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 or existing element face.

3.05 MATCHING AND PATCHING

A. Where items are removed from existing walls, ceilings, floors, or partitions to remain, Contractor shall repair wall, ceiling, floor, or partition disturbed by removal.

B. Where walls, ceilings, floors, or partitions are removed, Contractor shall repair abutting walls, ceilings, or floors disturbed by removal.

C. Where existing construction is cut or otherwise disturbed to permit installation of new work, Contractor shall match and patch existing disturbed construction.

D. Use methods and materials similar in appearance, and equal in quality to areas or surfaces being repaired. Methods, materials, and finished work are subject to review and approval by the Officer-in-Charge.

E. Remove areas, surfaces, or items which cannot be satisfactorily matched and patched. Replace at no additional expense to the Owner

3.06 WEATHER PROTECTION

A. Provide weather protection for all temporary power distribution equipment specified to be outdoors.

3.07 UTILITIES

A. Determine whether there are utilities in demolition areas that are needed for continued service to other facilities. Relocate, test and make functional such utilities before demolition work begins.

B. Notify Officer-in-Charge of utilities which must be turned off before isolation and demolition are started. Utilities serving facilities to be demolished shall be isolated as directed by the Officer-in-Charge. Isolation shall occur at a point closest to the remaining active portion of the utility

C. Provide temporary services during interruptions to existing utilities as acceptable to Officer-in-Charge.

3.08 EXTENTS

A. Unless otherwise specified when demolishing equipment, demolish appurtenant items such as piping, accessories, supports, piping and tubing supports, fasteners, anchor bolts, conduits and wiring from equipment back to nearest junction box, concrete pads that support equipment, and other accessories.

B. 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 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 Officer-in-Charge.

C. Unless otherwise specified when demolishing piping, demolish all fittings, valves, supports, joints, insulation, connections, inline instruments, labels, and other accessories.

D. Cut off or burn back concealed or embedded conduit, boxes, anchor bolts, supports, piping, or other materials a minimum of 1 inch below finished surface. Plug pipes or conduits. Fill holes with epoxy grout to create a finished surface uniform in appearance.

E. For existing circuits no longer needed, remove conductors from the conduit. Remove all surface-mounted conduit that is no longer needed. For conduit below grade or concealed within wall, cap and abandon conduit in place. For existing circuits to remain operational, intercept existing conduit at the most convenient location or as shown and splice and extend conduit to new location. Install new conductors where required to accomplish indicated results. Provide continuous new conductors without splices between J-boxes.

3.09 MISCELLANEOUS DEMOLITION

A. Replace surface features demolished because of the Contractor's activities back to its original condition.

3.10 EQUIPMENT TO BE SALVAGED OR RELOCATED

A. Contractor shall request the Officer-in-Charge to identify all items to be salvaged prior to the start of the Work. Salvaged items shall be properly disconnected to retain their full salvage value and cleaned before turning over to the City.

B. Do not damage equipment during removal. Repair or replace any damaged equipment at no expense to the Officer-in-Charge.

C. Properly store and maintain equipment and materials when removed.

3.11 PHOTOGRAPHS AND VIDEOS

A. Prior to the removal of existing construction, create photographs or videos of the existing construction to be removed in accordance with Section 01 45 21 to provide documentation of this facility and its surroundings. Submit photographs and/or video to the Officer-in-Charge for the record.

3.12 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be considered incidental and included in the lump sum bids for the respective line items in the Proposal Schedule.

END OF SECTION

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SECTION 03 11 00

CONCRETE FORMING

PART 1 GENERAL

1.01 SUMMARY

A. This Section describes formwork requirements for concrete construction.

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 03 30 00 – Cast-In-Place Concrete

1.03 REFERENCES:

A. The references listed below are part of this section. 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, the requirements of this section shall prevail.

Reference	Title
ACI 117	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 350.5	Specifications for Environmental Concrete Structures
National Institute of Standards - PS1	Construction and Industrial Plywood

1.04 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. Manufacturer's product data with installation instructions:
      a. Form materials.
      b. Form ties (with waterstops).
      c. Form release compound.

B. Informational Submittals:
   1. Procedures: Section 01 33 00.
   2. Letter of certification:
      a. Stating that formwork has been designed in accordance with this specification and referenced documents, sealed, and stamped by the Contractor’s registered design Engineer.

1.05 QUALITY ASSURANCE

A. Design – General:
   1. Provide design of formwork, shoring and reshoring systems by the Contractor's Professional Engineer currently registered in the State of Hawaii.
   2. Design, engineering, and construction of formwork, shoring, and reshoring systems is the responsibility of the Contractor.
   3. Develop a procedure and schedule for removal of shores (and installation of reshores).
   4. Structural record calculations, signed and sealed by the Contractor's Engineer, are required to prove that all portions of the structure, in combination with the remaining forming and shoring systems, have sufficient strength to safely support their own weight plus the loads placed thereon.
   5. When developing procedures, schedules, and structural calculations; consider the structural system that exists, effects of imposed loads, and the strength of concrete at each stage of construction.

B. Design Criteria:
   1. Design formwork in accordance with ACI 301 and ACI 318 for building structures and ACI 350 and 350.5 for environmental structures to provide concrete finishes as specified in Section 03 30 00.
   2. Design systems for full height of wet concrete pressure.
   3. Design formwork to limit maximum deflection of form facing materials, as reflected in concrete surfaces exposed to view, to 1/240 of span.

PART 2 PRODUCTS

2.01 FORMS

A. Wood Forms:
   1. Provide new and unused exterior grade plywood panels manufactured in accordance with American Plywood Association (APA) and bearing the trademark of that group.
      a. Forms for concrete surfaces exposed to view: use APA High Density Overlay (HDO) Plyform Class I Exterior 48" X 96" X 3/4".
      b. Forms for other concrete surfaces: use APA Douglas Fir B-B Plyform Class I Exterior 48" X 96" X 3/4-inch.
   2. When approved, plywood may be reused.

B. Metal Forms:
   1. Do not use aluminum. Provide forms free of rust and straight without dents to provide members of uniform thickness.

2.02 FORM TIES

A. Commercially fabricated for use in form construction. Fabricated so that ends or end fasteners can be removed without causing spalling at surfaces of the concrete. Cone on ends shall be 3/4 inch to 1 inch diameter. Provide embedded portion of tie not less than 1 1/2 inch from face of concrete after cone ends have been removed. Provide ties with integral waterstops at water-retaining and below grade structures.

B. Tapered through-bolts may be used when approved. Use 1-inch minimum diameter at the smallest end. Fill tapered tie holes after cleaning to produce watertight construction. Use a mechanical waterstop plug near the center of the wall and fill each side with non-shrink cement grout. Mechanical waterstop plug shall be Greenstreak Group, Inc. “X-Plug”; or approved equal.

2.03 FORM RELEASE COMPOUND

A. Coat form surfaces in contact with concrete using a non-staining, non-residual, water based, bond-breaking form coating.

PART 3 EXECUTION

3.01 PREPARATION

A. Cover surface of forms with form release compound prior to form installation in accordance with manufacturer’s recommendations.
B. Do not permit excess form coating material to stand in puddles on forms or hardened concrete surfaces against which fresh concrete is to be placed.
C. Clean surfaces of forms, reinforcing steel and other embedded items of accumulated mortar, grout, or other foreign materials from previous concreting or construction activities before concrete is placed.

3.02 FORMWORK CONSTRUCTION

A. Form vertical surfaces of cast-in-place concrete including sides of footings.
B. Construct and place forms so that the resulting concrete will be of the shape, lines, dimensions, and appearance indicated on the Drawings. Brace or tie forms together to maintain position and shape under the load of freshly-placed concrete.
C. Tighten forms to prevent leakage.
D. Provide temporary openings(windows) at base of column and wall forms and at other points where necessary to facilitate cleaning and observation immediately before concrete is placed.
E. Provide temporary openings 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, spaced no more than 8 feet on center measured horizontally and vertically.
F. Place a 3/4-inch chamfer strip at exposed to view corners of formed surfaces.
G. At construction joints, overlap hardened concrete surface by at least 1 inch. Brace forms against hardened concrete to prevent movement, offsets, or loss of mortar at construction joint and to maintain a true surface. Where possible, locate juncture of built-in-place forms at architectural lines, control joints, or at other inconspicuous lines.
H. Where circular sections are formed using flat faced materials, use flat form lengths not exceeding 2 feet wide and the resulting deflection angles at the joints is not greater than 3-1/2 degrees.
I. Construct wood forms for openings to facilitate loosening. Anchor forms so that movement of any part of the formwork system is prevented during concrete placement.

J. At platforms constructed to move equipment over in-place reinforcement, provide beams, struts, and/or legs, supported directly on formwork or other structural members without resting on reinforcing steel.

K. Provide a positive means of adjustment (wedges or jacks) at shores and struts to take up settlement during concrete placement. Brace forms against lateral deflection. Fasten in-place wedges and shims used for final adjustment of forms prior to concrete placement.

L. Place tapered through-bolt form ties with the larger end on the side of the structure in contact with liquid.

3.03 TOLERANCES

A. Install formwork with tolerances in accordance with ACI 117 and the following (the more stringent requirement controls):

1. Install formwork in accordance with manufacturer's written instructions.
2. Vertical surface tolerance from plumb; walls, columns, piers, and risers:
   ± 1/2 inch for entire height
   ± 1/4 inch in any 10 feet of height
3. Vertical surface tolerance from plumb; exposed wall corners, end columns, control-joint grooves, and other exposed to view vertical lines:
   ± 1/2 inch for entire height
   ± 1/4 inch in any 20 feet of height
4. Horizontal variation from level or from grade; top of slabs, slab soffits, ceilings, and beam soffits, measured before removal of supporting shores:
   ± 3/4 inch for entire length
   ± 3/8 inch for any bay or 20 foot length
   ± 1/4 inch in any 10 feet of length
5. Horizontal variation from level or from grade; exposed lintels, sills, parapets, horizontal grooves, and other exposed-to-view horizontal lines:
   ± 1/2 inch for entire length
   ± 1/4 inch in any 20 feet of length.
6. Plan position variation; columns, walls, and partitions:
   ± 3/4 inch for entire length
   ± 3/8 inch for any bay or 20 foot length
7. Plan location and size; sleeves, floor openings, walls, wall openings, beams, and columns:
   ± 1/2 inch
8. Cross sectional dimensions; columns and beams and thickness of slabs and walls:
   ± 3/8 inch
9. Plan dimensions; footings and foundations:
   minus 1/2 inch
   + 2 inches
10. Misplacement or eccentricity; footings and foundations:
    2 percent of footing width in direction of misplacement
    not more than 2 inches
11. Thickness; footings and foundations:
    minus 5 percent, no limit on the maximum increase except that which may interfere with other construction.

12. Step variance in flight of stairs:
    Rise ± 1/16 inch
    Tread from level ± 1/8 inch

B. Use control points and benchmarks for reference purposes to check tolerances. Establish and maintain reference points in an undisturbed condition until final completion and acceptance of the work.

C. Regardless of tolerances listed, no portion of a structure shall extend beyond the legal boundary of work site.

D. Camber formwork to compensate for anticipated deflections in formwork under wet load of concrete. Adjust camber to maintain above specified tolerances in hardened concrete after forms and shoring are removed.

3.04 REMOVAL OF FORMS

A. Do not impose construction loads or remove shoring from any part of the structure until that portion of the structure in combination with remaining forming and shoring systems has sufficient strength to safely support its weight and loads placed thereon.

B. If forms are loosened and not removed, proceed same day with wet curing operations to soak surfaces of concrete where forms are loosened. When wet curing is not practical or not planned, loosen, remove, and start approved curing procedures on the same day.

C. When required for concrete curing in hot weather, required for repair of surface defects, or when required for finishing at an early age; remove forms as soon as concrete has hardened sufficiently to resist damage from removal operations or lack of support.

D. Remove top forms on sloping surfaces as soon as concrete has attained sufficient stiffness to prevent sagging. Make repairs or finishing treatment on such sloping surfaces immediately after form removal.

E. Remove wood forms for wall openings as soon as this can be accomplished without damage to concrete.

F. Remove formwork from columns, walls, sides of beams, and other parts not supporting weight of concrete as soon as concrete has hardened sufficiently to resist damage from removal.

G. When shores and supports are so arranged such that non-load-carrying form facing material can be removed without loosening or disturbing other shores and supports, facing material may be removed when concrete has sufficiently hardened to resist damage from removal.

H. In all cases, proceed with curing same day as form removal.

I. 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-calendar day compressive strength.

3.05 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be included in the lump sum bids for the respective items in the Proposal Schedule.

END OF SECTION

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SECTION 03 20 00

CONCRETE REINFORCING

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies reinforcing steel for use in reinforced concrete.

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

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
ACI 117	Specification for Tolerances for Concrete Construction and Materials
ACI 315	Details and Detailing of Concrete Reinforcement
ACI 318	Building Code Requirements For Structural Concrete
ACI SP-66	ACI Detailing Manual
ASTM A615	Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A706	Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A1064	Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
AWS D1.4	Structural Welding Code - Reinforcing Steel
CRSI-PRB	Placing Reinforcing Bars
CRSI-MSP	Manual of Standard Practice
FEDSPEC QQ-W-461H	Wire, Steel, Carbon (Round, Bare, and Coated)

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. Mill certificates of mill analysis, tensile, and bend tests for all reinforcing.
5. Manufacturer and type of proprietary reinforcing steel splices. Submit a current ICC Report and manufacturer's literature that contains instructions and recommendations for each type of coupler used.
6. Qualifications of welding operators, welding processes and procedures.
7. 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.

1.05 DELIVERY, STORAGE AND HANDLING

A. Ship reinforcing steel 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.

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. Where specified, reinforcing steel shall be epoxy-coated in conformance with ASTM A775.

2.02 WIRE FABRIC

A. Wire fabric shall be welded steel mesh conforming to ASTM A1064.

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 A1064.

2.04 TIE WIRE

A. The wire shall be minimum 16 gage annealed steel conforming to FEDSPEC QQ-W-461H.

2.05 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 and placed in accordance with CRSI-PRB. Plastic coating on legs shall extend at least 0.5-inch upward from form surface.

B. Provide precast concrete blocks, four inches square in plan, with embedded tie wires (wire dobies) as specified by CRSI 1 MSP 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. Precast concrete blocks shall have same or higher compressive strength as specified for concrete in which they are located.

C. Provide stainless steel or plastic protected plain steel supports for other work.

2.06 FABRICATION:

A. Fabricate reinforcing steel bars in accordance with ACI 315 and the following tolerances:
   1. Sheared lengths: +/-1 inch.
   2. Overall dimensions of stirrups, ties, and spirals: +/-1/2 inch.
   3. All other bends: +0 inch, -1/2 inch
   4. Minimum diameter of bends of reinforcing steel bars: Per ACI 318.

PART 3 EXECUTION

3.01 PLACEMENT 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 +/-1/4 inch of specified clearance and minimum spacing between bars shall be a maximum of 1/4 inch less than specified.
   2. Reinforcing steel top bars in slabs and beams shall be placed +/-1/4 inch of specified depth in members 8 inches deep or less and -1/4", +1/2 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 1/2 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. Use Class B splice lengths in accordance with ACI 318 for all reinforcing steel bars unless shown otherwise on the drawings.
   2. Unless noted otherwise on the Drawings, splices in circumferential reinforcement in circular walls shall be Class B tension splices and shall be staggered. Adjacent hoop reinforcement splices shall be staggered horizontally by not less than one lap length (center of lap below to center of lap above) or 3 feet, whichever is greater, and shall not coincide in vertical arrays more frequently than every third bar.
   3. Splicing of reinforcing elements noted as “tension tie” members on the Drawings shall be avoided whenever possible. If splices cannot be avoided, the splices shall be made with full mechanical or full welded splice capable of developing at least 125 percent of the specified yield strength of the bar. Splices in adjacent bars shall be staggered at least 30 inches.
   4. 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.
   5. Splices of reinforcement steel bars not specifically indicated or specified shall be subject to the approval of the Officer-in-Charge. Mechanical proprietary splice connections may be used when approved by the Officer-in-Charge or as indicated on the drawings.
   6. Welding of reinforcing steel bars is not allowed unless approved by the Officer-in-Charge.

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. 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.
   3. 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. Place spacer reinforcing steel bars at a maximum of 3'-0" on center to maintain the minimum clear spacing between layers.
   4. Extend reinforcement to within 2 inches of formed edges and 3 inches of the concrete perimeter when concrete is placed against earth.
   5. Reinforcing steel bars shall not be bent after embedding in hardened concrete unless approved by the Officer-in-Charge.
   6. Tack welding or bending reinforcing steel bars by means of heat is prohibited.
   7. 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.
   8. Bars with kinks or with bends not shown shall not be used.
   9. Heating or welding bars shall be performed in accordance with AWS D1.4 and shall only be permitted where specified or approved by the Officer-in-Charge. Bars shall not be welded at the bend.

3.06 FIELD QUALITY CONTROL

A. Field quality control shall include the following:
   1. Notify the Officer-in-Charge whenever the specified clearances between the reinforcing steel bars cannot 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 Officer-in-Charge.
   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 this section. 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 Officer-in-Charge.
   3. Coated reinforcing steel bars will be inspected on the jobsite for handling defects, coating abrasion, coating thickness and continuity of coating. The Officer-in-Charge may defer final inspection of the coated reinforcing steel bars until bar erection and handling is complete. Repair coated areas as directed by the Officer-in-Charge and completed prior to concrete placement.

4. 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.

3.07 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be included in the lump sum bids for the respective items in the Proposal Schedule.

END OF SECTION

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies cast-in-place concrete, which consists of providing material, mixing, transporting equipment, and labor for the proportioning, mixing, transporting, placing, consolidating, finishing, curing, and protection of concrete in the structure.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related specification sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 33 00 – Submittal Procedures
   2. Section 01 40 00 – Quality Assurance, Inspection, and Testing
   3. Section 03 60 00 – Grouting
   4. Section 09 90 00 – Painting and Coating

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
ACI 117	Tolerances for Concrete Construction and Materials
ACI 211.1	Selecting Proportions for Normal, Heavy Weight and Mass Concrete
ACI 301	Specifications for Structural Concrete
ACI 305.1	Specification for Hot Weather Concreting
ACI 306.1	Standard Specification for Cold Weather Concreting
ACI 214R	Guide to Evaluation of Strength Test Results in Concrete
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 Containment Structures
ACI 503.7	Crack Repair by Epoxy Injection
ASTM C31	Making and Curing Concrete Test Specimens in the Field
ASTM C33	Concrete Aggregates
ASTM C39	Compressive Strength of Cylindrical Concrete Specimens
ASTM C42	Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
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

Reference	Title
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)
ASTM C1315	Liquid Membrane-Forming Compounds for Curing and Sealing Concrete
ASTM C1567	Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate
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
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 (✓) 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 signify compliance with the specification. Include a detailed, written justification for each deviation. Failure to include a copy of this marked-up specification section, along with justification(s) for requested deviations, with the submittal, is cause for rejection of the entire submittal with no further consideration.
   4. Each proposed mix design showing:
      a. Expected strength at 7 and 28-days
      b. Slump, before and after introduction of high-range water-reducing admixture
      c. Water/cement ratio
      d. Weights and test results of the ingredients
      e. Aggregate gradation
      f. Test results of mix design prepared by an independent testing laboratory

g. Shrinkage test results for liquid containing structures
h. Other physical properties necessary to review each mix design for conformance with these specifications

5. Mix designs proposed shall be sealed by a Professional Engineer registered in Hawaii.
6. Product literature and technical data for aggregates, cement, and pozzolan.
7. Product literature, technical data, and dosage of proposed admixtures including, but not limited to, air entraining, water reducing, retarding, shrinkage reducing, crystalline waterproofing, etc.
8. Anticipated average delivery time from batch plant to site. If this time exceeds the limit specified in Part 3, include proposed method to extend set time without deleterious effects on final product. Officer-in-Charge reserves the right to accept or reject such proposed methods.
9. Lift Drawings: Submit shop drawings for concrete placements on the project before on-site construction begins. The drawings shall be organized by structure and submitted as a complete set for the Engineer's review. The drawings shall be drawn to scale and show dimensions, forming details, and placement volumes. Show location of construction joints, details of surface preparation, scheduled finish, embedments, penetrations, openings, keyways, blockouts, bulkheads, etc. The drawings shall clearly show the placement sequence and will be accompanied by a schedule that shows the schedule dates for forming, placement, and stripping for each section of concrete placed within each structure.
10. Curing program description in sufficient detail to demonstrate that the Contractor will provide acceptable strength, finish, and crack control within the completed structure.
11. Product literature and technical data for waterstops, curing and sealing compounds, bonding compounds, surface hardeners, epoxy and chemical grout for crack injection, retardant, bearing pads, and trench drains.
12. Sample panels to demonstrate formed wall surface finishes as specified in Part 3.
13. Samples of concrete floor and slab finishes as specified in Part 3.
14. Concrete delivery truck tickets showing the information listed in ASTM C94, section 14.
15. Neoprene bearing pad sample, 4 inches x 4 inches; material data sheets verifying conformance with specification; shop drawing of each bearing pad showing splice locations, if any, and description of manufacturing and splice procedure.
16. Product data for prefabricated trench drains: material properties, cover, dimensions, and manufacturer's installation instructions.

1.05 QUALITY ASSURANCE

A. Quality Control by Owner:
   1. The Officer-in-Charge shall throughout the duration of construction, inspect construction and witness required testing to assure Contractor conformance with these specifications. Testing to be witnessed shall include special inspections and associated testing, as specified in this Section and as shown on the drawings for compliance with IBC Chapter 17, in addition to testing required of the Contractor in this and other specification sections.
   2. Refer to Section 01 40 00.

B. Quality Control By Contractor:
   1. Special Inspection of concrete work shall be performed by the Special Inspector in conformance with the IBC Chapter 17. Special Inspection of concrete is in addition to, not replacing, other inspections and quality control requirements specified herein. Where sampling and testing specified 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 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. 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 and ASTM C1077. The testing laboratory shall sample and test concrete materials as specified in this section. Costs of testing laboratory services shall be borne by the Contractor.
   4. Concrete testing laboratory personnel shall be certified in accordance with the ACI Concrete Laboratory Testing Technician – Level 1 Certification Program or the ACI Concrete Strength Testing Technician Certification Program, or an equivalent program.
   5. Refer to Section 01 40 00.
C. Basis For Quality:
   1. Cast-in-place concrete shall conform to the requirements of ACI 301, except as modified herein.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Cement:
   1. Store cement bags immediately upon receipt in a weatherproof structure as airtight as practicable. Elevate floor above ground to prevent absorption of moisture. Stack bags close together to reduce circulation of air but do not stack against outside walls. Stack to permit easy access for inspection and identification of each shipment.
   2. Transfer bulk cement to elevated airtight and weatherproof bins. At the time of use, cement shall be free flowing and free of lumps. Do not use cement which has been in storage longer than 180 calendar days.
B. Aggregates:
   1. Store aggregates on areas covered with tightly laid wood planks, sheet metal, or other hard and clean surfaces in a manner that will preclude the inclusion of foreign material. Store aggregates of different sizes in separate piles. Build stock piles of coarse aggregate in horizontal layers exceeding 4 feet in depth to minimize segregation. Remix segregated aggregates to conform to the grading requirements.
C. Admixtures:
   1. Store admixtures to prevent damage. Do not use air-entraining admixture which has been in storage for longer than 180 calendar days or has been frozen.
D. Pozzolan:
   1. Deliver and store pozzolan in the same manner as cement.

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. See Change of Materials paragraph below.

B. Ground granulated blast-furnace slag (GGBFS), if used in conjunction with portland cement, shall be per ASTM C989.

C. Aggregates:
   1. General:
      a. Except as modified herein, fine and coarse aggregates shall conform to ASTM C33. Fine and coarse aggregates are regarded as separate ingredients. Aggregates shall be non-reactive and washed before use.
      b. Check aggregates 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 may still be satisfactory provided ASTM C1567 concrete mix test results are submitted and show an expansion of less than 0.1% at 16 calendar days. Test results shall be no older than 1 year.
      c. 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. Establish the final combined aggregate gradation during mix design.
      d. Aggregates used in the project production concrete shall be obtained from the same sources and have the same size ranges as the aggregates used in the concrete represented by the submitted historical data or trial mixtures. See Change of Materials paragraph below.
   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.

b. Variations from the specified gradations in individual tests will be acceptable if the average of three consecutive tests is within the specified limits and the variation is within the permissible variation listed below:

U.S. standard sieve size	Permissible variation in individual tests, percent
30 and coarser	2
50 and finer	0.5

Other tests shall be in accordance with the following specifications:

Test	Test method	Requirements
Amount of material	ASTM C117	3 percent passing No. 200 sieve maximum by weight
Sand equivalent	ASTM D2419	Minimum 70 percent

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 shall conform to ASTM C33, Table 2.
   b. Variations from the specified gradations will be acceptable in individual tests if the average of three consecutive tests is within the specified limits.

D. Pozzolan:
   1. Pozzolan shall be Class N, natural pozzolan, or 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 Change of Materials paragraph below.
   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.

E. 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. Use admixtures in accordance with the manufacturer's recommendations and add separately to the concrete mix. 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 requirements specified in Part 3.
   2. Water Reducing Admixtures:
      a. Conform to ASTM C494, Type A. Acceptable products include: BASF “MasterPozzolith 322”; SIKA Chemical Corp. “Plastocrete 161”; Euclid Chemical Co. “Eucon WR 91”; or approved equal.
   3. Water Reducing and Retarding Admixtures:

a. Conform to ASTM C494, Type D. Acceptable products include: BASF "MasterPozzolith 80"; Sika Chemical Corp. "Plastiment"; Euclid Chemical Co. "Eucon Retarder 75"; or approved equal.

4. High Range Water Reducing (Superplasticizing) Admixtures:
   a. Conform to ASTM C494, Type F. Acceptable products include: BASF "MasterGlenium" Series; Sika Chemical Corp. "Viscocrete 2100" or "Viscocrete 2110" (Hot Weather) or "Viscocrete 6100" (Cold Weather); Euclid Chemical Co. "Eucon 37"; W.R. Grace "ADVA 195"; or approved equal.
5. High Range Water Reducing And Retarding Admixtures:
   a. Conform to ASTM C494, Type G. Acceptable products include: W.R. Grace "Daracem 100"; Sika Chemical Corp. "Sikaplast 200" ; Euclid Chemical Co. "Eucon 537"; or approved equal.
6. Air Entraining Agent:
   a. Conform to ASTM C260 and produce air entrained concrete as specified in the Mix Proportioning table below. Acceptable products include: BASF "MasterAir Series"; Sika Chemical Corp. "AEA-15"; Euclid Chemical Co. "AEA-92"; or approved equal.
7. Crystalline Waterproofing Admixture:
   a. Select admixture for compatibility with other ingredients in the concrete mix. Acceptable products include: Penetron International "PENETRON ADMIX SB", Xypex "Admix C-Series", Kryton "Krystol Internal Membrane (KIM)", or approved equal.

F. Water:
1. For washing aggregate, mixing, and for curing shall be free from oil and deleterious amounts of acids, alkalis, and organic materials; comply with the requirements of ASTM C1602. Additionally, water used for curing shall not contain an amount of impurities sufficient to discolor the concrete.

G. Change of Materials:
1. After each concrete mix design is approved, no changes of any sort or source will be allowed without prior written approval from the Officer-in-Charge. 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 Officer-in-Charge before use in concrete.

2.02 CONCRETE CHARACTERISTICS

A. Mix Proportioning:
1. Concrete shall be normal weight concrete composed of cement, pozzolan, admixtures, aggregates, and water; proportioned and mixed to produce a workable, strong, dense, and impermeable concrete. It is acceptable to 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.

2. Provide concrete mix designs in accordance with the following guidelines:

Concrete class	Minimum[a] 28-day compressive strength, psi	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)	Slump range[f] (inches)
B	3500	57 or 67	0.45	560	15-20[d]	4-6	3-5
C-1	4500	57 or 67	0.40	560	15-20	4-6	3-5
C-2	4500	57 or 67	0.42	560	15-20[d]	4-6	3-5
E[c]	2000	57	--	-	15-20[d]	Not Required	4-8

[a] *Determine compressive strength at the end of 28 calendar days based on test cylinders made and tested in accordance with ASTM C39.*

[b] *Not used.*

[c] *Concrete encasement for electrical conduit shall contain 3 pounds of red oxide per sack of cement.*

[d] *Pozzolan use is optional for this class of concrete.*

[e] *Not used*

[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. Provide concrete by class for the uses listed below.

Concrete class	Type of use
B	Non-structural concrete (sidewalks, curbs, pavers, pavements, supports etc.)
C-1	Typical cast-in-place structural concrete
C-2	Precast concrete vaults
E[a]	Pipe bedding and encasement, electrical conduit encasement (duct banks) and concrete fill

a Contractor's option to use the same concrete mix for pipe encasement as the concrete slab above.

C. Control Tests:

1. General:
   a. Select and adjust proportions of ingredients 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 Data method. Do not place concrete prior to submittal and acceptance of proposed mix.
2. Trial Mix Design:
   a. Mixes verified by this method shall have the samples produced for testing, manufactured at the batch plant which will supply concrete to the project, using materials proposed for the Work and material combinations listed above. Testing, data, and reporting shall conform to ACI 318 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 different trial 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) Design trial mixtures to produce a slump within ¾ inch of the maximum specified and an air content within 0.5 percent of the maximum specified.

4) For each w/cm ratio or cementitious materials content, cast and cure at least twelve standard test cylinders in accordance with ASTM C192. Four cylinders from each batch tested at age 7-calendar days, 14-calendar days, and 28-calendar days or as required to comply with ACI 318.

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 to be used unless a lower w/cm ratio is specified above.

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, 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) slump after introduction of admixtures +0/-1 inch.

b. Use of historical Field Experience Data does not allow modification of the project mix specifications herein without review and acceptance by the Officer-in-Charge.

2.03 WATERSTOPS

A. Polyvinyl Chloride (PVC):

1. Manufacture PVC waterstops from virgin polyvinyl chloride conforming to the Corps of Engineers Specification No. CRD-C572. Use 6-inch flat center/ribbed sides/0.375 inch thick less waterstops in construction joints. Acceptable products include: Greenstreak Group, Inc. "Model 679"; Vinylex Waterstops and Accessories "Model R638"; or approved equal. Use 9 inch center-bulb/ribbed sides/0.375 inch thick waterstops in expansion joints. Acceptable products include: Greenstreak Group, Inc. "Model 696"; Vinylex Waterstops and Accessories Model "RLB938"; or approved equal.

2. Use molded crosses, tees, and other shapes for changes of direction, intersections, and transitions or cut and splice as recommended by the manufacturer.

B. Expanding (Hydrophilic) Waterstops:
   1. Expanding waterstops shall be bentonite-free and made from unvulcanized rubber. Acceptable products include: Adeka Corporation “Ultra Seal MC-2010MN”; Greenstreak Group, Inc. “Hydrotite CJ-1020-2K”; or approved equal. These are allowable for use only where indicated on the drawings or accepted in writing by the Officer-in-Charge. Provide adhesive approved by the waterstop manufacturer plus concrete nails and fender washers to secure waterstop material in-place during concrete placement. The waterstop MUST be placed between two mats or curtains of steel reinforcement.
   2. For limited cover applications or where only one mat or curtain of reinforcement is present, use Adeka Corporation “Ultra Seal KBA-1510FP”or approved equal.

2.04 SEALANTS AND JOINT FILLERS

A. Sealants and preformed joint fillers are specified in Sections 07 92 00 and 07 91 26.

2.05 BONDING COMPOUNDS

A. Epoxy resin bonding compounds for use in wet areas shall conform to ASTM C881 Types IV or V, Class A, B, or C depending on temperature at use. Acceptable products include: BASF “MasterEmaco ADH 327RS” or “MasterEmaco ADH 1490”; Sika Chemical Corporation “Sikadur 32”; or approved equal.
B. Non-epoxy bonding compounds for use in dry areas for non-structural bonding or as noted on the drawings shall conform to ASTM C1059 Type II. Acceptable products include: Edoco “Burke Acrylic Bondcrete”; ChemMasters “Cretelox”; or approved equal.
C. Apply bonding compounds in accordance with the manufacturer’s instructions.

2.06 EPOXY FOR CRACK INJECTION

A. Use a two-component, moisture insensitive, high modulus, injection grade, 100 percent solids, epoxy-resin blend. Consistency as required to achieve complete penetration into cracks. Material shall conform to ASTM C881 Type 1 Grade 1. Acceptable products include: Sika Corporation “Sikadur 52”; Adhesives Technology Corporation “Crackbond SLV302”; or approved equal.
B. Use epoxy injection for structural crack repairs except as noted below for non-structural cracks in liquid-containing concrete structures. The Officer-in-Charge shall determine whether a crack is classified as structural or non-structural.

2.07 CHEMICAL GROUT FOR CRACK INJECTION

A. Use hydrophobic polyurethane grout at the Officer-in-Charge's discretion as an alternative for sealing non-structural cracks in concrete structures intended to be watertight. Acceptable products include: DeNeef Construction Chemicals "Hydro Active Cut" and “Flex SLV PURe” or Sika Corporation “SikaFix HH Plus” and “SikaFix HH LV”; or approved equal.

2.08 RETARDANT

A. Retardant for exposing aggregate for unformed surfaces in construction joints shall be Sika Corporation“Rugasol-S”; W.R. Grace “Top-Cast”; or approved equal.

B. Apply retardant in accordance with manufacturer's instructions sufficient to assure a minimum penetration of 1/4 inch.

2.09 CURING AND SEALING COMPOUNDS

A. Acceptable products include: BASF "MasterKure CC 250SB"; Dayton Superior "Cure & Seal 25% J22UV"; or approved equal, conforming to ASTM C309 and ASTM C1315.
B. Compound shall be clear and applied in accordance with the manufacturer's instructions.
C. Curing and sealing compound shall be certified compliant with final finish system if applicable.

PART 3 EXECUTION

3.01 GENERAL

A. Introduce pozzolan into the mixer with cement and other components of the concrete mix; do not introduce pozzolan into a wet mixer ahead of other materials or with mixing water.
B. Introduce water at the time of charging the mixer; additional water may be introduced within 45 minutes from charging the mixer, provided the specified w/c ration and slump is not exceeded and the maximum total water per the approved mix design is not exceeded.
C. Arrange with the testing laboratory for inspection as required to comply with these specifications.

3.02 BATCHING:

A. General:
    1. Batch concrete only from equipment with a current National Ready Mix Concrete Association Certificate of Compliance. Provide and maintain such means and equipment as are required to accurately determine and control the relative amounts of the various materials, including water, cement, pozzolan, admixtures, sand and each size of coarse aggregate used in the concrete.
    2. Proportion concrete batches on the basis of integral sacks of cement unless the cement is weighed. Introduce pozzolan into the mixture only with cement and other dry components of the concrete mix. Do not introduce pozzolan into wet mixer ahead of other materials or with mixing water. Determine amounts of sand and coarse aggregate required for each batch of concrete by weighing, and the required water by either weighing or metering.
    3. Deposit aggregates in the batch bins directly over the discharge gates. Deposit coarse aggregate in the batch bins through rock ladders when the free drop of the aggregate exceeds 4 feet. Convey batch materials from the weighing and batching hoppers so that there will be no spillage of the batched materials or overlapping of batches.
    4. Provide sufficient trucks to continuously deliver batched material. Each truck shall carry a delivery ticket showing the mix number, size of batch, and time water was added to the batch.

B. Weighing And Metering Equipment:

1. Equipment shall be sealed by the state agency having authority over weights and measures and shall be capable of adjustment for compensating for the varying weights and moisture changes which affect the concrete mix proportions and concrete consistencies.
2. Batching equipment shall be constructed and operated so that when the entire plant is running, the combined inaccuracies in feeding and measuring materials will not exceed 1 percent for water or cement and pozzolan, 2 percent for any size of aggregate, and 1 1/2 percent for the total aggregate in any batch.
3. Design equipment for convenient confirmation of the accuracy required for each batch. The equipment for measuring water shall not leak when the valves are closed.
4. Provide standard test weights and other auxiliary equipment required for checking the operating performance of each scale or meter and make tests at intervals of not more than 6 months in the presence of the state inspector. Provide copies of the complete results of check tests made, and make such adjustments, repairs, or replacements as necessary to secure satisfactory performance.
5. Where the batch plant involves the use of storage bins and weighing hoppers, each weighing unit shall include a visible springless dial or equally suitable device which will register the scale load at any stage of the weighing operation from zero to full capacity. Construct weighing hoppers to permit the convenient removal of overweight material in excess of the prescribed tolerances. Each dial and water-measuring device shall be in view of the operator and, if practicable, arrange the weighing equipment so that the operator may conveniently observe the operation of the bin gates and also the materials discharged into the mixer hopper.
6. Batching equipment in automatic plants shall be interlocked so that:
    a. A new weighing cycle cannot be started until the batchers are emptied and the dispatcher discharge gates and valves are closed.
    b. The batcher discharge gate cannot be opened until the correct weights of the materials are in the batching hoppers and the scales in balance.
    c. The discharge gates cannot be closed until materials are entirely discharged from the hopper and are back in balance.
    d. The water batcher discharge valve cannot be opened until the filling valve is closed. The admixture dispenser shall be interlocked to operate with the water batcher.
7. Dispensers for admixtures shall have sufficient capacity to measure at one time the full quantity of solution required for each batch. Add admixtures to premeasured water for the batch, or arrange their discharge into the batch to flow uniformly into the water stream for the batch from beginning to end of its flow into the mixer. Dosages of admixtures shall not vary from the required dosage by more than 5 percent.

3.03 MIXING:

A. Mix the concrete ingredients in batch mixers until the mixture is homogeneous and uniform in consistency. Mix each batch for at least 1 1/2 minutes for concrete not containing pozzolan and for at least 2 minutes for concrete containing pozzolan after all the ingredients, except the full amount of water, are in the mixer. The minimum mixing period specified is predicated on control of the speed of rotation of the mixer and the introduction of materials, including water, into the mixer.

B. Add water prior to, during, and following the mixer charging operations. Excessive mixing time requiring the addition of water (retempering) to preserve and secure the required concrete consistency is not acceptable.

C. Mixers shall not be loaded in excess of their rated capacity. Equip each mixer with a satisfactory mechanically operated timing, signaling (or locking), and metering device for indicating and assuring the completion of the required mixing period and for counting the batches.

3.04 CONVEYING AND PLACING CONCRETE

A. Convey concrete from the mixer to the forms in accordance with ACI 301. Remove concrete that has segregated in conveying from the site of the work.

B. Placing Concrete:
   1. General:
      a. Place concrete in accordance with ACI 301. Do not permit concrete to drop freely more than 4-ft.
   2. Placing Concrete By Pumping:
      a. Concrete placed by pumping is at Contractor's discretion and shall not be the cause to change or relax specified mix design characteristics. Concrete shall possess the specified characteristics at the point of placement.
      b. Measure slump at the hose discharge, except as follows: Initial slump testing in each placement 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.
      c. Measure air content 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. Increase the air content of the delivered concrete at the inlet hopper 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.
      d. Before starting each pumping operation, prime the pump and line with a cement slurry to lubricate the system. Waste cement slurry outside the forms. Equip hose tip with a safety chain for recovery in case of hose blowout during pumping. Hose or accessories shall not remain in the freshly placed concrete.
      e. Use tremie placing techniques and equipment for 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 Officer-in-Charge has verified equipment including the tremie plug. Should the discharge line become open, with zones empty of concrete, cease pumping and re-primed with tremie plug installed before continuing.
   3. Placing Concrete In Hot Weather:
      a. In temperatures above 80 degrees F, place concrete in accordance with ACI 305.1.

3.05 CONSOLIDATING CONCRETE:

A. Consolidate concrete in accordance with ACI 301. If evidence of inadequate consolidation is observed, concrete placement will be suspended until Contractor provides a revised plan to achieve proper consolidation.

3.06 CURING AND SEALING

A. General:
   1. Cure concrete using water, a clear membrane curing compound, or by a combination of both methods. Coordinate repairs or treatment of concrete surfaces so that interruption of curing will not be necessary.
   2. Maintain concrete surface temperature between 50 degrees F and 80 degrees F for at least 5 calendar days. Cure concrete in hot weather (above 80 degrees F) in accordance with ACI 305.1. Cure concrete in cold weather (below 45 degrees F) in accordance with ACI 306.1.

B. Water Curing:
   1. Keep concrete continuously wet for a minimum of 10-calendar days after placement. Absorptive mats or fabric may be used to retain moisture during the curing period.
   2. Use water curing in hot weather for liquid containment structures. Cover forms and keep moist. Loosen forms as soon as possible without damage to the concrete, and make provisions for curing water to run down inside them. During form removal, take care to provide continuously wet cover to newly exposed surfaces.

C. Curing Compound:
   1. When curing compound is allowed, apply it as soon as the concrete has set sufficiently so as not to be marred by the application or apply it immediately following form removal for vertical and other formed surfaces. Preparation of surfaces, application procedures, and installation precautions shall follow manufacturer's instructions. For liquid containing structures, apply curing compound at twice the manufacturer's recommended dosage rate, applied in two coats perpendicular to each other.
   2. Do not use curing compound on concrete surfaces to be coated, waterproofed, moisture-proofed, tiled, roofed, or where other coverings are to be bonded In these cases, use water curing unless the curing compound is first removed or is compatible with the final finish covering.

3.07 PROTECTION

A. Protect concrete from injurious action by sun, rain, flowing water, frost, and mechanical means.

B. Loading green concrete is not permitted. Green concrete is defined as concrete with less than 100 percent of the specified strength.

C. Backfill shall not be placed against concrete walls until the concrete has reached the specified strength, connecting slabs and beams have been cast and have also reached the specified strength, and watertightness testing and repairs have been completed for liquid containing structures to the satisfaction of the Officer-in-Charge.

D. Arrangements for covering, insulating, heating, and protecting concrete in cold weather shall be in accordance with ACI 306.1.

3.08 CONSTRUCTION JOINTS

A. General:
   1. Place concrete in each unit of construction continuously. Before new concrete is placed on or against concrete which has set, retighten forms and clean foreign matter from the surface of the set concrete. Provide waterstops as specified.

B. Construction:
   1. Form construction joints by producing a rough surface of exposed aggregates using a surface retardant; include 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, remove retarded surface mortar either by high pressure water jetting or stiff brushing or combination of both so as to expose coarse aggregate. 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 expose coarse aggregate to ensure adequate bond and watertightness at the construction joints.

C. Locations:
   1. Provide construction joint locations as follows:
      a. Cast walls exceeding 50 feet in length in panels not to exceed 30 feet in length. Cast adjoining panels only after 5-calendar days have elapsed. Joints are not allowed within the lesser of 10 feet or 25 percent of the wall length from a corner unless specifically detailed thus on the drawings.
      b. Locate joints in beams or girders at or near the quarter point between supports.
      c. Make joints in the members of a floor system at or near the quarterpoint of the span.
      d. Make joints in walls and columns at the underside of floors, slabs, beams or girders and at the tops of footings or floor slabs.
      e. Cast slab panels in checkerboard patterns not to exceed 40 feet in length and not to exceed 900 square feet in area, with maximum 1 ½ to 1 ratio of side lengths. Minimum lapsed time between placing adjacent panels shall be 3-calendar days. The requirements for size of slab panel is waived if joints are located on the Drawings.
   2. Vertical construction joints shall have edges grooved or beveled at faces exposed to view including interior faces of basins and tanks. Seal grooves subjected to wetting or weather with joint sealant.
   3. Continue reinforcing steel and welded wire reinforcement through construction joints. Beams, girders, and floor slabs shall not be constructed over columns or walls until at least one calendar day has elapsed to allow for initial shrinkage in the column or wall. No joint will be allowed between a slab and a beam or girder unless otherwise shown. Joints shall be perpendicular to the main reinforcement. Provide waterstops in construction joints as specified.

3.09 INSERTS AND EMBEDMENTS

A. Inserts:
   1. Where pipes, castings, or conduits are to pass through structures, position in forms before placing concrete; or where shown on Drawings or approved by the Officer-in-Charge, provide openings in the concrete for subsequent insertion of such pipes, castings, or conduits. Provided waterstops and a slight flare in the form to facilitate grouting and permit the escape of entrained air during grouting.
   2. Provide additional reinforcement around openings. Use non-shrink grout to infill around inserts.
   3. Place horizontal conduits and pipes, in slabs and beams, between the top and bottom layers of reinforcement. Spacing and size limitations shall conform to ACI 318.
   4. Conduits and pipes shall not run directly beneath a column or base plate.
   5. Position conduit, pipe, dowels, and other ferrous items such that there will be a minimum of 2-inches clearance between said item and concrete reinforcement. Welding inserts to reinforcement is not permitted.
   6. The outside diameter of conduit or pipe shall not exceed one-fourth the slab or beam thickness.

B. Embedments:
   1. Gate frames, gate thimbles, special castings, channels, grating frames, or other miscellaneous metal parts to be embedded in concrete shall be secured in the forms prior to concrete placement.
   2. Embed anchor bolts and inserts in concrete as shown. Provide inserts, anchors, or other bolts necessary for the attachment of piping, valves, metal parts, and equipment.
   3. Provide nailing blocks, plugs, strips, and the like necessary for the attachment of trim, finish, and similar work. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable material to prevent entry of concrete. Do not use continuous anchor slots or strips in concrete intended to be watertight.
   4. Position operators or sleeves for gate or valve stems to clear reinforcing steel, conduit, and other embedments, and to align accurately with equipment.

3.10 EXPANSION JOINTS

A. Expansion joints shall be as shown. Do not extend reinforcement or other embedded metal items through expansion joints. Provide waterstops where indicated.

3.11 WATERSTOPS

A. Waterstops shall conform to ACI 301. Tie waterstops in position prior to placement of concrete to prevent movement and deformation.

B. Provide waterstops in construction and expansion joints as follows:
   1. Joints in parts of structures exposed to ground or water on one side and occupied by non-submerged equipment or by personnel on the other.
   2. Wall and slab joints of tanks and channels subject to water pressure.
   3. Waterstops shall be provided for the full height of the walls.
   4. Provide at other locations shown on the Drawings.

C. Field splices shall be at straight sections using heat fused welded, butt splices only. Lapping of splices or joining by means other than heat fused welding is not allowed.

D. Install hydrophilic waterstops according to manufacturer's recommendations. Surfaces of concrete shall be prepared level/plumb and to the smoothness required by manufacturer. Grind surface as necessary. Provide bonding adhesive and concrete nails with fender washers to hold waterstop in position during concrete placement.

3.12 MODIFICATION OF EXISTING CONCRETE

A. General:
   1. Verify structural dimensions related to or controlled by previously constructed or existing structures prior to concrete work.

B. Cutting or Coring Concrete:
   1. Saw cut concrete to a depth of 1 inch to form straight outlines of concrete areas to be removed. Where reinforcement is exposed due to saw cutting or core drilling and no new material is to be placed on the cut surface, provide a protective epoxy coating to the entire cut surface.
   2. Coat surfaces of oversized openings with an epoxy bonding compound prior to re-finishing with profiling mortar to the required opening size.
   3. Grind existing joint edges to create a chamfer matching those used on adjacent construction.
   4. Investigate concrete to be drilled, cored, or sawcut to determine location of reinforcing steel. Locate penetrations to clear existing reinforcing steel. Where not possible to avoid reinforcing steel, consult the Officer-in-Charge as to acceptability of cutting reinforcing steel and provide new reinforcing systems as directed.
   5. Locating methods include chipping to expose reinforcing steel, ground penetrating radar, X-ray, or magnetic flux devices. Locates of existing reinforcing shall be by the Contractor.

C. Joining New Concrete To Existing:
   1. Existing concrete surfaces to be joined with new concrete shall be cleaned and roughened by abrasive blasting, bush hammering, or other method to achieve ¼-inch amplitude surface. Remove existing metalwork, embeds, or other interfering items. Coat existing surface with epoxy bonding compound prior to placement of new concrete.

D. Post-Installed Anchors and Dowels:
   1. Use non-destructive methods for locating reinforcement prior to drilling operations. For anchor and dowel locations that interfere with reinforcement, attempt to relocate to avoid drilling through the reinforcement if possible.
   2. For situations that do not allow relocation, cutting of reinforcement for installation is subject to the following:
      a. Prior to drilling through reinforcement, the Contractor shall consult the Officer-in-Charge.
      b. Drill holes with a hammer drill and carbide bit (core drilled holes are not allowed), followed by brushing and air-cleaning with oil-free compressed air.
      c. Holes drilled through reinforcement must be in compliance with adhesive anchor assumptions for roughened hole surface typical of a hammer drill and carbide bit. No smooth hole surfaces are allowed.

d. Do not cut slab rebar within 24 inches of a supporting wall, column, or an opening in the slab.
e. No cutting of rebar is allowed in the middle third of slab spans for anchors with diameters equal to or greater than 3/4 inch.
f. Maximum of two rebar may be cut in any 10 foot width of slab.
g. Maximum of two rebar may be cut within any 10 foot width of concrete wall.
h. Maximum of one rebar may be cut within any 8 foot width of CMU wall.

3. For anchors that cannot be moved and that conflict with the above requirements, consult Officer-in-Charge for direction. It is not acceptable to cut reinforcement in beams, columns, precast members, or stairs.
4. Use a pre-manufactured, self-mixing, injectable, two-component, epoxy adhesive, as per Section 03 60 00. Follow manufacturer's recommendations and ICC Evaluation Report for installation.

E. Waterstops:
1. Where a waterstop between new and existing concrete is required, install either a hydrophilic waterstop or a retrofit waterstop as indicated.

3.13 FORMED SURFACE FINISHES

A. Repair Of Surface Defects:
1. Repair surface defects, including tie holes, minor honeycombing, or otherwise defective concrete in accordance with ACI 301. Clean areas to be repaired. Cut and chip out honeycombed or otherwise defective areas to solid concrete, to a depth of at least 1-inch. If defective area includes exposed reinforcing steel, correct by removing concrete a minimum of 1-inch beyond the reinforcing. Make edges of the cut perpendicular to the surface of the concrete in a neat rectangular pattern.
2. Joints shall be grooved to a radius or bevel of ¾-inch depth.
3. Finish patches on exposed surfaces to match and blend with adjoining work. Cure patches as specified for the concrete. Protect finished surfaces from stains and abrasions.

B. Formed Surface Finishes:
1. Finish A - Grout Rubbed Finish
a. After repair of surface defects, apply a grout rubbed finish in accordance with ACI 301 except that all form fins and other protrusions shall be completely removed. Lightly sandblast surfaces prior to sacking. Sandblasting shall occur after the specified curing period.
b. Add a PVA bonding compound to the mix water used in sacking mortar; as recommended by the manufacturer.
c. Provide Finish A at uncoated surfaces of stair wells, interior surfaces of equipment rooms, galleries, tunnels, operations areas, exposed channels and tanks from 1 foot below minimum water surfaces and up, and at permanently exposed vertical and sloped surfaces such as pipe chases.
d. Do not provide Finish A at concrete surfaces receiving a coating.

2. Finish B - Smooth Surface Finish
a. Initial surface preparation is the same as Finish A; repair surface defects and remove all form fins.

b. Provide Finish B at surfaces to be coated. See Section 09 90 00 for additional concrete surface preparation, including filling of bug holes, and coating requirements.

3. Finish C - Rough Form Finish
   a. Repair surface defects and imperfections greater than 3/8 inch in any dimension. Remove form fins and protrusions down to less than 3/8 inch projection.
   b. Provide Finish C or smoother, for interior surfaces of wet wells, tanks, and channels; from 1 foot below minimum water surface and down.
   c. Also apply Finish C to unoccupied interior areas not otherwise specified.
4. Finish D – Unfinished Surface
   a. Repair surface defects and otherwise leave the surfaces as they come from the forms, except plug tie holes and repair or remove defects greater than 1/2 inch in any dimension.

C. Sample Of Formed Surface Finish A:
   1. Provide a sample concrete panel, minimum 4 feet by 4 feet; representative of formed surface Finish A. The panel shall be representative of the workmanship and finish required, including repair of defects, filling of tie holes, sandblasting, and rubbing.
   2. The sample shall be approved by the Officer-in-Charge prior to the start of production work. The sample shall be on display at the job site, and finished surfaces shall match sample.

3.14 SLAB FINISHES

A. General:
   1. The finishes specified herein include surface finishes, treatments and toppings for floors and slabs. Do not use dry cement on new concrete surfaces to absorb excess moisture. Round edges to a radius of 1/2 inch.
   2. Slope floors to drain uniformly within a room or space. Unless otherwise specified, slope shall be a minimum of 1/8 inch per foot toward nearest drain. Restrict use of floor drains with only locally depressed slabs to locations specifically noted.
   3. Immediately after final finish is applied, the surface shall be cured and protected as specified in Curing, Sealing, and Protection paragraphs above.
   4. Where finish is not specified, floor slabs shall receive a Steel Trowel Finish.

B. Float Finish:
   1. Perform floating 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. Float as required to meet tolerance requirements of ACI 117 for a conventional surface.
   2. Floating shall close cracks and checks plus compact and smooth the surface. Refloat the slab to a uniform texture.
   3. Apply float finish to surfaces of channels, tank bottom slabs, tops of footings, and surfaces to receive insulation or roofing.

C. Steel Trowel Finish:
   1. Float the concrete surface as indicated above and then trowel in accordance with ACI 301.

2. Provide Steel Trowel Finish on floors and walking surfaces unless specified otherwise.

D. Broom Finish:

1. Float the concrete surface as indicated above, then immediately give the concrete a coarse transverse scored texture by drawing a broom or burlap belt across the surface in accordance with ACI 301.
2. Provide a Broom Finish for walks, top of tank walls, slabs-on-grade exposed to atmosphere, and where otherwise indicated.

3.15 RELATED SURFACES

A. Finishing of Unformed Surfaces:

1. Adjacent Unformed Surfaces:
   a. Tops of walls, buttresses, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces shall be struck smooth after concrete is placed and shall be Float Finished to a texture reasonably consistent with that of the adjacent formed surface.
   b. Continue final treatment of formed surface uniformly across the top of the unformed surface.
2. Pavements and Sidewalks:
   a. The surface of the concrete shall be screeded to grade and sloped to drain. After screeding, the surface shall be Float Finished followed by a Broom Finish.
   b. Round edges and expansion joints to a radius of 1/2 inch. Control joints shall be grooved or sawcut to a minimum depth of 1/4 the slab thickness.

3.16 FIELD SAMPLING AND TESTS

A. General:

1. Field sampling and tests shall be performed by an independent testing laboratory. Samples of aggregates and concrete will be obtained at such times to represent the quality of the materials and work throughout the project.
2. The laboratory shall provide necessary labor, materials and facilities for sampling aggregate and for casting, handling, and initially storing the concrete samples at the work site.
3. The minimum number of samples and tests are specified in Testing paragraph below.

B. Sampling:

1. Aggregates:
   a. General:
      1) Sample fine and coarse aggregates in accordance with ASTM D75 not less than 30 calendar days prior to the use of such aggregates in the work.
      2) Take samples at the discharge gates of the bins feeding the weigh hopper. Repeat sampling when the source of material is changed or when unacceptable deficiencies or variations from the specified requirements of materials are found.
      3) Aggregate samples shall be tagged and their sources identified.

b. Coarse Aggregate:
    1) Take a sample weighing between 50 and 60 pounds after the batch plant is brought up to full operation.
    2) Take samples to obtain a uniform cross section, accurately representing the materials on the belt or in the bins for sieve analysis.
c. Fine Aggregate:
    1) Take samples as specified for coarse aggregate.
    2) Take samples of sand when the sand is moist for sieve analysis and specific gravity tests.

2. Concrete:
    a. Take samples of plastic concrete in accordance with ASTM C172.
    b. Take samples at the hopper of mixing equipment or transit mix truck, except as noted in the Placing Concrete by Pumping subparagraph of the Conveying and Placing article above.

C. Testing:
1. Aggregate:
    a. A minimum of one test of coarse aggregate per 400 cubic yards of concrete used 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.
    b. A maximum of one test per day of each aggregate is required.
    c. Repeat of the entire concrete mix design 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.
        2) Concrete samples 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 slab or wall surface area placed per day. Provide additional cylinders when an error in batching is suspected. Each set of cylinders are cast from material taken from a single load of concrete.
        3) Casting, handling and curing of cylinders shall be in accordance with ASTM C31. For the first 24 hours after casting, keep cylinders 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 testing laboratory will transport the cylinders to their laboratory.

4) Testing of specimens for compressive strength shall be in accordance with ASTM C39. Each test shall consist of two 6 x 12 inch (or three 4 x 8 inch) test cylinders from each group of six (or nine) specimens. Test at the end of 7 calendar days and at the end of 28 calendar days. The remaining cylinders shall be tested at the end of 56 calendar days if the 28-calendar day strength reports below specification.

5) A strength test shall consist of the average strength of two 6 x 12 inch (or three 4 x 8). 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 Officer-in-Charge.

6) The average of any three consecutive 28-calendar 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. Not more than 10 percent of the individual strength test results shall have values less than the specified 28-calendar 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.

7) Provide certified reports of the test results directly to the Officer-in-Charge. Test reports shall include sufficient information to identify the mix used, the stationing or location of the concrete placement, and the quantity placed. Slump, water/cement ratio, air content, temperature of concrete, and ambient temperature shall be noted.

8) The 28-calendar 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 project and shall be available for the Officer-in-Charge's inspection at any time.

9) If the 28-calendar 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. Report changes and adjustments in writing to the Officer-in-Charge.

10) 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 Officer-in-Charge. Costs of such tests and/or analysis shall be borne by the Contractor.

b. Tests for Consistency of Concrete:

1) Measure slump in accordance with ASTM C143. Take samples for slump determination from concrete during placement. Tests shall be made at the beginning of concrete placement operation, whenever test cylinders are cast, and at subsequent intervals to ensure that the specification requirements are met.

2) For pumped concrete, measure slump in accordance with the Placing Concrete by Pumping subparagraph of the Conveying and Placing article above.

3) When high range water reducer is added at the site, slump tests shall be taken before and after addition of the admixture.

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. Perform temperature tests whenever test cylinders are cast.

2) Measure air content in accordance with ASTM C231 whenever test cylinders are cast. For pumped concrete, measure air content in accordance with the Placing Concrete by Pumping subparagraph of the Conveying and Placing article above.

D. Final Laboratory Report:

1. The testing laboratory shall provide a final report 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.
2. Include final quality control charts for compressive strength tests for classes of concrete specified in each major structure. Also include the concrete batch plant's coefficient of variation and standard deviation results for each class of concrete.

3.17 REPAIR OF DAMAGED AND CRACKED CONCRETE:

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 these requirements shall be repaired, as approved by the Officer-in-Charge, to bring the concrete into compliance. Repair methods shall be in accordance with ACI standards, including ACI 503.7, and are subject to the approval of the Officer-in-Charge.
2. Concrete that cannot be brought into compliance by approved repair methods will be rejected. Remove and replace rejected concrete work.
3. The cost of repairs and replacement of defective concrete shall be borne by the Contractor.

B. Repair Methods:

1. Damaged/defective concrete or concrete with crack widths exceeding 0.004 inches at liquid-containing and conveying structures or crack widths exceeding 0.006 inches for other structures shall be repaired by one of the following methods (only the Officer-in-Charge may determine that a defect or crack does not require repair):

a. Perform watertightness testing and repair as needed to meet leakage criteria in this specification even when liquid-containing and conveying structures meet the crack width criteria defined above.

b. Damaged or defective concrete includes surface defects, honeycomb, rock pockets, indentations greater than 3/16 inch, spalls, chips, air bubbles greater than 1/2 inch diameter, pinholes, bugholes, embedded debris, lift lines, sand lines, bleed lines, leakage from form joints, fins, projections, form popouts, texture irregularities, and stains or other color variation that cannot be removed by cleaning.

1) Damaged or defective concrete is repaired according to procedures outlined above under finish requirements, Repair of Surface Defects.

2. Crack Repair Method 1:
    a. Fill the joint or crack by drilling holes to the affected area (following the product manufacturer's details), install injection ports, and force epoxy or chemical grout (expanding urethane) into the joint under pressure.
    b. Material type and repair procedures shall be approved by Officer-in-Charge.
    c. After injection and curing; ports, sealing mix, and surface shall be cleaned and worked to match the adjacent specified finish.
3. Crack Repair Method 2:
    a. 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.
    b. At a minimum, prepare surface to be clean and dry with no visible detrimental material in cracks to be filled. Conform to temperature limitations of epoxy. Clean and refinish to match adjacent surfaces.
4. Crack Repair Method 3:
    a. Cut a bevel groove 3/8 to 1/2 inch in width and depth, use backer rod or tape, and fill with sealant in accordance with manufacturer's instructions.
    b. This repair method is only used where approved by Officer-in-Charge.
    c. Groove and sealant shall be applied on wet or hydrostatic pressure side of surface.

C. Repair Method Use:
1. Repair Method 1: For cracks in walls, surfaces sloped 1:1 or greater, beams, columns, structural slabs, overhead surfaces, and liquid retaining surfaces. Need for repair depends upon crack width, location, and leakage.
2. Epoxy grout is used for repair of structural cracks and chemical grout (expanding urethane) for repair of non-structural cracks at liquid-containing structures. The Officer-in-Charge shall determine whether a crack is classified as structural or non-structural.
3. Repair Method 2: Utilized in lieu of Method 1 for slabs when approved by Officer-in-Charge. Final finish shall match adjacent surfaces.
4. Repair Method 3: Limited to dry-surface slabs, walls subject to less than three feet of liquid pressure, or as approved by Officer-in-Charge. Repair Method 3 is not an equivalent repair method to Repair Methods 1 or 2, which shall be considered the standards.

3.18 CLEANUP

A. Upon completion of the work and prior to final inspection, clean all concrete surfaces as follows: Sweep with a broom to remove loose dirt, then mop and/or flush with clean water. Scrub by hand or machine as required to remove and blend stains or discolored areas.
B. Clean floors that have curing and sealing compound as stated above, followed by the final application of curing and sealing compound.

3.19 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be included in the lump sum bids for the respective items in the Proposal Schedule.

END OF SECTION

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SECTION 03 60 00

GROUTING

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies grout for column base plates, other structural supports, equipment bases, reinforcing bar dowels, surface repair, grout toppings, patching of fresh concrete, and uses other than masonry. Adhesive anchor bolt grouting is specified in Section 05 05 20. Topping concrete over precast elements and clarifier topping concrete is specified in Section 03 30 00.

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 40 00 – Quality Assurance, Inspection, and Testing
   3. Section 03 30 00 – Cast-In-Place Concrete
   4. Section 05 05 20 – Anchor Bolts

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
ASTM C109	Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2 inch or 50 mm Cube Specimens)
ASTM C230	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 C939	Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)
ASTM C531	Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
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 Compressive Strength of Grouts for Preplaced-Aggregate Concrete in the Laboratory
ASTM C1107	Packaged Dry, Hydraulic-Cement Grout (Non-shrink)

Reference	Title
ASTM C1181	Standard Test Methods for Compressive Creep of Chemical-Resistant Polymer Machinery Grouts
ASTM E329	Agencies Engaged in Construction Inspection, Testing, or Special Inspection
COE CRD-C611	Flow of Grout for Preplaced Aggregate Concrete
COE CRD-C621	Non-shrink Grout
IBC	International Building Code

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. Complete product literature, including mixing, handling, and placement instructions for the following: Cementitious non-shrink grout, epoxy grout, adhesive for reinforcing bar dowel grouting, concrete repair mortar, and prepackaged cement grout products to be used on the project.
   5. Mix design for cement grout that is not prepackaged, including product data for aggregates and cement in accordance with Section 03 30 00.
   6. Current ICC Evaluation Service reports for adhesives used for reinforcing dowels.
   7. Installer certification in accordance with ACI/CRSI Adhesive Anchor Installer Certification Program for installers of horizontal or upwardly inclined reinforcing bar dowels grouted using adhesive.
   8. Certified test results verifying the compressive strength, shrinkage and expansion requirements specified herein.

1.05 QUALITY ASSURANCE

A. Quality Control by Owner
   1. The Officer-in-Charge shall throughout the duration of construction, inspect construction and witness required testing to assure Contractor conformance with these specifications. Testing to be witnessed shall include special inspections and associated testing, as specified in this Section and as shown on the drawings for compliance with IBC Chapter 17, in addition to testing required of the Contractor in this and other specification sections.
   2. Refer to Section 01 40 00.

B. Quality Control by Contractor
    1. Adhesive anchors installed in horizontal or upwardly inclined orientations to resist sustained tension loads shall be continuously inspected during installation by a Special Inspector.
        a. The Special Inspector shall furnish a report to the Engineer, Officer-in-Charge, 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).
    2. Provide the services of an independent testing laboratory which complies with the requirements of ASTM E329 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. The testing laboratory shall sample and test the proposed grout materials. Costs of testing laboratory services shall be borne by the Contractor.
    3. Refer to Section 01 40 00.
C. Certifications
    1. Installer certification shall be in accordance with ACI/CRSI Adhesive Anchor Installer Certification Program for installers of horizontal or upwardly inclined reinforcing bar dowels grouted using adhesive.
D. Compression test specimens will be taken during construction from the first placement of each type of grout and at intervals thereafter as selected by the Engineer to ensure continued compliance with these Specifications.
    1. Compression tests and fabrication of specimens for epoxy grout will be performed as specified in ASTM C579, Method B, at intervals during construction as selected by the Engineer. A set of three specimens will be made for testing at seven days and any other time period as appropriate.
    2. Compression tests and fabrication of specimens for cement grout and non-shrink grout will be performed as specified in ASTM C109 at intervals during construction as selected by the Engineer. A set of three specimens will be made for testing at seven days, 28 days, and any additional time period as appropriate.
E. Manufacturer Qualifications
    1. Manufacturer shall have a minimum of five years experience of producing products substantially similar to that required and shall be able to submit documentation of at least five satisfactory installations that have been in successful operation for at least five years each.
    2. When required, provide services of manufacturer's full-time employee, factory-trained in handling, use, and installing the products required, with at least five years of experience in field applications of the products required.

PART 2 PRODUCTS

2.01 CEMENTITIOUS NON-SHRINK GROUT

A. The grout material shall be an approved ready to use mixture requiring only water for use at the job site. The 2-inch cubes shall have a minimum compressive strength of 3,000 psi at 7 days and 7,000 psi at 28 days.
B. Cementitious non-shrink non-metallic aggregate grout shall be:
    1. BASF, Masterflow 928

2. Euclid Chemical Company, Hi-Flow Grout
3. Five Star Products, Inc., Five Star Grout
4. Sika Corporation, SikaGrout 212
5. Approved Equal

C. Non-shrink grout shall conform to CRD-C 621 and ASTM C1107, Grade B or C when tested at a maximum fluid consistency of 30 seconds per ASTM C939 at temperature extremes of 45 degrees Fahrenheit and 90 degrees Fahrenheit and an extended working time of 15 minutes.

D. Fluid grout shall pass through the flow cone, with continuous flow, one hour after mixing.

2.02 EPOXY GROUT FOR EQUIPMENT MOUNTING

A. Epoxy grout shall be a pourable, non-shrink, 100-percent solids system.

B. 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. Epoxy grout shall be:

1. BASF, Masterflow 648
2. Euclid Chemical Company, E3-G
3. Sika Corporation, Sikadur 42
4. Approved Equal

C. The following properties shall be attained with the minimum quantity of aggregate allowed by epoxy grout manufacturer.

1. Length change after hardening shall be less than 0.0006-inch per inch and coefficient of thermal expansion shall be less than 0.00003-inch per inch per degree F when tested in accordance with ASTM C531.
2. Compressive creep at one year shall be less than 0.001-inch per inch when tested under a 400-psi constant load at 140 degrees F in accordance with ASTM C1181.
3. Minimum seven-day compressive strength shall be 14,000 psi when tested in accordance with ASTM C579
4. Grout shall be capable of maintaining at least a flowable consistency for minimum of 30 minutes at 70 degrees F.
5. Shear bond strength to portland cement concrete shall be greater than shear strength of concrete when tested in accordance with ASTM C882/C882M.

2.03 ADHESIVE FOR GROUTING REINFORCING BAR DOWELS

A. Adhesive for setting dowels in concrete shall be an injectable two-component epoxy adhesive. Adhesive shall be approved for the intended use per the product ICC Report. Adhesive shall be:

1. Hilti, HIT-RE 500v3
2. Simpson Strong Tie, SET XP
3. Approved Equal (equivalent product must have ICC approval for use in cracked concrete in areas with high seismic risk).

B. Adhesive for setting dowels in concrete masonry shall be an injectable two-component epoxy adhesive. Adhesive shall be approved for the intended use per the product ICC Report or IAPMO Report. Adhesive shall be:
   1. Hilti, HIT-HY 70
   2. Simpson Strong Tie, SET XP
   3. Approved Equal (acceptable per ICC Report or IAPMO Report for resisting earthquake loads)

2.04 CONCRETE REPAIR MORTAR

A. Horizontal Applications: Repair mortars shall be:
   1. BASF, MasterEmaco S 466CI
   2. Sika Corporation, SikaTop 111 Plus
   3. Approved Equal
B. Vertical and Overhead Applications: Repair mortars shall be:
   1. BASF, MasterEmaco 1500HCR Vertical Overhead
   2. Sika Corporation, SikaTop 123 Plus
   3. Approved Equal

2.05 CEMENT GROUT

A. Cement grout shall be comprised of cement, fine aggregate, coarse aggregate, water, and admixtures proportioned and mixed in accordance with this Section.
   1. Minimum Compressive Strength: 4,500 psi at 28 days.
   2. Maximum Water Cement Ratio: 0.42 by weight.
   3. Coarse Aggregate: ASTM C33/C33M, No. 8 size.
   4. Fine Aggregate: ASTM C33/C33M, approximately 60 percent by weight of total aggregate.
   5. Air Content: Five percent (plus or minus one percent).
   6. Minimum Cement Content: 564 pounds per cubic yard.
   7. Slump for grout fill shall be adjusted to match placing and finishing conditions, and shall not exceed four inches.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine and accept existing conditions before beginning work.

3.02 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.
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.

3.03 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 requirements of Section 43 05 13, details on the Drawings, and in conformance with manufacturer's recommendations.

3.04 ADHESIVE FOR GROUTING REINFORCING BAR DOWELS

A. Follow manufacturer's instructions.

3.05 CONCRETE REPAIR MORTAR

A. Concrete repair materials and procedures shall be submitted for review to the Officer-in-Charge 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 Officer-in-Charge Representative and shall be accepted prior to commencement of the work.

3.06 CEMENT GROUT

A. Cement grout shall be used for grout toppings less than four inches thick and for patching of fresh concrete.
B. Grouting shall comply with temperature and weather limitations in Section 03 30 00 Cast-In-Place Concrete.
C. Cure grout in accordance with grout manufacturer's instructions for prepackaged grout and Section 03 30 00 Cast-In-Place Concrete for non-prepackaged cement grout.

3.07 MEASUREMENT AND PAYMENT

A. The work in this Section shall not be paid for directly, but shall be included in the lump sum bids for the respective items in the Proposal Schedule.

END OF SECTION

SECTION 05 05 20

ANCHOR BOLTS

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies bolts and all-thread rods used to attach structural elements and equipment to concrete and concrete masonry. 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.

1.02 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 45 00 – Quality Assurance, Inspection, and Testing
3. Section 01 73 24 - Design Requirements for Non-structural Components and Non-building Structures
4. Section 03 30 00 - Cast-In-Place Concrete
5. Section 03 60 00 - Grouting

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
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
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. 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 Engineer currently registered in the State of Hawaii. Calculations shall comply with the provisions of ACI 318-14, Chapter 17 ACI 318, Appendix D. 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.
   7. Submit record copy of proof loading test results within five calendar days after test.
   8. Product Data:
      a. ICC Evaluation Service 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.

1.05 QUALITY ASSURANCE

A. Quality Assurance
   1. Special inspection of anchor bolts shall be performed by the Special Inspector in accordance with IBC Chapter 17. Refer to Section 01 45 00 for definition and responsibilities for testing and inspection services, including special inspection sampling and testing.
   2. A five (5) 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 Officer-in-Charge.

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, Officer-in-Charge, 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.

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 24.

B. Design anchor bolts for support and bracing of non-structural components and non-building structures for loading specified in Section 01 73 24.

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
	ASTM A194 Heavy Hex Nuts Grade 8S (Nitronic 60)
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

Material	Specification
Concrete Adhesive Anchors	Hilti “HIT-RE 500V3”, Simpson Strong-Tie “SET-XP”, or approved equal, with Type 316 Stainless Steel threaded rods
Concrete Masonry Adhesive Anchors	Hilti "HIT-HY 270", Simpson Strong-Tie “SET-XP”, or approved equal, with Type 316 Stainless Steel threaded rods
Concrete Masonry Expansion (wedge) Anchors*	Hilti "KWIK BOLT 3", or approved equal, Type 316 Stainless Steel
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 Officer-in-Charge approves.*

2.04 STAINLESS STEEL FASTENER LUBRICANT (ANTI-SEIZING)

A. Anti-seizing Lubricant for Stainless Steel Threaded Connections:
   1. Suitable for wastewater application.
   2. Formulated to resist washout.
   3. Acceptable manufacturers are Bostik, Saf-T-Eze, or approved 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 approved 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 Officer-in-Charge 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 Officer-in-Charge and installation is by an Installer specially certified for overhead applications.
   4. Approval from Officer-in-Charge 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 Officer-in-Charge 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. 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.

B. Where slanting the drill does not resolve the conflict, notify the Officer-in-Charge, and resolve the conflict to the satisfaction of the Officer-in-Charge.

C. Abandoned post-installed anchor holes shall be cleaned and filled with non-shrink grout and struck off flush with adjacent surface.

D. 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.

E. Reinforcing steel in masonry shall not be damaged.

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 Engineer currently registered in the State of Hawaii.
   2. Calculations and details for redesign shall be submitted.

3.06 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be considered incidental and included in the lump sum bids for the respective items in the Proposal Schedule.

END OF SECTION

SECTION 05 50 00

METAL FABRICATIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes custom fabricated and miscellaneous metal fabrications, items, and certain manufactured units not otherwise indicated to be provided under work of other specification sections and/or not covered elsewhere.

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 73 24 – Design Requirements for Non-structural Components and Non-building Structures
   3. Section 05 05 20 – Anchor Bolts
   4. Section 09 90 00 – Painting and Coating

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
AISC 303	Code of Standard Practice for Steel Buildings and Bridges
AISC 360	Specification for Structural Steel Buildings
AISC Steel Construction Manual	American Institute of Steel Construction, Manual of Steel Construction
ANSI A14.3	Standard for Ladders - Fixed - Safety Requirements
ASTM A36	Carbon Structural Steel
ASTM A48	Gray-Iron Castings
ASTM A53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A108	Steel Bar, Carbon and Alloy, Cold-Finished
ASTM A123	Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
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 A240	Chromium and Chromium Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

Reference	Title
ASTM A276	Stainless Steel Bars and Shapes
ASTM A283	Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A307	Carbon Steel Bolts, Studs, and Threaded Rod 60000 psi Tensile Strength
ASTM A312	Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A320	Alloy-Steel Bolting Materials for Low Temperature Service
ASTM A325	Structural Bolts, Steel, Heat Treated 120/105 ksi Minimum Tensile Strength
ASTM A380	Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
ASTM A384	Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
ASTM A489	Carbon Steel Lifting Eyes
ASTM A500	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A554	Welded Stainless Steel Mechanical Tubing
ASTM A563	Carbon and Alloy Steel Nuts
ASTM A572	High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A653	Steel Sheet, Zinc Coated (Galvanized) or Zinc Iron Alloy Coated (Galvannealed) by the Hot Dip Process
ASTM A780	Repair of Damaged and Uncoated Areas of Hot Dip Galvanized Coatings
ASTM A786	Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates
ASTM A793	Rolled Floor Plate, Stainless Steel
ASTM A924	Steel Sheet, Metallic-Coated by Hot-Dip Process
ASTM A992	Structural Steel Shapes
ASTM A1011	Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM B209	Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B210	Aluminum and Aluminum-Alloy Drawn Seamless Tubes
ASTM B211	Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire
ASTM B221	Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B241	Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube
ASTM B308	Aluminum-Alloy 6061-T6 Standard Structural Profiles
ASTM B429	Aluminum-Alloy Extruded Structural Pipe and Tube
ASTM B632	Aluminum-Alloy Rolled Tread Plate
ASTM D1056	Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM F436	Hardened Steel Washers
ASTM F468	Nonferrous Bolts, Hex Cap Screws, SocketHead Cap Screws and Studs for General Use
ASTM F593	Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	Stainless Steel Nuts
AWS D1.1	Structural Welding Code - Steel
AWS D1.2	Structural Welding Code - Aluminum
AWS D1.6	Structural Welding Code - Stainless Steel
OSHA 29 CFR 1910.27	Fixed Ladders
OSHA 29 CFR 1926.502	Fall Protection Systems Criteria and Practices
SSPC SP5	White Metal Blast Cleaning
IBC	International Building Code

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. Manufacturer's product data.
   5. Detailed Shop Drawings:
      a. Fabrication drawings showing layouts, connections to structural system, and anchoring details.
      b. Erection and installation drawings indicating thickness, type, grade, class of metal, coating system and dimensions.
      c. Construction details, reinforcement, anchorage, and installation with relation to the building construction.
   6. Welding procedures and welder certificates and qualifications.
   7. Passivation method for stainless steel fabrications.

1.05 QUALITY ASSURANCE

A. Qualifications
   1. Fabricator shall have a minimum of five years experience in fabrication of metal specified.

B. Certificates
   1. Certified welding procedures and welding operators in accordance with AWS. Welding operator certificates shall be no more than one-year old and the welder shall have used the welding process to be performed within the last six months.

C. The use of salvaged, reprocessed or scrap materials will not be permitted.

D. Shop Assembly: Items in the shop shall be preassembled to the greatest extent possible, so as to minimize field splicing and assembly of units. Units shall be disassembled only to the extent necessary for shipping and handling limitations. Units shall be clearly marked for reassembly and coordinated installation.

1.06 DELIVERY, STORAGE AND HANDLING

A. Avoid damage during delivery and handling of fabrications.

B. Store off the ground on skids or other supports to keep items free of dirt and other foreign debris and to protect against corrosion.

PART 2 PRODUCTS

2.01 MATERIALS

A. Materials for miscellaneous metalwork are specified in the following table.

Material	Specification
Steel	
Sheets, plates and shapes (except W shapes)	ASTM A36
W shapes	ASTM A992
Pipe	ASTM A53, Grade B
Square/rectangular tubing	ASTM A500, Grade B
Headed Anchor Studs	ASTM A108
Carbon steel bolts	ASTM A307, Grade A
High strength bolts	ASTM A325 (Type 1)
Nuts	ASTM A563
Washers	ASTM F436
Stainless Steel	
Sheet and Plates	ASTM A240, Type 316 or 316L
Shapes, bars, and similar items	ASTM A276, Type 316 or 316L
Pipe	ASTM A312, Type 316 or 316L
Headed Anchor Studs	ASTM A276, Type 316L
Bolts	ASTM F593, Type 316
Nuts	ASTM F594, Type 316
Aluminum	
Sheets and plates	ASTM B209, Type 6061-T6
Bars, flats and similar items	ASTM B211 or B221, Type 6061-T6
Shapes	ASTM B308, Type 6061-T6
Round tubing and pipe	ASTM B241, Type 6061-T6
Square and rectangular tubing	ASTM B221, Type 6063-T52
Pipe	ASTM B211 or B241, Type 6061-T6
Bolts, Stainless Steel	ASTM F593, Type 316
Nuts, Stainless Steel	ASTM F594, Type 316
Checker Plate	
Steel	ASTM A786
Stainless steel	ASTM A793, Type 304
Aluminum	ASTM B632, Type 6061-T6

Material	Specification
Other steel items	
Iron castings	ASTM A48
Eyebolts	ASTM A489
Threaded rods	ASTM A36

2.02 FABRICATION

A. General
   1. Conform to AISC or Aluminum Association standards as applicable. Where Code defined loads apply, also conform to IBC requirements.
   2. Shop and field welding shall conform to the requirements of AISC, the Aluminum Design Manual, and applicable AWS procedures and specifications as required by the material being welded.
   3. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt, tight, flush, and hairline. Remove burrs and weld splatter. Ease exposed edges to small uniform radius.
   4. Holes shall be punched 1/16 inch larger than the nominal size of the bolts, unless otherwise specified. Whenever needed, because of the thickness of the metal, holes shall be subpunched and reamed or shall be drilled.
   5. Fabrication, including cutting, drilling, punching, threading and tapping required for fabrications or adjacent work, shall be performed prior to galvanizing.

2.03 FINISHES

A. Galvanizing
   1. Galvanize items specified to be zinc-coated, after fabrication where practicable. Galvanizing in accordance with ASTM A123, ASTM A153, ASTM A653 or ASTM A924, Z275 G90, as applicable. Galvanize anchor bolts, grating fasteners, washers, and parts or devices necessary for proper installation, unless indicated otherwise.
   2. Repair damaged Zinc-Coated surfaces with galvanizing repair method and paint conforming to ASTM A780 or by application of stick or thick paste material specifically designed for repair of galvanizing, as approved by Owner's Representative.
   3. Safeguard against warpage and distortion during galvanizing of steel in accordance with ASTM A384. Straighten items after galvanizing so that they are straight, free of racking and distortion.

B. Shop Painting
   1. Prepare and coat surfaces in accordance with Section 09 90 00.
   2. Steel to be embedded in concrete shall be free of dirt and grease.

C. Aluminum Surfaces
   1. Surface condition aluminum before finishes are applied. Remove roll marks, scratches, rolled-in scratches, kinks, stains, pits, orange peel, die marks, structural streaks, and other defects which will affect uniform appearance of finished surfaces.
   2. Aluminum finishes for unexposed sheet, plate and extrusions may have mill finish as fabricated.

3. Provide other aluminum items with a standard mill finish.
4. Provide a coating thickness not less than that specified for protection.
5. Provide decorative type finishes for items used in interior occupied locations or architectural type finish for items used in exterior locations.
6. Provide a polished satin finish on items to be anodized.

D. Stainless Steel Passivation
1. Stainless steel to be cleaned, descaled, and passivated after fabrication in accordance with ASTM A380. Passivate to remove iron compounds from the surface of the stainless steel.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify measurements at the site. Include field dimensions in shop drawings.

B. Examine and accept existing conditions before beginning work.

3.02 PREPARATION

A. Make provisions for erection loads with temporary bracing. Keep work in alignment.

B. Supply items required to be cast into concrete or embedded in masonry with setting templates.

3.03 INSTALLATION

A. Install items plumb, level and square, accurately fitted, and free from distortion or defects. Install rigid, substantial, and neat in appearance.

B. Allow for erection loads and provide temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.

C. Fieldwork shall not be permitted on galvanized items. Drilling of bolts or enlargement of holes to correct misalignment will not be allowed.

D. Protect encased or embedded dissimilar metals (both metals must be encased or embedded) from galvanic corrosion by means of pressure tapes, coatings or isolators.

E. Place metalwork to be embedded in concrete accurately and hold in correct position while the concrete is placed or, if indicated, form recesses or blockouts in the concrete. Thoroughly clean the surfaces of metalwork in contact with or embedded in concrete.

F. Concrete: Pan-filled stairs to be constructed in accordance with Section 03 30 00. Finish concrete with a “nonslip” finish with “very flat” tolerance as specified in ACI 301.

G. Fastening to Construction-In-Place: Provide anchorage devices and fasteners where necessary for fastening fabricated items to construction-in-place. Design anchorage devices in accordance with Section 01 73 24. Anchor bolts to be in accordance with Section 05 05 20.

3.04 REPAIR/RESTORATION

A. Galvanized
   1. Maximum area to be repaired shall not be more than 1/2 of 1 percent of the surface area or 36 sq. in. per ton of piece weight, whichever is less. Damage in excess of this requirement shall be repaired by stripping and recoating entire piece.
   2. Clean damaged areas to SSPC-SP5. Repair with zinc-rich paint in accordance with the manufacturer's instructions and with ASTM A780, Annex A2. Minimum thickness requirements shall be in accordance with ASTM A123.
   3. Use zinc-rich repair paint. Acceptable manufacturers:
      a. LPS, Cold Galvanize
      b. ZRC Worldwide, ZRC Galvilite
      c. Approved Equal

B. Painted
   1. After installation, clean and touch up damaged areas with the same materials used for the shop coat.

3.05 FIELD QUALITY CONTROL

A. Electrolytic Protection

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. Stainless Steel
   1. During handling and installation, take necessary precautions to prevent carbon impregnation of stainless steel members.
   2. After installation, visually inspect stainless steel surfaces for evidence of iron rust, oil, paint, and other forms of contamination.
   3. Remove contamination in accordance with requirements of ASTM A380.
   4. Brushes used to remove foreign substances shall utilize only stainless steel or nonmetallic bristles.

3.06 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be considered incidental and included in the lump sum bids for the respective items in the Proposal Schedule.

END OF SECTION

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SECTION 09 90 00

PAINTING AND COATING

PART 1 GENERAL

1.01 SUMMARY

A. 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 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 99 90 – Reference Forms
   3. Section 03 30 00 – Cast-in-Place Concrete

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. 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

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

Reference	Title
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
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.

1.04 SUBMITTALS:

A. Action Submittals:

1. Procedures: Section 01 33 00.
2. 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 Officer-in-Charge 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.
3. CSM's current printed recommendations and product data sheets for coating systems including:
    a. Volatile organic compound (VOC) data.
    b. Surface preparation recommendations.
    c. Primer type, where required.
    d. Maximum dry and wet-mil thickness per coat.
    e. Minimum and maximum curing time between coats, including atmospheric conditions for each.
    f. Curing time before submergence in liquid.
    g. Thinner to be used with each coating.
    h. Ventilation requirements.
    i. Minimum atmospheric conditions during which the paint shall be applied.

j. Allowable application methods.
k. Maximum allowable moisture content.
l. Maximum shelf life.

4. 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.
5. Material Safety Data Sheets (MSDS) for materials to be delivered to the job site, including coating system materials, solvents, and abrasive blast media.
6. List of cleaning and thinner solutions allowed by the CSMs.
7. Storage requirements including temperature, humidity, and ventilation for Coating System Materials as recommended by the CSMs.
8. 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.
9. Certification of the Contractor or CSA by respective coating manufacturers for each coating used on the project.

1.05 QUALITY ASSURANCE

A. 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 Officer-in-Charge that they are approved 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 approved 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.

B. Quality Control Requirements:
   1. The Contractor is responsible for the workmanship and quality of the coating system installation. Inspections by the Officer-in-Charge 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 Officer-in-Charge 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 Officer-in-Charge. The Contractor shall provide ventilation, ingress and egress, and other means necessary for the Officer-in-Charge'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.

C. 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 Officer-in-Charge such that the Officer-in-Charge may observe Contractor's inspections on a scheduled basis. The Contractor shall provide the Officer-in-Charge 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 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 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.

1.06 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 Officer-in-Charge.
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.

1.07 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 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. This inspection is in addition to the inspection performed by the Contractor in accordance with this Section.

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 this Section. 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 and the CSM's recommendations.

PART 2 PRODUCTS

2.01 MATERIALS

A. General:

1. Notwithstanding the listing of product names in this Section, 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.

Material Requirements for Coating Systems

Coating System	CSM	First Coat(s)		Finish Coat(s)
Epoxy Polyurethane				
		Primer Coat(s)	Intermediate Coat(s)	
EU-1	PPG PMC	Amercoat	Amercoat 385	Amercoat 450H
	Carboline	Carbozinc 859	Carboguard 890	Carbothane 134 VOC
	International Paint/ICI	Cathacoat 313	Devran 233 or 224HS	Devthane 379
	Sherwin Williams	Zinc Clad IV	Macropoxy 646	Hi Solids Polyurethane
	Tnemec	Series 90-97	Series V69	Series 1075
Latex Acrylic				
L-2	PPG PMC	Amercoat 220		Amercoat 220

Material Requirements for Coating Systems

Coating System	CSM	First Coat(s)	Finish Coat(s)
	Carboline	Carbocrylic 120	Carbocrylic 3359
	International Paint/ICI	Prep and Prime Gripper	Ultrahide 250-1406
	Sherwin Williams	Sher Cryl HPA	Sher Cryl HPA
	Tnemec	Series 1028 or 1029	Series 1028 or 1029

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 this Section 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 this Section for Quality Control and 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 this Section.

PART 3 EXECUTION

3.01 COATINGS

A. General:
   1. Coating products shall not be used until the Officer-in-Charge has accepted the affidavits specified in this Section, the Officer-in-Charge 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 this Section. Damaged, deteriorated and poorly applied shop coatings that do not meet the requirements of this Section shall be removed and the surfaces recoated. If the shop primer coat meets the requirements of this Section, 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.

3.02 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 Officer-in-Charger, 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. 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 Officer-in-Charge 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 ductile iron and stainless steel substrates are as follows:
    a. 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.
    b. 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.
    c. 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.
    d. 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, 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.

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 Officer-in-Charge 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. Valve stems shall not be coated.

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. Coating 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 shall be coated as specified in this Section.
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 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 Officer-in-Charge 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 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 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) Instrumentation panels shall be coated with 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. Nonmetallic electrical enclosures and equipment shall be the equipment manufacturer's standard grey color. Exterior color of instrumentation panels and cabinets mounted indoors shall be FS 26463 light gray; unless otherwise specified, exterior color for cabinets mounted outdoors shall be FS 27722, white.

3.04 CLEANUP

A. 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
EU-1	Zinc-epoxy-polyurethane system	Ferrous Metal	Exterior, exposed to direct sunlight, moderately corrosive non-immersed.
L-2	Latex	PVC and HDPE pipe	Exterior, direct sunlight exposure.

Coating System Specification Sheets (COATSPEC)

A.	**Coating System Identification: EU-1**	
1.	Coating Material:	Zinc-Epoxy-Polyurethane System
2.	Surface:	Ferrous Metal
3.	Service Condition:	Exterior, exposed to direct sunlight, moderately corrosive, non-immersed.
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-3 (Power Tool Cleaning) and recoated with the primer specified.
b.	Ferrous Metal:	Bare ferrous metal surfaces shall be prepared in accordance with SSPC SP-6 (Commercial Blast Cleaning) 2.5 – 3.0. Ductile iron surfaces to be coated shall be abrasive blast cleaned in accordance with paragraph 3.02 Metallic Surfaces.
		Ferrous metal with rust bleeding shall be cleaned in accordance with SSPC-SP-11 (Power Tool Cleaning to Bare Metal). Areas of rust penetration shall be spot blasted to SSPC SP-10 (Near White Blast) and spot primed with the specified primer.
c.	Galvanized Metal:	Damaged galvanized steel areas with exposed ferrous metal and/or rusted shall be cleaned in accordance with SSPC SP-5 (White Metal Blast Cleaning) or Power Tool Cleaned to Bare Metal in accordance with SSPC-SP-11 to achieve a uniform 1.0- to 1.5-mil profile and spot primed with the primer specified.
		Nonferrous and galvanized metal shall be prepared in accordance with SSPC SP-7 (Brush-off Blast Cleaning) to impart a 1.0- to 2.0-mil profile to the galvanized steel surfaces. Where this cannot be performed, prepare by abrading in accordance with SSPC-SP-3, Power Tool Cleaning to impart a 1.0- to 1.5-mil profile uniformly to the galvanized steel surfaces.
		For EU-1 over galvanized steel, delete the zinc rich primer.
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 a zinc rich epoxy or polyurethane primer compatible for use with urethane finish coats and applied in accordance with written instructions of the CSM or in the case of CARB or SCAQMD applications, prime with specified primer that is not zinc rich. In these cases, only a two-coat system is applied.
6.	System Thickness:	3 to 4 mils of zinc rich primer, one intermediate or primer epoxy coat at 5 to 6 mils

Coating System Specification Sheets (COATSPEC)

	and one finish coat of polyurethane at 2 to 3 mils DFT.
7. Coatings:	
a. Primer:	One coat at CSM's recommended dry film thickness.
b. Intermediate:	One coat at CSM's recommended dry film thickness.
c. Finish:	One coat at CSM's recommended dry film thickness per coat to meet the specified system thickness.
B. Coating System Identification: L-2	
1. Coating Material:	Latex
2. Surface:	PVC and HDPE pipe.
3. Service Condition:	Exterior, direct sunlight exposure.
4. Surface Preparation:	Plastic pipe shall be cleaned with solvent compatible with the specified primer and sanded to roughen surfaces to achieve a uniform surface profile of 1.0 to 1.5 mils. Vacuum clean after sanding to remove all loose dust, plastic particles, and dirt.
5. Application:	Field
6. System Thickness:	3 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 the specified system thickness.

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. Equipment and Metal Appurtenances		
a. Equipment, outdoors and/or exposed	EU-1	Match existing color (blue)
b. Valves, CARVS, ARVs.	EU-1	
c. Instrumentation panels, graphic indicating panels, indicating and transmitting field panels, unless otherwise specified	See paragraph 3.03 I Electrical and Instrumentation Equipment and Materials	FS 27722 White (outside)
2. Conduit, Piping and Ductwork		
a. Ferrous piping, couplings, fittings, rings, penetrations, and appurtenant hangers, clamps, and supports, non-immersed, outdoors, and/or exposed	EU-1	Match existing color (blue)
b. Stainless steel piping		

Coating Systems Schedule (Finish Schedule)

Location/Surface	Coating System Identification	Standard Color
1) Outdoors and/or exposed	EU-1	Officer-in-Charge to select color from coating manufacturer's standard color list
2) Buried	Uncoated	
c. Stainless steel appurtenant hangers, clamps, and supports	Uncoated	
d. Conduit, outlets and junction boxes, lighting transformers, lighting, communication and small power panels, control stations, piping, lagged ductwork, appurtenant hangers, clamps, and supports	EU-1	FS 26463 Light Grey
e. Plastic and fiberglass piping/conduit	L-2	FS 26463 Light Grey
3. Concrete, Grout, Masonry and Plaster		
a. Vault, interior, non-liquid-containing.	Uncoated	
b. Concrete equipment bases, pipe supports, valve supports.	Uncoated	
4. Handhole Covers and Hatches	Uncoated	
5. Precast Concrete Metalwork – fasteners, anchors, supports, etc.	EU-1	Match background/wall

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 Officer-in-Charge 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.

3.09 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be considered incidental and included in the lump sum bids for the respective items in the Proposal Schedule.

END OF SECTION

SECTION 13 10 00

WELL DEPTH MEASURMENT AND FILL REMOVAL

PART 1 GENERAL

1.01 SUMMARY

A. This Section summarizes the procedures for conducting well depth measurements and removal of existing well fill located at the bottom of a well. Well fill removal and restoration of existing well depth shall be conducted after the existing pump is removed, before well inspection and survey, and before well rehabilitation activities. See work sequence in Section 01 12 16.

B. Well No. 5 original total depth ~ 252 feet below ground surface
   1. 14-inch inside diameter (ID), 30-ft long solid casing, followed by:
   2. 14-inch ID, 100-ft long louvered screen, followed by:
   3. 20-inch ID, 122-ft long open hole

C. Well No. 6 original total depth ~202 feet below ground surface
   1. 14-inch ID, 30 ft long solid casing, followed by:
   2. 14-inch ID, 100-ft long louvered screen, followed by:
   3. 20-inch ID, 72-ft long open hole

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 12 16 – Work Sequence
   2. Section 01 33 00 – Submittal Procedures
   3. Section 13 20 00 – Well Inspection and Survey
   4. Section 13 30 00 – Well Rehabilitation

1.03 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. Proposed well fill removal method(s).

PART 2 PRODUCTS

2.01 GENERAL

A. Provide tools, accessories, power, other equipment, and experienced personnel necessary to conduct efficient operations at each injection well site.

PART 3 EXECUTION

3.01 WELL DEPTH MEASUREMENT

A. The Contractor shall conduct a well depth measurement and compare to the original well depth. Additional well depth measurements shall be taken after well fill removal until the original well depth is achieved, or as directed by the Officer-in-Charge.

3.02 WELL FILL REMOVAL

A. The Contractor shall remove all existing foreign material from the bottom of the well by bailing, air-lifting, or other means to reach the original well depth. Bailing shall be the preferred initial method of fill removal because the method will generate the least amount of water to be disposed of. Removed liquid and solids shall be captured in waterproof containment vessels and stockpiled and dried on site until after well rehabilitation activities have been completed. Dried solids shall be hauled out of Waikolu Valley and disposed of at the Molokai-Naiwa Landfill, unless otherwise directed by the Officer-in-Charge.

3.03 MEASUREMENT AND PAYMENT

A. Well depth measurements shall not be paid for directly, but shall be included in the lump sum bids for the respective items in the Proposal Schedule.

B. Measurement for well fill removal shall be based on the vertical feet of fill material removed from the interior of the well casing. Payment shall be as an Allowance at the unit price bid for well fill removal in the Proposal Schedule.

END OF SECTION

SECTION 13 20 00

WELL INSPECTION AND SURVEY

PART 1 GENERAL

1.01 SUMMARY

A. This Section summarizes the products and execution procedures for conducting well inspections and surveys before and after well rehabilitation activities. Well inspections and surveys shall be conducted after existing pump removal, well depth measurement, and well fill removal (if needed). Well inspections and surveys shall be conducted prior to new pump/mechanical improvements are initiated, and in accordance with Section 01 12 16.

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 12 16 – Work Sequence
   2. Section 01 33 00 – Submittal Procedures
   3. Section 13 10 00 – Well Depth Measurement and Fill Removal
   4. Section 13 30 00 – Well Rehabilitation

1.03 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. Video of well survey. Provide three (3) copies of each well in electronic format on DVD or thumb drive.

PART 2 (NOT USED)

PART 3 EXECUTION

3.01 SURVEY

A. The Contractor shall conduct a well depth measurement and remove fill material per Section 13 10 10 prior to survey.

B. The Contractor shall conduct a color television survey of well, from top of casing to total depth, in the presence of the Officer-in-Charge. The survey shall be performed using a video camera with two (2) camera lenses accompanied by the appropriate light sources. One lens shall be the conventional fish-eye and the other shall be a side scan wide-angle lens for viewing the interior of the casing and open borehole directly. The survey shall be recorded in color, show the date of survey, and a continuous forward and reverse display of the depth of the camera, in feet. One copy of the DVD or thumb drive shall be provided to the Officer-in-Charge on completion of the television well survey and the remaining copies shall be provided to the Officer-in-Charge within five (5) working days after completion of the survey.

C. Ensuring acceptable video clarity is the responsibility of the Contractor. It is recommended that the Contractor run a stream of clean water into the well or other method to ensure video survey clarity. Upon review, if the Officer-in-Charge determines that any portion of the video record is incomplete or of inadequate quality (e.g., clarity) to allow detailed examination of the inside of the well, the Contractor shall rerun the survey at the Contractor's expense. The survey clarity should be of sufficient clarity to evaluate the integrity of all welded casing and well screen joints, well screen openings, and the entire inside surface of the solid casing, louvered screen, and open borehole.

3.02 SURVEY APPROVAL

A. Results of the survey shall be submitted, reviewed, and approved by the Officer-in-Charge prior to proceeding with well rehabilitation activities per Section 13 30 00.

3.03 MEASUREMENT AND PAYMENT

A. The work of this Section shall be paid for per the specified line items in the Proposal Schedule.

END OF SECTION

SECTION 13 30 00

WELL REHABILITATION

PART 1 GENERAL

1.01 SUMMARY

A. This Section summarizes the procedures for conducting well rehabilitation to restore performance/capacity and well depth. Well rehabilitation shall not be initiated until the well inspection and survey have been completed and approval to start rehabilitation activities is issued from the Officer-in-Charge.

B. Well rehabilitation shall include super chlorination, well scratching, well water neutralization, well acidification, and airlift swabbing.

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 12 16 – Work Sequence
   2. Section 01 33 00 – Submittal Procedures
   3. Section 13 10 00 – Well Depth Measurement and Fill Removal
   4. Section 13 20 00 – Well Inspection and Survey

1.03 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. Super chlorination:
      a. Proposed agitation method
      b. Any other pertinent implementation details
   3. Well scratching:
      a. Scratching tool details
      b. Any other pertinent implementation details
   4. Well water neutralization:
      a. Neutralization chemical data
      b. Temporary injection line details
      c. Proposed agitation method
      d. Any other pertinent implementation details
      e. Proposed sampling and testing procedures for chlorine residual measurement
   5. Well acidification:
      a. Acidification chemical data
      b. Proposed agitation method
      c. Any other pertinent implementation details

6. Airlift swabbing:
    a. Airlift swab tool details
    b. Airlifting data (timing log, est. flow rate, fluid clarity, etc.), supporting equipment, and other pertinent information
    c. Piping plan from well, to holding tank, and back to well
    d. Any other pertinent implementation details

PART 2 PRODUCTS

2.01 SUPER CHLORINATION

A. Chlorine solution (12.5% liquid sodium hypochlorite, or household bleach) used for super chlorinating the well shall be of such volume, strength, and applied that a concentration of at least 1000 mg/L of chlorine shall be obtained in all parts of the well water plus the borehole volume at the well screen.

2.02 WELL SCRATCHING

A. Well scratching tool may be commercially made or fabricated by the Contractor and submitted for approval. Scratching tool shall have nylon bristles and be sized to provide effective incrustation removal. Well scratching tool shall be used for vertical scratching.

2.03 WELL WATER NEUTRALIZATION

A. Well water neutralization chemical shall be sodium thiosulfate, sodium bisulfite, or an equivalent chemical in common usage for dechlorination purposes.

2.04 WELL ACIDIFICATION

A. Cleaner employed for well acidification shall be Cotey Chemical Liquid Descaler, Johnson Screens Nu-Well products, or other ANSI/NSF 60 certified equivalent.

2.05 AIRLIFT SWABBING

A. Discharge Line And Holding Tank System
    1. Provide temporary discharge piping required to convey water from the well to a Contractor-supplied temporary holding tank system. Contractor shall supply the pumps, valves, fittings, temporary piping, power, fuel, labor, and all other items necessary for the well size.
    2. Temporary holding tank system shall be located adjacent to the well site and be capable of storing and settling a minimum of 10,000 gallons. The temporary holding tank system shall be comprised of multiple tanks connected in series. After settling out solids, water shall be piped back to the well.

B. Airlift Swab Tool

1. The airlift swabbing tool shall consist of a double flanged swab assembly with the swab flanges no more than 10 feet apart. The outside diameter of the swab rubbers shall be not more than 1/4-inch less than the I.D. of the well screen. The pipe section between the swab flanges shall have a sufficient number of openings to allow for passage of 300 gallons per minute (gpm). The air lift equipment shall be capable of pumping 300 gpm. The bottom of the pipe section below the swab flanges shall be closed.

PART 3 EXECUTION

3.01 SUPER CHLORINATION

A. Chlorine solution shall be injected in equal parts into the well water via a temporary tremie injection line submerged at well depths of 50, 100, and 175 ft below grade.

B. After chlorine insertion, well shall be agitated for four (4) hours utilizing a bailer, line swab, or surge block, appropriately sized for the well casing diameter.

3.02 WELL SCRATCHING

A. Contractor shall scratch well screen from the well bottom up to the top of the well screen. Scratching tool shall be inserted into the well and scratch the well screen by vertical movements in 10-ft intervals. Well scratching shall be for a period of eight (8) hours.

B. Contractor shall measure and record chlorine residual after well scratching.

3.03 WELL WATER NEUTRALIZATION

A. Neutralizing chemical shall be added to the well through a temporary injection line in such a manner to neutralize all trace of chlorine residual. After neutralization chemical injection, well shall be agitated for two (2) hours utilizing a bailer, line swab or surge block, appropriately sized for the well casing diameter.

B. Contractor shall test and record chlorine residual after well neutralization. Chlorine residual shall be less than 0.1 mg/L.

3.04 WELL ACIDIFICATION

A. The manufacturer's recommended strength based on the well water volume shall be prepared and injected into the well water via a temporary tremie injection line. Equal volumes of acid cleaner shall be placed through the injection line submerged at well depths of 50, 100, and 175 ft below grade. After acid cleaner injection, well shall be agitated for two (2) hours utilizing a bailer, line swab or surge block, appropriately sized for the well casing diameter.

3.05 AIRLIFT SWABBING

A. Airlift swabbing shall begin by gently surging in the blank casing immediately above the highest section of louvered well screen. Airlift swabbing shall continue downward at a rate of 50 feet per hour to the bottom of the louvered well screen, then shall be performed at the same rate from the bottom of the well screen to the top of the well screen, and shall continue until no additional appreciable quantity of sand and mud is brought into the well. Airlift swabbing shall be limited to 8 hours.

B. Remove airlift tool upon completion of airlift swabbing.

C. Contractor shall be responsible for 100% containment of all water developed during airlift swabbing operation.

D. Well discharge shall be sent to the holding tank system to allow large particles to settle to the bottom. The liquid portion of the discharge shall be conveyed back to the well.

3.06 WELL FILL REMOVAL

A. Contractor shall remove well fill material from well bottom per Section 13 10 00 after well rehabilitation activities.

3.07 MEASUREMENT AND PAYMENT

A. The work of this Section shall be paid for per the specified line items in the Proposal Schedule.

END OF SECTION

SECTION 26 05 00

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 – GENERAL

1.01 SUMMARY

A. Scope: This section specifies general requirements for electrical work. Project detailed requirements specified in other sections are subject to the requirements of this section.
   1. Furnish labor, equipment, tools, materials, supplies, and perform operations necessary to install a complete and operable electrical system. Furnish incidental material and perform work shown on the Drawings and in the Specifications.
   2. Perform electrical work and provide material and equipment in compliance with applicable National, State, and Local codes, regulations, laws, and ordinances.
   3. Obtain electrical permits, arrange for required inspections, correct deficiencies resulting from inspections, and pay permit fees and inspections charges. Pay fines and the cost of extra work incurred by action or inaction of the Contractor, at no additional cost to the Owner.
   4. Furnish properly executed certificates of final electrical inspection and approval from the Code Authority Having Jurisdiction (AHJ) at the conclusion of the work, before final acceptance.
   5. Maintain a complete set of Contract Drawings in "Record" condition, available for review by the Officer-in-Charge per Section 01 78 39.
   6. Field verify exact locations of equipment or equipment terminations. Use accepted equipment submittals as the basis of the conduit openings and slab penetrations.

B. Drawing Definitions and Requirements:
   1. Elementary or Schematic Diagram: Shows, by means of graphic symbols, the electrical connections and functions of a specific circuit arrangement that facilitates tracing the circuit and its functions without regard to the actual physical size, shape, or location of the component devices or parts.
   2. One-Line Diagram: Shows by means of single lines and graphical symbols the course of an electrical circuit or system of circuits and the components, devices or parts used therein. Physical relationships are usually disregarded.
   3. Block Diagram: Diagram of a system, instrument, computer, or program in which selected portions are represented by annotated boxes and interconnecting lines.
   4. Wiring Diagram or Connection Diagram: Includes all of the devices in a system and shows their physical relationship to each other including terminals and interconnecting wiring in an assembly. A panel layout diagram shows the physical location of devices and the wiring connections.
   5. Interconnection Diagram:
      a. Shows external connections between terminals of equipment in panels or electrical assemblies and outside points, such as motors, auxiliary devices, control devices, and instruments. Provide references to connection diagrams that interface to the interconnection diagrams of the continuous line type.
      b. Show bundled wires as a single line with the direction of entry/exit of the individual wires clearly shown. Show each wire identification as actually installed. Wireless diagrams and wire lists are not acceptable.

c. Provide wire identification for each end of the same wire for devices and equipment, indicate terminal blocks identification actually installed with individual terminal identification.

d. Show jumpers, shielding and grounding termination details not shown on the equipment connection diagrams on the interconnection diagrams. Wires or jumpers shown on the equipment connection diagrams shall not be shown again on the interconnection diagram. Signal and DC circuit polarities and wire pairs shall be shown. Show spare wires and cables.

6. Arrangement, Layout, or Outline Drawings: Shows the physical space and mounting requirements of a piece of equipment and may indicate ventilation requirements, space provided for connections, or the location connections are to be made.

1.02 REFERENCES

A. General:

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.

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.

C. ACI 318 – Building Code Requirements for Structural Concrete

D. ANSI A58.1 / ASCE 7 - Minimum Design Load in Buildings and Other Structures

E. ANSI C2 – National Electrical Safety Code (NESC

F. ANSI C80.1 - Rigid Steel Conduit - Zinc Coated

G. ASTM B3 - Soft or Annealed Copper Wire

H. ASTM B8 - Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

I. ASTM B33 - Standard Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes

J. IBC – International Building Code

K. ICEA S-68-516 / NEMA WC 70, 71, & 74 - Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

L. IEEE 81 - Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

M. IEEE 383 - Type Test of Class IE Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations

N. JIC EMP-1 - Electrical Standard for Mass Production Engineering

O. NECA 1 – Standard Practices for Good Workmanship in Electrical Contracting
P. NEMA 250 - Enclosures for Electrical Equipment (1000 Volt Maximum)
Q. NEMA ICS-1 – General Standards for Industrial Controls and Systems
R. NEMA ICS-2 – Industrial Control Devices, Controllers, and Assemblies
S. NEMA ICS-6 – Industrial Control and Systems: Enclosures
T. NEMA TC2 - Electrical Polyvinyl Chloride (PVC) Conduit
U. NEMA WC-70 - Non-Shielded Power Cable 2000V or Less (ICEA S-95-658)
V. NEMA WD-1 - General Requirements for Wiring Devices
W. NFPA 70 - National Electrical Code
X. UL 6 - Electrical Rigid Metal Conduit – Steel
Y. UL 44 - Thermoset-Insulated Wires and Cables
Z. UL 67 - Panelboards
AA. UL 83 - Thermoplastic-Insulated Wires and Cables
BB. UL 263 - Fire Tests of Building Construction and Materials
CC. UL 360 - Liquid-Tight Flexible Steel Conduit
DD. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
EE. UL 1277 - Electrical Power and Control Tray Cables with Optional Optical-Fiber Members

1.03 SUBMITTALS

A. Procedures: in accordance with Section 01 33 00.
B. Action Submittals:
    1. Product Data:
        a. Catalog cuts of equipment, devices, and materials requested by the individual specification sections.
            1) Catalog information with technical specifications and application information including ratings, range, weight, accuracy, and other pertinent product information.
            2) Edit catalog cuts to show only the items, model numbers, and information that apply.
            3) Assemble catalog cuts in a folder or three ring binders with a cover sheet, indexed by item, and cross-referenced to the appropriate specification paragraph.
    2. Arrangement, layout, and outline drawings with dimensions and weight, as appropriate.
    3. Control schematics and interconnection wiring diagrams depicting internal and external wire and cable terminations. Drawing cross-reference to specification and Contract Document drawings.
C. Closeout Submittals:
    1. Operating and maintenance information as specified in Section 01 78 23.
    2. Record documents as specified in Section 01 78 39.
    3. Certificates of final electrical inspection and approval from the Code Authority Having Jurisdiction (AHJ) as specified in paragraph 1.01 A 4.

4. Update panelboard schedules in the Drawings or Schedules to match the as-installed configuration of all circuits for record drawings, in accordance with Section 01 78 39.

D. Maintenance Material Submittals:
   1. Spare Parts: furnish at minimum the following:
      a. 1 set each of fuse size and type for power and control.
      b. 2 of each type control relay

1.04 QUALITY ASSURANCE

A. Listed and Labeled Products:
   1. Provide electrical equipment and materials listed or labeled by an independent testing laboratory for the purpose for which they are to be used and provide associated testing laboratory label.
   2. The independent testing laboratory shall be acceptable to the inspection authority having jurisdiction. Test Laboratory examples: Underwriters Laboratories (UL), Electrical Testing Laboratories (ETL), and Canadian Standards Association (CSA).
   3. Include costs and expenses incurred for special inspections in the contract price for electrical products required to undergo a special inspection either at the manufacturer's place of assembly or at the installed location by the local inspection authority when a product is not available with a testing laboratory listing or labeling.

B. Factory Tests:
   1. Perform factory tests at the place of fabrication and on completion of manufacture or assembly where specified in the individual product specification section.
      a. Include the costs of factory tests in the contract price.
      b. Include the costs of Engineer witness of factory tests in the contract price.

1.05 PROJECT/SITE CONDITIONS

A. General:
   1. Unless otherwise specified, equipment and materials shall be sized and de-rated for the ambient conditions specified in Section 01 11 80, but not less than an ambient temperature of 40 degrees C at an elevation ranging from sea level to 3000 feet without exceeding the manufacturer's stated tolerances.

B. The following areas are designated as corrosive:
   1. Outdoors

C. Hazardous (Classified) Areas:
   1. None

D. Electrical enclosures, raceways, and supports:
   1. Provide electrical enclosures, boxes, panels, wireways, raceways, fittings, hangers, supports, and all related components in accordance with the table below, except where noted otherwise in equipment specifications:

Location	Electrical Enclosure Rating	Exposed Raceway Type	Flexible Raceways for Final Connections	Hangers and Supports
Indoors: Electrical Room	NEMA 1: Steel	GRS	LFMC	Steel: HDGAF

Location	Electrical Enclosure Rating	Exposed Raceway Type	Flexible Raceways for Final Connections	Hangers and Supports
Outdoors	NEMA 4X: 316SS	PGRS	LFMC	316SS

HDGAF = Hot Dip Galvanized After Fabrication

Notes:

1. *Install conduit connections to control stations, enclosures, and device boxes through threaded hubs.*
2. *Install flexible conduit for final connections to devices, equipment and motors not exceeding 18 inches. Limit length to 36 inches where flexibility is required.*
3. *Mount enclosures, device boxes, control stations, and raceway systems with 1/4-inch (minimum) air space between the electrical system and supporting structure.*

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 01 66 00.

PART 2 – PRODUCTS

2.01 EQUIPMENT AND MATERIALS

A. General:
   1. Provide new equipment and materials free from defects. Provide material and equipment of the same or a similar type of the same manufacturer throughout the work. Use standard production materials wherever possible.

2.02 FINISHES

A. Provide equipment manufacturer's standard finish/coatings for the enclosure type and equipment standards referenced in the equipment specifications (IEEE, ANSI, NEMA, etc.).

B. Where referenced standards do not provide finish/coatings requirements, provide finish/coatings in accordance with section 09 90 00.

2.03 RACEWAYS, BOXES, AND SUPPORTS

A. General Raceway Requirements:
   1. Design and provide conduit routing that conforms to the installation requirements set forth herein and in accordance with the NEC.
   2. Provide separate raceways for lighting, receptacles, power, control, instrumentation, and signaling systems.
   3. Pullboxes, handholes, and device boxes are generally called boxes herein. Size boxes, manholes, and handholes in accordance with the National Electrical Code.
   4. Size and provide wireways at locations above and below boxes, panels and groups of devices. Comply with the NEC sizing for conductor fill requirements. Wireway NEMA type shall match the location and area classification and equipment NEMA enclosure ratings.
   5. Provide boxes containing terminal blocks with hinged doors and 2 or 3-point stainless steel quick release latches with locking features via handle or latching clasps with provisions for padlocks.

B. Raceway Application:
   1. Exposed raceways, boxes, enclosures, cabinets, wireways, and gutters: provide as specified for the area and environment of installation in Table A above.
   2. Raceways embedded in concrete floors and walls: provide PVC40 conduit
   3. Raceways encased in concrete duct banks: provide PVC40 conduit
   4. Direct buried raceways: provide PVC80 conduit

C. Raceway Types:
   1. GRS:
      a. Description: Galvanized rigid steel conduit (GRS)
      b. Compliance: ANSI C80.1 compliant, UL 6 listed
      c. Finish: Hot-dip galvanized after fabrication, inside and outside. Smooth finished surfaces.
      d. Manufacturers: Atkore, Allied Tube and Conduit, Wheatland Tube, or approved equal
      e. Minimum size: 3/4 inch
      f. Elbows:
         1) 3/4" thru 1-1/2" –- Factory fabricated or field bent.
         2) 2" thru 6" –- Factory fabricated only.
      g. Fittings:
         1) Locknuts, Rings, Hubs:
            a) Hot-dip galvanized insulated throat with bonding locknut or ring,. The hubs shall utilize a neoprene "O" ring and provide a watertight connection. O-Z Gedney, CHM-XXT, or approved equal.
         2) Unions:
            a) Electro-galvanized ferrous alloy type Appleton UNF or UNY, Crouse-Hinds UNF or UNY, or approved equal. Threadless fittings are not acceptable.
         3) Conduit Bodies:
            a) Oversized conduit bodies: Ferrous alloy type with screw taps for fastening covers to match the conduit system. Gaskets shall be made of neoprene.
      h. Boxes:
         1) Indoor:
            a) Type FD cast ferrous for all device boxes and for junction boxes less than 6 inches square.
         2) Outdoor:
            a) Type FD cast ferrous for all device boxes and for junction boxes less than 6 inches square.
         3) Corrosive:
            a) NEMA 4X stainless steel or nonmetallic, as specified.
         4) Hazardous:
            a) NEMA Class 7 cast ferrous or aluminum.
      i. Conduit Bodies (Oversized):
         1) 3/4" thru 4" –- Malleable iron, hot-dip galvanized, unless otherwise noted. Neoprene gaskets for all access plates. Tapered threads for conduit entrances.

2) 5" and 6" –- Electro-galvanized iron or cast iron box.

j. Manufacturers:

1) Appleton, Crouse-Hinds, Hubbell, O. Z. Gedney, or approved equal

k. Installation:

1) Rigid steel conduit shall be made up tight and with conductive thread compound. Joints shall be made with standard couplings or threaded unions. Steel conduit shall be supported away from the structures using hot-dip galvanized malleable iron straps with nesting backs or framing channel.

2) Conduit entering boxes shall be terminated with a threaded hub with a grounding bushing.

3) Exposed male threads on rigid steel conduit shall be coated with zinc-rich paint.

2. PGRS:

a. Description: Rigid steel conduit, corrosion-resistant, polyvinyl chloride (PVC) coated.

b. Compliance: ANSI C80.1 and NEMA RN 1 compliant, UL 6 listed

c. Finish:

1) Hot-dip galvanized rigid steel conduit as specified in for type GRS, with a PVC Coating. The PVC coating shall be gray, minimum 40 mils thick, bonded to the outside and continuous over the entire length of the conduit except at the threads, and be free of blisters, bubbles, or pinholes. Thread protectors shall be used on the exposed threads of the PVC coated conduit.

d. A 2-mil coat of urethane enamel coating shall be bonded to the inside. Coating shall be free of pinholes. Bond strength shall exceed the tensile strength of the PVC coat.

e. Elbows:

1) Factory fabricated only.

f. Fittings:

1) Similarly coated to the same thickness as the conduit and provided with Type 316 stainless steel hardware. Conduit and fittings shall be manufactured by the same company. Conduit and fittings shall be coated by the same company. Male threads on elbows and nipples, and female threads on fittings or conduit couplings shall be protected by application of urethane coating.

l. Covers:

1) PVC coated covers shall have V-groove seal and stainless steel hardware.

m. Hubs:

1) Hubs for connection of conduit to junction, device, or terminal boxes shall be threaded cast ferrous alloy.

2) Hubs shall have the same PVC coating as the conduit and insulating grounding bushings. Hubs shall utilize a neoprene "O" ring and shall provide a watertight connection.

n. Boxes:

1) Nonhazardous:

a) NEMA Class 4X stainless steel or nonmetallic.

2) Hazardous:
    a) NEMA Class 7 cast ferrous.

o. Manufacturers: Calbond, Perma-Cote, Plasti-Bond, Ocal, or approved equal

p. Installation:
    1) Plastic coated conduit shall be made up tight, threaded, and installed using tools approved by the PVC-coated conduit manufacturer.
    2) Exposed conduit threads shall be covered by a plastic overlap coated and sealed per manufacturer's recommendations.
    3) Pipe wrenches and channel locks shall not be used for tightening plastic coated conduits. Damaged areas shall be patched, using manufacturer's recommended material. The area to be patched shall be built up to the full thickness of the coating. Painted fittings are not acceptable.
    4) PVC coated conduit shall be supported away from the structure using PVC coated conduit wall hangers or PVC coated conduit mounting hardware.
    5) Damaged work shall be replaced.

q. Training:
    1) Installers shall be trained and certified in the proper installation techniques provided by the PVC-coated conduit system manufacturer.

3. PVC40:
    a. Description: Rigid PVC conduit
    b. Compliance: NEMA TC2 compliant, UL 651 listed
    c. Construction: Schedule 40, high-impact, polyvinylchloride (PVC)
    d. Minimum size: 3/4 inch
    e. Fittings:
        1) PVC solvent weld type
    f. Boxes:
        1) Indoor: NEMA 4, nonmetallic
        2) Outdoor and corrosive: NEMA 4X, nonmetallic
    g. Installation:
        1) PVC conduit entering fiberglass boxes or cabinets shall be terminated with a threaded male terminal adapter and locknut with neoprene O ring.
        2) Joints shall be made with standard PVC couplings.
        3) PVC conduit shall have bell ends where terminated at walls and boxes.

2. PVC80:
    a. Description: Rigid PVC conduit, heavy wall
    b. Compliance: NEMA TC2 compliant, UL 651 listed
    c. Construction: Schedule 80, high-impact, polyvinylchloride (PVC)
    d. Minimum size: 3/4 inch
    e. Fittings:
        1) PVC solvent weld type
    f. Boxes:
        1) Indoor: NEMA 4X nonmetallic
        2) Outdoor and corrosive: NEMA 4X nonmetallic

g. Installation:
    1) PVC conduit entering fiberglass boxes or cabinets shall be terminated with a threaded male terminal adapter and locknut with neoprene O ring.
    2) Joints shall be made with standard PVC couplings.
    3) PVC conduit shall have bell ends where terminated at walls and boxes.

D. Raceway and Box Supports:
    1. Provide stainless steel framing channel with end caps to support groups of conduit. Provide individual conduit supports that have one-hole stainless steel malleable iron pipe straps used with stainless steel clamp backs and nesting backs.
    2. Provide stainless steel supports, channel, fittings, all-thread, and fasteners in outdoor locations, in corrosive areas, and as shown. Provide factory end-caps for supports and channels.
    3. Independently support boxes by stainless steel brackets, expansion bolts, toggle bolts, or machine or wood screws as appropriate. Wooden or plastic plugs inserted in masonry or concrete shall not be used as a base to secure boxes, nor shall welding or brazing be used for attachment.

E. Raceway Markers:
    1. Provide raceway markers: solid 316SS tags with minimum 22 gauge thickness, stamped in 3/16-inch minimum height characters and attach tags to the raceway with 316 stainless steel wire. Install raceway markers inside of pull boxes, handholes, manholes, and where entering electrical equipment enclosures.
    2. Provide raceway markers indicating the power source and circuit number for lighting and receptacle raceways to the associated panelboard. Interior lighting and receptacle raceways do not require raceway markers for conduit between components.

F. Manholes, Handholes and Pullboxes:
    1. Manholes, handholes and pullboxes generally called boxes herein, contain wires, cables, and conductors. Provide box dimensions where shown. Provide boxes per NEC sizing rules where the dimensions are not sized or shown.
    2. Provide concrete boxes with covers designed for H-20 loading in traffic areas. Engrave box cover: "ELECTRICAL". Provide boxes with hinged, aluminum checkered plate covers with pull-handle to open in non-traffic areas.
    3. Provide precast Quazite Composite cement/polymer products, or approved equal, for handholes, pullboxes, manholes, meter boxes, equipment pads, and vaults where allowed by the electric power utility and for projects where precast concrete is not specifically shown or specified.
    4. Electrical manholes and/or handholes shall be installed with gravity drain piping to daylight. No French drains or gravel bottoms will be acceptable.

G. Underground Marking Tape:
    2. Provide underground detectable marking tape for early warning protection of digging around direct buried cables, conduits, and concrete duct banks.
    3. Low density polyethylene plastic, nominally 6 inches wide and minimum 4 mil thickness with metallic lined tape with red polyethylene film on top and clear polyethylene film on the bottom. Tape shall be imprinted with a warning continuously along the length similar to: "CAUTION BURIED ELECTRIC LINE BELOW." Tape shall be OSHA approved.
    4. Manufacturers: Ideal DU-601, Scotch 408, Seton 85517, approved equal

2.04 CONDUCTORS, WIRE, AND CABLE

A. General:

1. Application of Cable Types:

a. Where conductor or cable types are not shown on the Schedules or Drawings, provide cable types suitable for the application as identified by the "Uses Permitted" listed under each cable type in this Section and in accordance with NFPA 70.

b. Power and control conductors and cable:

1) Single Conductor:

a) Provide minimum conductor size of 12 AWG for power and lighting circuits and minimum conductor size of 14 AWG for control circuits.

2) Multiconductor Cable:

a) Provide multiconductor power and control cable where identified on the drawings.

1. Color Coding:

a. Power Conductors:

1) Power conductors shall have the following colors for the indicated voltage:

Power Conductor	480V	208/120V
Phase A	Brown	Black
Phase B	Orange	Red
Phase C	Yellow	Blue
Ground	Green	Green
Neutral	Gray	White

2) Cables may be black with colored 3/4-inch vinyl plastic tape applied at each cable termination and in pull boxes, handholes and manholes. Tape shall be wrapped with 25 percent overlay to provide 3 inches minimum coverage.

b. Control Conductors:

1) Single-conductor control conductors shall have the following colors for the indicated voltage:

Control Conductor	120V
Power (AC)	Black
Control (AC)	Red
Neutral	White
Ground	Green
Foreign Voltage (DC)	Blue/White
Foreign Voltage (AC)	Yellow
Power (DC)	Blue
Control (DC)	Violet
Intrinsically Safe	Light Blue

c. Signal Conductors:

1) Signal cable conductors shall be color coded black and white for pairs or black, white, and red for triads. Each conductor and each group of conductors shall be numbered.

B. Cable Types:
   1. XHHW-2:
      a. Description:
         1) Industrial grade single conductor
         2) Sizes: 14 AWG through 750 kcmil as shown
      b. Voltage: 600 volts
      c. Conductor Material:
         1) Bare annealed copper
         2) Stranded per ASTM B8
            a) Solid conductors may be used for termination of 15A or 20A receptacle and lighting circuits only.
      d. Insulation:
         1) NEC Type XHHW-2; 90 degree C dry and C wet;
         2) Cross-Linked Polyethylene (XLP) per ANSI/NEMA WC70 ICEA S-95-658 and UL-44;
      e. Manufacturer(s): General Cable, Okonite, Southwire, or approved equal
      f. Uses Permitted: Power, control, lighting and outlet circuits in raceways.
   2. MXLPE/PVC
      a. Description:
         1) Multiconductor Power or Control Cable
      b. Cable Configuration:
         1) Individually insulated conductors bundled in an overall protective cable jacket.
         2) Size and quantity of conductors as indicated on the Schedules or Drawings. Insulated ground conductor in all cables.
         3) Type TC-ER (Tray Cable – Extended Run)
         4) Conductor Identification:
            a) Sizes #14-10: ICEA Method 1 or 2 (integral color coding in conductor insulation)
            b) Sizes >= #8: ICEA Method 4 (numbers printed on each conductor)
      c. Voltage: 600 volts
      d. Conductor Material: Bare annealed copper; Class-B stranded per ASTM B8
      e. Conductor Insulation:
         1) NEC Type XHHW-2; 90 degree C dry and C wet;
         2) Cross-Linked Polyethylene (XLP) per ANSI/NEMA WC70 ICEA S-95-658 and UL-44
      f. Cable Jacket: PVC
      g. Manufacturer(s):
         1) General Cable 4500 /4550
         2) Okonite X-Olene-Okoseal
         3) Southwire 45052
         4) Approved equal

h. Uses Permitted:
    1) Power, control, lighting and outlet circuits in raceway or cable tray.

3. SIC (Single Instrumentation Cable)
    a. Description:
        1) Single twisted, shielded pair or triad, 18 or 16 AWG, instrumentation and signal cable; UL listed; Cable Tray rated
    b. Voltage:
        1) 600 volts
    c. Conductor Material: Bare annealed copper; stranded per ASTM B8
    d. Insulation:
        1) 15 mil, Polyvinyl Chloride (PVC) with 4 mil nylon, 90 degree C temperature rated; Color Code per ICEA Method-1: Pairs-Black and White with one conductor in each pair printed alpha-numerically for identification
    e. Lay:
        1) Twisted on a 2-inch lay
    f. Shield:
        1) 100 percent, 1.35 mil aluminum-Mylar tape with a 7-strand tinned copper drain wire
    g. Jacket:
        1) 45 mil Polyvinyl Chloride (PVC)
    h. Flame Resistance:
        1) UL 1685
    i. Manufacturer(s):
        1) Okonite, Okoseal-N Type P-OS (Pair(s) Overall Shield) and Type TOS (Triad(s) Overall Shield); or Cooper Industries-Belden equal; or General Cable equal; or approved equal.
    j. Flame Resistance:
        1) IEEE 1202
    k. Uses Permitted: Instrumentation signal circuits in raceway or cable tray.
4. MIC (Multiple Instrumentation Cable)
    a. Description:
        1) Multiple twisted, shielded pairs, 18 or 16 AWG, with overall shield instrumentation cable; Number of pairs as shown; UL listed, Cable Tray rated.
    b. Voltage:
        1) 600 volts
    c. Conductor Material:
        1) Bare annealed copper; Class-B stranded per ASTM B-8
    d. Insulation:
        1) 15 mil, Polyvinyl Chloride (PVC) with 4 mil nylon, 90 degree C temperature rated Color Code per ICEA Method-1: Pairs- Black and White with one conductor in each pair printed alpha-numerically for identification
    e. Lay:
        1) Twisted on a 2-inch lay

f. Shield:
    1) 100 percent, 1.35 mil aluminum/polyester or mylar tape with 7-strand tinned copper drain wire
g. Overall Shield:
    1) 2.35 mil aluminum-Mylar tape with 7-strand tinned copper drain wire
h. Jacket:
    1) Flame-retardant, moisture and sunlight resistant 45 mil Polyvinyl Chloride (PVC)
i. Flame Resistance:
    1) UL 1685 vertical tray flame test
j. Manufacturer(s):
    1) Okonite, Okoseal-N type SP-OS (Shielded Pairs with Overall Shield); or Cooper Industries-Belden equal; or General Cable equal, or approved equal
k. Uses Permitted: Instrumentation signal circuits in raceway or cable tray.

C. Electrical Enclosure Conductor Ratings:
1. Provide conductors with 600-volt insulation ratings in panels and other electrical enclosures. Conductors with less than 600-volt insulation ratings are prohibited, unless specifically identified.
2. Bundle and lace conductors in panels and electrical equipment at intervals not greater than 6 inches, spread into trees and connected to their respective terminals. Provide lacing using plastic cable ties that are tensioned and cut off using a tool specifically designed for the purpose such as a Panduit GS2B. Other methods of cutting cable ties are prohibited.
3. Bundle conductors crossing hinges into groups not exceeding 10 to 15 conductors and protected using nylon spiral flexible covers to protect conductors and provide oversized plastic panel wiring duct within panels.
4. Provide slack in junction boxes, pull boxes, handholes and manholes sufficient to allow cables or conductors to be routed along the walls with the amount of slack equal to largest dimension of the enclosure.
5. Provide dedicated electrical wireways and insulated cable holders mounted and secured on stainless steel unistrut in manholes and handholes.

D. Instrument Signal Cable:
1. Provide terminal blocks at instrument cable junctions within dedicated terminal boxes provided by the installer. Provide twisted shielded cable with individual shield for each pair. Provide twisted shielded cable multi-pair with overall shield and jacket. Provide triads wherever 3-wire circuits are required. Circuits shall not be made using conductors from different pairs or triads.
2. Install instrument, signal, and data communication circuits without splices between instruments, terminal boxes, or panels. Shields as a signal path, except for circuits operating at radio frequencies and utilizing coaxial cables are not acceptable. Common ground return conductors for two or more circuits are not acceptable.
3. Bond shields to the signal ground bus at the control panel. Isolate shields from ground and other shields at other locations by cutting short or taping. Provide terminal strips for signal leads and shield drain wires.

4. Terminate spare circuits and the shield drain wire on terminal blocks at both ends of the cable run. Shields or drain wires for spare circuit cables shall be bonded at control panel only with the other end insulated by tape cover.
5. Provide an instrument stand with terminal box mounted approximately 3 feet above grade to center or as shown. Provide terminal boxes for instrument cable with the cable and conductor labels specified.
6. Install and terminate conductors for paging, security, data communication, voice communication, and telephone systems in compliance with the manufacturer and the system utility recommendations.

E. Splicing and Terminating Materials:
1. Use an UL listed tool for the applied compression type of connectors with the correct size and type. Provide tin-plated high conductivity copper connectors. Mechanical clamp, dimple, screw-type connectors are prohibited.
2. Provide polymeric insulating material over motor terminations with high dielectric strength mastic or material to seal the ends against ingress of moisture and contamination.
3. Cover splices with electrical products designed for the application, and insulate with a heat-shrinkable sleeve or boot.

F. Fire Stop Sealant Materials:
1. Provide non-combustible silicone sealant for sealing apertures and cable through-penetrations for electrical conductors meeting UL 263 4-hour time-temperature requirements.
2. Manufacturer: STI Inc., Pensil Silicone Sealants PEN300 SpecSeal Firestop, or approved equal.

G. Terminal Blocks:
1. Power:
   a. Standards: UL 1953 listed or UL 1059 recognized
   b. Style: IP20 finger safe, mechanical set screw connection
   c. Ratings:
      1) Voltage: 600V
      2) Short-circuit current rating (SCCR): as required for the application, marked on terminal block.
   d. Manufacturers:
      1) Allen-Bradley PMDE/PDE series
      2) Eaton PDBFS series
      3) Mersen FSPDB series
      4) Schneider Electric NSYEB series
      5) TE Connectivity CBS50 series
      6) Weidmueller WPD series
      7) Approved equal
2. Control:
   a. Standards: UL listed or recognized
   b. Style: mechanical strap screw connection
   c. Ratings:

1) Voltage: 600V
2) Current: 20A continuous

d. Manufacturers:
1) Allen-Bradley 1492-J series
2) Phoenix Contact UT 2,5 series
3) Weidmuller W series
4) Approved equal

3. Identification:
a. Label with overall identifier/number for each terminal block group
b. Label with individual identifier/number for each terminal
c. Machine printed text minimum 1/8" high

2.05 CONTROL DEVICES

A. Pilot Devices:

B. Pushbuttons – Emergency Stop:
1. Standards: UL 508 listed
2. Style: Mushroom head, >=40mm diameter, maintained contact, push-pull operation
3. Size: 30.5mm mounting hole
4. Enclosure rating:
a. Electrical rooms: NEMA/UL Type 4 water-tight, oil-tight
b. Other unclassified locations: NEMA/UL Type 4X water-tight, oil-tight, corrosion-resistant
c. Class I, Division 2 locations:
1) NEMA/UL Type 4X with Class I, Division 2 rated contacts or;
2) NEMA/UL Type 7 if enclosure contains other components with arcing parts
d. Class I, Division 1 locations: NEMA/UL Type 7 explosion-proof
5. Color: red
6. Legend plates: install around each pushbutton, with text above the button identifying its function as indicated on the Drawings.
7. Temperature operating range: –10 degree C. to +55 degree C.
8. Dielectric strength: 2,200V for 1 minute
9. Contact rating:
a. NEMA A600 (10A continuous @ 600VAC)
b. NEMA Q600 (2.5A continuous @ 600VDC)
c. Installations in Class I, Division 2 locations: contact blocks UL listed for use in Class I, Division 2, Group B, C, and D hazardous locations.
10. Manufacturer:
a. Allen-Bradley 800H-FX6 series
b. Eaton HT8DBR series
c. Schneider Electric 9001SKR9RH series
d. Approved equal

2.06 GROUNDING SYSTEM

A. Provide electrical system grounding electrode conductors, equipment grounding conductors for equipment grounding and raceways, grounding electrodes, grounding electrode conductors, connections, and bonding in compliance with the National Electrical Code-Article 250 and the National Electrical Safety Code.

B. Provide annealed bare copper, concentric stranded grounding conductors. Provide the minimum sizes per NEC Article 250 for grounding conductors or service entrance conductors, if not sized on the drawings.

C. Bond grounding conductors entering enclosures together to metallic enclosure and to metallic raceways terminating at the enclosure. Clean the conductor and enclosure metal surface at the point of connection prior to making equipment grounding connections or bond connections.

D. Provide ground grid components of #4/0 AWG bare copper conductors connected to 10-foot ground rods installed at the four corners of a building, an equipment pad, or as shown on the Drawings. Provide concrete-encased electrodes (Ufer grounds) per NEC 250.52(3), by embedding conductors in concrete near bottom of footing.

E. Make grounding conductor connections to equipment and ground rods by bolted clamps, compression connectors, or exothermic weld connections in accordance with manufacturer's installation and testing instructions. Make connections to buried grounding connections using compression connectors or exothermic weld connections. Make connections at the ground grid test wells using bolted clamps.

F. Connect the ground grid to the following with grounding conductor specified herein or connect to the ground grid with grounding conductor as shown on the drawings:
   1. Building steel columns with #4/0 bare copper
   2. Electrical ductbank #4/0 embedded conductor with #4/0 bare copper
   3. Electrical distribution or utilization equipment metal enclosures with #4/0 green insulated copper
   4. Metal enclosure not containing electrical distribution with #4 green insulated copper
   5. Pump/motor frames with #4 bare or insulated
   6. Lightning and surge arresters using #4 bare or insulated
   7. Fences and gates with #4 bare or insulated
   8. Ground rods with #4/0 bare copper
   9. Power utility service entrance equipment with #4/0 bare copper
   10. Equipment ground plate with #4/0 bare copper.
   11. Other equipment: provide #1 green insulated copper. Provide ¾" conduit protection where subject to damage.

G. Ground Rods:
   1. Ground rods: copper-clad steel, 3/4-inch diameter and 10-feet long, with threaded end for connectors or installation tools.

H. Compression Connectors:
   1. Compression connections: cast copper.
   2. Manufacturer: Thomas & Betts Company, or approved equal.

I. Bolted Connectors:
   1. Bolted connectors: copper. Manufacturer: Burndy, O. Z. Gedney, or approved equal.

J. Exothermic Connectors:
   1. Exothermic connections copper products. Manufacturer: Cadweld process or approved equal.

2.07 POWER, CONTROL, AND METERING EQUIPMENT

A. Safety Disconnect Switches:
   1. Provide safety disconnect switches:
      a. UL 98 listed, NEMA KS-1 compliant
      b. Motor horsepower rated, heavy-duty
      c. Continuous current rating: as indicated on the Drawings
      d. Fusible when shown or required for short circuit current rating
         1) When fuses are required, provide Class R current-limiting fuses, conforming to NEMA FU-1 with a minimum of 100kAIC interrupting rating.
         2) Fuse continuous current rating: as indicated on the Drawings
      e. Safety type rated 600 volts AC
      f. Disconnect "open status" switch rated 1-ampere
      g. Switch operator with a positive, quick-make, quick-break mechanism
      h. NEMA-12 indoor-conditioned space, or as shown
      i. NEMA-4X 316 stainless steel below grade, process areas, outdoors, corrosive areas, or as shown
      j. NEMA-7 aluminum hazardous classified areas
      k. Manufacturer: ABB TH Series, Eaton DH Series, Schneider Electric H Series, Siemens or Approved equal

2.08 OVERCURRENT PROTECTION

A. Overcurrent Protection:
   1. Power Fuses:
      a. Provide Class R fuses and fuse holders where required for proper protection of equipment. Fuse clips shall be Class R rejection type and sized for UL Class R, one-time, time-delay fuses. Fuse assembly shall have a minimum short circuit capacity of 100,000 amps symmetrical.
   2. Control Fuses:
      a. Provide fuses for 120 Vac circuits with a minimum of 12,000-amperes interrupting capacity and blown fuse indicators. Fuses for 24 Vdc circuits shall be fast acting glass tube type rated 1/8 or 1/10 amp for 4-20 mA loops. Fuses for 24 Vdc circuits shall be 1/2 amp for the power supply to individual instruments. Fuse holders shall be tip-out or draw-out type.

PART 3 – EXECUTION

3.01 GENERAL

A. Construction:
   1. Perform the work specified by Contract Documents in accordance with these specifications.

2. Contract Drawings are diagrammatic, unless otherwise detailed or dimensioned. Coordinate the location of electrical material or equipment with the work and adjust conduit location to accommodate equipment in accordance with the accepted submittal drawings.

B. Housekeeping:
   1. Protect electrical equipment from dust, water and damage. Cover the exterior to keep dry. Electrical distribution equipment such as motor control centers, switchgear, switchboards, panelboards, and other power source buses shall be clean and free of dust and dirt.
   2. Protect electrical equipment temporarily exposed to weather, debris, liquids, or damage during construction as specified in Shipment, Protection, and Storage section. Touch up scratches on equipment as specified in Coating Systems section before final acceptance.
   3. Wipe clean and vacuum equipment on the inside prior to acceptance testing and energization and again prior to detailed inspection and acceptance of the work.

C. Installation:
   1. Perform the installation work specified in accordance with these specifications.
      a. Splices are not allowed except by permission. Submit proposed splice locations to the Owner for review prior to installation. Splices and terminations are subject to inspection prior to and after insulating and may require re-termination after inspection. Underground splices will not be allowed.
      b. Adhere to the NEC raceway fill limitations. Provide separate conduits for signal and instrument conductors and cables.
      c. Install power conductors derived from uninterruptible power supply systems in separate raceways.
      d. Provide terminations at 460-volt motors by bolt-connecting the lugged connectors and insulating. Alternately, provide Tyco Electronics GelCap Motor Connection Kit by Raychem.
      e. Install pre-approved in-line splices and tees with tubular compression connectors and insulate. Splices and tees in underground handholes or pull boxes shall be insulated using Scotch-cast epoxy resin splicing kits.
      f. Provide self-insulating tubular butt-splice type of compression connectors for terminations at solenoid valves, 120-volt motors, and other devices furnished with pigtail leads.
      g. Adjust motor circuit protectors in accordance with manufacturer's instructions and NEC requirements.
      h. Adjust motor overload device in accordance with manufacturer's instructions and NEC requirements.

D. Conductors, Wire, and Cable Installation:
   1. Identify conductors at each connection terminal and at splice points with the identification marking system specified.
   2. Install wire and cable into raceways, conduit, cable trays, or wireways without damaging or putting undue stress on the insulation or jacket. Provide manufacturer's recommended and UL Listed pulling compounds lubricants for pulling wire and cable. Grease is prohibited.

3. Raceway construction shall be complete, cleaned, and protected from the weather before cable is installed. Provide wire or cable support where wire or cable exits a raceway. Provide reusable stainless steel Kellums grips or approved equal product where cable support is required and where loads are removable.
4. Scratch-brush the contact areas and tinplate the connection where flat bus bar connections are made with tinplated or unplated flat bus bar. Provide non-oxide material approved for the function. Torque bolts to the bus manufacturer's recommendations.
5. Adhere to raceway fill limitations defined by NEC and the following: Lighting and receptacle circuits may be in the same conduit in accordance with de-rating requirements of the NEC. Lighting and receptacle circuits shall not be in conduits with power or control conductors. Signal conductors shall be in separate conduits.
6. Install pre-approved in-line splices and tees made with tubular compression connectors and insulated as specified for terminations and for motor terminations. Splices and tees in underground handholes or pull boxes shall be insulated using Scotch-cast epoxy resin or approved equal splicing kits.
7. Conductors in all handholes and manholes shall have adequate slack to be tied up around the perimeter of the vault and will be suspended by insulators around the vault's perimeter as needed to support the cable.

E. Raceway Installation:
1. Design and provide conduit routing that conforms to the installation requirements set forth herein and in accordance with the NEC.
2. Determine conduit routing that conforms to the installation requirements set forth herein and in accordance with the NEC requirements for size and number of pullboxes.
    a. Install exposed conduit either parallel or perpendicular to structural members and surfaces.
    b. Route two or more exposed conduits in the same general routing parallel with symmetrical bends.
    c. Install exposed conduit on supports spaced not more than 10 feet apart.
    d. Place conduits under the reinforcement in slabs with only a single layer of reinforcing steel. Route conduit clear of structural openings and shown future openings.
    e. Grout conduit into any openings cut into concrete and masonry structures.
    f. Cap conduits during construction to prevent entrance of dirt, trash, and water.
    g. Terminate exposed conduit stubs for future use with pipe-caps and provide couplings and pipe-plugs where flush with the slab.
    h. Determine concealed conduit stub-up locations from the manufacturer's shop drawings.
    i. Terminate conduit in equipment with conduit couplings with pipe-plugs flush with structural surfaces for empty conduit.
    j. Install conduit horizontally with at least 7-feet headroom clearance.
    k. Terminate conduit with fittings that ensure that the NEMA rating of the enclosure and provide conduit hubs, as required heretofore.
    l. Connect underground metallic or nonmetallic conduit that turns out of concrete, masonry, or earth to a 90-degree elbow of PVC-coated rigid steel conduit before emergence. Taped or painted GRS or PVC is prohibited.

m. Provide conduit crossing structural joints with structural movement with O-Z "Type DX" or Crouse-Hinds "Type XJG-SA," aluminum, bonded, weather-tight expansion fitting of the same size and type as the conduit.

n. Seal conduits in corrosive areas using removable mastic material.

o. Provide additional pullboxes for conduit runs with greater than 360 degrees in any run between pull boxes. Limit maximum conduit runs without additional pullboxes to 400 feet, less 100 feet for every 90 degrees for the conduit run change in direction.

F. Underground Raceway Installation:

1. Adhere to the Power Utility underground service entrance requirement for excavation, raceways installation and termination, pads and reinforcement, backfilling, and location criteria. Provide excavation, backfilling, and concrete work as specified and shown.

2. Provide underground conduit installations that conform to the following requirements:

a. Direct bury underground conduits that are not shown to be installed in an electrical ductbank.

b. Provide PGRS elbows for transitions from horizontal underground PVC conduit to vertical conduit runs.

c. Underground conduit bend radius: not less than 2 feet minimum at vertical risers nor less than 3 feet elsewhere for up to 2-inch diameter conduit.

d. Determine conduit manufacturer's bending radius requirement for 3-inch and larger diameter conduit and use factory "long radius" elbows.

e. Underground ductbanks and direct-buried conduits: 2-feet minimum earth cover, except where shown otherwise.

f. Concrete encased conduit:

1) Minimum concrete thickness of 2 inches between conduits 2.5-inch and smaller.

2) 3 inches between 3-inch conduit and larger or per NEC requirements.

3) 1-inch between conduit and reinforcing.

4) 3 inches over reinforcing.

5) Embed #4/0 bare ground in the concrete encasement and installed with direct buried raceways.

6) Standard detail or typical details shown supersede these general requirements.

7) Provide 3-pounds of red-oxide dye-color per sack of cement for in the concrete encasement for electrical ductbanks.

8) Provide 467-ASTM coarse aggregate size with 3-cement sacks per cubic yard concrete.

9) Concrete used for duct banks shall have a minimum strength of 3,000 psi and comply with Section 03 30 00.

G. 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.

H. 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 EARTHWORK FOR DUCTBANKS AND CONDUITS

A. General:
   1. Earthwork for ductbanks and conduits is specified in Table A; in the standard details; and in the following paragraphs.

Fill Classifications				
Fill class	**Material type**	**Maximum uncompressed layer depth, inches**	**Minimum relative compaction, percent**	**General application**
C1	C	8	90-95	Subsequent pipeline/ductbank backfill; compaction as specified

B. Ductbank 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. Ductbank Backfill:
   1. Class C1 backfill shall be used where specified. Trench excavation which meets the requirements of Class C1 material may be used, which shall be fine-grained materials (e.g., sand, silty sand, sandy silt). Rock fragments larger than 3 inches in maximum dimension shall be removed prior to reuse.

2. The trench above the ductbank 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.

3.03 ELECTRICAL IDENTIFICATION

A. Nameplates:
   1. Provide nameplates for all enclosures containing electrical and instrumentation equipment, including the following information:
      a. Unique identifier matching the Contract Drawings (e.g. LCP-2200)
      b. Functional description of equipment served (e.g. BAR SCREEN 2)
      c. Upstream disconnecting means / source of power (e.g. “SOURCE: LP-15 CKT 23”)
   2. Provide nameplates for all boxes (including pull, junction, and terminal boxes), including the following information:
      a. Unique identifier matching the Contract Drawings
         1) Where no identifier is present on the Drawings, assign a unique identifier that relates to the tags assigned to upstream conduits.
      b. Maximum operating voltage of conductors contained in the box (e.g. 480VAC, 120VAC, 24VDC, SIGNAL, NETWORK, or FIBER)
   3. Nameplates shall be made from laminated phenolic plastic.
      a. Black backgrounds with 3/16-inch white letters.
      b. Fastened using self-tapping stainless-steel screws. Nameplate adhesives will not be permitted on the outside of enclosures.
      c. Submit abbreviations due to space limitations to Owner prior to manufacture.

FF. Raceway Identification:
   1. Provide a permanent raceway identification tag on each new and reused conduit at each end and at each pull box, terminal box, wireway, gutter, manhole or handhole.
   2. Raceway Numbers:
      a. Tag raceways at all terminations. Raceway numbers will comply with raceway labels assigned on the drawings. Where raceway numbers have not been assigned, assign raceway numbers in accordance with the following system:

Raceway Prefix	Type of Function
H	Power >600V
P	Power <=600V
C	Control or power - 120V or less
S	Signal - data communication or instrumentation
N	Network communication
X	Spare

b. Provide 4-digit number after the prefixes. Add a letter suffix to distinguish the raceways where more than one raceway is routed to a particular piece of equipment. Example: Raceway number = P3109A where:
   1) P = conduit contains power
   2) 3109 = unique 4-digit number
   3) A = letter to distinguish raceways to same equipment

3. Raceway Markers:
   a. Solid 316SS tags with minimum 22 gauge thickness.
   b. Raceway identifier stamped or engraved in 3/16-inch minimum height characters
   c. Attached to the raceway with 316 stainless steel wire.

C. Conductor and Cable Identification:

4. Identify each conductor with a unique designation.
   a. Provide identification at each terminal to which the conductor is connected and intermediate boxes, handholes, and manholes.
   b. Provide identification of spare conductors at origin and destination enclosures and intermediate boxes, handholes, and manholes.
5. Identify conductors to match the identifiers on the Drawings or Schedules.
6. Where conductors are not labeled on the Drawings or Schedules, identify conductors using the following system: EQUIPMENT TAG NUMBER – DESTINATION FIELD TERMINAL NUMBER.
   a. Example: PMP-4300-T1 (480V power conductor to first T lead of pump motor)
   b. Example: LIT-5430-N (120V power conductor to neutral terminal of instrument)
   c. Example: LCP-1100-22 (control conductor to control terminal block 22)
   d. Example: LCP-1100-X3 (third un-terminated spare conductor routed to LCP-1100)
7. Where multiple conductors are in parallel from origin to destination, use the same conductor identifier for both, but add a suffix:
   a. Example: MCC-2500-1-1 (parallel 480V power conductor #1 to the first phase of the MCC main breaker).
   b. Example: MCC-2500-1-2 (parallel 480V power conductor #2 to the first phase of the MCC main breaker).
8. Where factory-wired equipment has terminal numbers different than the conductor numbers shown on the control diagrams:
   a. Show both on the interconnection diagram
   b. Include a copy of the interconnection diagram inside of the equipment cabinet.
9. Conductor and Cable Markers:
   a. Provide identification sleeves for conductors size No. 10 AWG or smaller. Provide locking tab type cable markers for conductors No. 8 AWG and larger. Provide white plastic tabs with conductor identification number permanently embossed. Adhesive strips are not acceptable.
   b. Machine print the letters and numbers that identify each wire on sleeves with permanent black ink with figures 1/8 inch high. Provide white or yellow tubing for sleeves sized to fit the conductor insulation. Shrink the sleeves with hot air after installation to fit the conductor.

3.04 TESTING

A. Provide electrical equipment acceptance tests in accordance with the latest version of NETA Acceptance Testing Specification for electrical distribution and utilization equipment to demonstrate that all electrical equipment is functioning as designed.

B. Test lighting system for proper function. Test wiring devices for correct connections. Test outlet grounding and polarity using a plug-in test device. Test motor control stations and control devices for proper function.

C. Test power, control, instrument, and signal conductors to verify free from grounds. Megger test all three-phase power conductors with the test voltage appropriate to the conductor insulation voltage. Use a1,000-volt megohmmeter for resistance measurements for 600VAC rated insulation and all motors. Test between conductors and from conductor to ground. Insulation with resistance of less than 10-megohms is not acceptable. Record the insulation resistance measurements in a format similar to or on the Form 26 05 00-A in Section 01 99 90.

D. Pre-test conductors prior to installation, as appropriate. Replace damaged conductors. Test all conductors after installation.

E. Measure motors insulation resistance before they are connected. For 50-horsepower and larger motor, measure the motor insulation resistance at the time of delivery and after they are connected. Insulation resistance values less than 10 megohms are not acceptable. Complete the Installed Motor Test Form: 26 05 00-B in Section 01 99 90, for each motor after installation.

3.05 FUNCTIONAL CHECKOUT

A. Prior to energization of equipment, perform a functional checkout of the control circuit. Prior to functional testing, adjust and make protective devices operative. Energizing each control circuit and operating each control, status, alarm, protective device, and each interlock to verify that the specified action occurs. Submit a description of his proposed functional test procedures prior to the performance of functional checkout.

B. Verify motors are connected to rotate in the correct direction by momentarily energizing the motor. Prior to motor rotation test, confirm that the motor, the driven equipment, nor personnel will be damaged by reverse operation.

3.06 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be included in the lump sum bids for the respective items in the Proposal Schedule.

END OF SECTION

SECTION 26 05 05

SELECTIVE DEMOLITION FOR ELECTRICAL

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Selective demolition for electrical

B. Coordinate all demolition work with:
   1. The Officer-in-Charge and their electrical safety plan and/or procedures.
   2. Operations.
   3. Systems Integrator for removal of instruments, control equipment and systems as shown or specified.
   4. Work of other trades and contractors.

C. Conditions:
   1. Perform preliminary investigations as required to ascertain extent of work and planning/coordination requirements. Conditions which would be apparent by such investigation will not be allowed as cause for claims for extra costs.
   2. See plans for extent of work and associated demolition in addition to this section.

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. Division 1 - General Requirements
   2. Division 2 - Existing Systems
   3. Division 3
      a. Section 03 60 00 - Grouting
   4. Division 26 - Electrical

1.03 REFERENCES

A. General:
   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.
3. NECA 1- Standard for Good Workmanship
4. NFPA 70 – National Electrical Code
5. NFPA 70E – Standard for Electrical Safety in the Workplace

1.04 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:
   1. Demolish: Detach items from existing construction and legally dispose of items off site, unless indicated as removed and salvaged, or removed and reinstalled.
   2. Remove: Planned deconstruction and disassembly of electrical items from existing construction including removal of conduit, junction boxes, cabling and wiring from electrical component to panel taking care not to damage adjacent assemblies designated to remain; legally dispose of items off site, unless indicated as removed and salvaged, or removed and reinstalled.
   3. Remove and Salvage: Detach items from existing construction and deliver them to Owner ready for reuse.
   4. Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.
   5. Abandon-In-Place: Render item permanently nonoperational in its existing location, detach from any existing construction and cease to maintain.
   6. Existing to Remain: Existing items of construction that are not removed and that are not otherwise indicated as being removed and salvaged, or removed and reinstalled.
   7. Hazardous Substances: Dangerous substances, dangerous goods, hazardous commodities and hazardous products may include asbestos, mercury and lead, PCBs, poisons, corrosive agents, flammable substances, radioactive substances, or other material that can endanger human health or wellbeing or environment if handled improperly as defined by Federal Hazardous Products Act (RSC 1985) including latest amendments.

1.05 ADMINISTRATIVE CONTROLS

A. Coordination:
   1. See Section 01 12 16.
   2. Coordinate work of this Section to avoid interference with work by other Sections.
   3. Coordinate with Officer-in-Charge in advance for scheduling removal of items.

B. Pre-demolition Meetings:
   1. Schedule Pre-demolition meeting with Officer-in-Charge.

2. Safety plan(s) and de-energization as required.
3. Review areas where existing construction is to remain and requires protection.
4. The Owner shall be given the opportunity to retain any of the equipment in the areas being demolished. Confirmation of any salvage items will take place at this meeting.

1.06 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. Landfill records: Indicate receipt and acceptance of selective demolition waste and hazardous wastes by a landfill facility licensed to accept hazardous wastes.
   3. Schedule of demolition activities: Schedule the following activities in conjunction with the requirements of Section 01 12 16:
      a. Detailed sequence of demolition and removal work, with starting and ending dates for each activity. Ensure OWNER's on-site operations are uninterrupted.
      b. Coordination plan by plant process or area.
      c. Provisions for temporary systems.
      d. List of equipment effected.
      e. Contingency plans or systems.
      f. Lockout/tagout procedures and permissions.
   4. Pre-demolition photographs or video: submit before work begins.

1.07 QUALITY ASSURANCE

A. Perform work in this section in accordance with:
   1. Code of Federal Regulation Part 1926 - Safety and Health Regulations for Construction.
   2. Site-specific health and safety guidelines.

1.08 SITE CONDITIONS

A. Condition of materials identified as being salvaged or demolished are based on their observed condition at time of site examination.

B. Discovery of Hazardous Substances:
   1. It is not expected that Hazardous Substances will be encountered in the work. Immediately notify Owner if materials suspected of containing hazardous substances are encountered.

1.09 SALVAGE AND DEBRIS MATERIAL

A. Demolished items become Contractor's property and will be removed from Project site; except for items indicated as being reused, salvaged, or otherwise indicated to remain the Owner's property.

B. Carefully remove materials and items designated for salvage and store in a manner to prevent damage or devaluation of.

PART 2 PRODUCTS

2.01 MATERIALS

A. Materials used to cover blank openings in NEMA 4X panels, boxes and equipment enclosures:
   1. Polished edge, sheet stainless steel equivalent to gauge of enclosure.
   2. Provide neoprene gasket or silicone-based caulk to maintain NEMA rating.

B. Materials used to cover blank openings in NEMA 7 boxes and equipment enclosures:
   1. Material must match box or enclosure.
   2. Must be threaded or have labyrinth type seals to maintain NEMA 7 construction integrity.

C. Materials used to cover blank openings in NEMA 1, 3R, 4 and 12 panels, boxes and equipment enclosures:
   1. Provide plugs or fittings that will maintain the NEMA construction integrity.
   2. Tape shall not be allowed to cover blank openings.
   3. Primed and painted to match enclosure.
      a. Provide neoprene gasket or silicone-based caulk to maintain NEMA rating.

D. Conduit Caps and Plugs:
   1. Same material as conduit.
   2. Glued or threaded as required.
   3. Tag conduit as SPARE and the destination equipment tag.

PART 3 EXECUTION

3.01 GENERAL

A. Provide partitions, barricades, warning lights, signage and other means necessary to ensure the safety of persons inside and outside of the area of work in accordance with NFPA 70E.
B. Pre-Bid Verification of Existing Conditions:
   1. Visit site, thoroughly examine and become familiar with conditions that may affect the work of this Section before submitting the Bid.
C. Ensure the integrity of all enclosures containing energized conductors or equipment is maintained during demolition. Provide barriers or covers over all openings during all phases of work.
D. Protect property to prevent damage during demolition.
E. Promptly cleanup and remove from site all material to be disposed.
F. Dispose of all materials in accordance with federal, state and local laws.

3.02 PREPARATION

A. Protect systems and components indicated to remain in place during selective demolition operations and as follows:

1. Prevent movement and install bracing to prevent settlement or damage of adjacent services and parts of existing buildings scheduled to remain.
2. Notify Owner and cease operations where safety of buildings being demolished, adjacent structures or services appears to be endangered and await additional instructions before resuming demolition work specified in this Section.
3. Prevent debris from blocking drainage inlets.
4. Protect mechanical systems that will remain in operation.
5. Demolition drawings are based on limited visual field observation and existing record documents:
    a. Contractor shall field verify all existing systems as required for demolition.
    b. Verify field measurements and circuiting arrangements are as indicated.
    c. Verify that abandoned wiring and equipment serve only abandoned facilities or systems.
    d. Report discrepancies to Owner before disturbing existing installation.
6. Maintain existing electrical system(s) in service until new system is complete and ready for service.
7. Beginning of demolition means installer accepts existing conditions.

3.03 DEMOLITION

A. General:
    1. All existing electrical equipment, systems, devices and fixtures to be removed shall be removed with such care as may be required to prevent unnecessary damage, to keep existing systems in operation and to maintain the integrity of the grounding systems.
    2. Unless otherwise shown on the Drawings, specified or directed, the Contractor shall dispose of all surplus excavated materials and materials and equipment form demolition, legally off the site.
B. Equipment Containing Toxic Substances:
    1. Perform work for removal and disposal of equipment and materials containing toxic substances regulated under the Federal Toxic Substances Control Act (TSCA) in accordance with applicable federal, state, and local regulations. Applicable equipment and materials include, but are not limited to:
        a. Polychlorinated biphenyls (PCB)-containing electrical equipment, including transformers, capacitors, and switches.
C. Wire and Cable:
    1. Remove power and control conductors from conduits and/or trays indicated or as required. Removal shall include conductors in duct banks and direct buried conductors as shown or specified.
    2. Conductors tapped from circuits that will remain in service:
        a. Disconnect conductors from terminals or splices at nearest pull box or equipment enclosure outside of the indicated removal area.
        b. Re-insulate gutter taps or terminals from which conductors have been removed to the original insulation level.
    3. Remove equipment grounding conductor(s) with phase conductors, unless indicated otherwise.

D. Conduit:
   1. Remove conduit from area indicated back to the nearest pull box, motor control center, or equipment enclosure outside of the indicated area or as noted on the drawings.
   2. Remove associated straps and supports.
   3. Install square head plug with thread sealing compound in cast enclosure hubs from which conduit has been removed.
   4. Restore fire rating of all partitions penetrated by conduit to be removed.
   5. Disconnect and remove or relocate all equipment indicated.
   6. Protect equipment to be reused from dust, dirt, impact or other damage during demolition.
   7. Close all conduit penetration, bus penetrations, or other openings in remaining equipment caused by the removal of equipment indicated.
   8. Remove equipment anchor bolts by grinding flush with floor surface or top of concrete pad if pad is to remain.
   9. Where removal of concrete equipment mounting pads is indicated, remove concrete and reinforcing flush to floor and seal exposed concrete surface.
   10. Spare space in electrical equipment shall be covered with manufacturer's plates and/or fillers as needed to close and safeguard space/equipment from any/all energized. Spare space shall be labeled as "SPARE" on equipment enclosures and/or schedules.

3.04 SALVAGE OF MATERIALS

A. Salvage items designated for Owner's salvage, as a unit.
   1. Clean, list and tag for storage.
   2. Protect from damage and deliver to locations designated.
   3. Salvage each item along with all ancillary equipment required for operation.
B. Remove items designated for reuse and reuse as a unit.
   1. Clean, tag and deliver to locations designated.
   2. Clean and lubricate moving parts.
   3. Cover openings and surfaces to protect from dirt, debris and damage during construction.
C. Owner has the right to first refusal on all salvage items. Contractor shall remove and dispose of items refused by Owner.
D. Arrange for legal disposal and remove demolished materials to accredited landfill site or alternative disposal site (recycle center) except where explicitly noted otherwise for materials being salvaged for reuse in new construction.

3.05 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment that remain or that are to be reused.
B. Panelboards: Clean exposed surfaces and check tightness of electrical connections.
C. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

3.06 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be included in the lump sum bids for the respective items in the Proposal Schedule.

END OF SECTION

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SECTION 26 08 00

COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Perform acceptance testing of all electrical materials and equipment shown in the Contract Documents and as specified in this Section.

B. Tests shall be witnessed by the Officer-in-Charge. Provide the Officer-in-Charge 30-day advanced notice for Testing Firm tests. Insulation tests by the Contractor typically will not be witnessed. Critical equipment witness testing may be requested by the Officer-in-Charge.

1.02 REFERENCES

A. General:
   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.

B. ANSI/NETA ATS – International Electrical Testing Association (NETA) – Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

1.03 SUBMITTALS

A. Procedures: in accordance with Section 01 33 00.
B. Action Submittals:
   1. Pre-Test Submittals:
      a. Description or samples of specified test procedures.
   2. Sample test report forms for the specified tests, demonstrating that the forms document the testing requirements of NETA ATS and provide at minimum the information required by the sample forms in Section 01 99 00. Where equipment tested has adjustable settings, test reports must show as tested and as left settings.
   3. Preliminary Schedule listing equipment to be tested.

4. Notification form for the work scheduled.
5. Pre-Functional test procedures and testing schedule.
6. Functional test procedures and testing schedule.
7. Post-Test Submittals:
    a. Test reports for all test reports performed under this Section.

C. Closeout Submittals:
1. Final copies of all test reports performed under this Section, incorporating all submittal review comments, combined into a single volume that includes all testing performed in different phases over the course of the project.

PART 2 PRODUCTS

2.01 TEST EQUIPMENT AND MATERIALS

A. Test instruments shall be calibrated to references traceable to the National Institute of Standards and Technology and shall have a current sticker showing date of calibration, deviation from standard, name of calibration laboratory and technician, and date recalibration is required.

PART 3 EXECUTION

3.01 TESTING

A. Insulation Resistance Measurements:
1. Insulation resistance measurements shall be made on conductors and electrical equipment that will carry current. Minimum acceptable values of insulation resistance shall be in accordance with the applicable NETA-ATS, ICEA, NEMA, or ANSI standards for the equipment or material being tested. The ambient temperature at which insulation resistance is measured shall be recorded on the test form.

B. Conductor and Cable Tests:
1. The phase-to-ground insulation resistance shall be measured for all circuits 120 volts and above except lighting circuits. Measurements may be made with motors and other load equipment connected. Insulation resistance measurements shall be recorded in a format similar to Form 26 05 00-A contained in Section 01 99 90, and submitted for acceptance. Insulation with resistance of less than 10 megohms is not acceptable.

C. Motor Tests:
1. The Installed Motor Test Form, Form 26 05 00-B, contained in Section 01 99 90, shall be completed for each motor after installation and submitted for acceptance. All motors shall have their insulation resistance measured before they are connected.
2. Motors 50 HP and larger shall have their insulation resistance measured at the time of delivery and when they are connected. Insulation resistance values less than 50 megohms are not acceptable.

3. Verify that motors are connected to rotate in the correct direction. Verification may be accomplished by momentarily energizing the motor, provided the Contractor confirms that neither the motor nor the driven equipment will be damaged by reverse operation.
4. Motor running current shall be measured on each phase with the motor operating under load. Current imbalance shall be less than 5-percent difference between phases.

D. Signal and Network Cable Tests:
1. Signal Cables: Test signal conductors and shield drain for insulation resistance with the other conductors in the cable grounded. Each shield drain conductor shall be tested for continuity. Insulation resistance measurements shall be recorded on Form 40 61 13-A contained in Section 01 99 90 or Testing Firm's equivalent form, and submitted.
    a. Instruments used for continuity measurements shall have a resolution of 0.1 ohms and an accuracy of better than 0.1 percent of reading plus 0.3 ohms. A 500-volt or 1000-volt meg-ohmmeter shall be used for insulation resistance measurements as appropriate.

E. Pre-Functional Checkout:
1. Prior to energizing equipment, the Contractor shall perform a pre-functional checkout of the power and the control circuit. Protective devices shall be installed and available for service and calibrated or adjusted with specified setpoints installed. Contractor selected initial setpoints shall be installed and recorded, when specified setpoints are not required from the manufacturer or the Engineer.
2. Contractor shall submit a description of proposed test and checkout procedures conforming to the following requirements, including a schedule for conducting these procedures, not less than 30 days prior to the performance of pre-functional testing.
3. Pre-functional checkout shall consist of energizing each control circuit and operating each control device, protective device, monitoring or alarm device, and each interlock and verify the specified action or response occurs. Coordinate testing with the requirements specified in Section 01 91 00.

F. Functional Testing:
1. Contractor shall submit a description of proposed functional test and checkout procedures conforming to the following requirements, including a schedule for conducting these procedures, not less than 30 days prior to the performance of functional testing.
2. Prior to functional testing, all protective devices shall be adjusted and made operative.
3. Prior to energization of associated equipment, perform a functional checkout of all electrical and instrumentation control circuits as specified in the following and in Division 40. Checkout shall consist of energizing each control circuit and operating each control, alarm, safety device, and each interlock, in turn, to verify that the specified action occurs.

3.02 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be included in the lump sum bids for the respective items in the Proposal Schedule.

END OF SECTION

SECTION 31 10 00

SITE PREPARATION

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies site preparation which consists of the following:
   1. Clearing, grubbing, and stripping.
   2. Demolition, relocation, and removal of vegetation, structures, and obstructions.
   3. Utility relocation, removal, and protection.
   4. Striping, stockpiling and restoring of top soil.
   5. Soil treatment for vegetation control

B. Existing Conditions:
   1. The Contractor shall determine the actual condition of the site as it affects this portion of work.

C. Protection:
   1. Site preparation shall not damage structures, subsurface or overhead utilities, landscaping, or vegetation adjacent to the site.
   2. The Contractor shall be solely responsible to repair, or replace any damaged improvements, landscaping or vegetation to the satisfaction of the Officer-in-Charge.

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 more stringent requirements shall prevail.

   Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid. 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 D2974	Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils.
ASTM D5268	Standard Specification for Topsoil Used for Landscaping Purposes.
Standard Specifications	Standard Specifications for Public Works Construction, County of Hawaii, 1986
Standard Specifications	Standard Specifications for Road and Bridge Construction, 2005 as amended, Department of Transportation, State of Hawaii.

Reference	Title
Hawaii Administrative Rules	Volume 3 Titles 10 - 12 Chapter 180: Soil and Water Conservation Districts, State of Hawaii Department of Land and Natural Resources, 1993.
Conservation Plan for Agribusiness Development Corporation	"Conservation Plan for Agribusiness Development Corporation," Oahu Resource Conservation and Development Council, the West Oahu Soil and Water Conservation District, and the Natural Resource Conservation Service, April 1993.

1.03 SUBMITTALS

A. Action Submittals
   1. Procedures: Section 01 33 00.
   2. Submit clearing and demolition plans to the Officer-in-Charge and obtain approval at least one (1) week before the demolition and excavation activities occur. Plans shall clearly indicate the Contractor's limits of clearing to be staked and trees to be removed prior to commencement of the Work.

1.04 PERFORMANCE REQUIREMENTS

A. Protection:
   1. Site preparation shall not damage structures, landscaping, or vegetation outside of the limits of the Work. The Contractor shall repair or replace any damaged improvements, including but not limited to structures, equipment, vegetation, and subsurface utilities.
   2. The Contractor shall construct and maintain temporary erosion and sedimentation controls on the site as specified in Section 31 25 00. Prior to commencing clearing and grubbing work, the Contractor shall establish basic erosion control measures.
   3. The Contractor's proposed temporary haul roads, beyond those identified in the Contract Documents, shall be submitted to the Officer-in-Charge for acceptance.
   4. The Contractor shall employ such measures as necessary to prevent surface runoff from entering excavations, and trenches and re-establish and maintain erosion control measures as the work progresses.
   5. The Contractor shall provide protection devices, including barricades, fencing, warning signs, lights, pollution control and other measures necessary to ensure the security of, and safety within, the project site during the duration of the Work. Refer to Division 01 for additional requirements.
   6. Contractor shall preserve in operating condition, unless otherwise noted, active utilities traversing Project Site. Contractor shall repair damage to such utilities caused by Work under this Contract to the satisfaction of the Officer-in-Charge.

B. Burning: The use of burning at the Project Site for the disposal of refuse and debris will not be permitted.

C. Explosives: Use of explosives will not be permitted.

D. Restoration:
    1. The Contractor shall restore any public or private improvement facility, structure, or land and landscaping within the limits of the Work that is damaged or injured directly or indirectly by or on account of an act, omission, or neglect in the execution of the Work. Restore to a condition substantially equivalent to that existing before such damage or injury occurred, by repairing, rebuilding, or otherwise affecting restoration thereof, or if this is not feasible, make a suitable settlement with the owner of the damaged property.
    2. Restore and/or repair any property outside of the limits of the Work that is damaged during the course of Work. Use a restoration process that follows the same guidelines as those outlined for restoration of facilities within the limits of the Work.

1.05 EXISTING CONDITIONS

A. The Contractor shall determine the actual condition of the Site as it affects this portion of Work.
    1. Give minimum thirty (30) days' notice to Officer-in-Charge to permit relocation of equipment, materials, and operations. Refer to Division 01 for notification and coordination requirements.
B. Existing conditions shall be documented using both still and video photography as specified in Section 01 45 21.

PART 2 PRODUCTS

2.01 TOP SOIL

A. Friable clay loam surface soil containing 4% to 12% organic matter. Soil shall be screened with nothing larger than a 2 inch screen and free of subsoil, clay lumps, stones, rocks, weeds, roots, construction debris, and other unsuitable materials as determined and approved by the Officer-in-Charge.

B. Do not mix topsoil or other unsuitable / deleterious materials with subgrade soil(s) or other materials.

PART 3 EXECUTION

3.01 CLEARING, GRUBBING, AND STRIPPING

A. General:
    1. Unless otherwise specified, the Contractor shall remove obstructions such as brush, trees, logs, stumps, roots, heavy sod, vegetation, rock, stones, and broken or old concrete and pavement, and debris where the completion of the Work require their removal.
    2. The area to be cleared, grubbed, and stripped shall be within the limits specified, as staked by the Contractor, and as reviewed by the Officer-in-Charge.
        a. Included in this Work shall be the preservation from injury or defacement, and the replacement, in kind, to the satisfaction of the Officer-in-Charge, of any such injured or defaced vegetation or objects outside the limits of construction as staked by the Contractor, and as reviewed by the Officer-in-Charge.

b. Logs, stumps, roots, and vegetation shall be either chipped and left onsite or placed at locations specified by the Officer-in-Charge.
c. Clearing and grubbing shall be performed prior to performing any other Work.

3. Grub all roots, stumps, or other vegetative matter greater than 1 inch in diameter to a depth of at least 12" below the existing round surface or subgrade of new graded surface, whichever is lower.
4. Excavate and remove all boulders, rock, or other interfering objects.

B. Disposal:
1. All surface soils containing organics, debris, and other deleterious materials shall be stripped and left near the project site in coordination with the Officer-in-Charge and in accordance with the requirements of the State Department of Health and at an authorized area. Stripped materials shall not be used for embankment or for backfilling of any type.

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. the demolition and removal of structures shall be as shown on the Contract Drawings, and any other incidental obstructions onsite. In rights-of-way or easement areas, the contractor shall excavate within the boundaries designated on the contract drawings. Backfill trenches, cavities, depressions, and pits left by the removal of obstruction to level of surrounding ground.

B. Salvage: The Officer-in-Charge has the right to salvage any items scheduled for removal from their respective property as identified in the contract drawings. The Contractor shall notify the Officer-in-Charge five (5) days prior to any salvage or demolition Work to determine the disposition of items to be removed. The Officer-in-Charge will mark items to be salvaged. Such items shall be properly disconnected, removed from their foundations, cleaned, and stored at the respective Site.

Before beginning any cutting or demolition Work, the Contractor shall carefully survey the existing Work and examine the Contract Drawings and specifications to determine the extent of the Work. The Contractor shall take all necessary precautions to insure against damage to existing Work to remain in place, and any damage to such Work shall be repaired or replaced as approved by the Officer-in-Charge at no additional cost to the Owner. The Contractor shall carefully coordinate the Work of this section with all other Work and construct and maintain shoring, bracing, and supports, as required.

C. Dust Control: The amount of dust resulting from demolition shall be controlled to avoid creation of a nuisance in the surrounding area. Use of water will not be permitted when it will result in, or create hazardous or objectionable conditions such as flooding and pollution.

D. Filling: Holes and other hazardous openings shall be filled.

E. Disposition of Material: Title to all materials to be demolished is vested in the Contractor upon receipt of notice to proceed, and such materials are designated as scrap. The Officer-in-Charge will not be responsible for the condition, loss, or damage to such property after notice to proceed. At this option, the Contractor may retain these items in usable form and take possession of them for his own benefit providing that there is not subsequent cost of inconvenience to the Officer-in-Charge. The Officer-in-Charge does not guarantee that these items are complete, and the Contractor shall assume responsibility for any damages caused by their use immediately upon taking possession of them. Scrap materials shall be removed from Officer-in-Charge property before completion of the Contract. Scrap shall not be sold on the Site.

F. Cleanup: Remove debris and rubbish from the Site daily. Do not allow to accumulate on Site. Remove debris from excavations. Remove and transport debris in a manner as to prevent spillage to adjacent areas. Local regulations regarding hauling and disposal apply.

3.03 UTILITIES:

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.

B. Provide horizontal and vertical locations of potholed underground utilities as identified on the Drawings.

C. The Contractor shall provide for all labor, equipment, materials, and services necessary to remove, relocate, or maintain existing utilities. The Work on each utility shall be performed in a manner satisfactory to the Officer-in-Charge.

D. Disconnection of Utilities Services: Utilities shall be disconnected at the points indicated on the Contract Drawings. Where such disconnection will interrupt the utility services to an area not included in the Contract, arrangements for such interruption shall be made with the utility or property Owner at least thirty (30) days in advance of the interruption.

E. Removal of Utilities: Remove all existing utilities as indicated on the Contract Drawings. When utility lines are encountered that are not indicated on the Contract Drawings, the Officer-in-Charge shall be notified. They shall be removed to the extent that they would project into or interfere with new construction. Existing utilities cannot be removed until replacement utilities are installed, tested, and put into service.

3.04 SALVAGING, STOCKPILING AND PLACING TOPSOIL

A. Salvage topsoil within the work limits prior to beginning excavating, fill or hauling, operations by excavating topsoil and stockpiling the material at locations as accepted by the Officer-in-Charge.

B. Stockpile topsoil in a storage pile as accepted by the Officer-in-Charge. Storage pile(s) shall be shaped to freely drain surface water and be protected from soil and sediment erosion and separated from other debris.

C. Topsoil shall be placed in a uniform manner after grading operations are complete. Do not place topsoil when subsoil or topsoil is frozen, excessively wet, or otherwise detrimental to the Work.

D. Prior to final placement of topsoil, any areas compacted by construction activities shall be decompacted to at least 85 Proctor by repeated ripping in rows twelve inches (12”) or less, apart, to a depth of twelve inches (12”). All subsoil areas, including any graded areas or cut slopes should be roughened with furrows four to six inches (4”-6”) deep to key the topsoil into the subsoil.

E. Manually spread and rake topsoil around structures, trees, fences or other obstructions.

F. Placed topsoil shall be stabilized immediately by:

G. Preparing and seeding with the approved seed mixture and mulch,

H. Installing perimeter silt fence and/or straw wattles,

I. Roughening and application of 2500 pounds per acre hydromulch with 150 pounds per acre approved tackifier and later seeding and mulching, per the plans.

J. Water shall be applied to the topsoil in a fine spray by nozzles or spray bars so the topsoil areas will not wash or erode the topsoil areas.

K. Salvaged topsoil exceeding the quantity required shall be disposed of by the Contractor.

3.05 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be considered incidental and included in the lump sum bids for the respective items in the Proposal Schedule.

END OF SECTION

SECTION 31 25 00

EROSION, SEDIMENTATION AND DUST CONTROL

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies control measures as required by local regulations and by the Officer-in-Charge, specified herein, and shown on the Drawings during the life of the contract to control erosion, sedimentation, and dust.

B. The Contractor shall establish, construct, and maintain erosion and sediment control measures. Siltation control devices shall be installed in the appropriate locations before construction begins. The erosion control structures shall be maintained until temporary ground cover is established to stop all sediment and erosion. All fines imposed for improper erosion and sedimentation and control shall be paid by the Contractor responsible for the work.

C. Temporary erosion and pollution control shall include construction work off-site where such work is necessary as a result of borrow pit operations, stockpiles, haul roads or equipment storage sites.

D. The Contractor shall install temporary erosion and sediment controls which will ensure that the stormwater, other water, and drainage from job site areas which will be stripped or modified of its naturally existing or artificially established stabilization or protection against erosion shall pass through some type of sedimentation or filter system before being discharged and that these areas shall be kept sufficiently moist to control dust.

1.02 RELATED SECTIONS

A. This Section contains references to the following sections. Additional related sections may apply that are not specifically listed below.

1. Section 01 33 00 – Submittal Procedures

1.03 SLOPE PROTECTION AND EROSION CONTROL

A. Whenever steeper slopes or abrupt changes in grade are required, a diversion or berm ditch shall be constructed at the top of the slope to cause the surface water to flow along the diversion to a controlled down slope. The diversion shall be protected against erosion with mulch and hay bales, or equivalent where needed.

1.04 SILTATION FENCES

A. Siltation fences shall be installed in the locations as indicated on the Drawings. Siltation fences shall be installed prior to clearing operations. Siltation fences shall be kept in good repair and maintained throughout construction. Sediment shall be removed when the ponding capacity is reduced by one-half.

B. Siltation fences shall be constructed around all inlets to the stormwater system. Fences shall be repaired and maintained throughout construction. Sediment shall be removed before the ponding capacity is reduced by one-half.

1.05 DUST CONTROL

A. The Contractor shall exercise precautionary measures to minimize dust emissions, which will include, but shall not be limited to, periodic sprinkling or wetting of the site and dust control fences, where appropriate. The Contractor has the option of using a dust palliative. The Contractor shall comply with all local requirements.

1.06 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. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for 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
City and County of Honolulu Code, Chapter 10	Erosion and Sedimentation Control
HAR 11-55	Hawaii Administrative Rules, Title 11, Department of Health, Chapter 55, Water Pollution Control
City and County of Honolulu, Title 20, Chapter	Rules Relating to Water Quality of the Administrative Rules, Title 20, Department of Planning and Permitting, Chapter 3, as amended
Construction BMP Field Manual	Hawaii Department of Transportation (DOT) Construction Best Management Practices Field Manual 2008
Standard Specifications	Standard Specifications for Public Works Construction, 1986
ASTM D3786	Standard Test Method for Bursting Strength of Textile Fabrics – Diaphragm Bursting Strength Tester Method
ASTM D4355	Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus
ASTM D4491	Standard Test Methods for Water Permeability of Geotextiles by Permittivity
ASTM D4533	Standard Test Method for Trapezoid Tearing Strength of Geotextiles
ASTM D4632	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
ASTM D4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile
ASTM D6241	Standard Test Method for Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe

Reference	Title
AASHTO R 51-13	Standard Practice for Compost for Erosion/Sediment Control (Filter Berms and Filter Socks)

1.07 SUBMITTALS

A. Action Submittals
   1. Procedure: Section 01 33 00.
   2. The Contractor shall prepare and submit a SWPPP detailing the methods and procedures for erosion and siltation control for review and approval by the Officer-in-Charge. The SWPPP shall be prepared by a Professional Civil Engineer registered in the State of Hawaii, and signed and certified by the Contractor's Project Manager and registered Professional Engineer.
      a. The Contractor shall prepare and submit the SWPPP in accordance with the outline provided below. The SWPPP must be submitted no later than 30 days after the Notice to Proceed. The SWPPP shall be approved by the Officer-in-Charge before any soil disturbance activity. The SWPPP shall remain in effect for life of the Contract regardless of the year or season. A copy of this plan must be on-site at all times.
      b. The Contractor shall develop and amend or revise the SWPPP, when necessary, to meet the objectives outlined below. Amendments will be implemented only after they have been approved:
      c. Identify all pollutant sources including sources of sediment that may affect the quality of storm water discharges associated with construction activity.
      d. Identify non-storm water discharges.
      e. Identify, construct, and implement in accordance with a time schedule, and maintain Best Management Practices (BMPs) to reduce or eliminate pollutants in storm water discharges and authorized non-storm water discharges from the construction site during construction
      f. Develop a maintenance schedule for BMPs installed during construction designed to reduce or eliminate pollutants after construction is completed (post-construction BMPs).
      g. Include a site description.
      h. Identify pollution controls.
   3. Plan Revisions: Modify and resubmit the above items to correct unforeseen conditions that develop during pre-construction and construction.

PART 2 PRODUCTS

2.01 FILTER SOCK MATERIAL

A. HDPE inner confinement netting and outer polyester knitted mesh fabric provided per Manufacturer recommendations. Compost filter sock shall be Envirotech Biosolutions, or approved equal.

2.02 SILT FENCE

A. Silt fence shall be nylon reinforced polyester netting with fabric weight in excess of 4.0 ounces per yard and having a built-in cord running throughout the top edge of the fabric. Silt fence fabric shall be equal to Mirafi 100X, inert to chemicals commonly found in soil, and resistant to mildew, rot, insects, and rodent attack. Posts shall be either steel or 2 inch square pressure treated fir, southern pine or hemlock and shall be spaced not more than 6 feet on center.

2.03 CONSTRUCTION ENTRANCES, TEMPORARY HAUL/ACCESS ROADS, AND STAGING AREAS

A. Crushed Rock:
   1. Construction Entrances, Haul/Access Roads, and Staging Areas: Per Contract Drawings and Section 31 20 00, "Earthwork."

2.04 COMPOST FILTER SOCK

A. Filter Sock Material: HDPE inner confinement netting and outer polyester knitted mesh fabric provided per Manufacturer recommendations.
B. Compost Filtration Media:
   1. Use only mature compost that has no offensive odor, meets AASHTO R 51-13, and has the following properties:

Material Properties

Property	Acceptable Range
pH	5.0 – 8.5
Moisture content	30 - 60%
Organic matter	25 - 65%, dry weight
Particle size	100% passing 3-inch sieve 30 to 75% passing 1/4-inch sieve 6-inch maximum length
Physical Contaminants	Less than 1% dry weight

C. Products:
   1. Compost filter sock shall be Envirotech Biosolutions, or approved equal.

PART 3 EXECUTION

3.01 PRE-CONSTRUCTION REQUIREMENTS

A. Submittals:
   1. Work shall not begin on the Project until the submittals detailed in this Section are completed, reviewed by the Officer-in-Charge, and submitted/accepted by the appropriate regulatory agency.
B. Permits:
   1. Provide site specific and project specific information to necessary to obtain final permits and conform to the requirements of the permits. Keep a copy of all final approved permits and any revisions onsite for the duration of the Project.

C. Training:
    1. Provide training for all on-site employees of the Contractor and any subcontractors. At a minimum, training should cover proper practices, operating procedures and BMPs that have been accepted, approved and implemented on the Project.

3.02 INSTALLATION

A. Silt fences shall be installed by securely fastening silt fence fabric using wire ties. The silt fence fabric panels shall be installed loosely with adjacent panels overlapped a minimum of 12 inches. Silt fence material shall be embedded at least six inches beneath ground surface and shall extend upward at least 1.5 feet above the disturbed area ground surface. The top edge of the fabric shall be reinforced or shall have a one-inch tuck.

B. Accumulated silt and debris shall be removed by the Contractor from behind the face of the silt fence as needed to provide proper silt fence operation. Clogged or damaged fabric shall be immediately replaced at no additional cost.

C. Accumulated silt and debris and damaged or deteriorated bales shall be removed by the Contractor at no additional cost.

D. Temporary construction exits shall be maintained in a condition that will prevent tracking or flow of mud out of the work area or onto public roads.

3.03 PROVISIONS FOR EROSION CONTROL DURING CONSTRUCTION

A. The Contractor shall implement erosion control measures around all areas to be disturbed prior to disturbing ground in the area, to the satisfaction of the Officer-in-Charge. The Officer-in-Charge will periodically inspect erosion control structures to confirm that the Contractor is maintaining these features.

B. Establish, construct, and maintain erosion and sediment control BMPs. All erosion and sediment control BMPs shall be installed before construction begins. Contractor to comply with City Chapter 14, Article 14 Erosion and Sedimentation Control and the guidelines set in the State of Hawaii DOT, Highways Division Construction BMP Field Manual.

C. The Contractor shall take sufficient precautions during construction to eliminate run-off of polluting substances such as silt, clay, wastes, fuels, oils, and bitumen into water supplies and surface waters. Special precautions shall be taken in the use of construction equipment to conduct operations in a manner that reduces erosion.

D. The temporary drainage ditches, silt fences, and other erosion and sediment control features shall be maintained at locations identified by the Officer-in-Charge.

E. Disposal of drainage from the site shall be at a location approved by the Officer-in-Charge. Drainage shall not be disposed of until silt and other sedimentary materials have been removed. Particular care shall be taken to prevent the discharge of unsuitable drainage to a water supply or surface water body.

F. As a minimum, the following shall apply:
    1. Silt sock or approved silt fencing shall be provided at points where drainage from the work site leaves the site, to reduce the sediment content of the water. Sufficient silt fence shall be provided such that all flow will filter through the straw or silt fence. Other methods, which reduce the sediment content to an equal or greater degree, may be used as approved by the Officer-in-Charge.

2. Drainage leaving the site shall flow to water courses in a manner that controls erosion.

3.04 MEASUREMENT AND PAYMENT

A. The work of this Section shall be paid for under the specified line item in the Proposal Schedule.

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, and supports for process and mechanical 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 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. 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 Procedure
2. Section 01 66 00 – Shipment, Protection, and Storage
3. Section 01 73 24 – Design Requirements for Non-Structural Components and Non-Building Structures
4. Section 03 30 00 – Cast-in-Place Concrete
5. Section 31 20 00 – Earthwork
6. Section 40 05 02 – Piping System Schedules
7. Section 40 05 06 – Specialty Couplings and Adapters for Process Piping
8. Section 40 05 07 – Hangers and Supports for Process Piping
9. Section 40 05 45 – Piping System Identification

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
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
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 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 other than buried, submerged, or encased/embedded.

B. Piping System Identification - Mechanical
   1. Process and mechanical utility 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.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordination required with the design of piping supports (hangers, guides, anchors, structural attachments, etc.). Refer to Section 40 05 07.

1.06 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 Officer-in-Charge.
3. A copy of this specification section, along with Sections 01 73 24 and 40 05 07, 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 Officer-in-Charge 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. Submit piping layout drawings for all piping systems. Indicate assembly details, location and placement of field welds, unions and flanges, fittings, valves, drains, guides, anchors, hangers, supports, and the provisions for thrust restraint, as well as any other pertinent details and appurtenances for all piping, including wall penetrations, where applicable, in that area. Indicate location and clearances from structures and other utilities (conduit, 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.
6. 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). Written procedures to be stamped and sealed by a Professional Engineer registered in the State of Hawaii 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 and 40 05 07.13. 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 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 Officer-in-Charge, 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. Operation and maintenance submittals per Section 01 78 23.
   3. Post-Construction Data:
      a. Inspection reports, authored, sealed, and signed by the Design Professional retained under the provisions of this Section submitted to the Officer-in-Charge. The Design Professional's final report shall be submitted to the Officer-in-Charge prior to substantial completion.
      b. Submit the test procedure and test results for the final pressure/leakage test conducted for each piping system schedule included in the project.

1.07 QUALITY ASSURANCE

A. Review the drawings prior to installation of piping, conduit services, and fixtures. Identify any conflicts and cooperate with the Officer-in-Charge 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 Officer-in-Charge 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 Officer-in-Charge.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00.

B. Requirements:

1. Deliver pipe, fittings, and specials to site using loading methods which do not damage pipe or linings, or coatings.
2. Piping materials delivered to site will be clearly marked to indicate size, type, class/schedule, and coatings.
3. Until ready for incorporation in the work, store on site as recommended by the piping materials manufacturer to prevent damage, undue stresses, or weathering.
4. Store materials at least 8 inches above ground. Provide sufficient supports to prevent undue bending.
5. Protect non-UV light inhibited plastic from sunlight.
6. Cover openings in piping, and temporarily seal to protect from contamination.
7. 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.
8. Protect unfinished work at end of each workday from damage, contamination, and moisture by use of plugs, caps or covers.
9. Protect piping and valves from damage pending performance of system tests.
10. 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.
11. Inspect each pipe and fitting prior to installation. Do not install damaged pipe or pipe with damaged protective coatings or linings.
12. 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.

1.09 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 Hawaii.
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 Officer-in-Charge. The division of responsibility for work is shown in the following table:

Piping System Element (Specification)	Design Professional's Responsibility	Designer'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	(NA)
Seismic bracing (Sections 40 05 07.13 and Section 01 73 24, and related sections)	All piping	(NA)
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 Officer-in-Charge 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 Officer-in-Charge 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 Officer-in-Charge 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 Officer-in-Charge, 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.

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.

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, and all associated appurtenances. Provide Pipe Support 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
All Piping	Type 316 stainless steel	Type 316 stainless steel, fully passivated[2]

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. *Provide stainless steel nuts with Tripac 2000 blue coating or approved equal.*

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).

2.04 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.

2.05 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. 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.

2.06 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 or PIPESPECS.

2.07 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. CPE - Chlorinated Polyethylene
7. PTFE bonded EPDM, full-face gaskets
8. Viton/FKM – Fluoroelastomer, 75 Durometer

2.08 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.

2.09 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.

2.10 PIPE MARKERS, DETECABLE WARNING TAPE, AND TRACER WIRE

A. Pipe marker material requirements are 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. 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.

C. 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.

D. 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 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.

3.04 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.

3.05 SLEEVES

A. 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.

3.06 PIPE JOINTS AND CONNECTIONS

A. Cut pipe with appropriate tool and deburr.
B. Make joints tight. Test and remake leaking joints with new materials. Do not use thread cement or caulking to remake joints.
C. Do not use sharp toothed wrench in making up brass pipe, or chrome plated items.
D. Provide thread forms and length in accordance with ASME standards. Use lubricant or sealant on male threads suitable for proposed pipe service.
E. Clean joints before soldering. Use flux and alloy appropriate for specified operating temperature and pressure.
F. 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).
G. Coat gasket with gasket manufacturer's recommended lubricant between flange faces.

3.07 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.

3.08 EXPOSED INSTALLATION

A. Fabricate and install 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. Expanding or swaging of tubing to fit IPS (Iron Pipe Size) fitting sockets is not permitted.
    3. Use reducing fittings where change in pipe size occurs.
    4. Use couplings only where pipe runs are longer than standard supplied pipe lengths.
    5. Make exposed polished or enameled connections to fixtures or equipment with special care to avoid damage to finished surfaces.
    6. Make changes in direction only with fittings.

7. Install piping with not less than minimum slope to ensure adequate drainage and venting.

C. Make adequate provision in piping and pipe support systems for 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. Provide temporary supports as necessary during construction to prevent overstressing of equipment, valves, or pipe.

G. Accurately cut all piping for fabrication to field measurements.

H. 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.

I. 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 Officer-in-Charge, the "springing" of pipe and fittings to ensure alignment is not permitted. Undo and subsequently remake all pipework connections where so instructed by the Officer-in-Charge to ensure that unintended springing does not occur. Take care not to damage equipment, valves, or flanges.

J. In parallel pipe runs, offset flanges and/or grooved joint fittings by a minimum of 8 inches longitudinally to allow for proper access.

K. Provide pipe markers for all exposed pipe.

3.09 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.

3.10 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.

3.11 REPAIR/RESTORATION

A. Repair pipe with damaged shop-applied protective linings in accordance with specified standard (e.g. AWWA C210) or accordance with the lining manufacturer's directions, if no standard is cited.

B. Patching inserts, overlays, or pounding out of dents is not permitted.

C. 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.

D. Other requirements may be stipulated in related piping sections.

3.12 FIELD QUALITY CONTROL

A. Inspections:

1. Inspect and provide reports as specified in Sections 40 05 07.
2. Submit the Design Professional's final report before substantial completion.

3.13 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 required for pressure testing.

E. Supply all pumps, compressors, gauges, etc. required for testing.

F. Install 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.

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 Officer-in-Charge 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.

N. Dispose of flushing water in manner approved by the Officer-in-Charge, which causes no damage to buildings or siteworks.

3.14 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.

3.15 CLEANING AND FLUSHING

A. After installation and prior to testing, perform initial cleaning of piping. 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. Give lines smaller or equal to 6 inches an initial flush or purge.

B. Unless specified otherwise, flush liquid systems after testing, with clean water. Maintain flushing for a minimum period of 15 minutes.

3.16 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be included in the lump sum bids for the respective items in the Proposal Schedule.

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
RW	Irrigation (Raw) Water	40 05 02.29	Water	Blue

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 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
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

Reference	Title
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
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

Reference	Title
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
AWWA C151	Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water and Other Liquids

Reference	Title
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
	Uniform 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. EFSW - Electro-Fusion Socket Weld
12. FLG – Flanged
13. FLRD – Flared
14. FP – Full Penetration
15. FSW – Fusion Socket Weld
16. HAS – Hub and Spigot, Compression (Cast Iron Soil Pipe)
17. HGRV – HDPE Groove Coupling
18. HLF CPLG – Half Coupling
19. HPEG – HDPE Plain End with Gripping Teeth
20. HXGT - HDPE by Grooved End Transition
21. LR ELL – Long Radius Elbow
22. MJ – Mechanical Joint
23. PGRV - Proprietary Groove Coupling
24. PO – Push-on
25. RGRV – Rolled Grooved End Coupling
26. RMJ – Restrained Mechanical Joint
27. RPO – Restrained Push-On joint
28. SLV – Solvent Weld
29. SLW – Single Lap Weld (Bell and Spigot)
30. SR ELL – Short Radius Elbow
31. SW – Socket Weld
32. THD – Threaded
33. UN – Union

C. 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

D. Materials:
1. DI – Ductile Iron
2. HDPE – High Density Polyethylene
3. PVC – Polyvinyl Chloride
4. RCP – Reinforced Concrete Pipe
5. SS – Stainless Steel
6. SV – Service (Cast Iron Soil Pipe available with SV rating or XH, extra heavy, rating)

E. Welding:
1. FP – Full Penetration
2. SML – Seamless
3. WLD – Welded

F. 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

Schedule 40 05 02.29 – Irrigation Water

Process Service	Irrigation Water				
Process Service Identifier	RW				

Test Conditions

Pressure (psig)	Duration (min.)	Medium
150	120	Water

General Requirements

1. Full-Faced flanges mated with raised face flanges are not permitted.
2. 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.
3. Threads per ASME B1.20.1.
4. 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.)

Notes:

1. Flange 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. Provide full flow fittings. Segmentally welded fittings are not acceptable.
3. Install lining and coating prior to welding Threadolet or Half Coupling.
4. FNPT tap at factory installed tapping boss. Taps at other locations on pipe and fittings are not permitted.
5. Bolts and nuts with metallurgy specified in AWWA C111.
6. Apply multiple wraps as necessary to achieve the specified system thickness.

Schedule 40 05 02.29 – Irrigation Water

Process Service	Irrigation Water				
Process Service Identifier	RW				

Outdoor - Exposed

Component	Line Size, in	Rating	Conn./Joints	Material	Spec Section	Notes
Pipe	1/8 thru 2-1/2	Sch. 40S	THD	Stainless Steel: ASTM A312-TP316, WLD or SML, Dim per ASME B36.19	40 05 23	
	3 thru 10	Class 125	FLG	Ductile Iron: AWWA C151	40 05 19	
Lining for Pipe & Fittings	Stainless Steel, All	—	—	None	—	
	Ductile iron, all	40 mils	—	Ceramic Epoxy: Per Specification, Factory applied	40 05 19	
External Coating	Stainless Steel, All		—	None	40 05 23	
	Ductile iron, All	Thk. per Std.	—	Epoxy Primer: Per specification, factory applied Coating System E-1: Per specification, field applied Coating System EU-1: Per specification, field applied, outdoor only	40 05 19 09 90 00	
	Valves	—	—	Epoxy Primer: Per specification, factory applied Coating System E-1: Per specification, field applied Coating System EU-1: Per specification, field applied, outdoor only	09 90 00	
Fittings	1/8 thru 2-1/2	Class 150	THD	Stainless Steel: ASTM A351-CF8, Dim. Per ASME B16.3	40 05 23	
	3 thru 24	250 psi	FLG	Ductile Iron: AWWA C110 or AWWA C153	40 05 19	2
Taps	Ductile Iron, All	Sch. 40	THD	Steel Short Nipple: ASTM A53, seamless-Gr B, Type E or Type S, galvanized, Dim. Per ASME B36.10	40 05 19	
Flanges	1/2 thru 3 4 thru 12	Class 2000 250 psi	FLG FLG	Stainless Steel: ASTM A182-F316L Ductile Iron: AWWA C115 for pipe, AWWA C110 for fittings, Dim. Per ASME B16.1-Class 125	40 05 23 40 05 19	
FLG Bolts, nuts and hardware	All	All	—	Stainless Steel Bolts: ASTM F593 Type 316 with Xlyan fluoropolymer coating, Tripac 2000 Blue or approved equal Stainless Steel Nuts: ASTM F594 Type 316 with Xlyan fluoropolymer coating, Tripac 2000 Blue or approved equal	—	1
Flange gaskets	All	1/16 in Thk.	FLG	Nitrile or Neoprene	40 05 01	
Mechanical Coupling Gaskets	All	—	—	Nitrile or Neoprene	40 05 01	
Valves	1/4 thru 2-1/2		THD	Ball: Bronze Body/Ball, 40 05 63.02	40 05 60	
	3 thru 48		FLG	Gate: AWWA C500, Class 125, 40 05 61.17 Control Valve: Pilot Controlled, Class 125, 40 05 67.36	40 05 60	

SECTION 40 05 06

SPECIALTY COUPLINGS AND ADAPTERS FOR PROCESS PIPING

PART 1 GENERAL

1.01 SUMMARY

A. This 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.

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 09 90 00 – Painting and Coating
2. Section 40 05 01 – Piping Systems
3. Section 40 05 02 – Piping System Schedules
4. Section 40 05 19 – Ductile Iron Pipe

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.

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

Reference	Title
ASTM A36	Standard Contract document for Carbon Structural Steel
ASTM A53	Standard Contract document for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A193	Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
ASTM A194	Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
ASTM A536	Standard Contract document for Ductile Iron Castings

ASTM F593	Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	Standard Specification for Stainless Steel Nuts
AWWA C105	Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C111	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C116	Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings
AWWA C153	Ductile-Iron Compact Fittings
AWWA C206	Field Welding of Steel Water Pipe
AWWA C219	Bolted, Sleeve-Type Couplings for Plain-End Pipe
AWWA C550	Protective Epoxy Coatings for Valves and Hydrants
AWWA M11	Steel Pipe-A Guide for Design and Installation
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.

B. Informational Submittals:
   1. Procedures: Section 01 33 00
   2. Operation and maintenance data per Section 01 78 23.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide specialty couplings and adapters where specified or at locations indicated on drawings.

B. Couplings and adapters shall be specifically designed for the pipe material and installation location/condition, and shall be free from defects and conform to the requirements and standards specified in this Section.

C. Unless otherwise specified, couplings and adapters must meet or exceed the pressure rating requirements specified in Section 40 05 02 Piping Systems.

2.02 MECHANICAL COUPLINGS

A. Fasteners and Gaskets
   1. Except as otherwise specified in this Section, fasteners specified by area.
      a. Outdoor: Manufacturer's Standard
   2. Gasket material requirements for mechanical couplings are specified in the Piping System Schedules (Section 40 05 02.00 to Section 40 05 02.99).

B. 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 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

2.03 UNIONS

A. 2-inch and Smaller: Ground joint screwed pattern unions.
B. 2 1/2-inch and Larger: Ground joint flange unions.

2.04 COATINGS

A. Provide manufacturer's standard fusion bonded epoxy coating on all mechanical couplings.
B. Where manufacturer does not offer a fusion bonded epoxy coating, field coat mechanical couplings per Section 09 90 00.

PART 3 EXECUTION

3.01 GENERAL

A. Install couplings and adapters in strict accordance with manufacturer's requirements.

3.02 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be included in the lump sum bids for the respective items in the Proposal Schedule.

END OF SECTION

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SECTION 40 05 06.16

PIPING CONNECTIONS

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies the following methods of connecting metallic piping: flanges, threading, mechanical couplings, equipment connection fittings, dielectric unions, and welding.

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
ANSI BI.1	Unified Inch Screw Threads (UN and UNR Thread Form)
ANSI BI.20.1	Pipe Threads, General Purpose (Inch)
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings
ANSI B16.5	Pipe Flanges and Flanged Fittings
ANSI B18.2.1	Square and Hex Bolts and Screws Inch Series
ANSI B18.2.2	Square and Hex Nuts (Inch Series)
ANSI B31.1	Power Piping
ASME Section IX	Boiler and Pressure Vessel Code; Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators Qualifications
ASTM B98	Copper-Silicon Alloy Rod, Bar and Shapes
ASTM F37	Standard Test Methods for Sealability of Gasket Materials
ASTM F104	Standard Classification System for Nonmetallic Gasket Materials
ASTM F152	Standard Test Methods for Tension Testing of Nonmetallic Gasket Materials
ASTM F593	Stainless Steel Bolts, Hex Cap Screws, and Studs
AWWA C111	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C206	Field Welding of Steel Water Pipe
AWWA C207	Steel Pipe Flanges for Waterworks Service-Size 4 in. through 144 in.
AWWA C219	Bolted, Sleeve-Type Couplings for Plain-End Pipe
AWWA C550	Protective Epoxy Coatings for Valves and Hydrants

Reference	Title
AWWA C606	Grooved and Shouldered Joints
AWWA M11	Steel Pipe-A Guide for Design and Installation

1.03 SUBMITTALS

A. In addition to the material listed in the detailed specification, the following submittals shall be provided in accordance with Section 01 33 00:
   1. For Equipment Connection Fittings used in pumping applications submit thrust rod stretch calculations in accordance with paragraph 2.02 Equipment Connection Fittings. and dimensional layout data.

PART 2 PRODUCTS

2.01 FLANGE ASSEMBLIES

A. Flanges:
   1. General: Flanges shall either be flat flanges or convoluted ring flanges as specified in the following paragraphs.
   2. Flat Flanges: Cast iron flanges shall be faced in accordance with ANSI B16.1. Where companion flanges are used, the flanges on pipe shall be refaced to be flush with the companion flange face. Class 150 and Class 300 forged steel flanges shall be raised face conforming to ANSI B16.5. Lightweight slip-on flanges shall be plain face conforming to AWWA C207, Class B and ANSI B16.5. Unless otherwise specified, steel flanges shall be ANSI B16.5, Class 150 or AWWA C207, Class D. Class E AWWA flanges shall be provided where test pressure exceeds 175 psi. Plain faced flanges shall not be bolted to raised face flanges.
   3. Convoluted Ring Flanges: Convoluted ring flanges shall be ductile iron, forged steel or cast stainless steel, designed to bear on hubs welded to the pipe and shall be as manufactured by Improved Piping Products, or approved equal. The flange joints shall be rated for not less than 150 percent of the test pressures listed in Section 40 05 01 and shall conform to the requirements of ANSI B 16.5 and AWWA C207. The flange manufacturer shall be prepared to demonstrate, by certified pressure test that the flanges will meet these requirements.

B. Gaskets:
   1. Gasket material shall be as specified in paragraph 2.03.
   2. Gaskets for plain faced flanges shall be the full face type. Thickness shall be 1/16 inch for pipe 10 inches and less in diameter and 1/8 inch for pipe 12 inches and larger in diameter. Unless otherwise specified, gaskets for raised face flanges shall match the raised face and shall be 1/16 inch thick for pipe 3-1/2 inches and less in diameter and 1/8 inch thick for pipe 4 inches and larger.

C. Bolts:

1. Flange assembly bolts shall be ANSI B18.2.1 standard square or hexagon head bolts with ANSI B18.2.2 standard hexagon nuts. Threads shall be ANSI Bl.1, standard coarse thread series; bolts shall be Class 2A, nuts shall be Class 2B. Bolt length shall conform to ANSI B16.5.
2. Bolts shall be made of Type 316 stainless steel in conformance with ASTM F593, marking F593F. Where washers are required, they shall be of the same material as the associated bolts.

2.02 MECHANICAL COUPLINGS

A. Sleeve-Type Couplings:

1. Unless otherwise specified, sleeve-type mechanical pipe couplings shall be Smith-Blair Type 411, Dresser Style 38, or equal, with the stop removed from the middle ring. Reducing couplings shall be Smith-Blair Type 415, Dresser Style 62, or equal. Sleeve-type flanged coupling adapters shall be Smith-Blair Type 913, Dresser Style 128, or equal. Insulating couplings shall be Smith-Blair Type 416, Dresser Style 39, or equal.
2. Bolts shall be made of Type 316 stainless steel in conformance with ASTM F593, marking F593F. Where washers are required, they shall be of the same material as the associated bolts.
3. Gaskets shall be as specified in paragraph 2.03 and AWWA C111.

B. Plain End Couplings:

1. Plain end pipe couplings for pipe sizes 6 inches and smaller shall be Gustin-Bacon 200, Victaulic Style 99, or equal for Schedule 80 pipe and Gustin-Bacon 205, Victaulic Style 90, or equal for lighter weight pipe. Plain end couplings for pipe sizes 8 inches and larger shall be Gustin-Bacon 200, Victaulic Style 99, or equal. Unless otherwise specified, bolts and nuts shall comply with AWWA C606.
2. Gaskets shall be as specified in paragraph 2.03 and AWWA C606.

2.03 GASKETS

A. Gaskets designated in Section 40 05 01 shall be as follows:

1. EPDM: ethylene-propylene-diene-terpolymer.
2. Neoprene: neoprene.
3. Nitrile: nitrile (Buna N).
4. Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder; ASTM F104 (F712400), 2500 psi (ASTM F152), 0.2 ML/HR LEAKAGE FUEL A (ASTM F37).
5. Compressed gasketing consisting of organic fibers (Kevlar) and SBR binder; ASTM F104 (F712400), 2500 PSI (ASTM F152), 0.1 ml/hr leakage Fuel A (ASTM F37).
6. Gylon gasketing, Garlock Style 3500, 2000 psi (ASTM F152), 0.22 ml/hr Fuel A (ASTM F37).
7. Gylon gasketing, Garlock Style 3510, 2000 psi (ASTM F152), 0.04 ml/hr Fuel A (ASTM F37).
8. Gylon gasketing, Garlock Style 3504, 2000 psi (ASTM F152), 0.12 ml/hr Fuel A (ASTM F37).

9. TFE: noncreeping tetrafluoroethylene (TFE) with insert filler.
10. PTFE bonded EPDM: PTFE bonded to EPDM in full-face gasket having concentric-convex molded rings; Garlock Stress Saver 370 or approved equal.

2.04 THREAD

A. Pipe thread dimensions and size limits shall conform to ANSI Bl.20.1.

2.05 DIELECTRIC UNIONS

A. Dielectric unions shall be EPCO, Capitol Manufacturing, or equal.

2.06 COATINGS

A. Unless otherwise specified, coatings shall be per Section 09 90 00.

2.07 PRODUCT DATA

A. In accordance with Section 01 33 00, the Contractor shall provide for each welder, a welder qualification certificate indicating the welder is certified for pipe welding in accordance with ASME Boiler and Pressure Vessel, Section IX. Each welder's certificate shall be provided to the Officer-in-Charge prior to that welder working on the job.

PART 3 EXECUTION

3.01 PIPE CUTTING, THREADING AND JOINTING

A. Pipe cutting, threading and jointing shall conform to the requirements of ANSI B31.1.

3.02 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 ANSI B31.1 for piping Systems 8, 26, and 28 specified in Section 40 05 01. Welds shall be made in accordance with the requirements of ANSI B31.3 for piping System 20 specified in Section 40 05 01.
B. Welds for piping systems not specified above shall be made in accordance with AWWA C206.

3.03 TAKEDOWN COUPLINGS

A. Takedown couplings shall be screw unions, flanged or grooved end mechanical coupling type joints and shall be provided as specified. Flanged or grooved end joints shall be employed on pipelines 2-1/2 inches in diameter and larger. Where piping passes through walls, takedown couplings shall be provided within 3 feet of the wall, unless specified otherwise.
B. A union or flanged connection shall be provided within 2 feet of each threaded end valve.

3.04 FLEXIBILITY

A. Unless otherwise specified, piping passing from concrete to earth shall be provided with two pipe couplings or flexible joints (or a single Flexijoint) as specified on the buried pipe within 2 feet of the structure for 2-inch through 6-inch diameter pipe; within 3 feet of the structure for 8-inch through 24-inch diameter pipe; and within one and one-half pipe diameters of the structure for larger pipe. Where required for resistance to pressure, mechanical couplings shall be restrained in accordance with Chapter 13 of AWWA M11, including Tables 13-4, 13-5 and 13-5A, and Figure 13-20.

3.05 DIELECTRIC CONNECTIONS

A. Where a copper pipe is connected to steel or cast iron pipe, an insulating section of rubber or plastic pipe shall be provided. The insulating section shall have a minimum length of 12 pipe diameters. Dielectric unions as specified in paragraph 2.05 may be used instead of the specified insulating sections. Where copper pipe is supported from hangers, it shall be insulated from the hangers, or copper-plated hangers shall be used.

3.06 EQUIPMENT CONNECTION FITTINGS

A. Where shown, equipment connection fittings shall be provided between field piping systems and equipment inlet and outlet connections.

3.07 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be included in the lump sum bids for the respective items in the Proposal Schedule.

END OF SECTION

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SECTION 40 05 06.33

PIPING APPURTENANCES

PART 1 GENERAL

1.01 SUMMARY

A. Scope:
   1. Review the process mechanical layout and the Process and Instrumentation Diagram(s) (P&ID) drawings within the Contract Documents that relate to the equipment specified in this Section to familiarize themselves with the location, arrangement and the application of the equipment specified and confirm that the equipment specified is appropriate for and coordinated with what is shown on the Drawings.
   2. 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 Section 40 61 13.01 – Process Control Systems General Provisions.

C. Required Coordination
   1. Review the process mechanical layout and the Process and Instrumentation Diagram(s) (P&ID) drawings within the Contract Documents that relate to the equipment specified in this Section to familiarize themselves with the location, arrangement and the application of the equipment specified and confirm that the equipment specified is appropriate for and coordinated with what is shown on the Drawings.

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
   3. Section 40 61 13.01 – Process Control Systems General Provisions

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
SAMA PMC 17-10	Bushings and Wells for Temperature Sensing Elements

1.04 SUBMITTALS

A. The following minimum documentation shall be submitted per Section 01 33 00 - Submittal Procedures

B. Action Submittals:

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. 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.
2. Locate appurtenances on the piping layout drawings by plant area and submit in accordance with Section 40 05 01.
3. Manufacturer's product data.
4. Operations and Maintenance Manuals (including Warranty) in accordance with Section 01 78 23 – Operations and Maintenance Data

C. Closeout Submittals: The following minimum submittals shall be submitted for inspection.

1. Final Operations and Maintenance Manuals (including final Warranty documents) in accordance with Section 01 78 23 – Operations and Maintenance Data.

1.05 SHIPMENT AND STORAGE

A. Ship and store products in accordance with Section 01 66 00 – Product Storage and Handling.

B. Provide the Contractor with detailed recommendations and instructions for product storage.

PART 2 PRODUCTS

2.01 GENERAL

A. Unless otherwise specified or shown on the Drawings:
   1. All equipment shall be the same size as adjoining pipe.
   2. Body material of appurtenances shall match pipeline material.
   3. Pressure rating of appurtenances shall be no less than 150 psi.
   4. Electrical housings shall be NEMA 4.

B. All units shall have the name of the manufacturer and the size of the unit cast on the body or shown on a permanently attached plate in raised letters.

C. All equipment provided shall be equipped with flanges, integral unions, or other functional connections for removal.

2.02 FLOW AND LEVEL GAGES

A. Rotameters:
   1. Purge Rotameters (Flushing Water):
      a. General:
         1) Variable area type
         2) Factory assembles with integral needle valve and flow controller.
         3) Range:
         4) 200 psi working pressure
      b. Flow control valve shall be pressure compensated to maintain set flow rate with constant upstream pressure and variable downstream pressure.
         1) Materials:
            a) Meter tube: glass
            b) Body and frame: 316 stainless steel
         2) Acceptable manufacturers:
            a) Wallace and Tiernan: 32A113SSTX3.
            b) ITT Conoflow: GDH 2119 or GDH 2123
            c) Or Approved equal.
   2. Rotameters for high-capacity service: Not used.

B. Sight Gages:
   1. Type and material: automatic water gage complete with Pyrex gage glass and gage glass protector.
   2. Overall length of gages, type of mounting, and orientation of set shall be as specified.
   3. Acceptable manufacturers:
      a. 3/4-inch Penberthy.
      b. LDO Industries
      c. Or Approved equal.

C. Flow Indicators:
   1. Flow indicators shall be provided where specified.
   2. Fabrication: bronze body with threaded ends and a sight glass with rotary wheel.

3. Pressure ratings for flow indicators shall match pipe pressure ratings.
4. Acceptable manufacturers:
    a. Jacoby-Tarbox.
    b. Eugene Ernst Products.
    c. Or Approved equal.

2.03 PRESSURE DEVICES

A. Pressure Gages (water or air service only):
    1. Unless otherwise indicated, pressure gage scales shall be selected so that the normal operating pressure falls between 50 and 80 percent of full scale.
    2. Diameter: 4-1/2 inch.
    3. Movement: 270 degrees.
    4. Accuracy: 0.5 percent.
    5. Case: Non-metallic case with a 1/2-inch NPT bottom connection.
    6. Type: Premium grade, heavy duty Type 316 stainless steel bourdon tube units with plastic bushings and pinion, and stainless steel sector. Internal pulsation dampening system consisting of either a glycerin fill or a silicone fluid fill; snubbers or orifices are not acceptable.
    7. All gauges shall be vertically oriented.
    8. All gauges shall have an ½" isolation ball valve in accordance with 40 05 01.
    9. Bleed-off valves shall be ¼" ball valves in accordance with 40 05 01.
    10. Acceptable manufacturers:
        a. Ashcroft Duragage 1279.
        b. Ametek 1981.
        c. Or Approved equal.
B. Diaphragm Seals:
    1. Type 1:
        a. Body and diaphragm material: Type 316 or Type 316L stainless steel.
        b. Flushing connection: 1/4-inch
        c. Process connection: 1/2-inch
        d. Unless otherwise indicated, fill fluid shall be Silicone DC200.
        e. Acceptable manufacturers:
            1) Ashcroft Type 101.
            2) Ametek.
            3) Or Approved equal.
    2. Type 2:
        a. Type: flexible sleeve type.
        b. Size: 1-inch, unless otherwise indicated.
        c. Unless otherwise indicated, sleeve shall be Buna-N.
        d. Acceptable manufacturers:
            1) Red Valve Series 742.
            2) Ashcroft Type 85

3) Or Approved equal.

C. Flexible Sleeve Pressure Sensors:
   1. Type: in-line full stream captive sensing liquid type.
   2. Materials:
      a. wetted parts: 316 stainless steel
      b. sleeve: Buna-N, unless otherwise indicated
      c. capillary tubing: armored stainless steel
   3. Seals:
      a. Rated for 200 psi with 5-inch SC hysteresis.
      b. Acceptable manufacturer:
         1) Ronningen-Petter.
         2) Red Valve.
         3) Or Approved equal.
   4. Fill fluid shall be rated for a temperature range of -20 degrees F to 200 degrees F.
   5. Vacuum filling: 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. Water Strainers:
   1. Unless otherwise indicated, water strainers shall be Y-pattern.
   2. Bronze bodies shall be provided with copper piping. Cast iron bodies shall be provided with steel piping.
   3. Strainers shall have 304 stainless steel screens and tapped and plugged blowoff connections.
   4. Screen perforations shall be 0.045 inch.
   5. Acceptable manufacturers:
      a. Mueller.
      b. Armstrong.
      c. Or Approved equal.

2.05 QUICK CONNECT FITTINGS

A. All other quick connect fittings:
   1. Type: Coupler type, with cam arms. Capable of connecting to a hose adapter without the use of tools.
   2. Size: The same size as the pipeline.
   3. Materials: PVDF with Teflon gaskets.
   4. Acceptable manufacturers:
      a. Kamlock.
      b. Chicago Pneumatic.
      c. Or Approved equal.

PART 3 EXECUTION

3.01 GENERAL

A. Manufacturer to provide the Contractor with detailed recommendations and instructions for installation of the equipment specified in this Section.

3.02 GAGE TAPS

A. Provide gage taps on the suction and discharge of pumps, fans, compressors, vacuum pumps and blowers.
B. Gage taps for water and air service shall consist of a 1/4-inch gage cock attached by a threaded nipple to the pipeline, duct or equipment.
C. Gage taps and valves for gas service shall be in accordance Section 40 61 13.01 – Process Control Systems General Provisions.

3.03 VENTS AND DRAINS

A. Vents:
   1. Provide manual air vents at the high points of each reach of pipeline shown on the drawings, and provide additional manual drains as required and specified by the Project Representative after completion of piping installation.
   2. Provide manual air vents between all double block valves, as indicated on the drawings.
   3. Air vents shall be 1-inch and shall consist of full port ball valve and copper tubing return.
   4. Air vents shall be taken to the nearest floor with ball valve mounted 4 feet above the floor.
   5. Fit vents in piping systems for fluids containing solids with quick couplers.
B. Drains:
   1. Pipe each drain to a sump, gutter, floor drain or other collection point with a valve mounted 4 feet above the floor.
   2. Drain valves in piping systems for fluids containing solids shall be threaded end full port plug valves of the size specified, fitted with quick couplers. All other drain valves shall be threaded end gate valves of the size specified, fitted with quick couplers.
   3. When a drain cannot be run to a collection point, route the drain to a point of easy access and install a valve, of the type and size specified, fitted with a male threaded nipple suitable for connection to a hose.

3.04 FLEXIBLE SLEEVE PRESSURE SENSORS

A. If system has not been factory filled, vacuum fill the system in the field. Solder filling connections shut after vacuum evacuation and filling.

3.05 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be included in the lump sum bids for the respective items in the Proposal Schedule.

END OF SECTION

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SECTION 40 05 07

HANGERS AND SUPPORTS FOR PROCESS PIPING

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies hangers and supports for all exposed piping systems specified in Section 40 05 01.

B. 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.

1. Whether a design or general arrangement is shown or not, Contractor's Design Professional shall design all pipe supports, anchorage, restraints and expansion control, as specified. Where a conflict arises, Contractor's Design Professional shall present any conflict to Officer-in Charge for resolution.
2. The Design Professional's work shall incorporate design criteria and other conditions as specified herein, in related sections and as shown on the drawings.
3. Additional requirements are specified in related sections.
4. Bidding: For purposes of bidding supports within Design Professional's Scope of Responsibility, Contractor may use the support and seismic restraint tables presented in Appendix A of this Section and information shown on the Drawings.
    a. Additional supports are required for concentrated loads, changes in direction and disassembly.
    b. Support frequency shall be determined based upon hanger load capacity, with minimum indicated factor of safety specified. Rod hanger support frequency indicated in Table A (Appendix A) shall not be represented as being sufficient to address seismic loads.
    c. Notwithstanding the Mechanical Standard Details and direction as shown on the Drawings, the full scope of supports, specified and shown, including those within the Design Professional's Scope of Responsibility is required work and differences between bid quantities and actual requirements will not be considered as extra work subject to adjustment by change order.

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 – Shipment, Protection, and Storage
3. Section 01 73 24 – Design Requirements for Non-Structural Components and Non-Building Structures
4. Section 03 30 00 – Cast-in-Place Concrete
5. Section 05 05 20 – Anchor Bolts
6. Section 40 05 01 – Piping Systems
7. Section 40 05 02 – Piping System Schedules
8. Section 40 05 06 – Specialty Couplings and Adapters for Process Piping

9. Section 40 05 07.13 – Seismic Restraints for Piping
10. Section 40 05 45 – Piping System Identification
11. 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 shall prevail.

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

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordination required with the design of piping systems, expansion joints, and expansion control and seismic restraints.
   2. Refer to Section 40 05 01 for additional coordination requirements.
   3. Refer to paragraph 1.08 Hanger and Supports Selection and Design for additional coordination requirements.

1.05 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section, and those listed below 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. 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.
   3. Hanger and support locations and components on the piping layout drawings required by Section 40 05 01.

B. Informational Submittals:
   1. Procedures: Section 01 33 00.

2. Design Professional's reports as specified in paragraph 3.05.

1.06 QUALITY ASSURANCE

A. Refer to Section 40 05 01 for additional quality assurance requirements.

B. Refer to paragraph 1.08 Pipe Hanger and Support Selection and Design for additional quality assurance requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00.

B. Additional requirements: 40 05 01.

1.08 PIPE HANGER AND SUPPORT SELECTION AND DESIGN

A. Hanger And Support Selection:

1. The Contractor shall cause the pipe hangers and supports to be designed and selected by the Design Professional retained under the provisions of Section 40 05 01. This provision, however, shall not relieve the Contractor of overall responsibility for this portion of the work. Hanger and support selection shall be based on the following.

   a. The Contractor shall select pipe hangers and supports as specified in the Contract Documents. Selections shall be based upon the pipe support classifications specified in MSS-SP 69, and any special requirements which may be specified in the Contract Documents

   b. 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.

   c. Where a particular pipe support arrangement is shown, a design incorporating that arrangement shall be used.

   d. Where a particular pipe support design is shown, that design shall be used.

   e. Pipe supports shall be spaced such that pipe span deflections do not exceed 0.1-inch.

   f. Pipe support design shall incorporate applicable criteria of ASME or other recognized standard.

   g. Pipe hanger and support system shall be coordinated with seismic requirements per Section 40 05 07.13.

   h. Hangers and supports shall withstand all static and specified dynamic conditions of loading to which the piping and associated equipment may be subjected. As a minimum, consideration shall be given to the following conditions:

      1) Weights of pipe, valves, fittings, insulating materials, suspended hanger components, and normal fluid contents.

      2) Weight of hydrostatic test fluid or cleaning fluid if normal operating fluid contents are lighter.

      3) Reaction forces due to test and operational conditions.

      4) Reaction forces due to the operation of safety, relief, or other valves.

      5) Wind loadings on outdoor piping.

6) Supports shall be designed to prevent transfer of the weight of piping, valves and piping appurtenances to equipment piping connections. All supports adjacent at equipment connections to piping systems shall have provisions for vertical and horizontal adjustment. Two flexible piping connections not less than one pipe diameter apart shall be provided between piping supports and any equipment piping connection.

i. Hangers and supports shall be sized to fit the outside diameter of pipe, tubing, or, where specified, the outside diameter of insulation.

j. 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.

k. 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.

l. 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.

m. 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.

n. 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.

o. Stock hanger and support components shall be used wherever practical.

B. The following structural criteria shall also be applied:

1. Unless otherwise specified, existing pipes and supports shall not be used to support new piping.
2. Unless otherwise specified, pipe support components shall not be attached to pressure vessels.
3. Pipe support hangers, brackets etc. shall be of suitable capacity and shall be appropriate to the individual structural member that is used to support the pipe.
4. The structural integrity of existing and new members shall in no way be impacted by the placement of connections for pipe supports. For example, the tension reinforcement in reinforced concrete members shall not be impacted in any way by the placement of fasteners for pipe supports.
5. Spacing and arrangement of hangers supporting pipe shall be provided in such a manner that the loads from the pipes on existing and new structural members shall be quasi-uniform. These quasi-uniform loads shall not exceed the allowable design loads for mechanical equipment as shown on existing (not necessarily contract) drawings and as listed under Design Live Loads in the General Notes.
6. The loads and specific attachment requirements for pipe supports on new concrete Tees shall be coordinated with the Tee manufacturer and incorporated into the design of the Tees.
7. Unless otherwise specified, pipe supports from existing Tees or other roof types shall not be constructed without an evaluation of capacity and appropriate design from Contractor's Design Professional.

PART 2 PRODUCTS

2.01 PERFORMANCE/ DESIGN CRITERIA

A. Service 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, all pipes are assumed to be operating in an ambient temperature range of 60 degrees F to 119 degrees F.

B. Design:
   1. The Contractor shall cause the design of pipe hanger and support systems to be developed in conjunction with preparation of the design seismic restraints and expansion control system by the Design Professional selected in accordance with Section 40 05 07. The pipe system drawings specified in Section 40 05 07 shall show the hanger and support locations as well as the details of the seismic restraints and expansion control systems. The pipe hanger and support design drawings and calculations shall be prepared and signed by the design professional and shall bear the Design Professional's registration seal.

2.02 MATERIALS

A. Standard pipe supports and components shall be manufactured by B-Line, Carpenter & Patterson, Kin-Line, Grinnell, Michigan, Pipe Shields Incorporated, Superstrut, Unistrut, or approved equal. Pipe support components shall conform to the requirements of MSS SP-69 and FEDSPEC WW-H-171e.

B. 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.

2.03 CONFIGURATION, COMPONENTS, FEATURES

A. General:
   1. Unless otherwise specified, pipe hangers and supports, structural attachments, fittings, nuts, bolts, washers, and accessories shall be 316 stainless steel.

B. Pipe Hangers and Supports:
   1. Provide insulation or other dielectric separation where pipe hangers / supports are of dissimilar metals than the pipe being supported. Pipe hangers and supports shall support pipe in the manner recommended by the pipe manufacturer and/or applicable building or piping codes.
   2. Type 6 - Framing Channel Pipe Clamp: Pipe clamps shall be 316 stainless steel with material thickness as listed below.
      a. All pipe - 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 approved equal.

3. Type 10 - Pipe Stanchion Saddle: Saddles and yokes shall be 316 stainless steel and comply with MSS Type 37 and FEDSPEC Type 38.
    a. All pipe - shall be Carpenter & Patterson Fig. 125, B-Line B3090, or approved equal, with insulation shield.

C. 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 approved 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 approved 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 approved 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 approved 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 approved 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 approved 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 approved equal.
9. Type J - Adjustable Beam Attachment: Beam attachment shall be carbon steel, Carpenter & Patterson Fig. 151, B-Line B3082, or approved equal.
10. Type K - Double Channel Bracket: Wall channel shall be single channel framing channel as specified in paragraph 2.03 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 approved equal.
11. Type L - Single Channel Bracket: Wall channel shall be single channel framing channel as specified in paragraph 2.03 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 approved equal.
12. Type M - Wall Mounted Channel: Wall channel shall be single channel framing channel as specified in paragraph 2.03 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.

14. Type Q - Continuous Concrete Inserts: shall be 1 5/8 by 1 3/8 Channel, cold formed 12 Ga. steel conforming to ASTM A 1001, stainless steel GR 33 or ASTM GR 33 A., hot dip galvanized conforming to ASTM A123 or A153, UNISTRUT P3200 Series, or approved equal.

D. 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 approved 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 approved 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 approved equal.
5. Framing Channel: Framing channel shall be 1 5/8 inches square, roll formed, 12-gage 316 stainless steel. Channel shall have a continuous slot along one side with in-turned clamping ridges. Single channel: Unistrut P1000, B-Line B22, or approved equal. Double channel: Unistrut P1001, B-Line B22A, or approved equal. Triple channel: Unistrut P1004A, B-Line B22X, or approved equal.

PART 3 EXECUTION

3.01 HANGER AND SUPPORT LOCATIONS

A. Locate hangers and supports shall be located where shown on the Drawings and as near as possible to concentrated loads such as valves, flanges, etc.

B. Locate at least one hanger or support within 2 feet from a pipe change in direction.

C. 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 a valve, piping assembly, etc., that will require removal for maintenance, support the piping 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, valves, and fittings.

3.02 INSTALLATION

A. 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.

B. Install items to be embedded before concrete is poured. Fasten embedded items securely to prevent movement when concrete is poured.

C. Embedded anchor bolts shall be used instead of concrete inserts for support installations in areas below water surface or normally subject to submerging.

D. Hanger and support components in contact with plastic pipe shall be free of burrs and sharp edges.

E. 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.

F. Baseplates shall be cut and drilled to specified dimensions prior to welding stanchions or other attachments and prior to setting anchor bolts.

G. Plastic or rubber end caps shall be provided at the exposed ends of all framing channels.

3.03 ADJUSTMENTS

A. 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.

3.04 ANCHOR BOLTS

A. Anchor bolts in new concrete shall be cast in place. Refer to Section 05 05 20.

3.05 INSPECTION AND CERTIFICATION

A. The Design Professional retained by the Contractor under the provisions of Section 40 05 01 shall inspect the pipe hangers, support and restraint systems during construction and furnish the Officer-in-Charge with an inspection report. The Design Professional shall inspect the completed pipe hanger, support and restraint system prior to substantial completion and provide written certification, without any qualification statements, that the installation conforms to the design professional's design and the Contract Document requirements as may be described in other Sections or on the drawings. All reports shall bear the Design Professional's seal and signature in accordance with the laws, rules and regulations of the state. The Design Professional shall be registered in the State of Hawaii.

3.06 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be included in the lump sum bids for the respective items in the Proposal Schedule.

END OF SECTION

APPENDIX A: PIPE HANGERS AND SUPPORTS TABLES

TABLE A - SUPPORT SPACING AND ALLOWABLE ROD LOADS

NOMINAL PIPE SIZE (INCHES)	SUPPORT ROD SIZE AND MAXIMUM LOAD PER ROD - SEE NOTES 1 AND 2		MAXIMUM SUPPORT SPACING (FEET)			
	ROD SIZE (INCHES)	MAX LOAD (POUNDS)	STEEL	COPPER	PLASTIC SEE NOTE 4	CAST IRON SEE NOTE 5
3/8 TO 3/4	3/8	610	5	5	CONTINUOUS	---
1	3/8	610	5	5	5	---
1-1/4	3/8	610	5	5	5	---
1-1/2	3/8	610	5	5	5	---
2	3/8	610	10	5	5	
2-1/2	3/8	610	10	10	5	
3	3/8	610	10	20	5	12 FEET FOR PRESSURE PIPE
4	1/2	1130	10	20	5	10 FEET FOR SOIL PIPE
6	5/8	1810	15	20	5	
8	3/4	2710	15	20	5	
10	3/4	2710	20	---	5	
12	1	4960	20	---	10	
14	1	4960	20	---	---	
16	1	4960	20	---	---	
18	1	4960	20	---	---	
20	1-1/4	8000	20	---	---	
24	1-1/4	8000	20	---	---	
30	1-1/2	11630	20	---	---	

TABLE A NOTES:

1. DESIGN WEIGHT SHALL BE TWICE THE WEIGHT OF THE PIPE FULL OF WATER PLUS THE WEIGHTS OF VALVES, FITTINGS, INSULATING MATERIALS AND SUSPENDED HANGER COMPONENTS ON THE RUN OF PIPE BEING SUPPORTED.
2. ROD SIZES SHOWN ARE FOR THE SUPPORT OF A SINGLE PIPE. WHEN SUPPORTING MORE THAN ONE PIPE, ROD SHALL BE SIZED USING DESIGN WEIGHTS (SEE NOTE 1) TO DETERMINE THE TOTAL DESIGN LOAD. THE TOTAL DESIGN LOAD SHALL NOT EXCEED THE MAXIMUM LOADS IN THE TABLE ABOVE.
3. 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.
4. SPAN SHOWN IS FOR SCHEDULE 80 PVC PIPE AT 100°F. SPANS FOR OTHER PLASTICS, OTHER PVC PIPE SCHEDULES AND PIPES AT HIGHER TEMPERATURES SHALL BE SHORT- ENED IN ACCORDANCE WITH THE PIPE MANUFACTURER'S RECOMMENDATIONS. ``CONTINUOUS" MEANS PIPE SHALL BE IN UNISTRUT OR SIMILAR CHANNEL.
5. PROVIDE A MINIMUM OF ONE HANGER PER PIPE LENGTH, WITHIN 4-INCHES OF THE BELL.
6. PIPE HANGER AND SUPPORT SELECTION SHALL BE IN ACCORDANCE WITH TABLE B (M2302) AND SPECIFICATION SECTION 15096.

TABLE B HANGER AND SUPPORT SELECTIONS

SYSTEM TEMP RANGE DEG F	INSULATION NOTE 1	PIPE ATTACHMENTS								BUILDING STRUCTURAL ATTACHMENTS			
		HORIZONTAL							VERTICAL	STEEL AND/OR MALL. IRON			
		STEEL STRAPS	STEEL BANDS	STEEL CLAMPS	CAST IRON HANGING ROLLS	CAST IRON SUPPORTING ROLLS	STEEL TRAPEZES AND RACKS	THERMAL HANGER SHIELDS	STEEL OR CAST IRON STANCHIONS	STEEL RISER CLAMPS	INSERTS	BEAM CLAMPS	WELDED AND BOLTED ATTACHMENTS	BRACKETS
HOT A-1 120 TO 450	COVERED	13	1, 2	3	4, 5	8	20, 21	SEE SPEC	10	11, 12	A	C, D	F, J, M	B, G, H, K, L
	BARE	6, 7 13	1, 2	3	4, 5	8	20, 21	NONE	10					
HOT A-2 451 TO 750	COVERED	13	1	3	4, 5	8	20, 21	SEE SPEC	10	11, 12	A	C, D	F, J, M	B, G, H, K, L
	BARE	NONE	NONE	3	NONE	NONE	20, 21	NONE	NONE					
HOT A-3 OVER 750	COVERED	13	1	3 (ALLOY)	4, 5	8	20, 21	SEE SPEC	10	11, 12	NONE	C, D	F, J, M	B, G, H, K, L
	BARE	13	NONE	3 (ALLOY)	NONE	NONE	20, 21	NONE	NONE					
AMBIENT B 60 TO 119	COVERED	13	1, 2	3	4, 5	8	20, 21	SEE SPEC	9,10	11, 12	A	C, D	F, J, M	B, G, H, K, L
	BARE	6, 7 13	1, 2	3	4, 5	8	20, 21	NONE	9,10					
COLD C-1 33 TO 59	COVERED	13	1, 2, 3	3	4, 5	8	20, 21	SEE SPEC	10	11, 12	A	C, D	F, J, M	B, G, H, K, L
	BARE	6, 7 13	1, 2, 3	3	4, 5	8	20, 21	NONE	10					
COLD C-2 -2 TO 32	COVERED	13	1, 2, 3	3	4, 5	8	20, 21	SEE SPEC	10	11, 12	A	C, D	F, J, M	B, G, H, K, L
	BARE	NONE	1, 2, 3	3	4, 5	8	20, 21	NONE	10					

TABLE B NOTES:

1. HANGERS ON INSULATED SYSTEMS SHALL INCORPORATE THERMAL HANGER SHIELDS.
2. HANGER AND SUPPORT SPACING SHALL BE IN ACCORDANCE WITH TABLE A (M2301).

TABLE C
SEISMIC RESTRAINT SPACING

NOM. PIPE SIZE	MAXIMUM SPAN BETWEEN BRACES		BRACE TYPE	MAXIMUM BRACE LENGTH
	LATERAL BRACE (FEET)	LONGITUDINAL BRACE (FEET)		
2	40	80	A1	9'-4"
2-1/2	40	80	A1	9'-4"
3	40	80	A1	9'-4"
4	40	80	A1	9'-4"
6	40	80	A1	9'-4"
8	40	40	A1	9'-4"
10	40	40	A1	9'-4"
12	40	40	A2	10'-0"
14	30	30	A2	10'-0"
16	25	25	A2	10'-0"
18	20	20	A2	10'-0"
20	16	16	A2	10'-0"
24	10	10	A2	10'-0"

(S) - STANDARD WALL

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SECTION 40 05 07.13

SEISMIC RESTRAINTS FOR PIPING

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies seismic restraints for bracing all piping systems specified in Section 40 05 01.

B. Provide professional engineering services for a piping system design engineer (hereinafter the "Design Professional") as specified in Section 40 05 01, this Section, and related sections.

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 – Shipment, Protection, and Storage
3. Section 01 73 24 – Design Requirements for Non-Structural Components and Non-Building Structures
4. Section 03 30 00 – Cast-in-Place Concrete
5. Section 05 05 20 – Anchor Bolts
6. Section 40 05 01 – Piping Systems
7. Section 40 05 02 – Piping System Schedules
8. Section 40 05 06 – Specialty Couplings and Adapters for Process Piping
9. Section 40 05 07 – Hangers and Supports for Process Piping
10. Section 40 05 45 – Piping System Identification

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
AISC Manual of Steel Construction	American Institute of Steel Construction Manual of Steel Construction, Allowable Stress Design, 9th Edition
MFMA-2	Metal Framing Standards Publication
MFMA-101	Guidelines for the Use of Metal Framing
MSS SP-58	Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-69	Pipe Hangers and Supports - Selection and Application
MSS-SP-89	Pipe Hangers and Supports – Fabrication and Installation Practices
SMACNA	Seismic Restraint Manual—Guidelines for Mechanical Systems

1.04 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:
   1. Longitudinal direction: direction parallel to the pipe axis.
   2. Lateral direction: direction perpendicular to the pipe axis.

1.05 ADMISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordination required with the design of piping systems, expansion joints, pipe supports, and expansion control and seismic restraints.
   2. Refer to Section 40 05 01 for additional coordination requirements.
   3. Refer to paragraph 1.09 Seismic Restraint Design for additional coordination requirements.

1.06 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. Seismic restraint system drawings and calculations as specified in this section.
   3. Seismic restraint locations and legend.
B. Informational Submittals:
   1. Procedures: Section 01 33 00
   2. The Design Professional's reports and certification of final installation as specified in Section 40 05 01 and this section.

1.07 QUALITY ASSURANCE

A. Refer to Section 40 05 01 for additional quality assurance requirements.
B. Refer to paragraph 1.09 Seismic Restraint Design for additional quality assurance requirements.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00.
B. Additional requirements: Section 40 05 01

1.09 SEISMIC RESTRAINT DESIGN

A. Design Professional:
   1. The seismic restraint system shall be designed by the Design Professional retained under Section 40 05 01. Seismic restraint details shall be designed in conjunction with preparation of pipe system hangers and drawings specified in Section 40 05 01.
   2. All drawings and work product for the seismic restraint 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.

B. Restraint Selection:
   1. The Contractor shall select, locate and provide seismic restraints for piping in accordance with this section. As set forth in Section 40 05 01, this work shall be the product of a Design Professional retained by the Contractor.
   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. All piping less than 2 1/2-inch inside diameter
   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.

PART 2 PRODUCTS

2.01 PERFORMANCE/ DESIGN REQUIREMENTS

A. Service Conditions:
   1. Provide seismic bracing to resist seismic loading caused by forces applied at the individual pipe's center of gravity. Designed seismic bracing for seismic loading as specified in Section 01 73 24. Seismic loading shall be assumed to be acting in the lateral, longitudinal, and vertical directions simultaneously.
   2. Provide all piping systems with seismic restraints conforming to governing state and local codes.
   3. Seismic restraints shall conform to the guidelines given in the SMACNA Seismic Restraint Manual for the Seismic Hazard Level consistent with the requirements of governing state and local codes. In case of conflict, the governing state or local code shall be followed.

2.02 MANUFACTURERS

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 approved equal.
B. Pipe restraint materials, design, manufacture, installation, and application shall conform to the requirements of MSS SP-58, MSS-SP-69, MSS-SP-89, MFMA-1, and MFMA-101.

2.03 MATERIALS

A. General:
   1. Unless otherwise specified, restraints manufactured of iron or steel, including braces, pipe and structural attachments, shall be hot-dip galvanized after fabrication.
   2. Nuts, bolts and washers, fittings and accessories, shall be Type 316 stainless steel.

PART 3 EXECUTION

3.01 PIPE RESTRAINT LOCATIONS

A. Locate the first seismic restraint on a piping system not more than 10 feet from the main riser, entrance to a building or piece of equipment.

B. Brace ductile and cast iron pipe on each side of a change in direction of 90 degrees or more. Brace or stabilize joints in risers between floors.

C. At a minimum, brace no-hub and bell and spigot cast iron soil pipe 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. Indicate seismic restraint locations and components on the piping layout drawings required by Section 40 05 01. The drawings shall bear a legend giving load information and restraint component selection at each restraint location and shall be sealed and signed by the Design Professional retained by the Contractor for design of the pipe hanger and support system under the provisions of Section 40 05 01.

3.02 INSTALLATION

A. Use rod stiffener assemblies at seismic restraints for hanger rods over 6 inches in length. Use a minimum of two rod stiffener clamps on any rod stiffener assembly.

B. Install lateral and longitudinal bracing between 45 degrees above and 45 degrees below horizontal, inclusive, relative to the horizontal centerline of the pipe.

C. Weld and bolt attachments to the building structural steel in accordance with the requirements of AISC M011. There shall be no drilling or burning of holes in the building structural steel without approval of the Officer-in-Charge.

D. Use embedded anchor bolts instead of concrete inserts for seismic brace installations in new concrete areas below water surface or normally subject to submerging. Otherwise, design and provide anchor bolts in accordance with Section 05 05 20.

E. Restraint components in contact with plastic pipe shall be free of burrs and sharp edges.

F. Rollers shall roll freely without binding.

G. Provide plastic or rubber end caps 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 shall inspect the seismic restraint system at not less than bi-weekly intervals during construction and furnish the Officer-in-Charge with monthly reports.

B. The Design Professional shall inspect the completed seismic control system before the City assumes beneficial occupancy and provide written certification in accordance with Section 40 05 07 requirements.

3.04 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be included in the lump sum bids for the respective items in the Proposal Schedule.

END OF SECTION

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SECTION 40 05 19

DUCTILE IRON PIPE

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies ductile iron pipe and fittings.

1.02 RELATED SECTIONS

A. This Section contains references to the following 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 09 90 00 – Painting and Coating
   4. Section 40 05 01 – Piping Systems
   5. 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 shall prevail.

Reference	Title
ASME B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, and 250
ASME B16.5	Pipe Flanges and Flanged Fittings
ASTM B1000	Casting Preparation and Test Procedure of Porcelain Enamel-lined Pipe, Fittings, and Valves for Use in the Municipal Wastewater, Sewage, and Water Treatment Industry
ASTM C150	Portland Cement
ASTM A716	Standard Specification for Ductile Iron Culvert Pipe
AWWA C104	Cement-Mortar Lining for Ductile- Iron and Gray-Iron Pipe
AWWA C105	Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C110	Ductile-Iron and Gray-Iron Fittings
AWWA C111	Rubber-Gasket Joints for Ductile- Iron and Gray-Iron Pressure Pipe and Fittings
AWWA C115	Flanged Ductile-Iron and Gray-Iron Pipe with Threaded Flanges
AWWA C116	Protective Fusion-Bonded-Epoxy Coating for the Interior and Exterior Surfaces for Ductile-Iron and Gray-Iron Fittings.
AWWA C150	Thickness Design of Ductile-Iron Pipe
AWWA C151	Ductile-Iron Pipe, Centrifugally Cast
AWWA C153	Ductile-Iron Compact Fittings
AWWA C600	Installation of Ductile-Iron Water Mains and Their Appurtenances.
AWWA C606	Grooved and Shouldered Type Joints
ISO 8179-1	Ductile Iron Pipes – Externa Zinc-based Coating - Part 1: Metallic Zinc with Finishing Layer

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 from specification requirements. Check-marks (✓) denote full compliance with a paragraph as a whole. Underline deviations and denote with a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined 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 will be sufficient cause for rejection of the entire submittal with no further consideration.
   3. Manufacturer's product data, catalog cuts, joints, gaskets, pipe and fittings dimensions, wall thickness, weight, lining and coatings. Indicate each Piping System Schedule where the product will be used.
   4. Manufacturer's product data, catalog cuts, dimensions, thickness, markings and weight for polyethylene wrap and tape. Indicate each Piping System Schedule where the product will be used.

B. Informational Submittals:
   1. Procedures: Section 01 33 00.
   2. Certifications indicated in the following documents:
      a. ASTM A716, sworn statement of inspection and certification.
      b. AWWA C110, certification of inspection and testing.
      c. AWWA C111, record of specified tests.
      d. AWWA C115, affidavit of compliance.
      e. AWWA C151, manufacturer's statement and affidavit of compliance.
      f. AWWA C606, affidavit of compliance.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00 for shipment and storage.

PART 2 PRODUCTS

2.01 MATERIALS

A. All pipe system materials to be new, free from defects and conforming to the requirements and standards identified in Section 40 05 02 and related sections.

2.02 PIPE LINING

A. Provide pipe and fittings with lining as specified in Piping System Schedules in Section 40 05 02.00 through 40 05 02.99. Requirements for each lining type are specified in this Section.
   1. Ceramic Epoxy
      a. Factory applied.

b. Line pipe and fittings with amine cured novolac epoxy containing at least 20 percent ceramic quartz pigment.
c. 40 mils minimum thickness.
d. Candidate Manufacturers:
1) Protecto 401
2) Approved Equal

2.03 PIPE COATING

A. Provide pipe with coating as specified in Piping System Specification Sheets in Section 40 05 02. Requirements for each coating type are specified in this Section and Section 09 90 00.
1. Asphaltic Coating
a. Factory applied.
b. Coat pipe and fittings with 1 mil, minimum, of asphaltic material as specified in AWWA C151.
2. Zinc Coating with Asphaltic Top Coat
a. Factory applied
b. Coat pipe and fittings with a layer of arc-sprayed zinc per ISO 8179-1. Zinc applied at not less than 200 g/m^2 of pipe surface area. Apply a finishing layer asphaltic topcoat per AWWA C151.
3. Polyethylene Encasement
a. Field installed
b. Encase pipe and fittings in polyethylene wrap as specified in AWWA C105.
c. Polyethylene tubing shall be Anti-microbial, Low Density Polyethylene (LDPE) or High Density Polyethylene (HDPE):
1) LDPE: 8-mil linear low density polyethylene film meeting the requirements of AWWA C105, impregnated with ½ percent NM-100 anti-microbial compound. Fulton Enterprises Biofilm, or Approved Equal.
2) HDPE: 4-mil high-density, cross-laminated polyethylene film meeting the requirements of AWWA C105.
d. Seam/Joint Tape – Acceptable manufacturer:
1) Polyken No. 900 (polyethylene)
2) Scotchwrap No. 50 (polyvinyl)
3) Approved equal
4. Epoxy Primer.
a. Factory or shop applied.
b. Coat pipe and fittings with Amide or Polyamide cured epoxy, 6 mils DFT

2.04 FUSION-BONDED EPOXY LINING AND COATING FOR FITTINGS

A. Factory or shop applied.

B. Fusion bonded epoxy lining and coating per AWWA C116.

2.05 JOINTS AND COUPLINGS

A. Restrained Push-On (RPO) Joint
   1. Restrained, rubber ring compression gasket, push-on joints conforming to AWWA C111
   2. Restrained by the interference of metallic rings, bolts, locking segments or other interlocking components with flanges, lugs, beads, grooves, or retainer rings that are integrally cast into or welded onto both ends of the joint. Restrained joints with gripping wedges, or gripping gaskets, radial pads, or other devices that penetrate, grip, or embed in the pipe material to resist axial thrust loads are not acceptable.
   3. Candidate manufacturers:
      a. American Cast Iron Pipe Company, Flex-Ring or Lok-Ring
      b. U.S. Pipe, TR Flex or HP LOK
      c. McWane Pipe, Tr-Flex
      d. Approved Equal

B. Mechanical Joint (MJ)
   1. Mechanical Joints per AWWA C110 and AWWA C111

C. Restrained Mechanical Joint (RMJ)
   1. Restrained by tie-rods/bolts tying the gasket gland to a second retainer/follower gland behind a welded ring on the spigot end of the joint. Restrained joints with gripping wedges, or gripping gaskets, radial pads, or other devices that penetrate, grip, or embed in the pipe material to resist axial thrust loads are not acceptable.
   2. Fully restrained mechanical joints for above or below ground service conforming to AWWA C110 and AWWA C111.
   3. Candidate manufacturers:
      a. American Cast Iron Pipe Company, Mechanical Joint Coupled Joint
      b. U.S. Pipe, BOLT-LOK or MECH-LOK
      c. Approved equal

D. Grooved couplings (CGRV) and fittings
   1. Cast or cut groove dimensions per AWWA C606
   2. Flexible or Rigid Couplings as specified in the Piping System Schedules (Sections 40 05 02.00 through 40 05 02.99).
   3. When pipe wall thickness does not meet the minimum requirements of AWWA C606 for rolled or cut groove joints, provide shouldered ends per the requirements of AWWA C606.
   4. Candidate manufacturers:
      1) Victaulic
      2) Gruvlok
      3) Approved equal
   5. Grooved end flanged coupling adapters candidate manufacturers:
      a. Victaulic Style 341
      b. Approved equal
   6. Grooved end transition couplings to steel pipe candidate manufacturers:
      a. Victaulic Style 307
      b. Approved equal

E. Sleeve/Transition Coupling
   1. When connecting new ductile iron piping to existing piping, field verify outside diameters of existing pipe prior to connection. See drawings for location and installation requirements.
   2. Candidate Manufacturers:
      a. Romac, "501"
      b. JCM, "212"
      c. Smith-Blair, "461"
      d. Approved equal

F. Fittings and Outlets
   1. Fittings: ANSI/AWWA C153/A21.53 or ANSI/AWWA C110/A21.10 for diameters 3-inch through 12 inch; minimum working pressure rating of 250 psi and test pressure of 1.25 times working pressure.
   2. Outlets: Welded outlets and tangential welded outlets may be used for branch connections, air valve and drain connections. Outlets must be shop fabricated by the manufacturer and provide restrained joint connections with adaptors to flanged connections or threaded fittings. Pipe manufacturer's warranties will apply to fabricated outlets.]

G. Flange Assemblies
   1. See Pipe Schedules 40 05 02 for flange requirements. Minimum wall thickness for pipe having threaded flanges shall be minimum special thickness Class 53 per ANSI/AWWA C151.
   2. Flanged DIP pipe shall be shop fabricated, not field fabricated. Flanges shall be individually fitted and machine tightened in the shop, then machined flat and perpendicular to the pipe barrel. Flanges shall be backfaced parallel to the face of flange.

H. Blind Flange Assemblies
   1. Blind flanges shall be ductile iron with equivalent lining and coating to the pipe or fitting to which they are installed.

I. Restrained Flanged Coupling Adapters:
   1. Ductile Iron, ASTM A536, Grade 65-45-12, flanges per ANSI Class 125 bolt circles. Fusion bonded epoxy coating required. ROMAC RFCA 19.50, or approved equal.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
   1. Follow piping routes specified on the drawings as closely as possible. Submit proposed deviations in accordance with Section 01 33 00.
   2. Install pipe in accordance with AWWA C600.
   3. Assemble joints in accordance with manufacturer's directions.
   4. Make connections to existing structures and manholes so that the finished work will conform as nearly as practicable to the requirements specified for new manholes, including necessary concrete work, cutting, and shaping. Shape concrete mortar within any structure and manhole as specified.

B. Anchorage: Provide as specified on the Drawings.

3.02 REPAIR/RESTORATION

A. Per Section 40 05 01.

3.03 COMPONENT TEST PHASE

A. Exposed and Concrete Encased Piping: Conduct hydrostatic pressure tests in accordance with Section 40 05 01.

3.04 FIELD WELDING

A. Field welding of restrained joint rings or other ductile iron components is not allowed.

3.05 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be considered included in the lump sum bids for the respective items in the Proposal Schedule.

END OF SECTION

SECTION 40 05 23

STAINLESS STEEL PIPE

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
ANSI B31.3	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 Officer-in-Charge 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. Pipe wall thickness calculations for pipe fabricated per AWWA C220. Demonstrate the maximum permissible internal design pressure in the pipe based on the wall/shell thickness specified in the Piping System Schedule for the associated Process Service and pipe size and the support and/or bedding conditions specified on the Drawings. Steel pipe design calculations conform to AWWA M11.
6. Pipe wall thickness and reinforcement calculations for fittings fabricated per AWWA C226. Demonstrate that the maximum permissible internal design pressure for fabricated fittings matches or exceeds the maximum permissible internal design pressure in the connecting pipe for the support and/or bedding conditions specified on the Drawings. Fabricated steel pipe fitting design calculations conform to AWWA M11.
7. Calculations for any pipe and fittings that are not fabricated per one of the components standards listed in the specified ASME B31 code.
8. 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 6600 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. Use pickled and annealed sheet or plate for manufacture of fabricated stainless steel pipe.
2. 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. Plate steel backing ring flanges, AWWA C207 Class D minimum thickness.
2. Ductile iron backing ring flanges with the following flange thicknesses.

Flange Size, in	Flange Thickness, minimum, in.
3	1/2
4	9/16
6 thru 10	5/8
12 thru 16	3/4

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. 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 B31.3.
   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.

3.04 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be included in the lump sum bids for the respective line items in the Proposal Schedule.

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 05 60.

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 40 05 02 – Piping System Schedules
3. Section 40 05 60 – Valves

1.03 REFERENCE STANDARDS

A. This Section contains references to the following documents. Those documents are a part of this Section as specified and modified. 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
ANSI Z535.1	Safety Colors/APWA Uniform Color Code for Marking Underground Utilities
ASME A13.1	Scheme for the Identification of Piping Systems
MIL-STD-810	Environmental Engineering Considerations and Laboratory Tests

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 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. Submit the following minimum documentation per Section 01 33 00 - Submittal Procedures

B. Action Submittals: Submit the following prior to construction of this element of the Work.

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. Checkmarks (✓) 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
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.

C. Informational Submittals: Submit the following for inspection.

1. Electrical continuity test results.
2. Sample of each piping identification plastic marker used.
3. 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.

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 FIELD QUALITY CONTROL

A. Comply with manufacturer's handling and installation instructions.

B. Provide continuity testing of tracer wire as specified herein.

3.03 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be included in the lump sum bids for the respective items in the Proposal Schedule.

END OF SECTION

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SECTION 40 05 60

VALVES

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies the supply, installation and testing of valves. Materials and performance requirements for valves are specified in Detailed Valve Specifications. Detailed Valve Specifications are provided in Sections 40 05 61.01 through 40 05 89.99.

B. Determining Valve Type:

1. Drawings specify valve types (gate, plug, butterfly, check, globe, etc.) used in each pipeline. Process fluids that will be conveyed in pipelines are identified by the Process Service Identifiers shown on the Drawings.
2. Piping System Schedules (Sections 40 05 02.01 through 40 05 02.99) specify piping system materials and components, including valve requirements, based on the Process Service Identifier specified on the Drawings for the pipeline or piping system. Piping System Schedules reference Detailed Valve Specifications that specify requirements for each valve type used in the pipeline or piping system.
3. Provide valves conforming to the Detailed Valve Specifications listed in the Piping System Schedule for the valve/line size, process service, and valve type specified on the Drawings. Example: The Drawings specify a ball valve on a 1-inch line. The Piping System Schedule for the process service specified on the Drawings refers to Section 40 05 63.01 for 1/2 through 2 1/2 inch ball valves. For this example, provide the subject ball valve per the requirements specified in 40 05 63.01.

C. Section 40 06 20.13 specifies electric, pneumatic, and hydraulic powered control valves, complete with valve, actuator, and other ancillaries.

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 – Shipment, Protection, and Storage
3. Section 01 78 23 – Operating and Maintenance Information
4. Section 40 05 02 – Piping System Schedules
5. Section 40 06 20.13 – Actuated Valve and Gate 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 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. 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 16.10	Face-to-Face and End-to-End Dimensions of Valves
ANSI B1.20.1	Pipe Threads, General Purpose
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, and 250
ANSI B16.5	Pipe Flanges and Flanged Fittings
ANSI B16.34	Valves—Flanged, Threaded, and Welding End
API 607	Fire Test for Quarter-turn Valves and Valves Equipped with Nonmetallic Seats
ASTM A48	Gray Iron Castings
ASTM A108	Steel Bars, Carbon, Cold-Finished, Standard Quality
ASTM A126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A216/A216M	Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service
ASTM A276	Stainless and Heat Resisting Steel Bars and Shapes
ASTM A351	Castings, Austenitic, for Pressure-Containing Parts
ASTM A516	Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A536	Ductile Iron Castings
ASTM A571	Austenitic Ductile Iron Castings
ASTM A995/A995M-13	Castings, Austenitic-Ferritic (Duplex) Stainless Steel, for Pressure-Containing Parts
ASTM B124	Copper and Copper Alloy Forging Rod, Bar, and Shapes
ASTM B148	Aluminum-Bronze Sand Castings
ASTM C283	Resistance of Porcelain Enameled Utensils to Boiling Acid
ASTM D1784	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D5162	Discontinuity (Holiday) Testing of Nonconductive Protective Coating on Metallic Substrates
AWWA C500	Metal-Seated Gate Valves for Water Supply Service
AWWA C504	Rubber-Seated Butterfly Valves
AWWA C507	Standard for Ball Valves
AWWA C508	Swing Check Valves for Waterworks Service, 2 – 24 Inches NPS
AWWA C517	Resilient-Seated Cast Iron Eccentric Plug Valves
AWWA C550	Protective Interior Coatings for Valves and Hydrants
MSS SP-70	Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-80	Bronze Gate, Globe, Angle and Check Valves
MSS SP-81	Stainless Steel, Bonnetless, Flanged, Knife Gate Valves
MSS SP-110	Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends
UL 429	Electrically Operated Valves
UL 1002	Electrically Operated Valves for Use in Hazardous Locations, Class I, Groups A, B, C, and D, and Class II, Groups E, F, and G

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 from specification requirements. Check-marks (✓) denote full compliance with a paragraph as a whole. Underline deviations and denote with a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined 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 will be sufficient cause for rejection of the entire submittal with no further consideration.
   3. Catalog cuts and/or shop drawings for each type of valve indicating the valve type (Detailed Valve Specification Section Number), materials of construction, dimensions, operating torque, valve end connection configuration, pressure rating, and operating temperature range.
   4. An amended Detailed Valve Specification for all valve types provided for this contract. Indicate with check marks where the valve supplied meets the requirements specified and with written amendments where the product differs from the specification.
   5. Factory Acceptance Test results and/or Certified Statement of Proof-of-Design testing results when specified in Detailed Valve Specifications.
   6. Action Submittal Items listed on Detailed Valve Specifications

B. Informational Submittals:
   1. Procedures: Section 01 33 00.
   2. Affidavits and registration numbers as specified.
   3. 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.
   4. Informational Submittal Items listed on Detailed Valve Specifications.

1.05 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. Tag loose valves as specified in Section 01 66 00, 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.

1.06 WARRANTY

A. Where a warranty duration is specified by the Detailed Valve Specification, provide a special warranty valid for the specified duration.

B. Where no special warranty requirements are specified in the Detailed Valve Specification, provide manufacturer's standard warranty.

PART 2 PRODUCTS

2.01 VALVE CONFIGURATION REQUIREMENTS

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 by turning the valve shaft to rotate counter-clockwise unless otherwise specified in the Detailed Valve Specification Section.

B. Provide pad-lockable lockout feature on all valves.

C. Manual Operators
   1. Provide valves with manual operators as specified in the Detailed Valve Specification, unless specified otherwise in 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 torque reduction gearbox 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 valves with square nut operators.
   5. Quarter turn lever operators are to be perpendicular to the pipe runs when the valves are closed.
   6. 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 torque reduction gearbox operator.
   7. Provide grease lubricated, worm gear type operators for torque reduction gearbox operators. Gearbox 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/plug 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 gearbox operators are intended for direct bury or submergence, seal units with long life lubricant.

D. Valve Stem Extensions and Wrench Nuts
   1. Provide valve stem extensions where shown on the drawings, 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 wrench nut operated valves.

2.02 VALVE IDENTIFICATION TAGS

A. Provide valve identification tags for all valves with an identification tag number on the drawings (Mechanical and PI&D drawings).

B. Match tag numbers shown on the drawings.

C. Type 316 stainless steel tags, minimum 2.5-inches x 0.75 inches, with 0.1875 inch numbers and letters. Complete tag number shall be embossed on the tag. Tags shall be attached using stainless steel wire.

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 hydraulic, pneumatic, and electric power actuators.

C. Where conflicts are identified, inform the Owner.

3.02 INSTALLATION

A. Install valves in conjunction with the piping specified in the Piping System Schedules (Sections 40 05 02.01 through 40 05 02.99), 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 with a vertical operating shaft with the actuator at the top. In no case install a valve with the operator below the valve.

C. When joining valves to pipe or fittings, do not over torque bolts to correct for misalignment.

D. Support valves in position using temporary supports until valves are fixed in place.

E. Permanently support valves to prevent transmission of loads to adjacent pipework and/or equipment.

F. Install gate valves in the closed position.

G. 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 Owner.

H. Unless otherwise specified, install single seated valves with the seat downstream.

I. Install all valves in accordance with the manufacturer's recommendations.

J. Protect valves installed below grade with a shrink sleeve or polyethylene sheath attached to the pipe with tape wrap.

K. 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 per Detailed Valve Specifications.

B. Pressure test all valves in conjunction with the pipes in which the valves are installed at test pressures specified in the applicable Piping System Schedule.

3.04 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be included in the lump sum bids for the respective items in the Proposal Schedule.

END OF SECTION

40 05 61.17

GATE VALVES, SOLID WEDGE DUCTILE IRON AWWA C500

GENERAL

1. Line Size: 4 through 12 inches
2. Rated Limits: Pressure 200 psi, Temperature 100 °F

VALVE MATERIALS

1. Body: Ductile Iron
2. Wedge: Ductile Iron
3. Seat rings: Bronze
4. Stem: Stainless Steel or Bronze

VALVE CONFIGURATION

1. Valve End/Connections: Flanged, ANSI B16.1 Class 125
2. Type of Wedge: Solid Wedge
3. Operator: Handwheel or 2-inch square operating nut as shown on Drawings; non-rising stem
4. Reference Standard: AWWA C500

SUBMITTALS

1. Action Submittals:
   a. Per Section 40 05 60
   b. AWWA C500 certification
2. Information Submittals:
   a. Per Section 40 05 60
3. Closeout Submittals:
   a. Per Section 40 05 60

CANDIDATE MANUFACTURERS

1. J&S Series 3800
2. Henry Pratt
3. Approved Equal

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40 05 63.01

BALL VALVE, BRONZE/BRASS

GENERAL

1. Line Size: ¼ through 3 inches
2. Rated Limits: Pressure 600 psi; Temperature 100 °F (WOG)

VALVE MATERIALS

1. Body: Bronze or Brass
2. Ball: Bronze or Chrome-Plated Brass
3. Seats: PTFE or RPTFE
4. Shafts: Bronze, Brass, or Stainless Steel; blowout-proof stem

VALVE CONFIGURATION

1. Valve End/Connections: Threaded, Female; provide threaded end cap and chain in drain pipes
2. Pattern: 1 Piece or 2 Piece; regular port
3. Ball Mount: Floating
4. Manual Operator: Lever
5. Reference Standard: MSS SP-110

SUBMITTALS

1. Action Submittals:
   a. Per Section 40 05 60
2. Information Submittals:
   a. Per Section 40 05 60
3. Closeout Submittals:
   a. Per Section 40 05 60

CANDIDATE MANUFACTURERS

1. Watts B6000
2. Apollo 77-100
3. Crane Figure 9201
4. Approved Equal

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40 05 66.01

GLOBE VALVE, BRONZE

GENERAL

1. Line Size: ¼ through 3 inches
2. Rated Limits: Pressure 125 psi; Temperature 353 °F (Steam)
   Pressure 200 psi; Temperature 100 °F (WOG)

VALVE MATERIALS

1. Body: Bronze
2. Disc: Polyurethane or PTFE
3. Seats: Bronze
4. Stem: Brass or Bronze

VALVE CONFIGURATION

1. Valve End/Connections: Threaded, Female
2. Operator: Handwheel; rising stem

SUBMITTALS

1. Action Submittals:
   a. Per Section 40 05 60
2. Information Submittals:
   a. Per Section 40 05 60
3. Closeout Submittals:
   a. Per Section 40 05 60

CANDIDATE MANUFACTURERS

1. Kitz Model 03
2. Hattersley Figure 13
3. Crane 7TF
4. Crane 17TF
5. Approved Equal

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SECTION 40 05 67.36

PRESSURE-REGULATING VALVES

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies direct acting and pilot controlled pressure regulating valves for water service.

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 B16.5	Pipe Flanges and Flanged Fittings

B. Performance:
   1. Direct acting type pressure regulating valves shall control the discharge pressure within ±5 percent of set pressure.
   2. Pilot controlled type pressure regulating valves shall maintain the set discharge pressure regardless of fluctuations in inlet pressure.

C. Testing:
   1. Hydrostatic tests shall be conducted by the manufacturer for one valve of each type supplied for a particular service. Steel-bodied valves shall be hydrostatically tested in accordance with the requirements of ANSI B16.5. Aluminum-, bronze-, and brass-bodied valves shall be hydrostatically tested at double the MAX pressure specified. Leakage, sweating or visible deformation at any point on the valve shall be cause for rejection of valves of that type and manufacture.

1.03 SCHEDULE

Valve number	Service	Valve size, inches	Maximum flow, GPM	Inlet pressure range, PSIG	Outlet pressure, PSIG
CV-502	RW	6	1,800	Field Verified	Field Verified
CV-602	RW	6	1,800	Field Verified	Field Verified
ZSC-502	RW	Manufacturer Recommended	Manufacturer Recommended	Field Verified	Field Verified
ZSC-602	RW	Manufacturer Recommended	Manufacturer Recommended	Field Verified	Field Verified

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

A. General:
   1. Pressure regulating valves shall be flanged or threaded connections as specified. Moving parts requiring lubrication shall have means provided for lubrication and shall be lubricated prior to delivery.

B. Water Service:
   1. Valves 1-1/4 inches and larger shall be pilot-controlled type, unless otherwise specified. Valves 1-1/4 inches and larger shall be diaphragm actuated type shall be Cla-Val Co. Clayton 60-31 Series, or equal.

2.02 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00:
   1. Manufacturer's product data.
   2. Hydrostatic test results.

PART 3 EXECUTION

3.01 INSTALLATION

A. Pressure regulating valves shall be installed in accordance with the manufacturer's recommendations.

3.02 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be included in the lump sum bids for the respective items in the Proposal Schedule.

END OF SECTION

SECTION 40 05 78.13

AIR/VACUUM VALVES FOR WATER SERVICE

PART 1 GENERAL

1.01 SUMMARY

A. Scope:
   1. This section specifies air release valves, air and vacuum valves, and combination air valves for clean water service, pumping, and storage applications.

B. Types:
   1. Air and Vacuum Valves: Air and vacuum valves (AVV) shall have a large venting orifice to permit the release of air as the line is filling or relieve the vacuum as the line is draining or is under negative pressure. Size and capacity
   2. Air Valves for Vertical Turbine Pumps: Air valves for vertical turbine pumps (ATP) shall consist of an air and vacuum valve with throttling device for sizes 3-inch and less, and a dual body construction combination air valve mounted on top of a surge check for sizes 4-inch and larger. Size and capacity shall be as specified.

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
ASTM A126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A240	Heat-Resisting Chromium and Chromium Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels

1.03 SCHEDULE

Valve number	Valve size, inches	Type	System press, PSI	Capacity, SCFS
ARV-501	2	AVV	300	10 (minimum)
ARV-601	2	AVV	300	10 (minimum)

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

A. Air release and vacuum valves shall be Val-matic, APCO as manufactured by Valve and Primer Corporation, Crispin as manufactured by Multiplex Manufacturing Company, or approved equal, modified to provide the specified features and to meet the specified operating conditions.

2.02 MATERIALS

Component	Material
Body, cover	Cast iron, ASTM A126, Grade B
Float	Type 316 SS, ASTM A240
Seat	Buna-N or Type 316 SS
Trim	Type 316 SS, ASTM A240

A. Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The Contractor may propose alternative materials for the purpose of providing greater strength or to meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose.

2.03 CONSTRUCTION

A. Air release valves shall be float operated, compound lever type, except air release valves less than 1-inch may be simple lever type.

B. Air and vacuum valves shall be designed to protect the float from direct contact of the rushing air and water to prevent the float from closing prematurely in the valve. The seat shall be fastened into the valve cover, and shall be easily removed if necessary. The float shall be center or peripheral guided for positive shutoff into the seat.

C. Air valves for vertical turbine pumps (sizes 3-inch and less) shall be designed and constructed as specified for air and vacuum valves except the discharge orifice shall be fitted with a throttling device to regulate and restrict air venting and establish a pressure loading on the rising column of water on pump start. Unless otherwise specified, air valves, 4-inch and larger, shall be dual body combination air valves except the inlet shall be fitted with a surge check to prevent water column entering the valve on pump start.

D. Valves shall be suitable for pressures up to 150 psi.

2.04 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00:
   1. Manufacturer's product data.
   2. Applicable O&M instruction manuals per Section 01 78 23.

PART 3 EXECUTION

3.01 INSTALLATION

A. Air release and vacuum valves shall be installed in accordance with the manufacturer's recommendations. Unless otherwise specified, isolation valves per Section 40 05 01 shall be provided below each air valve.

3.02 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be included in the lump sum bids for the respective items in the Proposal Schedule.

END OF SECTION

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40 05 82.01

SOLENOID VALVE, 2-WAY, 2-POSITION

GENERAL

1. Line Size: 3/8 through 2-1/2 inches
2. Rated Limits: Pressure 125 psi, Temperature 180 °F (Water)

VALVE MATERIALS

1. Body: Stainless Steel (316, or 304 if 316 not available)
2. Seal: Buna-N or PTFE
3. Disc: Buna-N or PTFE

VALVE CONFIGURATION

1. Valve End/Connections: Threaded
2. Operator: Solenoid, Normally Closed
3. Lining: None
4. Pattern: 2-Way/2-Position, Direct Acting and Internal Pilot Type; capable of sealing or unsealing the pressurized (supply) port when mounted in any position or orientation, furnish flow restriction on exhaust port to limit actuation speed to the "Open/Close Time" specified in Section 40 06 20.13, capable of opening or closing against the maximum differential pressure specified in Section 40 06 20.13, capable of opening or closing with a minimum operating pressure differential of 35 kPa, unless otherwise specified in Section 40 06 20.13 "Remarks" column
5. Solenoid Coil: Fully Encapsulated Class F or Class H Coil; continuous duty rating, 120 VAC
6. NEMA Enclosure, Type: 4X, dual rated unless otherwise specified in Section 40 06 20.13 "Remarks" column, UL 429 and UL 1002 listed

SUBMITTALS

1. Action Submittals:
   a. Provide manufacturer's product data.
   b. Per Section 40 05 60
2. Information Submittals:
   a. Per Section 40 05 60

CANDIDATE MANUFACTURERS

1. Automatic Switch Company (ASCO) 8210
2. Honeywell Skinner
3. Approved equal

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40 05 82.03

SOLENOID VALVE, 3-WAY, 2-POSITION

GENERAL

1. Line Size: 1/8 through 1/2 inches
2. Rated Limits: Pressure 120 psi; Temperature 200 °F

VALVE MATERIALS

1. Body: Stainless Steel (304)
2. Seal: Buna-N or PTFE
3. Disc: Buna-N or PTFE

VALVE CONFIGURATION

1. Valve End/Connections: Threaded
2. Operator: Solenoid, Normally Closed
3. Lining: None
4. Pattern: 3-Way/2-Position, Direct Acting and Internal Pilot Type; capable of sealing or unsealing the pressurized (supply) port when mounted in any position or orientation, furnish flow restriction on exhaust port to limit actuation speed to the "Open/Close Time" specified in Section 40 06 20.13, capable of opening or closing against the maximum differential pressure specified in Section 40 06 20.13, capable of opening or closing with a minimum operating pressure differential of 35 kPa, unless otherwise specified in Section 40 06 20.13 "Remarks" column
5. Solenoid Coil: Fully Encapsulated Class F or Class H Coil; continuous duty rating, 120 VAC
6. NEMA Enclosure, Type: 4X/7; explosion-proof, dual rated unless otherwise specified in Section 40 06 20.13 "Remarks" column, UL 429 and UL 1002 listed

SUBMITTALS

1. Action Submittals:
   a. Provide manufacturer's product data.
2. Information Submittals:
   a. Per Section 40 05 60

CANDIDATE MANUFACTURERS

1. Automatic Switch Company (ASCO) 8300
2. Approved Equal

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SECTION 40 06 20.13

POWER ACTUATED VALVE AND GATE SCHEDULE FOR PROCESS SERVICES

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies requirements for actuators for valves and gates that are positioned or controlled by means other than manual actuation. For the purposes of this Section, actuated valves and gates include valves and/or gates that are operated and/or controlled using hydraulic, pneumatic, or electric power.

1.02 RELATED SECTIONS

A. Section 40 05 02 – Piping Systems Schedules
B. Section 40 05 60 – Valves
C. Section 43 05 11 – General Requirements for 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
ISA-S75.02	Standard Control Valve Capacity Test Procedure

1.04 ADMINISTRATIVE REQUIREMENTS

A. Unit Responsibility:
   1. Assign Unit Responsibility, as specified in Section 43 05 11, to the actuator manufacturer. The actuator manufacturer has Unit Responsibility, as defined in Section 43 05 11, for each valve or gate and the associated actuator. Assemble the valve/gate and actuator at the factory for shipment to the project site.

1.05 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00
   2. Valve Specifications for all valve types (Valve Specifications in Sections 40 05 60 through 40 05 90). Indicate with check marks where the valve supplied meets the requirements specified and with written amendments where the product differs from the specification.
   3. Catalog cuts and/or shop drawings for each valve type listed in the Actuated Valve and Gate Schedule. For each valve type (Valve Specification in Sections 40 05 60 through 40 05 90) indicate materials of construction, dimensions, operating torque, fail position, valve end connection configuration, pressure rating, and operating temperature range.

4. Open/Close time. Where open/close times are specified in the Actuated Valve and Gate Schedule, submit information documenting valve operating speed. Include information on motor operating speed, gear ratio, exhaust port flow restriction, or other means of speed control.
5. For each solenoid valve type and size combination, submit manufacturer's literature listing enclosure type, solenoid valve model number/type, maximum differential operating pressure, and minimum operating pressure.
6. List actuator type for each equipment number listed in the Actuated Valve and Gate Schedule.
7. Submittal information listed in actuator specification.
8. Certificate of Unit Responsibility attesting that the Contractor has assigned unit responsibility in accordance with the requirements of this section and Section 43 05 11.

B. Closeout Submittals:
1. Procedures: Section 01 33 00.
2. Operating and maintenance submittals per Section 01 78 23.

1.06 ACTUATED VALVE AND GATE SCHEDULE

A. Furnish valves and gates conforming to the requirements specified in the Actuated Valve and Gate Schedule

B. Equipment Tag:
1. Refer to Section 01 08 00 for identification requirements.
2. The Equipment Tag for the valve is constructed as follows (e.g., *SV-501*):
   a. *SV –Equipment abbreviation (Solenoid Valve).*
   b. *501 – Well Identifier (501)*

C. Valve / Gate Type:
1. The Gate/Valve Type column identifies a Valve Specification or Gate Specification for each Valve/Gate and Actuator combination.
2. Refer to the listed specification for the required valve or gate characteristics (i.e. valve/gate materials, dimensions, and configuration).

D. Actuator types used in the valve and gate schedule are defined as follows:

Actuator Type (ACTUSPEC)	Service	Definition
SOL	Isolating (Open-Close)	Solenoid

E. Actuator Enclosure, NEMA Type: Enclosure requirements for actuators are specified by NEMA enclosure type.

F. Maximum Pressure Differential: Pressure drop across each valve is specified for the purpose of actuator and gear box sizing. If no value is specified in this column, use the test pressure from the specified Piping System Schedule (Section 40 05 02.00 through 40 05 02.99) as the maximum pressure differential. Seating and unseating head requirements for gates are specified in the gate specification and are not included in this Section.

G. Open/Close Time: The open/close time refers to the time required for the valve to travel from full closed to full open. Open/close times are based on continuous operation of the actuator. Entries in this column are minimum values. Configure the actuator to provide an open/close time greater than the value listed in this column. Actuators that include programmed stops or steps are not acceptable.

H. Fail Position: Fail position indicates the position that the actuator will default to upon loss of electric, pneumatic, or hydraulic power supply for control of the actuator:

   1. Closed. (Fail Closed) Configure actuator to close upon loss of electric, pneumatic, or hydraulic power supply for control of the valve or gate.
   2. Open. (Fail Open) Configure actuator to open upon loss of electric, pneumatic, or hydraulic power supply for control of the valve or gate.
   3. Last. (Fail Last Position) Configure actuator to remain in the position last held by the actuator prior to loss of electric, pneumatic, or hydraulic power supply for control of the valve or gate.

I. Voltage: This column specifies the supply power voltage and number of phases for the power supply to solenoids, electric motor actuators, and electro-hydraulic actuators. Provide actuators for operation with the specified power supply voltage and phase.

J. Maximum Power Demand: This column specifies the maximum amperage rating for the electric power supply to the actuator. Provide actuators with electric power requirements that do not exceed the specified amperage rating listed in this column.

K. DeviceNet Communication: This column specifies which actuators are to be furnished with DeviceNet network communication capabilities. If a check mark (✓) appears in the schedule, furnish the associated actuator with DeviceNet communications capabilities as specified in the actuator specification.

L. Remote Control Station: This column specifies which actuators are to be furnished with a Remote Control Station. If a check mark (✓) appears in the schedule, furnish the associated actuator with a remote control station, configured as specified on the Drawings.

PART 2 NOT USED

PART 3 NOT USED

PART 4 SCHEDULE

4.01 ACTUATED VALVE AND GATE SCHEDULE

Equipment Number	Valve/Gate Specification	Actuator Type	Actuator Enclosure, NEMA Type	Maximum Differential Pressure (psi)	Open/Close Time (seconds)	Fail Position	Voltage (Voltage / Phase)	Maximum Power Demand, Amps	DeviceNet Communication	Remote Control Station	Notes
SV-502	40 05 82.03	SOL	4X	300	0.01	CLOSED	120/1	2	-	-	-
SV-505	40 05 82.01	SOL	4X	125	0.01	OPEN	120/1	2	-	-	-
SV-602	40 05 82.03	SOL	4X	300	0.01	CLOSED	120/1	2	-	-	-
SV-605	40 05 82.01	SOL	4X	125	0.01	OPEN	120/1	2	-	-	-

END OF SECTION

SECTION 40 61 13

PROCESS CONTROL SYSTEM GENERAL PROVISIONS

PART 1 GENERAL

1.01 SUMMARY

A. Scope:

1. This Section specifies requirements which are applicable to all process control, instrumentation, communication, and signal systems. The Contractor shall supply, install and startup the equipment for a complete, functional system as shown and specified.
2. Supply and install the equipment and field instruments as shown and specified.
3. Well No. 5:
    a. Replace existing pump discharge flow meter.
    b. Replace existing flow switch on the pre-lube water pipe.
    c. Replace existing pump discharge pressure transmitter.
    d. Modify the scaling for new instrument inputs to existing Allen Bradley Compactlogix PLC.
    e. Adjust alarm and shutdown setpoints in the PLC program as necessary.
4. Well No. 6:
    a. Replace existing pump discharge flow meter.
    b. Replace existing flow switch on the pre-lube water pipe.
    c. Replace existing pump discharge pressure transmitter.
    d. Modify the scaling for new instrument inputs to existing Allen Bradley Compactlogix PLC.
    e. Adjust alarm and shutdown setpoints in the PLC program as necessary.
5. The above is a general summary of the major items and is not intended to be all inclusive.

B. Work included:

1. Major constituents of this system shall include, but are not limited to, all materials, equipment and labor required to implement a complete and operating system of instrumentation and controls. The Contractor shall supply, install, calibrate, test, and document each system in its entirety. The Contractor shall also place the completed systems in operation including tuning loops and make final adjustments to instruments as required during plant startup. The Contractor shall provide the services of NICET certified instrument technicians for testing and adjustment activities. 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. The system shall include control panels containing microprocessor-based display and control devices, electronic signal conditioning equipment, programmable logic controllers, and power supplies. Field mounted equipment shall include electronic transmitters and control devices as well as final control elements, and primary elements for process variable measurements. Process variables shall include, but are not limited to, flow, level, pressure, temperature and analytical measurements.

C. Related Work:

1. Raceways, signal cables, and their requirements are specified in Division 26.

D. Definitions:

1. General: The definitions of terminology used in these specifications shall be defined in ISA Standard S51.1 unless otherwise specified.
2. Solid State: Circuitry or components of the type which convey electrons by means of solid material such as crystals or which work on magnetic principles such as ferrite cores. Vacuum tubes, gas tubes, slide wires, stepping motors, or other devices are not acceptable substitutes for solid state components or circuitry.
3. Integrated Circuit: A number of circuit elements inseparably associated on or within a continuous body to perform the function of a circuit.
4. Two-Wire Transmitter: A transducer which derives operating power supply from the signal transmission circuit and therefore requires no separate power supply connections. s used in this specification, two-wire transmitter refers to a transmitter which 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.
5. Galvanic Isolation: Pertaining to an electrical node having no direct current path to another electrical node. As used in this specification, galvanic isolation refers to a device with electrical inputs and/or outputs which are galvanically isolated from ground, the device case, the process fluid, and any separate power supply terminals, but such inputs and/or outputs are capable of being externally grounded without affecting the characteristics of the devices or providing path for circulation of ground currents.
6. Panel: An instrument support system which may be a flat surface, a partial enclosure, or a complete enclosure for instruments and other devices used in process control systems. Panels may provide mechanical protection, electrical isolation, and protection from dust, dirt, and chemical contaminants which may be present in the atmosphere. Panel shall include consoles, cabinets and racks.
7. Data Sheets: Data sheets as used in this specification shall refer to ISA S20.
8. Signal Types: The following types of signals are used in systems specified in this division.
    a. Low Level Analog: A signal that has a full output level of 100 millivolts or less. This group includes thermocouples and resistance temperature detectors.
    b. Digital Code: Coded information such as that derived from the output of an analog to digital converter or the coded output from a digital computer or other digital transmission terminal. This type includes those cases where direct line driving is utilized and not those cases where the signal is modulated.
    c. Pulse Frequency: Counting pulses such as those emitted from speed transmitters.
    d. High Level Analog: Signals with full output level greater than 100 millivolts but less than 30 volts, including 4-20 mAdc transmission.
    e. Modulated Signals: Signals emanating from modems or low level audio signals. Normal signal level is plus 4 dBm to minus 22 dBm. Frequency range is 300 to 10,000 hertz.

f. Discrete Events: Dry contact closures monitored by solid state equipment. If the conductors connecting to dry contacts enter enclosures containing power or control circuits and cannot be isolated from such circuits in accordance with NEC Article 725, this signal shall be treated as low voltage control.

g. Low Voltage Control: Contact closures monitored by relays, or control circuits operating at less than 30 volts and 250 milliamperes.

h. High Level Audio Signals: Audio signals exceeding plus 4 dBm, including loudspeaker circuits.

i. Radio Frequency Signals: Continuous wave alternating current signals with fundamental frequency greater than 10 kilohertz.

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
API RP550	Manual on Installation of Refinery Instruments and Control Systems, Part I-Process Instrumentation and Control Sections 1 Through 13
ASME Section VII	Rules for Construction of Pressure Vessels
ASTM B68	Seamless Copper Tube
ASTM B209	Aluminum and Aluminum Alloy Sheet and Plate
ASTM D883	Terms Relating to Plastics
ASTM D1248	Polyethylene Plastics Molding and Extrusion Materials
IEEE 100	Dictionary of Electrical and Electronic Terms
IEEE C37.90.1	Guide to Surge Withstand Capability (SWC) Tests
ISA RP7.1	Pneumatic Control Circuit Pressure Test
ISA RP12.6	Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations
ISA S5.4	Instrument Loop Diagrams
ISA S18.1	Annunciator Sequences and Specifications
ISA S51.1	Process Instrumentation Terminology
MILSPEC MIL-I-46058C	Insulating Compound, Electrical (For Coating Printed Circuit Assemblies)
NEMA 250	Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 1	General Standards for Industrial Control and Systems
NEMA ICS 2	Industrial Control Devices, Controllers, and Assemblies
NFPA 70	National Electrical Code (NEC)

Reference	Title
SAMA PMC 17-10-63	Bushings and Wells for Temperature Sensing Elements
UBC	Uniform Building Code
UL 1012	Power Supplies
UL 94	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
Weik, Martin H.	Communications Standard Dictionary, Van Nostrand Reinhold Co., 1983

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 Officer-in-Charge.

C. Systems Integrator Qualifications:
   1. The following Systems Integrators are pre-qualified to perform the work specified in Division 40 without the need to provide Evidence of Experience:
      a. Pacific Electro-Mechanical Inc.
      b. Or approved equal as required below.
   2. Contractor-proposed Systems Integrator shall be evaluated based on submittal of the following Evidence of Experience:
      a. Submit evidence of experience in performing three similar successful projects in the last 5 years with one project currently in progress or completed within the last 2 years.
      b. Submit project descriptions with contact names, addresses, and telephone numbers from the project Owner, General Contractor, and Principal Design Firm.
      c. Submit organization chart and resumes for proposed project personnel.
      d. 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:
      e. Project manager: Control System Engineer (CSE) registration, Hawaii Professional Engineer (PE) registration, or Project Management Professional (PMP) certification.
      f. Systems engineer: CSE registration, Hawaii PE registration, or completion of the relevant core courses in the Engineering Skills Training program.
      g. Programmer: CSE registration, Hawaii PE registration.

h. Field instrument technician: Certified Control Systems Technician (CCST) registration or completion of the relevant core courses in the Technical Skills Training program.

i. Certified training programs, as offered by ISA.

j. Submit financial data for Systems Integrator division when subsidiary to a parent corporation. Include two years of financial data.

1) Financial Statement.

2) Balance Sheet.

3) Dun & Bradstreet Report.

D. Systems Integrator Personnel Qualifications:

1. Provide qualified personnel to complete the work specified for this project. Demonstrate by including the following:

2. Organization chart and resumes for proposed project personnel showing experience for the proposed roles on this project.

3. 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, Hawaii Professional Engineer (PE) registration, or Project Management Professional (PMP) certification.

b. Systems engineer: Control System Engineer (CSE) registration, Hawaii Professional Engineer (PE) registration, or completion of the relevant core courses in the Engineering Skills Training program as certified by ISA.

c. Programmer: Certified by the software/hardware manufacturer for the software and hardware being used on the project, or Control System Engineer (CSE), or Hawaii 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 as certified by ISA.

E. 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 a copy of the manufacturer's submittal with 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 Officer-in-Charge for resolution before proceeding.
7. Manufacturer:
    a. 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.

E. Installer:
1. Installation, calibration and testing of equipment furnished under this section shall be performed by qualified, skilled, NICET certified technicians who are regularly engaged in such activities involving systems of similar complexity, and who possess all licenses and certificates required to perform such work.

G. Identification of Listed Products:
1. Electrical equipment and materials shall be listed, for the purpose for which they are to serve, by an independent testing laboratory. Two such organizations are Underwriters Laboratory (UL) and Electrical Testing Laboratories (ETL). The Independent laboratory under which a product is listed shall be acceptable to the inspection authority having jurisdiction.
2. When a product is not available with a testing laboratory listing for the purpose for which it is to serve, the product may be required by the inspection authority, to undergo a special inspection at the Manufacturer's place of assembly. All costs and expenses for such inspections shall be included in the original Contract Price.

1.03 PROJECT/SITE CONDITIONS

A. General:
1. Specified communication and process control equipment shall be modified, if necessary, to make it suitable for operation in the following ambient conditions. Indoor and outdoor field location temperatures and relative humidity are specified in Section 01 11 80.

B. All Areas:

Atmospheric Contaminants

Dust	50.0 µg/m^3

Electromagnetic Radiation

27-500 MHz	10 volts/m

C. Indoor Field Locations:

Temperature	40 to 100 degrees F
Humidity	10 to 100 percent

D. Outdoor Field Locations:

Temperature	0 to 105 degrees F
Humidity	10 to 100 percent

E. Hazardous Locations:

1. Hazardous locations shall be as specified in Division 26 and or shown on the drawings.

F. Corrosive Locations:

1. Corrosive locations shall be as specified in Division 26 and or shown on the drawings.

G. Electric Power:

1. Electric power for instrumentation and communication systems shall be obtained from the power distribution system specified in Division 26. This power is not regulated, wave forms may be distorted, and significant amounts of electrical noise may be present. Equipment shall be configured to withstand a momentary power outage where the equipment when energized returns to the ready state.
2. The Contractor shall provide all necessary power supply and conditioning equipment to provide electrical power of the required voltages and current capacities and of adequate quality to ensure reliable operation of the instrumentation and communication systems. Unless otherwise specified, the Contractor shall assume that the power supply for instrumentation systems is 120 volts plus or minus 15 percent, 60 hertz plus or minus 3 hertz, 5 percent maximum harmonic distortion.

1.04 SUBMITTALS

A. General:

1. Procedures: Submittals shall be provided in accordance with Section 01 33 00.
2. Deviations: A copy of each specification section in this division, 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. If deviations from the specifications are indicated and, therefore requested by the Contractor, the submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification for any requested deviations to the specification requirements, with the submittal shall be cause for rejection of the entire submittal with no further consideration.
3. Completeness: A separate submittal shall be provided for each section of this division requiring a submittal. The submittal for each section shall be bound separately and shall include all the information required for each item specified in the subject section. Submittals which do not have all the information required to be submitted, including deviations, are not acceptable and will be returned without review.

B. Additional Information:

1. Test Forms: Test report forms shall, where appropriate, conform to the requirements of reference forms 40 61 13-A through 40 61 13-H included in Section 01 99 90. Additional and/or more detailed forms shall be developed as necessary to suit more complex instrumentation. Usage of terms used on test forms shall be in compliance with ISA S51.1.

2. Data Sheets: Data sheets for all instruments and accessories to be provided shall be submitted. Data sheets shall be in accordance with ISA S20. All applicable entries on the data sheet shall be completed.
3. Drawings:
    a. General: The drawings included in this project manual are functional in nature and do not show exact locations of equipment or interconnections between equipment. Detailed construction drawings as specified below shall be provided. Drawings shall be prepared on 11-inch by 17-inch drafting media. Drawings shall have borders and title blocks identifying the project, system, revisions to the drawing, and type of drawing. Each revision of a drawing shall carry a date and brief description of the revisions. Diagrams shall be developed using NEMA standards, carry a uniform and coordinated set of wire numbers and terminal block numbers in compliance with paragraph 3.01 B. of this section.
    b. Elementary and Loop Diagrams: Elementary diagrams shall be provided. Loop diagrams shall be prepared in compliance with ISA S5.4 and shall be provided for all loops. Elementary diagrams and loop diagrams shall show circuits and devices of a system. These diagrams shall be arranged to emphasize device elements and their functions as an aid to understanding the operation of a system and maintaining or troubleshooting that system. Elementary and loop diagrams shall also show wire numbers, wire color codes, signal polarities, and terminal block numbers. Loop drawings shall include the process, field instrument, control panel (front and behind), software functions and SCADA.
    c. Connection Diagrams: Connection diagrams for panels shall be provided. Connection diagrams shall show components of a control panel in an arrangement similar to the actual layout of the panel. Internal wiring between devices within the panel shall be shown on these diagrams. Connection diagrams shall show all terminal blocks whether used for internal or field wiring. Those used for field wiring shall be clearly identified as such. Wiring diagrams shall indicate insulation color code, signal polarities, and shall show wire numbers and terminal block numbers.
4. Product Data
    a. Material List: Within 60 days after "Notice to Proceed", a list of the manufacturer and model series for each major category of equipment, system, and instrument to be provided shall be submitted.
    b. Catalog Cuts: Catalog cuts showing pertinent information and features for the proposed equipment shall be provided. Catalog information shall include technical specifications and application information for each piece of equipment. Catalog cuts shall be edited to indicate only those items, model or series of equipment which are being provided. All extraneous materials shall be crossed out or otherwise obliterated.
    c. Certification:
        1) Temperature: Test data, certified by the manufacturer, shall be provided to demonstrate that field electronic devices are suitable for the specified ambient temperatures.
        2) Corrosion: Data shall be provided showing design features of the electronic equipment provided to protect against damage by the specified atmospheric contaminants and specific evidence that similarly protected electronic equipment has operated in similar environments for a period of not less than 5 years without failure due to corrosion.

d. Record Documentation: Panel wiring diagrams, connections diagrams, interconnection diagrams, loop diagrams, elementary control diagrams, and data sheets included in paragraph 1.04 of this section, and all schedules included in this section shall be provided as record drawings in accordance with Section 01 78 39. Following start-up but prior to acceptance of the work, the Contractor shall provide electronic copy on CD using ACAD format and full-size reproducible prints of elementary, loop, connection and interconnection diagrams and reproducible prints of other drawings; and PDF format for equipment data sheets. Documentation shall reflect the final constructed state of the instrumentation and control systems.

C. Operation and Maintenance Information: Operation and maintenance information shall be provided in accordance with Section 01 78 23.

D. Test Results: Test data sheets, printouts, and other records of testing as specified in paragraph 3.02 of this section shall be provided.

PART 2 PRODUCTS

2.01 GENERAL

A. Materials and Quality:

1. Material shall be new, free from defects, and of the quality specified. Each type of instrument, instrument accessory, and device shall be by the same manufacturer throughout the work.
2. Electronic equipment shall be of solid-state construction unless otherwise specified. Printed or etched circuit boards shall be glass epoxy of sufficient thickness to prevent warping. Solder shall be tin-lead plate, 55 to 75 percent tin, electrodeposited followed by tin emersion and reflow (fusing). Printed wiring shall have solder finish with no exposed copper on surface, edges, or in holes of finished product. Printed circuit boards in field mounted equipment shall be coated with 2 mils of a solderable conformal coating complying with MILSPEC MIL-I-46058C. Alignment and adjustments shall be noncritical, stable with temperature changes or aging and accomplished with premium grade potentiometers. Components of standard electronic assemblies shall not be replaced with components of different characteristics to meet the performance requirements of this specification. Parts shall be as shown in the instruction manuals and shall be replaceable with standard commercial components of the same description without degrading the performance of the completed assembly.

B. Instrumentation Specification Sheets (INSTRUSPEC):

1. General requirements for instruments specified in this section are listed on INSTRUSPEC sheets in paragraph 3.03 of this section.

C. Instrument Schedule:

1. The Instrument Schedule, paragraph 3.04 of this section, lists major instruments required to provide the process instrumentation system. All instrument functions specified on this list shall be provided. Additional instruments may be required to complete the instrument loops because of certain characteristics of the specific equipment provided. Such additional instruments shall be provided at no additional cost even though not specified in the Instrument Schedule or on the Contract Drawings.

2. In some cases, it is possible to combine the functions of two or more instruments specified in the Instrument Schedule into a single instrument. Functions which may be ordinarily combined into a single instrument are multiple alarms derived from a common transmission signal, and signal linearization may be combined into transmitters except where the nonlinear signal is used for specific purposes such as standardized flow calculations. Flow computers may be used in lieu of individual function modules for standardized flow calculations providing equivalent performance is provided. Alarm or safety functions shall be derived directly from process measurements and shall not be derived from transmission signals unless specifically shown. Alarm or safety functions shall not be combined into any instrument used for process control, indication, recording, or any combination thereof unless specifically shown.
3. Standard instruments shall be modified as necessary to meet the specified application requirements.

2.02 PROCESS TAPS AND ACCESSORIES

A. Valves:
   1. Valves shall be full port ball valves with ASTM A276, 316 stainless steel trim and body and with Teflon seats and packing. Valves shall be Whitey series 40, Hoke Flowmite, or approved equal.
   2. Gauge Valves: Gauge valves shall be globe or angle pattern units machined from ASTM A276 bar stock and shall be provided with two 1/2-inch NPT ports. Valves shall be Anderson, Greenwood & Company M9 series, Hoke 2100 series, or approved equal. Valve material shall be compatible with that of the gauge.
   3. Root Valves: Root valves shall be ASTM A276, type 316 stainless steel bar stock with 1/2-inch NPT male process connection and three 1/2-inch NPT female instrument connections. One instrument connection shall be provided with an ASTM A276, type 316 stainless steel bleed valve. ASTM276, type 316 stainless steel plugs shall be provided for unused ports. Lagging type units shall be provided for insulated vessels and pipes. Root valves shall be Anderson, Greenwood & Company M5A VS-44, Hoke 6802L8Y, or approved equal.
   4. Manifolds: Manifolds shall be three-valve bar-stock type. Manifold body shall be machined from ASTM, type 316 stainless steel bar stock. Valves shall be globe configuration with 316 stainless steel ball seats and Teflon stem packing. Manifolds shall be designed for direct mounting to differential pressure transmitters in place of the flanges normally furnished. Fabricated manifolds or manifolds employing needle or soft seat valves are not acceptable. Purge taps, 1/8-inch NPT shall be furnished on manifolds where water purge is specified. Manifolds shall be Anderson Greenwood M4T VS, HEX 8123F8Y, or approved equal.

B. Tubing and Tubing Fittings:
   1. Instrument tubing between the process connection and instruments shall be 1/2-inch x 0.035-inch seamless annealed Type 316 stainless steel.
   2. Tubing fittings shall be Type 316 stainless steel. Fittings shall be of the double-ferrule swage type. Flare, ball sleeve compression or single-ferrule swage type are not acceptable. Fittings shall be Crawford "Swagelok", Hoke "Gyrolok", or approved equal.

C. Chemical Seals:

1. Diaphragm: Seal shall be the diaphragm type with flushing connection, Type 316 stainless steel body and Type 316L diaphragm unless otherwise specified. Fill fluid shall be DC200 silicone oil and the process connection shall be 1" unless otherwise specified. Seal shall be Mansfield and Green Type SG, Ashcroft Type 101, or approved equal.
2. Annular: Seal shall be the in-line full stream captive sensing liquid type. Metallic wetted parts shall be 316 stainless steel. Flexible cylinder shall be Buna-N unless otherwise specified. Seals shall be rated 200 PSIG with not more than 5-inch WC hysteresis. Fill fluid shall be DC200 silicone oil unless otherwise specified. Seals shall be Ronningen-Petter Iso-Ring, Red Valve series 40, or approved equal.

2.03 TRANSMITTERS

A. General: Unless otherwise specified in paragraph 3.03 of this section, Instruspec Sheets, or in paragraph 3.04 of this section, Instrument Schedule, measuring elements and transmitters shall comply with the following requirements:

1. Output indicators complying with paragraph 2.07 B of this section shall be provided with any transmitter that does not include an integral process variable indicator.
2. Transmitters shall be two-wire type with operating power derived from the signal transmission circuit.
3. Transmitter output shall be 4 to 20 milliamperes, current regulated and shall drive any load between 0 and 550 ohms with the power supply at 23 volts DC.
4. Transmitters shall meet specified performance requirements with load variations within the range of 0 to 600 ohms with the power supply at 24 volts DC.
5. Transmitter output shall be galvanically isolated.
6. Time constant of transmitters used for flow or pressure measurement, including level transmitters used for flow measurement, shall be adjustable from 0.5 to 5.0 seconds.
7. Transmitter output shall increase with increasing measurement.
8. Transmitter enclosures shall be rated NEMA 250, Type 4, unless otherwise specified.
9. Transmitters located outdoors shall be provided with surge protectors: EDCO SLAC (4-wire type), EDCO SS64 (2-wire type), or approved equal.
10. Transmitters located outdoors shall be provided with aluminum or 316 stainless steel sunshields to protect the instrument from direct sunlight.
11. Two-wire transmitters located in Class 1, Division 1 and 2 areas shall be made safe by suitable intrinsic safety barriers as specified in paragraph 2.09 of this section.

B. Output Indicators:

1. Integral: When available, transmitters shall be provided with integral output indicators. Indicators shall be 2 1/2 inches 90-degree movement or LCD milliammeters. Output indicators connect into the transmission circuit by means of banana jacks, and a permanently connected diode shall be provided to bypass the jacks if the meter is removed. Error shall not exceed ±2 percent of span.

C. Signal Current Isolator: Isolator shall provide galvanic isolation of milliampere transmission signals from transmitters with inadequately isolated output circuits. Isolator shall be housed in a NEMA 250, Type 4/7 conduit body and shall derive its operating power from the signal input circuit. Input and output signals shall be 4 to 20 milliamperes, and error shall not exceed 0.1 percent of span. Input resistance shall not exceed 550 ohms with an output load of 250 ohms. Isolator shall be Moore Industries SCX/4-20MA/4-20/MA/5.5DC/-RF[EX]; the Engineer is not aware of an equal product.

2.04 PROCESS SWITCHES

A. Unless otherwise specified in paragraph 3.03 of this section, Instruspec Sheets, or in paragraph 3.04 of this section, Instrument Schedule, switches shall comply with the following requirements:

1. Contact outputs used for alarm actuation shall be ordinarily closed and shall open to initiate the alarm.
2. Contact outputs used to control equipment shall be ordinarily open 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 designed for switching currents from 20 to 100 mA at 24 volts DC.
4. Contacts monitored by electro-magnetic devices such as mechanical relays shall be rated NEMA ICS 2, designation B300.
5. Double barriers shall be 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 shall be rated NEMA 250, Type 4 minimum.
7. Contacts located in Class 1, Division 1 and 2 areas shall be made safe by suitable intrinsic safety barriers or relays as specified in paragraph 2.09 of this section.

2.05 NAMEPLATES

A. Nameplates shall be machine engraved white phenolic with black lettering. Where nameplate engraving is not specifically specified, it shall include the equipment or instrument loop title as specified in the Instrument Schedule, paragraph 3.04 of this section, and the instrument or equipment tag number. Lettering shall be 5/32-inch minimum unless otherwise specified. Nameplate wording may be changed without additional cost or time if changes are made prior to commencement of engraving. Name plates shall be mechanically fastened with stainless steel self-tapping screws.

2.06 SPARE PARTS

A. Furnish a spare surge protector of each type provided.

B. Furnish 5 spare fuses of each type provided.

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Equipment shall be installed in accordance with manufacturer's instructions, NFPA 70, API RP550, this section, and as shown on the drawings. Equipment shall be located so that it is readily accessible.

B. Process Connections:

1. Unless otherwise specified, process taps shall comply with API RP550 and Section 40 05 01. Root valves shall be provided at taps, except temperature taps and pump discharge pressure taps. Process connections shall be arranged, where possible, 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. 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.

C. Field Equipment:

1. General: Equipment shall be provided as specified on the drawings such that ports and adjustments are accessible for in-place testing and calibration. Where possible, equipment shall be located between 48 and 60 inches above the floor or a permanent work platform. Instrumentation equipment shall be mounted for unobstructed access but mounting shall not obstruct walkways. Equipment shall not be mounted where shock or vibration will impair its operation. Support systems shall not be attached to handrails, process piping or mechanical equipment except for measuring elements and valve positioners. Instruments and cabinets supported directly by concrete or concrete block walls shall be spaced out not less than 5/8 inch by framing channel between instrument and wall. Steel used for support of equipment shall be 316 stainless steel, unless otherwise specified. Support systems including panels shall be designed in accordance with Standard Building Code and to prevent deformation greater than 1/8 inch under the attached equipment load and an external load of 200 pounds in any direction.

2. Signal Wiring:

a. General: Electrical signal wiring and equipment shall be in compliance with Division 26. Electric signal connections to equipment shall be made on terminal blocks or by locking plug and receptacle assemblies.

b. 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 3 feet. Flexible cable, receptacle and plug assemblies shall be used only where specified.

c. Signal Types: Signal types as specified in paragraph 1.01 D.8. of this section shall be installed in raceways as described below. Signals of different types shall not be run together in common raceways unless expressly stated.

1) Signal type specified in paragraph 1.01 D.8.a. of this section shall be run in metallic raceways separate from all other signal types.

2) Signal type specified in paragraph 1.01 D.8.b. of this section shall be run in metallic raceways separate from all other signal types.

3) Signal type specified in paragraph 1.01 D.8.c. of this section shall be run in metallic raceways separate from all other signal types.

4) Signal type specified in paragraph 1.01 D.8.e. of this section shall be run in metallic raceways separate from all other signal types.

5) Signal types specified in paragraphs 1.01 D.8.d. and 1.01 D.8.f. of this section shall be run in cables separate from each other, but may be run in a common raceway. Where open raceways are used, cable shall be double-shielded.

6) Signal types specified in paragraphs 1.01 D.8.g. and 1.01 D.8.h. of this section shall be run in cables separate from each other, but may be run in a common raceway.

3. Identification Tags: Each field mounted instrument or device shall be provided with a 16-gauge stainless steel identification tag. Identification tags shall bear the complete instrument number as listed in paragraph 3.04 of this section. Characters shall be 1/4 inch, die-stamped. Identification tags shall be securely attached to the equipment in a readily visible location using stainless steel screws or wire.

D. Signal Transmission:

1. Signal transmission between electric or electronic instruments not located within a common panel shall be 4 to 20 milliamperes and shall operate at 24 volts DC unless otherwise specified. Milliampere signals shall be current regulated and shall not be affected by changes in load resistance within the unit's rating. Milliampere signals from field shall be converted to a 1- to 5-volt signal by dropping across a plus/minus 0.1 percent, 250-ohm, 0.5 watt resistor at the external terminals of each panel, and all instruments within the panel shall be parallel wired. Measurement loops shall be grounded at external terminals by bonding to the instrument panel signal ground bus. Isolating amplifiers for field equipment possessing a grounded input or output shall be provided.
2. High frequency (greater than 1 kHz) pulse rate signals from field transmitters shall be converted to DC voltage signals at the panel.
3. Platinum resistance temperature detector (RTD) outputs shall be carried to the control panel and converted to a dc voltage signal unless otherwise specified or shown.
4. All other transmission systems, such as impulse duration, low frequency pulse rate, and voltage regulated, will not be permitted except where specifically noted in the Instrument Schedule, paragraph 3.04 of this section. When transmitters with non-standard outputs are specified, their output shall be converted to 4 to 20 milliamperes at the field instrument.
5. Spacing between signal conductors and alternating current power and control conductors shall be maintained at not less than 24 inches, except (1) at terminations on equipment, (2) where both the signal conductors and the power and control conductors are enclosed by separate metallic raceways, the spacing may be reduced to 12 inches, and (3) where power and signal conductors cross at 90 degrees.

3.02 TESTS AND INSPECTIONS

A. General Requirements:

1. Materials, equipment, and construction included under this specification shall be inspected in accordance with this section. Testing shall be performed in accordance with Section 01 45 20, and this section. No required test shall be applied without prior notice to the Officer-in-Charge, who has the right to witness any test. At least 14 days before the commencement of any testing activity, a detailed step-by-step test procedure, complete with report forms for the recording of test results, shall be provided. All equipment necessary to perform the specified tests shall be provided.

B. Delivery Inspection:

1. The Contractor shall notify the Officer-in-Charge upon arrival of any material or equipment to be incorporated into the work and shall remove protective covers or otherwise provide access in order that the Officer-in-Charge may inspect such items.

C. Installed Tests and Inspection:

1. Test Reports: Test reports shall conform to the requirements of reference forms 40 61 13-A through 40 61 13-K included in Section 01 99 90.
2. Test Equipment: Test equipment used to simulate inputs and read outputs shall have a rated accuracy at the point of measurement at least three times greater than the component under test. Each test instrument shall be calibrated prior to the commencement of a testing activity and at the completion of a testing activity. Certified calibration reports traceable to the National Bureau of Standards shall be included with the test report. Buffer solutions and reference fluids shall be provided as necessary for tests of analytical equipment.
3. Testing Stages:
   a. General: Each instrument loop shall be tested in the following sequence:

Testing sequence	Form reference
Wiring and piping	40 61 13-A
Individual components	40 61 13-G through H

Testing of piping and wiring and individual components shall be completed with certified test reports provided to the Officer-in-Charge prior to commencement of individual loop testing, which shall be completed with certified test reports provided to the Officer-in-Charge prior to commencement of loop commissioning.

   b. Piping Testing:
      1) Pneumatic Piping Systems: Pneumatic piping systems shall be tested for leaks in compliance with ISA RP7.1.
      2) Liquid Piping Systems: Liquid piping systems shall be tested for leaks in compliance with Section 40 05 01.
   c. Individual Component Calibration and Test: Each instrument and final element shall be field calibrated in accordance with the manufacturer's recommended procedure and then tested in accordance with the Contractor's test procedure. Data shall be entered on the applicable test report form at the time of testing. Alarm trips, control trips, and switches shall be set to the initial values specified in paragraph 3.04 of this section. Final elements shall be checked for range, dead-band, and speed of response.
   d. Any component which fails to meet the required tolerances shall be repaired by the manufacturer or replaced, and the above tests repeated until the component is within tolerance.
   e. Loop Test: Each instrument loop shall be tested as an integrated system. This test shall check operation from transmitter to readout components. 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.
   f. If any output device fails to indicate properly, corrections to the loop circuitry shall be made as necessary and the test repeated until all instruments operate properly.

g. Closed-Loop Commissioning Test: Commissioning test shall be performed as part of the system acceptance test specified in paragraph 3.02 C.3.f. of this section, and shall demonstrate stable operation of the loop under actual plant operating conditions. This test shall include adjustment of loop tuning parameters. Tuning parameters (proportional gain, integral time constant, and derivative time constant) for each control loop shall be adjusted to provide 1/4-amplitude damping unless otherwise specified. A chart recording showing loop response to a step disturbance shall be provided for each loop. Two charts shall be made for cascade loops, one showing the secondary loop response with its setpoint on manual, and the second showing overall loop response. Each control loop with "batch" feature shall be adjusted to provide optimum response following start-up from an integral action saturation condition. Chart recording shall be provided showing this response. Chart recordings shall be made at sufficient speed and amplitude to clearly show 1/4-amplitude damping and shall be annotated to show loop number and title, and settings of parameters and setpoint.

h. SYSTEM ACCEPTANCE TEST: The system test shall be executed after all component and subsystem tests have been completed and be designed to place the completed system in full operation and demonstrate that all functional requirements of this specification have been met. The system test shall, as a minimum demonstrate the following:

   1) That each component of the system operates correctly with all other components of the system;
   2) That analog control loops operate in a stable manner;
   3) That all interlocks perform correctly;
   4) That all control sequences perform correctly;
   5) That the complete system is reliable and consistent under all conditions of plant operation.

3.03 INSTRUSPEC SHEETS (STARTS ON THE NEXT PAGE)

3.03 INSTRUMENT SPECIFICATION SHEET–INSTRUSPEC

Instrument Identification:	FM
Instrument Function:	Flow Measurement
Instrument Description:	Magnetic Flow Metering System
Signal Input:	Process
Signal Output:	Analog signal as specified herein
Process Connection:	Flange, ANSI B16.5, Class 150, raised face.
Product Requirements:	Magnetic flow meter provided as a system consisting of a flow tube with separate or integral converter / indicating transmitter, as shown on the contract drawings, complete with interconnecting cables
	Locally mounted indicating transmitter for full-scale flow rates from 1.0 to 30 feet per second. System error shall not exceed the greater of 0.5 percent of flowrate or 0.1 foot per second from 3 to 30 feet per second.
Flow Tube:	Flow tube manufacturer shall provide grounding rings fabricated from the same metal as for the electrodes below. Flow tube shall be rated for accidental submergence and Class I, Division 2 if located in this area.
	Electrodes: 316L stainless steel
	Liner: Hard Rubber.
Transmitter:	Contain electronics associated with the magnetic flow meter system. Enclosure rating NEMA-4, cast aluminum or metal compartment for power, field connections and calibration adjustments separate from digital circuitry.
	Means to calibrate the metering system without use of external calibration units. Transmitter self-diagnostics. Traceability certificate of actual flow lab certification provided with each flow tube.
	Integral 4-digit LCD flow indication calibrated in process units. Data retained in non-volatile memory.
	Internal circuitry to drive flow signal to zero upon flow meter determined empty pipe condition.
	Pulse frequency shall stop at flows below two percent of maximum range, where the pulse frequency feature is specified.
	Provide protection from sunlight and rain.

Instrument Identification:	FM (continued)
Execution:	
Installation:	Install in accordance with manufacturer's instructions and the specified functional requirements.
Cable:	Signal cable between the flow tube and transmitter provided by the system manufacturer with sufficient length of cable for continuous installation between the flow tube and the transmitter.
Manufacturers:	Endress + Hauser Promag W 400 Mccrometer Ultra Mag Approved equal

3.03 INSTRUMENT SPECIFICATION SHEET–INSTRUSPEC

Instrument Identification:	PGT
Instrument Function:	Pressure Measurement
Instrument Description:	Gage Pressure Transmitter
Power Supply:	As specified in paragraph 40 61 13.01-2.08
Signal Input:	Process
Signal Output:	Analog transmission signal
Process Connection:	1/2-inch female NPT flange adapter
Product Requirements:	Pressure Transmitter: Capacitance or piezoresistive type.
	Wetted Parts: Type 316 stainless steel or as specified in Section 40 61 13.01 Instrument Index.
	Range: 100:1.
	Accuracy: 0.25 percent of calibrated span.
	Static Pressure Rating: 2,000 psi.
	Indicator: LCD display.
	HART standard data communication protocol
Acceptable Manufacturer:	Rosemount 2051CG, ABB, Foxboro, or Approved Equal
Execution:	
Installation:	Install in accordance with manufacturer's instructions and the Engineer’s installation detail.
	Root valves provided at all process pressure taps.
	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.
	Safety instruments shall not be connected to the same process tap as instruments used for control, indication, or recording.
	Pressure instruments located as close as practical to the process tap and be positioned to permit observation and maintenance.
	Pressure instruments shall not be supported from process piping.
	Pressure instruments for use with integral seals, or remote seals and capillary tubing provided by a single manufacturer, and all components factory-assembled prior to shipping.

3.03 INSTRUMENT SPECIFICATION SHEET—INSTRUSPEC

Instrument Identification:	FVS
Instrument Function:	Flow Measurement
Instrument Description:	Vane actuated Flow Switch
Signal Input:	Process
Signal Output:	Contacts, in accordance with this section.
Process Connection:	Female NPT
Product Requirements:	Vane actuated flow switch shall consist of a vane and a magnetically actuated switch. The body of the switch divided into upper and lower sections so that the upper section is isolated from the process fluid. A stainless steel vane and a primary magnet located in the lower section. The force of the process fluid impinging on the vane shall produce movement of the primary magnet. The primary magnet shall produce movement of the secondary magnet located in the upper body section, actuating the switch. The switch shall be DPDT and enclosed in an explosion-proof housing. The switch body and vane shall be type 316 stainless steel unless otherwise specified. Minimum pressure rating of 400 psig and minimum temperature rating of 220 degrees F.
Acceptable Manufacturer:	Dwyer, W. E. Anderson model V6, or approved equal.
Execution:	
Installation:	Install in accordance with the manufacturer's instructions, and the specified functional requirements. Application/Calibration: application, calibration and set points as specified in Section 40 06 70.

3.03 INSTRUMENT SPECIFICATION SHEET—INSTRUSPEC

Instrument Identification:	PG
Instrument Description:	Pressure gauge
Signal Input:	Process pressure
Process Connection:	1/2-inch male NPT
Product Requirements:	Pressure gauges 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.
Execution:	
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. Gauge 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 gauges 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.

3.04 INSTRUMENT SCHEDULE

A. General: The following is a schedule of instrumentation equipment and devices to be provided as part of this Contract.

B. Clarification:

1. Loop Number: The loop number appears as a sub-heading and consists of a one-letter prefix, indicating the loop function, followed by a number identifying that particular loop (see Drawing P1). In addition, a functional description of the loop is given. The loop number is followed by a list of the individual devices which are part of the loop. Example: **F-101 PLANT INFLUENT FLOW.
2. Instrument Number: The instrument number consists of a unique alpha-numeric identifier for each instrument or device (see Drawing P1).
3. Location Reference: Lists the electrical plan drawing which best indicates the location of instruments which are not mounted in process lines or in panels. In the case of panel mounted instruments, the number of the appropriate panel is given.
4. Specification Reference: Lists the area of the Project Manual which specifies the particular item listed.
5. P&I Diagram: Lists the piping and instrumentation diagram number on which the instrument is shown.
6. Control Diagram: Lists the control diagram and drawing number on which the instrument is shown.
7. Mechanical Reference: Lists the mechanical drawing which best indicates the location of instruments which are mounted in process lines.
8. Notes: Specifies setpoints, ranges, scales, etc., as required. Provides modifying specifications or requirements for individual instruments or general information required.

C. Instrument List: (starts on next page)

3.05 TRAINING

B. In accordance with Section 01 79 00, operation and maintenance training on the equipment provided under this section shall be provided for the Owner's personnel by a representative of the manufacturer, at the Owner's facility. Subjects shall include operation and troubleshooting of both hardware and software, programming, and basic program generation. The program written for installation will be used for examples during the training. Training sessions shall not exceed 8 hours per day and shall be held during the Owner's normal daytime working hours. If more than 8 hours of training is required, the sessions shall be held on consecutive business days. The training shall be certified by the manufacturer on Form 43 05 11-B included in Section 01 99 90. A minimum of four (4) hours of training per site shall be provided.

3.06 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be included in the lump sum bids for the respective items in the Proposal Schedule.

END OF SECTION

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INSTRUMENTATION INDEX

Tag Name	Device Function	Min Calibration or Setpoint	Max Calibration or Deadband	Units	Specification Number	Device Type, Instruspec	P&ID Number	Comments
PI-501	Well No. 5 Discharge Pressure Indicator	0	200	PSIG	40 61 13.01	PG	P-101	
PIT-501	Well No. 5 Discharge Pressure Transmitter	0	200	PSIG	40 61 13.01	PGT	P-101	
FE-503	Well No. 5 Flow Tube	0	1200	GPM	40 61 13.01	FM	P-101	
FIT-503	Well No. 5 Flow Transmitter	0	1200	GPM	40 61 13.01	FM	P-101	
FS-506	Well No. 5 Lube Water Flow Switch				40 61 13.01	FVS	P-101	
PI-601	Well No. 6 Discharge Pressure Indicator	0	200	PSIG	40 61 13.01	PG	P-201	
PIT-601	Well No. 6 Discharge Pressure Transmitter	0	200	PSIG	40 61 13.01	PGT	P-201	
FE-603	Well No. 6 Flow Tube	0	1600	GPM	40 61 13.01	FM	P-201	
FIT-603	Well No. 6 Flow Transmitter	0	1600	GPM	40 61 13.01	FM	P-201	
FS-606	Well No. 6 Lube Water Flow Switch				40 61 13.01	FVS	P-201	

SECTION 43 05 11

GENERAL REQUIREMENTS FOR EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

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 Officer-in-Charge 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.
2. 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.

D. 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 PUMP SHAFT SEALS

A. Pump shaft seals are specified in the individual pump specification.

2.04 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.

2.05 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.

2.06 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. Letters shall be white on a red background. The sign size and pattern shall be as shown on the drawings. Signs shall be installed near guarded moving parts.

2.07 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.

2.08 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.

2.09 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 (Section 01 45 23), 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.

2.10 ANCHOR BOLTS

A. Anchor bolts shall be designed for lateral forces for both pullout and shear in accordance with the provisions of Section 05 05 20. Unless otherwise stated in the individual equipment specifications, anchor bolt materials shall conform to the provisions of Section 05 05 20.

2.11 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.

3.02 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be included in the lump sum bids for the respective items in the Proposal Schedule.

END OF SECTION

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. Completed equipment mounts shall consist of equipment pads, equipment anchors, and mounting plates (baseplates, soleplates, or fabricated steel frames) set in grout.
   2. Equipment mounts shall conform to the requirements specified in this specification. Where equipment mounting requirements are not specifically identified, the default mounting configuration for equipment shall consist of Pad Anchored Equipment Pads, mounting plates leveled within 0.005 inch/foot, anchored to the equipment pad with cast-in-place equipment anchors, equipment anchor sleeve length is 10 times the bolt diameter, and the mounting plate is grouted in position using non-shrink grout.
   3. If a conflict exists between this section and requirements of individual equipment manufacturers, the more restrictive requirements shall prevail.
   4. Requirements for non-rigid equipment mounts (vibration isolation systems) are specified in individual equipment specifications. Rigid equipment mounts conforming to the requirements of this Section shall be furnished for the equipment pad and other equipment mounting components supporting the vibration isolation system.

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 61 45 – Area Exposure Designations
   2. Section 01 73 23 – Structural Design and Anchorage Requirements for Nonstructural Components and Non-Building Structures
   3. Section 01 99 90 – Reference Forms
   4. Section 03 60 00 – Grouting
   5. Section 05 05 20 – Anchor Bolts
   6. Section 09 90 00 – Painting and Coating
   7. Section 43 05 11 – General Requirements for Equipment
   8. Section 43 05 14 – Machine Alignment
   9. Section 43 05 17 – Vibration and Critical Speed Limitations

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
ACI 318, Appendix D	Building Code and Commentary, Anchorage to Concrete
HI 14.3	Rotodynamic Pumps –for Design and Application
HI 14.4	Rotodynamic Pumps –for Installation, Operation and Maintenance
API RECOMMENDED PRACTICE 686	Recommended Practices for Machinery Installation and Installation Design
ASCE 7	Minimum Design Loads and Associated Criteria for Buildings and Other Structures
ASME B1.1	Unified Inch Screw Threads (UN and UNR Thread Form)
ASTM E329	Inspection and Testing Agencies for Concrete, Steel, and Bituminous Materials as Used in Construction
ASTM F593	Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F1554	Anchor Bolts, Steel, 36, 55 and 105 ksi Yield Strength
MIL-PRF-907E	Anti-Seize Thread Compound, High Temperature
SSPC	Society for Protective Coatings Specifications, Vol. 2
IBC	International Building Code (including local amendments)

1.04 DEFINITIONS:

A. Specific equipment mounting terminology used in this section conforms to the following definitions:

1. Baseplate: A mounting plate configured with a top plate and a perimeter edge of the mounting plate that is below the top plate. Baseplates have a cavity between the top plate and a horizontal plane at the bottom edge of the perimeter of the mounting plate.
2. Soleplate: A machined or pre-formed mounting plate with a uniform horizontal surface across the entire underside of the mounting plate, excepting shear lugs/keys, grout pour holes, vent holes, and attachment hardware (nuts, bolts, tapped holes, etc.). Soleplates have a top plate but lack the perimeter bottom edge that extends below the underside of the top plate that is a defining feature of baseplates.
3. Fabricated Steel Frame: An equipment mounting plate constructed of rolled steel shapes and plates welded into a frame. Fabricated steel frames do not have top plates.
4. Equipment Pad: Concrete foundation (block or slab) supporting and elevating mounting plates above the supporting structural floor slab or local grade.
5. Mounting Pads: Milled/machined areas of baseplates, soleplates, and fabricated steel frames where the feet or mounting surfaces of mounted equipment and drivers are bolted to the baseplate, soleplate, or fabricated steel frame.
6. Leveling Blocks: Steel blocks temporarily placed under baseplates, soleplates, or fabricated steel frames at leveling positions (at equipment anchors) for the purpose of leveling baseplates, soleplates, or fabricated steel frames prior to grouting.
7. Shims: Thin stainless steel plates of uniform thickness used for fine adjustment of level. Shims are used on top of leveling blocks for mounting plate leveling or used between equipment drivers and baseplates, soleplates, or fabricated steel frames for equipment alignment.

8. Wedges: 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 fabricated steel frames for the purpose of leveling mounting plates.
9. Mounting Stud: Threaded rod or bolts anchored to baseplates, soleplates, or fabricated steel frames for the purpose of mounting equipment or ancillary devices onto baseplates, soleplates, or fabricated steel frames.
10. Reinforcement Dowels or Reinforcement Hooks: Steel reinforcement rods embedded in concrete, across a cold joint, for the purpose of transferring loads or force across the joint.
11. Leveling Position: 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 fabricated steel frames prior to grouting.
12. Grout Manufacturer: Refers to the manufacturer of the grout product used for installation of rigid equipment mounts.
13. Grout Manufacturer's Technical Representative(s): Refers to the technical representative(s) of the Grout Manufacturer. The Grout Manufacturer's Technical Representative shall not be an employee of the Contractor.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Pre-installation Meetings:
   1. Conduct a pre-installation meeting with the Construction Manager's representative prior to installation of equipment mounts.
   2. Schedule a pre-installation meeting for the equipment mounts associated with each system or group of identical equipment items.
   3. Where equipment anchors are cast in the floor slab or foundation, schedule the pre-installation meeting prior to pouring the floor slab or foundation.

1.06 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this Section, including addendum updates, (referenced sections need not be included for this Section) with each paragraph check-marked to indicate compliance or marked to indicate requested deviations from specification requirements. Check marks denote full compliance with a paragraph as a whole. Underline each deviation and denote with 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. Mark copies of this Section with the specification number and equipment number for inclusion (filing) with submittal materials furnished for individual equipment specifications.
   3. Name, employer, and a copy of the employee's Qualified Millwright card or other equivalent certificate of journeyman qualifications for millwrights who will install rigid equipment mounts, as specified in this Section.

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 this Section.
5. List of Contractor's equipment installation staff that have completed epoxy grout manufacturer's grout installation training specified in this Section.
6. Shop drawings for equipment pads, equipment anchors, and baseplate, soleplate or fabricated steel frame depict size and location of equipment pads and reinforcement; equipment drains; equipment anchor, size, location, and projection; expansion joint locations; grout formwork; 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 fabricated steel frames to be numbered and marked (specification number and equipment number) for inclusion (filing) with the associated equipment submittal requirements.

B. Informational Submittals:
1. Procedures: Section 01 33 00
2. Submit equipment anchor calculations demonstrating compliance with this Section. Submit equipment anchor calculations with submittal information specified in the associated equipment specification.
3. Results of grout strength tests, as specified in this Section.
4. Completed Rigid Equipment Mount Installation Inspection Checklist Forms (43 05 13-A), as specified in this Section.

1.07 QUALITY ASSURANCE

A. Quality Control By Contractor:
1. Except where union rules require installation by another trade, all machinery to be mounted and leveled by journeyman millwrights.
2. Epoxy grout installation performed by employees that have completed the epoxy grout manufacturer's grout installation training specified in this Section.
3. Provide the services of an independent testing laboratory that complies with the requirements of ASTM E329. Testing laboratory to sample and test materials installed as part of rigid equipment mounts specified in this Section. Testing laboratory services costs borne by the Contractor.
4. Where epoxy grout is specified for bedding mounting plates, furnish the services of a grout manufacturer's technical representative who has been factory trained by the grout manufacturer. The grout manufacturer's technical representative performs training and quality control for epoxy grout installation for rigid equipment mounts as specified in this Section.

B. Special Inspection for Equipment Anchors:
1. Equipment anchors shall comply with special inspection requirements specified in Section 05 05 20.

PART 2 PRODUCTS

2.01 GENERAL

A. Configure rigid equipment mounts as specified in the Equipment Mounting Schedule (See Part 4 of this specification) or as specified in individual equipment specifications. Equipment mounting configuration requirements in individual equipment specifications govern over configuration requirements specified in the Equipment Mounting Schedule. In the absence of equipment mounting configuration requirements in either of these locations, mount equipment per the default requirements specified in paragraph 1.01.

B. Pumps installed in accordance with this Section, HI 14.3, and HI 14.4.

2.02 EQUIPMENT PADS

A. Equipment pads shall be reinforced concrete. Mounting plate leveling tolerance shall be 0.005 in/ft. Grout shall be non-shrink grout.

2.03 EQUIPMENT ANCHORS

A. Equipment Anchor Materials:
   1. Equipment anchors shall be all thread rod with heavy hex welded nuts, heavy hex bolts, Post-installed anchors (wedge, sleeve, undercut, expansion, and adhesive anchors), or adjustable canister anchors.
   2. Post-installed anchors (wedge, sleeve, undercut, expansion, and adhesive anchors) shall conform to the requirements of Section 05 05 20.
   3. Adjustable canister anchors shall be cast-in-place pre-manufactured adjustable anchor inserts. Adjustable canister anchors shall provide a minimum of 6 inches of vertical bolt height adjustment and lateral adjustment of the anchor bolt while maintaining the anchor bolt in a true vertical orientation. Adjustable canister anchors shall be Jakebolts as manufactured by Unisorb, Heavy Duty Adjustable Anchors as manufactured by Deco, Rowan Adjustable Canister Anchor Bolt, or approved equal.
   4. Equipment anchor materials shall conform to the following table for the area exposure condition where the equipment is installed.

Area Exposure	Equipment Anchor Materials
All Exposures	316 Stainless, ASTM F593, Cond. CW

B. Equipment Anchor Design:
   1. The size (diameter) of anchors for clamping/fastening mounting plates to equipment pads shall be as specified by the equipment manufacturer.
   2. Equipment anchor size, embedment, and edge distance shall comply with the 2018 IBC with Hawaii and Honolulu Amendments and shall be sufficient to resist the maximum lateral and vertical forces specified in Section 01 73 24.
   3. The Contractor shall furnish equipment anchor calculation submittals for all pumps. Equipment anchor calculations shall be furnished as product data and submitted with equipment submittals. Equipment anchor calculations shall be sealed by a registered structural or civil engineer licensed in the State of Hawaii.

C. Equipment Anchor Tension:

1. Unless alternate bolt torque/tension requirements are specified by the equipment manufacturer, equipment anchors shall be tightened to provide a final clamping force that produces a tensile stress of 15,000 psi in each equipment anchor. Adjustable canister anchors shall be tightened to the manufacturer's maximum safe working load. Equipment anchors consisting of Post-installed anchors shall be tightened to manufacturer's recommendations.
2. Bolt torque values required to produce the specified bolt tension based on well lubricated plain finish national coarse thread bolts are presented in the following table. Revise bolt torque values per equipment manufacturer's recommendations for alternate thread patterns, thread lubrication, bolt material, or bolt finish.

Bolt Diam. (in)	3/8	1/2	5/8	3/4	7/8	1	1-1/8	1-1/4	1-1/2
Final bolt torque for 15,000 psi bolt stress (ft*lbs)	8	15	30	50	80	125	180	250	400

3. Prior to leveling and grouting mounting plates, grouted equipment anchors (standard detail M7003) shall be pull tested to the values specified in the following table.

Anchor Diam. (in)	3/8	1/2	5/8	3/4	7/8	1	1-1/8	1-1/4	1-1/2
Pull test load (kips)	2.1	3.8	6.1	9.1	13	17	22	28	43

D. Anchor Sleeves:

1. Equipment anchors shall be fitted with sleeves. Sleeve length for equipment anchors shall be 15 times the bolt diameter. Sleeves may be installed at the Contractor's option even if sleeves are not required or specified.
2. Adjust equipment anchor length/embedment depth if sleeves are not required.
3. Anchor sleeves shall be flexible polyurethane foam, steel cylinder/tubes, or ribbed plastic sleeves.
4. Fill steel cylinders/tubes and ribbed plastic sleeves with a flexible room temperature vulcanizing (RTV) sealant prior to embedment/installation.

2.04 MOUNTING PLATES

A. General:

1. All baseplates, soleplates, and fabricated steel frames shall have edges of surfaces bearing on grout rounded to a radius of not less than 0.25 inch.
2. Perimeter corners of baseplates, soleplates, or fabricated steel frames shall be rounded to a radius of not less than 2.0 inches to avoid producing stress risers on the grouted foundation.
3. Grout pouring holes (minimum 4 inches in diameter for epoxy grout, minimum 2.5 inches in diameter for cementitious non-shrink grout) shall be provided in all baseplates and soleplates and all baseplates and soleplates shall have air release holes.
4. Grout relief or vent holes (minimum 1 inch in diameter) shall be provided in all baseplates and soleplates.

5. Mounting holes for equipment anchors shall be drilled through baseplates, soleplates, and fabricated steel frames.
6. Mounting holes for equipment anchors shall be drilled. Mounting holes shall not be burned out and they shall not be open slots.
7. Terminations requiring connections to baseplates and soleplates shall be acorn nuts welded to the underside of the baseplate or soleplate or nuts welded to the underside of the baseplate or soleplate and plugged with cork, plastic plugs or grease.
8. Where fasteners terminate only into the baseplate, soleplate, or fabricated steel frame, threaded lengths (tapped or embedded in mounting plates) shall be not less than the bolt diameter.
9. Where baseplates, soleplates, or fabricated steel frames are leveled using jackscrews, jackscrew threads shall be tapped in thickened pads or otherwise in sufficient metal to provide ease in adjusting level.
10. Mounting pads and/or mounting surfaces for baseplates, soleplates, and fabricated steel frames shall be milled flat after all welding and stress relieving and shall be coplanar within 0.0005 inch per foot in all directions. Baseplates shall be pre-grouted prior to milling.
11. Baseplates, soleplates, and fabricated steel frames shall provide common support for the equipment and driver (and flywheel, if one is specified).
12. Baseplates, soleplates, and fabricated steel frames for equipment with drivers 20 horsepower and greater shall be furnished with transverse alignment (horizontal) positioning jackscrews for alignment of equipment drivers on horizontal surfaces of baseplates.
13. Alignment/positioning jackscrews shall be in perpendicular directions in a horizontal plane at the mounting position for each corner or foot of the equipment driver. (Additional jackscrews shall be provided for transverse alignment of the flywheel, if flywheels are specified in the equipment specification.)
14. Where specified in individual equipment specifications; baseplates, soleplates, and fabricated steel frames shall be fitted with RK Fixators as manufactured by Unisorb, or approved equal.
    a. Fixators shall be installed at mounting surfaces for drivers.
    b. Fixators shall be a three-piece wedge leveling adjustment device incorporating a spherical washer assembly to provide true level height adjustment at each mounting surface for the equipment driver.

B. Fabricated Steel Frames:
1. Fabricated steel frames shall be plate or fabricated structural steel mounting plates with thickened steel mounting pads for bolting equipment to the mounting plate.
2. Fabricated steel frames shall be rectangular in shape, excepting fabricated steel frames for centrifugal refrigeration machines and pumps which may be T- or L-shaped fabricated steel frames to accommodate the equipment driver and accessories.
3. Fabricated steel frames for split case pumps shall include supports for suction and discharge elbows, if required by the specified configuration.

4. Perimeter members shall be I-beams or C-channel with a minimum depth equal to 1/10 of the longest dimension of the fabricated steel frame. Beam depth need not exceed 14 inches provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer.
5. Fabricated steel frames shall be furnished with mounting pads welded to the fabricated steel frame.
6. Surfaces of fabricated steel frames in contact with grout shall be sandblasted to white metal per SSPC SP-5.
7. Apply a high-strength epoxy primer as specified in paragraph 2.06 within 8 hours of sandblasting the fabricated steel frame.

C. Baseplates:
1. Baseplates shall be welded steel, cast steel, or cast iron with thickened mounting pads for bolting equipment to the baseplate.
2. 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.
3. The minimum acceptable opening in cross bracing and stiffeners shall be 2 inches high by 6 inches wide.
4. All welds shall be continuous and free from skips, blowholes, laps and pockets.
5. Baseplates shall be pre-grouted at the factory after all welding has been completed and prior to machining the mounting pads on the baseplate. Baseplates that have not been pre-grouted at the factory shall be pre-grouted in the field by removing the equipment from the baseplate, inverting the baseplate, and pre-grouting as specified in this Section.
6. The underside of baseplates shall be sandblasted to white metal per SSPC SP-5 prior to pre-grouting.
7. Pre-grouting shall be completed within 8 hours of sandblasting.
8. Pre-grouting shall fill the underside of the baseplate to the bottom edges of the baseplate.
9. Cast iron baseplates shall be sealed to prevent surface bleeding prior to shipment to the project site.

D. Plate Steel Soleplates:
1. Plate steel soleplates shall be not less than 1.0 inch thick for equipment with drivers greater than 30 horsepower.
2. Plate steel soleplates shall be furnished with grout keys/lugs or stiffeners on the underside of the soleplate.
3. Excepting grout keys, grout pour holes, vent holes, and attachment hardware (nuts, bolts, tapped holes, etc.) the underside of plate steel soleplates shall be a flat uniform horizontal surface.
4. The underside of plate steel soleplates shall be scribed with the words “THIS SIDE DOWN” using welding rod material prior to milling the mounting pads for equipment or mounting surfaces.
5. Plate steel soleplates without grout pouring holes are acceptable provided that no dimension of the soleplate (width or length) exceeds 18 inches.
6. Surfaces of plate steel soleplates in contact with grout shall be sandblasted to white metal per SSPC-SP-5 prior to shipment to the project site.

7. Apply a high-strength epoxy primer as specified in paragraph 2.06 within 8 hours of sandblasting the underside of plate steel soleplates.
8. 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 mounting on a common equipment pad and soleplate. In such instances, the equipment shall be supported at the feet or mounting surfaces on individual plate steel soleplates, which shall be leveled and grouted into place on the individual piers or equipment pads as specified in this section. Where multiple soleplates are installed for an equipment installation, soleplates shall be installed coplanar within 0.002 inch/foot.

E. Polymer Concrete Soleplates:
1. Polymer Concrete Soleplates shall be pre-cast soleplates consisting of polymer concrete with stainless steel inserts for equipment mounting.
2. Mounting surfaces on Polymer Concrete Soleplates shall be coplanar within 0.002 inch/foot. Polymer Concrete Soleplates shall be furnished with a uniform horizontal surface over the entire underside of the mounting plate.
3. Excepting grout keys, grout pour holes and vent holes, the underside of soleplates shall provide a flat uniform horizontal surface.
4. Polymer Concrete Soleplates shall be PoxyBase as manufactured by Basetek, Chembase as manufactured by Goulds, or approved equal.

F. Corrosion Resistant FRP Baseplates:
1. Corrosion Resistant FRP Baseplates shall be pre-formed fiber reinforced plastic fabrications.
2. Corrosion Resistant FRP Baseplates shall be products of the manufacturer of the equipment that is mounted on the baseplate.

2.05 GROUT FOR EQUIPMENT PADS

A. Epoxy Grout for Equipment Mounting:
1. Grout for setting bearing surfaces of baseplates, soleplates, and fabricated steel frames 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 as specified in Section 03 60 00.

B. Cementitious Nonshrink Grout:
1. Cementitious Non-shrink Grout, specified in Section 03 60 00, may be used for setting bearing surfaces of baseplates, soleplates, or fabricated steel frames. Where the term non-shrink grout or cementitious grout is used in the context of details and specifications for equipment mounting it shall mean Cementitious Non-shrink Grout as specified in Section 03 60 00. Training and quality control by the grout manufacturer's technical representative is not required for rigid equipment mounts installed with cementitious non-shrink grout.

2.06 EPOXY PRIMER

A. Epoxy primer shall be a high-strength, lead free, chrome free, and rust inhibiting two-component epoxy primer specifically designed for use on metal substrates and in conjunction with epoxy grout. The epoxy primer's bond strength to sandblasted metal shall not be less than 1500 psi. Epoxy primer shall be Phillybond Phillyclad 1000 Series, or approved equal.

2.07 ANTI-SEIZE/ANTI-GALLING COMPOUND

A. Anti-seize or anti-galling compound shall be a molybdenum disulfide and graphite combination in 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 approved equal.

2.08 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 demonstrating compliance with paragraph 2.03 Equipment Anchor Design.
   2. Results of grout strength tests, as specified in paragraph 3.03 Grouting.
   3. Completed Rigid Equipment Mount Installation Inspection Checklist Forms (43 05 13-A), as specified in this Section.
   4. List of Contractor's equipment installation staff that has completed epoxy grout manufacturer's grout installation training specified in this Section.

PART 3 EXECUTION

3.01 GENERAL

A. General Requirements:
   1. Roughen the underside of soleplates and fabricated steel frames and wipe with a residue-free solvent as recommended by the epoxy primer manufacturer before placement of the baseplate, soleplate, and fabricated steel frames on the equipment pad for leveling. Roughen surfaces of mounting plates that will be in contact with grout by power tool cleaning. Cleaning shall be performed by power wire brushing, power sanding, power grinding, power tool chipping or power tool descaling. Cleaning shall impart a minimum profile of 1.0 mil.
   2. Prior to placement on the equipment pad for leveling, exposed grout surfaces of pre-grouted baseplates shall be roughened and wiped with a residue-free solvent as recommended by the manufacturer of the epoxy grout used for pre-grouting.
   3. Prepare the underside of corrosion-resistant FRP baseplates and polymer concrete baseplates per the baseplate manufacturer's recommendations prior to placement of the baseplate on the equipment pad for leveling.
   4. Grouting for installation of equipment on equipment pads shall take place prior to connecting any field piping or electrical and instrumentation systems.
   5. Unless the Officer-in-Charge accepts an alternate installation procedure in writing, baseplates, soleplates, and fabricated steel frames shall be leveled and grouted with the equipment removed.

6. 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.
7. Connecting piping with flexible connections and/or expansion joints shall be anchored such that the intended function of these joints is maintained in the piping system without imposing strain on the equipment connections.

B. Alternate Piping Connections:
   1. 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:
      a. The baseplate, soleplate, or fabricated steel frames supporting the equipment shall be installed, leveled, and grouted in place as specified in this section.
      b. The equipment shall be installed and aligned in place using laser alignment equipment and techniques as specified in Section 43 05 14.
      c. 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.
      d. All piping shall be fully supported by supports designed to accept their full weight and thrust forces.
      e. 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.
      f. The final piping joints shall be welded only after the previous steps have been completed and accepted by the Officer-in-Charge.

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 who will be using 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, including form construction for each equipment installation, surface preparation, mixing, application, void prevention/elimination, and clean up. 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 who have been satisfactorily trained to perform epoxy grout installation for equipment mounting.

B. Epoxy Grout Quality Control:

1. For equipment mounted with epoxy grout, 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 installation 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.
2. 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 installed with epoxy grout:
    a. Inspect ambient conditions during various phases of epoxy grouting installation for conformance with the epoxy grout manufacturer's requirements.
    b. 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.
    c. Inspect the surface preparation of the metallic substrates onto which the epoxy primer is to be applied.
    d. Inspect the epoxy-primed metallic substrate for coverage and adhesion.
    e. Inspect preparation and application of epoxy grout form work for conformance to the specifications.
    f. Inspect and record that the "pot life" of epoxy grout materials is not exceeded during installation.
    g. Inspect epoxy grout for cure.
    h. Inspect and record that localized repairs made to grout voids conform to the specification requirements.
    i. Conduct a final review of completed epoxy grout installation for conformance to these specifications.
    j. 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. Roughen the top of the equipment pad after the concrete has reached its 28-day compressive strength.
2. Remove all laitance and defective or weak concrete.
3. Roughened surface profile shall be 0.25 inch amplitude, minimum.
4. Expose broken aggregate without dislodging unbroken aggregate from the cement matrix and without fracturing concrete and aggregate below the concrete surface.
5. Roughen using a light-duty (15 pounds or less), hand-held chipper with a chisel type tool.
6. Abrasive blast, bush-hammer, jack hammers with sharp chisels, heavy chipping tools, or needle gun preparation of concrete surfaces to be grouted are not acceptable.
7. Demonstrate removal of defective or weak concrete to the Officer-in-Charge prior to leveling.

8. The chipped surface of the concrete shall be such that the final elevation of the equipment pad provides the grout manufacturer's recommended thickness between the surface of the equipment pad and the lower baseplate flange, underside of the soleplate, or underside of the fabricated steel frame.
9. All dust, dirt, chips, oil, water, and any other contaminants shall be removed and the surface protected with plastic sheeting until grout is installed.
10. 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. Leveling:
1. Except where union rules require installation by another trade, all equipment and machinery shall be mounted and leveled by a Qualified Millwright.
2. Use precision surveying equipment for leveling.
3. Machinists' spirit levels will not be permitted for leveling purposes for any baseplate, soleplate, or fabricated steel frame with a plan dimension greater than 4 feet.
4. Baseplates, soleplates, and fabricated steel frames shall be leveled to the tolerance specified or as otherwise required by the equipment manufacturer, if more stringent.
5. An anti-seize or anti-galling compound specified in paragraph 2.07 shall be applied to all equipment anchor threads prior to beginning baseplate, soleplate, or fabricated steel frame leveling.
6. All baseplates, soleplates, and fabricated steel frames 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.
7. Leveling equipment and tools shall be stainless steel leveling blocks and shims, steel wedges, or jackscrews bearing on leveling plates.
8. Leveling nuts may be used for leveling baseplates, soleplates, and fabricated steel frames weighing less than 200 pounds (including the weight of the equipment if leveled with the equipment on the mounting plate).
9. Leveling blocks shall be stainless steel, 4 inches square and 1.5 inches thick with an open-ended slot terminating in the center for the equipment anchor.
10. Leveling blocks shall be machined flat on all horizontal surfaces and placed under the baseplate or soleplate at each equipment anchor.
11. Shims shall be pre-cut stainless steel, slotted for removal after grouting. 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.
12. Clamp baseplates, soleplates, or fabricated steel frames in position (after leveling) by installing the equipment anchor nuts and washers.
13. Bolt tension to fix the position of mounting plates during grouting shall be 30 to 60 percent of the final clamping force applied to clamp the mounting plate to the equipment pad.

14. Prior to grouting, verify that the correct level and position of the baseplate, soleplate, or fabricated steel frame has been maintained after clamping it to the equipment pad.

C. Grouting:
   1. Design forms for a minimum of 6 inches hydrostatic head above the final elevation of the grout.
   2. Install grout expansion joints at 4 to 6 foot intervals, perpendicular to the centerline of baseplates. Design expansion joints in accordance with the grout manufacturer's written instructions.
   3. Coat forms with three coats of paste wax on all areas of the forms that will be in contact with the grout.
   4. Wax forms before assembly.
   5. Prevent accidental application of wax to surfaces where the grout is to bond.
   6. Remove any foreign material, such as oil, sand, water, wax, grease, etc., from concrete surfaces that will contact grout before forms are installed.
   7. Forms shall be liquid tight. Seal any open spaces or cracks in forms, or at the joint between forms and the foundation using sealant, putty, or caulking compound.
   8. Vertical and horizontal edges of the grout shall have 45-degree chamfers as specified in equipment pad details. The 45-degree perimeter chamfer strip shall be located at the final elevation of the grout.
   9. Match chamfers in concrete portions of the equipment pad.
   10. Install block outs at all leveling positions to allow removal of leveling equipment and leveling nuts to be backed off after the grout has cured.
   11. Coat jackscrews with a light oil or other acceptable bond-breaking compound prior to grouting.
   12. Final elevation of grout on fabricated steel frames shall be at the top of the lower flange of the perimeter I-beams or C-channel.
   13. Top of grout elevation for baseplates and soleplates shall be at least 0.125 inch but not more than 0.5 inch above the bottom or underside of the perimeter edge of the baseplate or soleplate.
   14. Seal equipment anchor sleeves to protect the sleeved length of the anchor from contact with grout.
   15. Wrap exposed portions of equipment anchors with duct tape to protect them from grout splatter and to prevent bonding to grout.
   16. Adjust ambient temperature to maintain mounting plate, foundation, and grout temperatures to grout manufacturer's recommended temperature.
   17. Mix grout for equipment mounting in accordance with the grout manufacturer's written recommendations.
   18. Epoxy grout shall be placed in a manner that avoids air entrapment, using a head box to pour grout into the grout holes.
   19. Place grout at one end of the baseplate or soleplate and work grout toward the opposite end to force the air out from beneath the baseplate or soleplate.
   20. Pour grout through a head box into grout pouring holes.
   21. When the head box is moved to the next grout hole, a 6 inch standpipe shall be placed over the grout hole and filled with grout.

22. Use of vibrating tools and/or jarring (rapping or tapping) forms to facilitate grout flow is not permitted during placement of epoxy grout.
23. Never allow the grout in the head box to fall below the top of the baseplate or soleplate once the grout has made contact with the baseplate or soleplate.
24. Grout placement shall be continuous until all portions of the space beneath the baseplate, soleplate, or fabricated steel frame have been filled.
25. Prepare subsequent batches of grout prior to depleting the preceding batch.
26. Maintain grout height in standpipes after the space under the baseplate, soleplate, or fabricated steel frame has been filled.
27. 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.
28. Check for leaks throughout grout pours. Leaks shall be repaired immediately to prevent formation of voids.
29. Check baseplate, soleplate, or fabricated steel frame level and elevation before the grout sets.
30. Cure grout in accordance with the grout manufacturer's written instructions.
31. Where specified in the individual equipment specifications, a grout sample shall be taken for each equipment pad.
    a. Samples shall be placed in a cylinder of sufficient size to yield three 2-inch cubes as test samples.
    b. Samples shall be tagged with project name, date, time, the equipment number, and ambient temperature at the time of placement.
    c. Place samples next to the foundation of the equipment being grouted and cure for 48 hours.
    d. Test grout samples in accordance with the grout manufacturer's recommendations.
    e. Grout samples shall be tested by the independent testing laboratory specified in paragraph 1.02 Quality Control by Contractor.
    f. Test results shall be reported directly to the Officer-in-Charge.

D. Completion:
    1. Upon acceptance by the Officer-in-Charge 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, and 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 bolt tension specified in paragraph 2.03 Equipment Anchor Tension.
    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 fabricated steel frames and pointed after the equipment anchor nuts have been tightened to final values. Jackscrews shall be removed and holes in the baseplate, soleplate, or fabricated steel frames filled with a flexible sealant (silicone rubber) or a short cap screw.
5. Check for baseplate, soleplate, or fabricated steel frame 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 fabricated steel frame 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 fabricated steel frames.
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 fabricated steel frames. Grout voids shall be marked. At the discretion of the Officer-in-Charge, grout voids may be repaired as specified in Chapter 5, Section 3.16 of API RP 686.

3.04 FINAL INSPECTION

A. The Officer-in-Charge will conduct a final inspection with the Contractor for conformance to requirements of this section.

3.05 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be included in the lump sum bids for the respective items in the Proposal Schedule.

END OF SECTION

SECTION 43 05 14

MACHINE ALIGNMENT

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies requirements for alignment of directly coupled mechanical equipment weighing 1000 pounds or more and/or greater than 75 horsepower furnished or modified under this contract.

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 43 05 11 – General Requirements for Equipment
   2. Section 43 05 13 – Rigid Equipment Mounts

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. 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/ASA S2.75 Part 1	Shaft Alignment Methodology, Part 1: General Principals, Methods, Practices, and Tolerances
ANSI/ASA S2.75 Part 2	Shaft Alignment Methodology, Part 2: Vocabulary
ANSI/ASA S2.75 Part 3	Shaft Alignment Methodology, Part 3: Alignment of Vertically Oriented Rotating Machinery
Shaft Alignment Handbook	Shaft Alignment Handbook, Third edition, John Piotrowski, Marcel Dekker Inc.

1.04 DEFINITIONS

A. Follow definitions as defined in ANSI/ASA S2.75, Parts 1, 2, and 3.

1.05 QUALITY ASSURANCE

A. General:
   1. All equipment shall be aligned using laser alignment equipment to the tolerances specified by the subject equipment manufacturer or the criteria specified in this section, whichever is more stringent.

B. Alignment Criteria:
   1. Unless otherwise specified by more stringent manufacturer's requirements or the detailed equipment specification:
      a. Meet the level, flatness, and coplanarity limits in ANSI/ASA S2.75, Part 1, Table 1, for equipment bases and sole plates..
      b. Comply with shaft runout tolerances in ANSI/ASA S2.75, Part 1, Table 2,
      c. Conduct a test for soft foot prior to aligning machines.
         1) Soft foot (machine frame distortion) shall be not more than 2.0 mils for any speed.
      d. Align all process equipment, including pumps, blowers, turbines, and similar machines to meet the Precision Tolerance Range in Tables 3 and 4 of ANSI/ASA S2.75, Part 1.

C.

C. Qualifications:
   1. All alignment work shall be performed by millwrights trained in the use of the laser alignment equipment by the manufacturer

1.06 SUBMITTALS

A. Provide in accordance with Section 01 33 00:
   1. Action Submittals:
      a. Prior to testing, provide a Testing Plan Report identifying, for each piece of equipment, testing location and passing measurement values for each location and test type.
      b. Summary report verifying compliance with the alignment criteria as set forth in paragraph 1.06.B. Include hard copy of all alignment records, signed and dated by the technician performing the work.
      c. Electronic files, including both a summary (pdf) file and files native to the alignment software used for completing the work specified in this section.
      d. Qualifications of the alignment technician.
         1) Millright training
         2) Training certification from the laser alignment equipment manufacturer

PART 2 PRODUCTS

2.01 EQUIPMENT

A. Laser alignment equipment shall be:
   1. Easy-Laser®
   2. PrufTechnik

3. ACOEM,
4. or approved equal.

B. Alignment equipment used to perform the work required under this section shall employ laser alignment techniques to achieve the required tolerances. The equipment shall be computer based and its software shall be compatible with current Windows® based spreadsheets and databases. The equipment shall employ a hand-held field computer using a graphic interface to determine actual alignment and necessary corrective action to bring equipment into required tolerance. The link between field measurement components and the computer shall be through cable, infrared, or wireless transmission.

2.02 ITEMS TO BE FURNISHED TO OFFICER-IN-CHARGE:

A. The following shall be furnished to the Officer-in-Charge upon completion of all alignment work for the project or appropriate portion thereof and prior to substantial completion of the project or portion thereof:
   1. All alignment records, in both hard copy and in computer memory. The hard copy shall be signed and dated by the technician performing the alignment work and shall be witnessed by the Officer-in-Charge.

PART 3 EXECUTION

3.01 GENERAL

A. After machine base grouting as specified under Section 43 05 13, all machines mounted on baseplates or soleplates specified above shall be aligned as specified under this section.
B. Alignment work shall be performed by journeyman millwrights skilled in this type of work under the supervision of a technician trained in the use of the laser alignment by the manufacturer or vendor of the alignment equipment. The use of untrained laborers, carpenters or apprentices for this work will not be acceptable.
C. Submit alignment report for each machine within 2-weeks of completing the alignment.

3.02 PROCEDURE

A. Sequence:
   1. Machines supported on integral feet or support pads shall be leveled, grouted and aligned in the following order: driven machine; intermediate bearings or machines; and driver. Under certain circumstances, such as a diesel engine driving a generator, it may be preferable to reverse this order and set the driver first. The Contractor shall submit a written request for a reversal of the alignment order to the Officer-in-Charge and the Officer-in-Charge must approve any change in alignment order in writing before it will be allowed.
B. Alignment:
   1. All machines shall be rough aligned without any connections to piping, electrical and instrumentation systems. Upon completion of all field connections, alignment shall be rechecked to demonstrate no change. If change has occurred, the Contractor shall eliminate any external forces affecting machine alignment.

2. Next, soft foot (machine frame distortion) shall be measured and brought to within the permissible tolerances. Thereafter, the alignment shall be rechecked and the alignment process repeated if necessary to bring all machinery to final alignment tolerances.

3.03 VERIFICATION

A. Factory Personnel:
   1. Where required by other sections in the Contract Documents, factory authorized installation technicians representing the equipment manufacturer shall witness final alignment work. After completion of all alignment work, acceptance of the work shall be documented in writing by factory installation technicians.

B. Verification:
   1. All alignment work shall be independently checked using the shaft and coupling spool method described in the Shaft Alignment Handbook. All final results of the alignment work shall be subject to inspection and verification by the Officer-in-Charge.

3.04 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be included in the lump sum bids for the respective items in the Proposal Schedule.

END OF SECTION

SECTION 43 05 21

COMMON MOTOR REQUIREMENTS FOR EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Squirrel cage type, AC induction motors, up to 500 HP, for up to 4 poles (3600 or 1800 rpm nominal), or up to 250 HP for over 6 poles (1200 rpm or slower) shall be per NEMA MG1, Small or Medium.
   2. Special purpose motors with features or ratings which are not specified herein, are specified in the particular equipment specifications.

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.

Reference	Title
ABMA 9	Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	Load Ratings and Fatigue Life for Roller Bearings
IEEE 112	Standard Test Procedures for Polyphase Induction Motors and Generators
IEEE 841	Standard for Petroleum and Chemical Industry- Premium-Efficiency, Severe Duty Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors - Up to and Including 500 HP
NEMA ICS 2	Industrial Control and Systems Controllers, Contactors and Overload Relays Rated Not More Than 2000 Volts AC or 750 Volts DC
NEMA 250	Enclosures for Electrical Equipment (1000 volts maximum)
NEMA MG 1	Motors and Generators
Department of Energy	Energy Policy and Conservation Act, Final Rules EERE-2010-BT-STD-0027-0117
UL 674	Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations
UL 1004	Electric Motors

1.03 DEFINITIONS

A. Terminology used in this Section conforms with NEMA MG-1. Motors covered in this specification are those defined in NEMA MG1 as Small (Fractional) and Medium (Integral) AC induction motors.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Unit Responsibility: Where Unit Responsibility is specified in the driven equipment sections of these specifications, the motor supplier shall coordinate with the provider of the driven equipment to verify that the motor provided under this section is fully compatible with and meets the specified performance requirements for that equipment.

1.05 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
      a. Copy of this Section, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
      b. Check-marks (✓) to denote full compliance with a paragraph as a whole. Underline deviations and denote by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance. Include a detailed, written justification for each deviation.
      c. Failure to include a copy of the marked-up specification sections with justification(s) for any requested deviation will cause rejection of the entire submittal with no further consideration.
   2. Motor Data Sheets specified in this Section and Division 01.
      a. Motors in conformance with IEEE 841: Manufacturers to complete IEEE Standard 841 Data Sheet for AC Induction Motors.
      b. Motors not in conformance with IEEE 841: Motor supplier to complete Form 43 05 21-A in Section 01 99 90 with required factory data.
      c. Motor Speed-Torque curve, where specified.
   3. Routine Factory test data for polyphase motors.
      a. High-potential test.
   4. Factory test data, from required dynamometer tests, where specified.
   5. Vibration level when measured in accordance with NEMA MG 1, for all IEEE 841 motors, and where elsewhere specified.
   6. Motor heating curve, where specified,
   7. Motor mounting, outline, dimensions, and weight.
   8. Motor bearing and winding RTDs (resistance temperature detector), where specified.
   9. Motor winding thermostat or thermistor, where specified.
   10. Motor winding space heaters, where specified.
   11. Motor nameplate data.

B. Informational Submittals:
   1. Procedures: Section 01 33 00 and 01 78 23.
   2. Submittal requirements for operation and maintenance manuals as per requirements of Section 01 78 23.

1.06 QUALITY ASSURANCE

A. Factory Testing:
   1. All polyphase motors shall be factory tested in conformance with routine tests per NEMA MG1 and IEEE 112. Provide the following tests:
      a. Measurement of winding resistance.
      b. No-load readings of current and speed at normal voltage and frequency.
      c. Current input at rated frequency with rotor at standstill.
      d. High potential test.

B. Where specified for use in corrosive or hazardous locations, motor testing shall additionally be per IEEE 841. Test report shall be certified by the motor manufacturer's test personnel and submitted to the Officer-in-Charge.
    1. For motors larger than 100 horsepower, test and submit results for the following:
        a. Routine tests per NEMA MG1 and IEEE 112. Provide tests as noted in paragraph 1.07 Factory Testing. Test report shall be certified by the motor manufacturer's test personnel and submitted to the Officer-in-Charge.
        b. For motors larger than 200 horsepower, efficiency and power factor by Test Method B, IEEE 112. Submit Form B and B-2.

1.07 DELIVERY, STORAGE AND HANDLING

A. Procedures shall be in accordance with Section 01 66 00.

1.08 SPECIAL WARRANTY

A. Provide warranty of one year from date of substantial completion and Owner acceptance, and not from the date of delivery or initial field setup. Warranty shall be for manufacturing defects (materials, workmanship, or design) or failure of the equipment caused by normal wear and tear. At the discretion of the manufacturer, the product shall be modified, repaired, or replaced.

B. Submit warranties in writing to include 100 percent full payment coverage for parts and labor for repair or replacement of the motor (s) during the warranty period. Copies of warranty shall be provided with equipment submittal and include contact information for warranty service.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this Section. The manufacturer's standard product may require modification to conform to specified requirements:
    1. General Electric/Wolong
    2. US Motors/Nidec
    3. Approved Equal

2.02 PERFORMANCE/DESIGN CRITERIA

A. Service Conditions:
    1. Temperature: -25-degree C to +40 degree C.
    2. Altitude: 0 to 3300 feet above sea level minimum.
    3. Derate motors for higher ambient temperature and for higher altitude with motor size based on brake-horsepower.

B. Design Requirements:
    1. Operation: Continuous.
    2. Compliance: Energy Policy Act of 1992 (EPAct), Final Rule 2014.

3. Tolerance: +/- 10-percent of rated voltage at rated frequency; +/- 5-percent of rated frequency at rated voltage.
4. Standard design: NEMA Design B.

C. Service Factor (percent of additional horsepower):
1. 1.15 for Sine-wave motors.
2. Dual rating: 1.15 Sine-wave and 1.0 Inverter Duty for Inverter Duty motors.

D. Motor Efficiency:
1. NEMA Premium™ efficiency electric motor, single-speed, polyphase, 1 to 500 horsepower, 3600-rpm 2-pole, 1800-rpm 4-pole, and 1200-rpm 6-pole (1 to 250 HP), squirrel cage induction motors, NEMA Design B, continuous rated. NEMA Standards Publication MG 1 2011, in Table 12-12.

Table 12-12

Full-Load Efficiencies for 60 HZ Premium Efficiency Electric Motors

Rated 600 Volts or Less (Random Wound)

Open Motors

HP	2 Pole		4 Pole		6 Pole		8 Pole	
	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency
1	77.0	74.0	85.5	82.5	82.5	80.0	75.5	72.0
1.5	84	81.5	86.5	84.0	86.5	84.0	77.0	74.0
2	85.5	82.5	86.5	84.0	87.5	85.5	86.5	84.0
3	85.5	82.5	89.5	87.5	88.5	86.5	87.5	85.5
5	86.5	84.0	89.5	87.5	89.5	87.5	88.5	86.5
7.5	88.5	86.5	91.0	89.5	90.2	88.5	89.5	87.5
10	89.5	87.5	91.7	90.2	91.7	90.2	90.2	88.5
15	90.2	88.5	93.0	91.7	91.7	90.2	90.2	88.5
20	91.0	89.5	93.0	91.7	92.4	91.0	91.0	89.5
25	91.7	90.2	93.6	92.4	93.0	91.7	91.0	89.5
30	91.7	90.2	94.1	93.0	93.6	92.4	91.7	90.2
40	92.4	91.0	94.1	93.0	94.1	93.0	91.7	90.2
50	93.0	91.7	91.5	93.6	94.1	93.0	92.4	91.0
60	93.6	92.5	95.0	94.1	94.5	93.6	93.0	91.7
75	93.6	92.4	95.0	94.1	94.5	93.6	94.1	93.0
100	93.6	92.4	95.4	94.5	95.0	94.1	94.1	93.0
125	94.1	93.0	95.4	94.5	95.0	94.1	94.1	93.0
150	94.1	93.0	95.8	95.0	95.4	94.5	94.1	93.0
200	95.0	94.1	95.8	95.0	95.4	94.5	94.1	93.0
250	95.0	94.1	95.8	95.0	95.8	95.0	95.0	94.1
300	95.4	94.5	95.8	95.0				
350	95.4	94.5	95.8	95.0				
400	95.8	95.0	95.8	95.0				
450	96.2	95.4	96.2	95.4				

Table 12-12

Full-Load Efficiencies for 60 HZ Premium Efficiency Electric Motors

Rated 600 Volts or Less (Random Wound)

Open Motors

HP	2 Pole		4 Pole		6 Pole		8 Pole	
	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency
500	96.2	95.4	96.2	95.4				

Table 12-12

Full-Load Efficiencies for 60 HZ Premium Efficiency Electric Motors

Rated 600 Volts or Less (Random Wound)

Enclosed Motors

HP	2 Pole		4 Pole		6 Pole		8 Pole	
	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency
1	77.0	74.0	85.5	82.5	82.5	80.0	75.5	72.0
1.5	84.0	81.5	86.5	84.0	87.5	85.5	78.5	75.5
2	85.5	82.5	86.5	84.0	88.5	86.5	84.0	81.5
3	86.5	84.0	89.5	87.5	89.5	87.5	85.5	82.5
5	88.5	86.5	89.5	87.5	89.5	87.5	86.5	84.0
7.5	89.5	87.5	91.7	90.2	91.0	89.5	86.5	84.0
10	90.2	88.5	91.7	90.2	91.0	89.5	89.5	87.5
15	91.0	89.5	92.4	91.0	91.7	90.2	89.5	87.5
20	91.0	89.5	93.0	91.7	91.7	90.2	90.2	88.5
25	91.7	90.2	93.6	92.4	93.0	91.7	90.2	88.5
30	91.7	90.2	93.6	92.4	93.0	91.7	91.7	90.2
40	92.5	91.0	94.2	93.0	94.1	93.0	91.7	90.2
50	93.0	91.7	94.5	93.6	94.1	93.0	92.4	91.0
60	93.6	92.5	95.0	94.1	94.5	93.6	92.4	91.0
75	93.6	92.4	95.4	94.5	94.5	93.6	93.6	92.4
100	94.1	93.0	95.4	94.5	95.0	94.1	93.6	92.4
125	95.0	94.1	95.4	94.5	95.0	94.1	94.1	93.0
150	95.0	94.1	95.8	95.0	95.8	95.0	94.1	93.0
200	95.4	94.5	96.2	95.4	95.8	95.0	94.5	93.6
250	95.8	95.0	96.2	95.4	95.8	95.0	95.0	94.1
300	95.8	95.0	96.2	95.4				
350	95.8	95.0	96.2	95.4				
400	95.8	95.0	96.2	95.4				
450	95.8	95.0	96.2	95.4				
500	95.8	95.0	96.2	95.4				

2.03 MATERIALS

A. Motor frames:
   1. TEFC motors shall be cast iron.
   2. Aluminum frame motors are not permitted.

B. Stator windings:
   1. Shall be copper with Class F minimum insulation not to exceed Class B temperature rise of 80-degree C at rated load and with Design B torque /current characteristics for all Medium (Integral) motors.
   2. Small (fractional) motors shall be supplied with Class F insulation where available.

C. Rotor material shall be aluminum or copper.

D. Fans shall be non-sparking fan blades.

E. Motor leads shall be non-hygroscopic.

2.04 MOTOR TYPES

A. General Requirements for motors 1/2 horsepower through 500 horsepower:
   1. Three phase, squirrel cage, with copper windings.
   2. Rated for full voltage starting and continuous duty.
   3. Rating shall be:
      a. 460/ 230 volts, three-phase, 60-Hertz, as shown on the contract drawings.
   4. Severe Duty Type Motors, which may also be called Type 2 per the project equipment specifications, shall be in accordance with IEEE 841.
      a. Totally Enclosed Fan-Cooled Motors (TEFC) shall be defined per NEMA MG1.
      b. Enclosure: totally enclosed, fan cooled, with external fan blowing air to the motor frame cooling fins for cooling.
      c. Applications: severe duty and most outdoor installations.

2.05 COMPONENTS

A. Inverter-Fed Polyphase Motors per NEMA MG1 Part 31:
   1. Applications: variable torque or constant torque loads, for vertical or horizontal motors with variable frequency drive controllers (VFD).
   2. Features shall include:
      a. Insulation design to meet 2000-Volt peak at a minimum of 0.1 micro-second rise time.
      b. Built-in motor winding protection as specified.
      c. Electrically insulated bearings or,
      d. Provide Electro Static Technology's AEGIS Shaft Grounding Ring for Bearing Protection or equal. The shaft grounding ring shall be solidly bonded per manufacturer's recommendations.

B. Vertical Motors:
   1. Features: Inverter duty or non-inverter duty with solid shaft P-base and high thrust bearing compatible with loads imposed by the driven equipment.

C. Thermal Protection:
   1. Inverter duty motors:
      a. Motors up to 50 horsepower:
         1) Protection to be NEMA Type 2 bi-metallic thermal switch (Klixon) type.
         2) Motor Nameplate: Marked "OVER TEMP PROT 2" in accordance with NEMA MG 1 12.43.
   2. Motors larger than 50 horsepower up to and including 250 horsepower:
      a. Unless another form of thermal protection is specified in the driven equipment specification, provide a NEMA Type 1 temperature sensing device embedded in the motor winding which is sensitive to motor running over temperature.
      b. Sensor: Wired to a temperature relay in a NEMA 4 box located near or on the motor, or to the variable frequency drive controller.
      c. Motor Nameplate: Marked "OVER TEMP PROT 1" in accordance with NEMA MG 1 12.43.

D. Motor Nameplates:
   1. Materials: Engraved or stamped stainless steel.
   2. Features shall be as follows:
      a. NEMA Standard MG 1 motor data.
      b. Permanently fastened to the motor frame.
      c. ABMA bearing identification number for motors meeting IEEE 841.
      d. NEMA nominal efficiency for all motors.
      e. NEMA nominal and minimum efficiency for motors meeting IEEE 841.
      f. UL frame temperature limit code for explosion proof motors.
      g. Space heater data.
      h. Over Temperature Protection Type Number.
      i. Temperature device rating and alarm and shutdown setpoint.
      j. Provide motor nameplates for motors with space heaters located in Class I, Division 2, Groups C, and D areas in accordance with NEC 501.125(B).

E. Conduit Boxes:
   1. Provide oversized boxes, with split construction with threaded hubs and petroleum-resistant gaskets.
   2. Conduit boxes can be rotated in order to permit installation in any of four positions 90 degrees apart.
   3. Provide grounding lug located within the conduit box for ground connection.
   4. Provide separate conduit boxes for temperature devices and space heaters.
   5. Separate terminal box for any signal leads (RTD, thermistor, vibration transmitter, etc.).

F. Bearings:
   1. Provide oil or grease lubricated ball bearings, angle contact roller bearings for axial thrust loads, and cylindrical bearings for radial-only loads.
   2. Rated for a minimum L-10 life of 50,000 hours for direct-connected loads.
   3. Cartridge type bearings will not be accepted.
   4. Fitted with lubricant fill and drain or relief fittings.
   5. Belt loads not to exceed forces calculated from NEMA MG 1 Table 14-1 and 14-1A.

G. Bearing lubrication shall be either grease or oil as per the requirements in either 1 or 2:
   1. Grease lubricated bearings:
      a. Shall be for electric motor use only.
      b. Grease shall be capable of higher temperatures associated with electric motors and shall be compatible with Polyurea-based greases.
      c. Provide grease fittings, similar to Alemite™ type (or equivalent).
      d. Shielded bearings with regreasable provisions are permissible.
   2. Provide oil lubricated bearings with externally visible sight glass to view oil level.

H. Lifting Eyes:
   1. Provide lifting eyes with a safety factor of 5.
   2. Provide one lifting eye for motors more than 50 pounds.
   3. Provide two lifting eyes for motors over 150 pounds.

I. Winding Space Heaters when specified or shown:
   1. Provide winding space heaters to prevent condensation.
   2. Rating: 120 volts, single phase, 60 Hertz.
   3. Motor nameplate to show space heater rating in watts and volts.
   4. Provide terminal block in motor conduit box for heater leads termination.

2.06 FINISHES

A. Paint Finish:
   1. Provide standard manufacturer paint finish.
   2. Provide motors with semi-gloss finish, scratch and heat resistance electric motor paint.

PART 3 EXECUTION

3.01 EXAMINATION

A. Delivery Inspection:
   1. Inspect driven equipment-motor assembly and components immediately upon delivery and unloading at the job site for damages.
   2. Take photos of damage(s) if any, to substantiate the delivery inspection report.

3.02 INSTALLATION

A. Grounding of Motors:
   1. Connect the motor feeder ground cable (green) to the grounding lug terminal in the conduit terminal box.

B. Supplemental Grounding of Motors: Provide for motors fed from VFDs, all motors above 100 horsepower, and all motors in classified areas, where feasible.
   1. Bond the motor frame to the grounding grid/electrode system to provide supplemental grounding.

C. Field Coating of Motors:
   1. Refer to the driven equipment specification section and Section 09 90 00 for coating requirements.

3.03 FIELD QUALITY CONTROL

A. Field Testing:
   1. Measure winding insulation resistance of motors to no less than 10-megohm with a 1000-Vac megohmmeter.
   2. Perform motor phases current imbalance testing for motors 20 horsepower and larger.
   3. Test motors for proper rotation prior to connection to the driven equipment.
   4. Perform thermographic survey per NETA ATS, for motors over 100 horsepower.

B. Field Inspection:
   1. Compare equipment nameplate data with drawings and specifications.
   2. Inspect physical and mechanical condition.
   3. Inspect anchorage, alignment, and grounding.
   4. Verify the installation of breather/drain fittings as specified herein.
   5. Check for proper connections of space heaters, winding and RTDs and or thermostats.
   6. Visually check for correct phase and ground connections:

C. Manufacturer Services: Provide where specified or shown on the drawings.
   1. Provide services to the driven equipment manufacturer for the inspection and certification of the installation of the motor driven equipment.
   2. Provide assistance in the start up and operational testing of the motor driven equipment.

3.04 SYSTEM START UP

A. Commissioning Test: Provide where specified or shown on the drawings.
   1. Provide assistance during the commissioning test of the motor driven equipment.

3.05 CLOSEOUT ACTIVITIES

A. Operation and Maintenance:
   1. Provide the operation and maintenance manual of the motor(s). Include testing result information in the O&M manual.

3.06 MEASUREMENT AND PAYMENT

A. The work of this Section shall not be paid for directly, but shall be included in the lump sum bids for the respective items in the Proposal Schedule.

END OF SECTION

SECTION 43 23 73

VERTICAL LINESHAFT DEEP WELL PUMPS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. This section specifies vertical lineshaft deep well pumps with water lubricated lineshafts for pumping fluids which may contain mildly abrasive small diameter solids such silt and sand.
   2. The pumping arrangement shall be complete with a surface discharge assembly and a vertical motor.

B. Equipment furnished under this section shall be constant speed multi-stage vertical turbine pumps designed specifically for pumping water from a well casing. The pumps shall be complete with suction pipe, suction case with threads, intermediate bowls, discharge case, impellers, lineshaft, discharge column, discharge head and electric motor. Pump installation shall reuse existing concrete pump base.

C. Equipment List:

Item	Equipment No.
Non-Potable Water Pump No. 5	P-501
Non-Potable Water Pump No. 6	P-601

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 45 20 – Equipment and System Performance and Operational Testing
   2. Section 01 73 24 – Structural Design and Anchorage Requirements for Nonstructural Components and Nonbuilding Structures
   3. Section 01 78 23 – Operation and Maintenance Data
   4. Section 01 79 00 – Training
   5. Section 01 91 00 – Commissioning
   6. Section 09 90 00 – Painting and Coating
   7. Section 43 05 11 – General Requirements for Equipment
   8. Section 43 05 13 – Rigid Equipment Mounts
   9. Section 43 05 21 – Machine Alignment
   10. Section 43 05 21 – Common Motor Requirements for 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 shall prevail.

Reference	Title
AISC	American Institute of Steel Construction Manual of Practice
ANSI/HI 9.1 – 9.5	Pumps – General Guidelines
ANSI/HI 9.6.1	Rotodynamic Pumps – Guideline for NPSH Margin
ANSI/HI 9.6.2	Rotodynamic Pumps for Assessment of Allowable Nozzle Loads
ANSI/HI 9.6.3	Rotodynamic Pumps Guideline for Operating Regions
ANSI/HI 9.6.4	Rotodynamic Pumps for Vibration Measurements and Allowable Values
ANSI/HI 9.6.8	Rotodynamic Pumps – Guideline for Dynamics of Pumping Machinery
ANSI/HI 9.8	Pump Intake Design
ANSI/HI 14.1 – 14.2	Rotodynamic Pumps for Nomenclature and Application
ANSI/HI 14.3	Rotodynamic Pumps for Design and Application
ANSI/HI 14.4	Rotodynamic Pumps for Installation, Operation, and Maintenance
ANSI/HI 14.6	Rotodynamic Pumps for Hydraulic Performance Acceptance Tests
ASME Code	ASME Boiler and Pressure Vessel Code
ASTM A36	Standard Specification for Carbon Structural Steel
ASTM A48	Standard Specification for Gray Iron Castings
ASTM A53	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A108	Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
ASTM A193	Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications
ASTM A995/A995M	Castings, Austenitic-ferritic (duplex) Stainless Steel, for Pressure-containing Parts
ASTM A582	Standard Specification for Free-Machining Stainless Steel Bars
ASTM B505	Standard Specification for Copper Alloy Continuous Castings
ASTM B584	Copper Alloy Sand Castings for General Applications
AWWA E103	Horizontal and Vertical Line Shaft Pumps
AWWA C210	Liquid-Epoxy Coatings and Linings for Steel Water Pipe and Fittings
AWWA C222	Polyurethane Coatings for Steel Water Pipe and Fittings
ISO 1940	Mechanical Vibration - Balance Quality Requirements for Rotors in a Constant (Rigid) State
ISO 9001	Quality Management Systems

1.04 DEFINITIONS

A. General: Terminology and definitions in this section follow those established in American National Standards Institute (ANSI)/Hydraulic Institute (HI) 9.1-9.5 and ANSI/HI 14.1-14.2, unless otherwise noted.

1. Efficiency: For the purposes of this section and sections referencing this section, efficiency, as related to pumps, is the ratio of the pump output power (water horsepower [hp]) divided by the pump input power (brake horsepower) required to deliver the total head, with meanings as defined in ANSI/HI 14.2. For column-type pumps, efficiency is computed inclusive of inlet, bowl, column, and discharge head losses.
2. Net positive suction head available (NPSHA): as defined in ANSI/HI 9.6.1
3. Net positive suction head, 3 percent reduction (NPSH3): as defined in ANSI/HI 9.6.1
4. Net positive suction head, required (NPSHR): as defined in ANSI/HI 9.6.1
5. NPSH margin: as defined in ASNI/HI 9.6.1.

6. POR: preferred operating region as defined in ANSI/HI 9.6.3.
7. AOR: allowable operating region as defined in ANSI/HI 9.6.3.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate pump and motor operational and starting characteristics with the electrical control equipment. Including the following:
      a. Operating limits that are imposed by the driven equipment for operation and warranty.

B. Unit Responsibility:
   1. Assign unit responsibility, as specified in Section 43 05 11 to the Contractor for the pumps, lubrication system, motors as specified in Section 43 05 21. Provide a completed and signed Unit Responsibility Certification Form (Form 43 05 11-C) in Section 01 99 90.

1.06 SUBMITTALS

A. Procedures: Section 01 33 00.

B. Action Submittals
   1. Certificate of Unit Responsibility attesting that the Contractor has assigned unit responsibility in accordance with the requirements of paragraph 1.05 - Administrative Requirements. *No other submittal material will be reviewed until the certificate has been received and found to be in conformance with these requirements.*
   2. A copy of this specification section, Section 43 05 21 and all other applicable specification sections governing the pump, drive and driver, supports and specified appurtenances. Ensure the specification copies shall be complete with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. *Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.*
   3. Documentation of certification of quality as specified under paragraph 1.07 - Quality Assurance.
   4. Predicted pump performance curves for each condition point specified showing head, power, efficiency, and NPSH required on the ordinate plotted against capacity (in gpm) on the abscissa. Curves shall show bowl efficiency and allowances for inlet, column, and discharge head losses separately. All curves shall clearly display the specified operating conditions and conformance with POR and AOR limits specified in this section.

5. NPSH margin calculations performed for each specified operating condition in accordance with paragraph 2.03-B - Operating Conditions as applicable and including the information required under paragraph 1.08-E - Net Positive Suction Head Margin Limitations.
6. Motor submittal information as specified in Section 43 05 21.
7. Complete description and sketch of proposed test setup for factory test. Submittal material shall include sample calculations and proposed test log format.
8. Drawings showing general dimensions and confirming the size of pumps, motors, drives and specified appurtenances; piping connections; construction details of equipment; wiring diagrams; and weight of equipment.
9. Rotordynamic Executive Summary Report as described in paragraph 1.08-C - Rotordynamic Analysis.

C. Informational Submittals
1. The qualifications of the independent testing laboratory proposed by the Contractor to perform field vibration testing in accordance with the requirements of paragraph 3.06 - Field Vibration.
2. Performance guarantee as specified in paragraph 1.07-B - Performance Confirmation.
3. Operation and maintenance information specified in Section 01 78 23.
4. Motor information as specified in Section 43 05 21.
5. Rotordynamic Final Report as described in paragraph 1.08-C - Rotordynamic Analysis.
6. RCF analysis calculations demonstrating compliance with paragraph 1.08-C – Rotordynamic Analysis.
7. Motor balance logs as specified in paragraph 1.08-F - Electric Motors.
8. Pump balance logs as specified in paragraph 2.10 - Balance.
9. Manufacturer's Installation Certification Form 43 05 11-A.
10. Certification of satisfactory factory testing of each unit as specified. The certified material shall include sealed copies of test logs and resulting performance curves.
11. Results of field vibration tests as specified under paragraph 3.06 - Field Vibration.

D. Closeout Submittals
1. Operation and Maintenance data.
2. Spare Parts: Provide the following spare parts:
   a. Two impeller collet sets
   b. Two sets of pump bearings
   c. Two sets of wear rings
   d. Two shaft seals, complete

1.07 QUALITY ASSURANCE

A. Quality Certification:
1. All manufacturers and manufacturing sites proposed by the Contractor for supply of equipment furnished under this section and sections referencing this section shall document quality assurance procedures conforming to ISO 9001. The documentation shall include the manufacturer's written Quality Assurance/Quality Confirmation (QA/QC) program and the documentation plan conforming to ISO 9001.

B. Performance Confirmation:
   1. Hydrostatic Tests:
      a. Subject all pressure-sustaining parts to factory hydrostatic tests, excluding the column pipe and lineshaft. Hydrostatic tests shall conform to the requirements of ANSI/HI 14.6, except that the test duration shall be for a minimum of thirty (30) minutes.
   2. Performance Guarantee:
      a. The acceptance criteria for head and capacity test results shall be based upon the rated condition specified and as required in ANSI/HI 14.6 for acceptance Grade 1B.
         1) The factory tests shall include test data for each full speed performance requirement (Condition Points A, B and C specified in paragraph 2.03 - Performance/Design Criteria). Where there are none stipulated, the acceptance criteria for head and capacity test results for specified duty conditions, other than the rated condition, shall be within the manufacturer POR.
         2) The test setup in the manufacturer's test facility shall duplicate as closely as possible the inlet conditions in the proposed installation.
         3) Include in the guarantee a statement to the effect that the pump will operate within the operating regions specified in the detailed specification. The guarantee shall be in writing and sealed by the chief engineer or individual in responsible charge of the test facility. Under no circumstances shall deviations from specified operating conditions result in overload of the driver furnished with the equipment, nor should such deviations result in power requirements greater than the driver's nameplate rating plus 5% of the driver's horsepower (1.05 service factor).
   3. Pump performance (flow and head, efficiency, and NPSH3) shall be guaranteed by the pump manufacturer to the criteria specified under this paragraph.
      a. Non-Witnessed Tests: All pumps shall be performance tested to the criteria specified herein. Equipment performance documentation, including test data, shall include sufficient test points (not less than eight) to document hydraulic performance along the complete head/capacity curve from shutoff to maximum capacity, and covers full-speed operating points.
      b. Not less than eight (8) test points shall be taken, including not less than three within ±8 percent (in terms of rated flow) of the rated condition (Condition Point A) and not less than two test points within ±4 percent of the pump's best efficiency point at the test speed. In addition, one test point shall be sufficient to define head and power requirements at shutoff head. All test procedures shall be in strict conformance with the referenced standards, except prediction of performance of a trimmed impeller from test data of the larger impeller will not be permitted.
      c. Include in the performance documentation curve at maximum operating speed for the application.
      d. The Contractor shall furnish the Officer-in-Charge with not less than 2 weeks' advance written notice of the date and place of the non-witnessed tests.

e. All test results, including test logs and generated curves, shall be certified correct and sealed by the chief engineer or individual in responsible charge of the manufacturer's test facility, and shall be submitted as an Action Submittal per paragraph 1.06-B - Action Submittals.

1.08 DESIGN REQUIREMENTS

A. General:

1. Equipment furnished in this section shall meet the longevity objective that the pumping equipment, motor, shafting, and coupling, and appurtenances are designed for a minimum service life of 10-years and 3 years of "uninterrupted operation". All components associated with the rotating elements in the drive train, including equipment supports and supports for rotating elements, shall be selected and designed to function without damage or disassembly at reverse rotational speeds up to 130 percent of maximum operational speed during flow reversals through the pump. The complete pumping unit shall operate without overload on any component at any point along the pump's entire full-speed operating curve. Pumps required by virtue of the specified operating conditions to operate against a closed valve or throttled for any period of time exceeding 5 seconds shall be furnished with drivers sized to operate continuously at the power requirement for that condition.

B. Pump Selection:

1. Pumps furnished under this section shall be selected to place all specified continuous duty operating conditions within the manufacturer's Allowable Operating Region (AOR), as defined under ANSI/HI 9.6.3.
2. Pump selection for a given application shall be predicated on locating the specified most frequent operating condition(s) in the Preferred Operating Region (POR) as defined in ANSI/HI 9.6.3. These points will always include Condition Point A and additionally will include any other Condition Points indicated in the detailed specification as continuous duty conditions, or any additionally specified for inclusion in the POR. Condition Point A shall be the pump's rated condition and shall be guaranteed to meet both specified head and flow within the limit established in paragraph 1.07-B - Performance Confirmation.
3. Pump selections proposing maximum diameter impellers for the proposed pump model and casing size will not be accepted.
4. The pumps shall operate without cavitation or damaging vibration over the entire specified range of flow and head conditions.
5. All pumps furnished under sections referencing this section shall be designed in accordance with applicable portions of ANSI/HI 9.1 – 9.6 and ANSI/HI 14.1 – 14.6 and the requirements of this section.
6. Unless otherwise noted or specified, pump head capacity curves shall slope in one continuous curve within the specified operating conditions. No points of reverse slope inflection capable of causing unstable operation will be permitted within the specified zone of continuous duty operation. Pumps with head/capacity curves as described in paragraph 9.6.3.3.12 of ANSI/HI 9.6.3 are specifically prohibited if these characteristics will cause unstable operation within the specified range of operating conditions and where startup/shutdown conditions entail operation against a slow opening/closing valve.

7. Pump discharge column sizes shall be selected to limit the calculated average velocity at peak flow (as defined previously) to no more than 10 feet/second and no less than 5 feet/second.

C. Rotordynamic Analysis:
   1. General:
      a. A Level 1 rotordynamic analysis in accordance with ANSI/HI 9.6.8 shall be conducted as indicated in the Design Requirements table in Part 2 of this section.
      b. Submit Level 1 calculation as indicated below.
      c. All reports, calculations, and recommendations resulting from the required analyses shall bear the seal and signature of the registered professional engineer that performed the analysis.
   2. Level 1 Rotordynamic Analysis
      a. To determine the potential for a critical structural natural frequency occurring within the normal operating speed range of the pump, a level 1 structural dynamic analysis shall be performed of the vertical pump structure in accordance with ANSI/HI 9.6.8 Rotodynamic Pumps Guideline for Dynamics of Pumping Machinery, Table 9.6.8.4. The structural reed critical frequency (RCF) calculation shall be performed in accordance with Section 9.6.8.5.7 and Appendix C. The minimum frequency separation margin obtained by analysis shall be ± 20 percent.

D. Component Design Criteria:
   1. General:
      a. Unless otherwise specified, combined stresses in steel frames and supports shall not exceed those permitted by the American Institute of Steel (AISC) Manual of Practice. Combined stresses in cast, forged, rolled, or fabricated pressure retaining components, frames and supports shall not exceed that allowed for the given material in Section VIII, Division 1 of the ASME Code. Design pressures for pressure-retaining parts shall be not less than twice the pump's shutoff head at the manufacturer's listed maximum operating speed. The pump casing strain at any head on the full speed operating curve (including allowances for increases caused by specified multi-stage applications) shall not result in distortions at the bearing housings greater than the maximum allowable by the bearing manufacturer to provide the specified bearing life.
      b. The term "combined stresses" in this section shall mean the sum of all operating stresses, including stresses induced by dynamic and static forces as developed via the analysis procedures stipulated in this section. Static forces (x, y, z, and moments in all planes) shall include the relevant maximum nozzle loads specified in ANSI/HI 9.6.2 or as stipulated by the pump manufacturer. Dynamic forces shall include both steady state and transient stresses induced by operating conditions within the zone of operation established by the specified operating conditions.
   2. Anchorage and Equipment Mounts:
      a. Anchorage requirements for pumps shall conform to the standards of the Hydraulic Institute. Conform anchorage and equipment support requirement for pumps to the requirements of Section 43 05 13.

b. Connecting bolts for all assemblies supported by other assemblies furnished under this section or sections referencing this section shall be designed in accordance with the latest revisions of the International Building Code (IBC).

c. Provide anchor bolts and connecting bolts for pumps that are designed in accordance with Section 01 73 24. All operation and maintenance (O&M) manuals for pumps and assemblies shall contain criteria for anchor and baseplate bolt torque values.

d. Contractor shall fabricate the new discharge head to match the existing pump discharge head bolt pattern. The contractor shall mount the new discharge head to the existing concrete pump pedestal.

e. Reuse or replace existing base plate anchor bolts. Additional bolts may be added if required for pump anchorage. The Contractor shall hold pump manufacturer responsible for design of the anchor-bolting system. Anchor bolts shall comply with Sections 43 05 13.

f. Provide discharge head and drive unit support that can adapt to existing pump foundation, column piping, and discharge piping. Provide custom fabricated discharge heads if needed to adapt to align with the existing piping.

E. Net Positive Suction Head Margin Limitations:

1. General:

a. Pumps furnished under this section shall meet the NPSH margin limitations set forth in this section and ANSI/HI 9.6.1.

b. For pumps with a NPSH margin 120% of that required in ANSI/HI 9.6.1, NPSH3 tests are not required.

c. Document the method used to determine NPSH3 for the proposed pump and justifying compliance with the NPSH margin limitations established under this paragraph for each specified operating condition in material submitted under paragraph 1.06 - Submittals. Include in the documentation justification of the NPSH3 tests used to develop NPSH3 characteristics, including the following:

1) Date, test procedure, and test logs of original NPSH3 information used to project requirements for the pump selected for the application

2) Test pump size, impeller diameter, impeller model, eye diameter, and speed

3) Calculations projecting NPSH3 test information to NPSH3 curve information for the pump proposed for the application

4) Calculations demonstrating compliance with the NPSH margin requirements established in this paragraph

d. Provide margin calculations justifying the proposed pump selection with the material required under paragraph 1.06 - Submittals. The NPSH margin ratios in ANSI/HI 9.6.1 are the minimum acceptable margin ratios. If the proposed pump requires greater margin ratios to operate within the specified operating conditions without loss of head due to cavitation, then it is the responsibility of the contractor to bear costs associated with achieving the required margin ratio by lowering the elevation of the pump setting, lowering the elevation of the structure, or through other means. Subject any such adjustments to review and acceptance by the Officer-in-Charge if necessary.

e. Individual restrictions are applicable to NPSH margin depending upon the type of pumping equipment and the fluid to be pumped as set forth in ANSI/HI 9.6.1, Table 9.6.1.5.5. Under no circumstances may the absolute value of the NPSH3 margin be less than 3.5 feet.

F. Electric Motors:
   1. General:
      a. Motors shall conform to the requirements of Section 43 05 21 - Common Motor Requirements for Equipment.
      b. Unless otherwise specified, pumps shall be electric motor driven. All motors shall be selected to not exceed a 1.05 service factor condition.
   2. Balance:
      a. Motors rated 50 horsepower and greater shall be precision balanced, conforming to a balance grade of G2.5 per International Organization for Standardization (ISO) 1940-1.
      b. The Contractor shall provide certified balance logs attesting to achieving these requirements, as an Informational Submittal under paragraph 1.06 - Submittals. The chief engineer or person in charge of the test facility shall sign the balance logs.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this section. The manufacturer's standard product may require modification to conform to specified requirements:
   1. Fairbanks Nijhuis
   2. Floway
   3. Flowise
   4. Goulds
   5. Peerless
   6. Approved Equal
B. Units shall meet requirements of AWWA E103 unless modified by these specifications.

2.02 TYPE

A. Constant speed vertical turbine pumps specifically designed for pumping water from a well casing.
B. Complete with suction pipe, a suction case with threads, intermediate bowls, discharge case, impellers, lineshaft, discharge column, discharge head and electric motor.

2.03 PERFOMANCE/DESIGN CRITERIA

A. Service Conditions:
   1. The fluid to be pumped by the equipment furnished under this section will be groundwater. The pumps shall be specifically designed to pump this fluid and shall operate without clogging or fouling caused by material in the pumped fluid within any operating condition within the range of service specified.

B. Operating Conditions:

1. The operating conditions shall match the operating conditions of the existing pumps. Equipment furnished under this section shall be fully suitable for continuous operation at the specified conditions in the following table. The notes presented at the end of the table are intended to be complimentary to the information presented in the table.

Equipment number	P-501	P-601
Operating Condition		
Pump Setting Depth, ft	120	120
Full Speed, Condition A[1,2]		
Capacity, gpm	800	1000
Head, ft	294	315
NPSHA, feet	120	130

Notes:

1. *Condition A shall be taken as the rated operating condition. Condition A shall be used for pump selection. Performance at the rated condition shall be guaranteed in accordance with paragraph 1.07.B - Performance Confirmation. Condition A has been selected to obtain the rated pumping capacity for the installation. Provide pumps under this section to achieve Condition A performance, but also operate continuously without objectionable vibration or cavitation. Condition A shall be located in the Preferred Operating Region as established by the pump manufacturer in accordance with ANSI/HI 9.6.3 and listed in the manufacturer's published application data for the specific model proposed for this application.*
2. *Total head in the above tabulation is the algebraic difference between the discharge head and suction head as defined in ANSI/HI 14.6. Net positive suction head available (NPSHA) in the above tabulation is referenced to the project elevation of 682 and 642 feet above sea level and is calculated in accordance ANSI/HI 14.3 for average barometric pressure and maximum temperature conditions, and has been adjusted to the first bowl elevation noted on the drawings. Calculated NPSHA has been reduced by five feet as an allowance for uncertainties associated with the pumped fluid and well conditions, and no reduction in NPSH margin limitations specified in paragraph 1.08-E - Net Positive Suction Head Margin Limitations will be permissible due to the inclusion of this allowance.*

C. Design Requirements:

Pump		
Equipment number	P-501	P-601
Discharge head size, (Column x discharge, inches)	8 x 8	8 x 8
Efficiency, min., percent[1]	77%	80%
Bowl efficiency, min., percent[1]	81%	81%
Rotordynamic Analysis Level (ANSI/HI 9.6.8)	1	1
Motor (Section 43 05 21)		
Horsepower, maximum, HP	75	100
Speed, maximum, rpm	1800	1800
Service Factor	1.15	1.15
Volt/Hertz/Phase	460/60/3	460/60/3
Motor Type	TEFC	TEFC

Full Load Motor Efficiency, min., percent	95%	95%
Full Load Motor power factor, min., percent	85%	85%
Well		
Casing ID, inches	14	14

Note:

1. *The efficiency is the minimum acceptable peak efficiency and is required to coincide with operating Condition A in paragraph 2.03-B – Operating Conditions.*
2. *All components of the specified equipment shall be designed and sized for equipment weight plus the maximum hydraulic downthrust at all points on the pumping curve. Additionally, pumps shall be provided with drivers having a momentary upthrust capacity equal to or exceeding 30 percent of the downthrust rating. Driver shall allow operation up to a 1.05 service factor condition.*

2.04 SYSTEM OPERATION

A. Constant speed pumps will be started and stopped remotely, based on SCADA input.

2.05 MATERIALS

A. Materials shall conform with the following:

Component	Material
Bowl assembly, suction case and discharge case	Cast iron, ASTM A48, Class 30
Discharge column pipe and suction pipe	Carbon Steel, ASTM A53, Grade B, Schedule 40
Headshaft	Stainless Steel, ASTM A582, Type 416
Impeller	Stainless steel, ASTM A193, Type 316
Pump (bowl) shaft	Stainless steel, ASTM A582, Type 416
Pump (bowl) bearings and wear rings	Bronze, ASTM B584 or B505
Stuffing box assembly	Cast iron, ASTM A48
Stuffing box gland parts	Bronze, ASTM B584
Lineshaft	Stainless steel, ASTM A582, Type 416
Lineshaft bearings	ThorPlas-White or approved equal
Discharge head	Fabricated Steel
Bolts, studs, and nuts	Stainless steel, ASTM A193, Type 316
Bearing Retainers	Bronze, ASTM B584 or B505

2.06 COMPONENTS

A. Suction Pipe:
   1. The case and bowl assembly suction case shall be provided with a suction pipe and shall extend 5 feet below the pump. Suction Case:
   2. The suction case shall be designed to provide conservative entrance velocities and evenly distribute the flow to the impeller. The inner surface of the case shall be smooth and free from projections or cavities. The pump shaft lower bearing shall be housed in a streamlined casing, centered and held in place by means of rigid cast vanes. The bearing housing and vanes shall be designed to conduct the flow efficiently into the impeller eye.

B. Pump Bowl:
   1. The pump bowl shall be flanged for registered fit.

2. Bowl assembly shall be equipped with wear rings. One bowl wear ring shall be installed for each bowl in the bowl assembly. Bowl wear rings shall be installed by the Manufacturer on the suction side of the bowl seat.

C. Impeller:
   1. The impeller shall be constructed free from projections, cavities, or abrupt transitions. The impeller surfaces shall be stainless steel per table in paragraph 2.05 - Materials.
   2. Impellers shall be of the enclosed type, with the shroud designed to rotate against wearing rings installed in the bowl assembly. Impellers shall be secured to the pump shaft using tapered collets.

D. Shafts:
   1. Shafts shall be sized to prevent excessive elongation and transmit the rated driver horsepower without distortion in both the forward and reverse direction. Shafts shall have a first critical speed not less than 20 percent above maximum operating speed. The pumping units shall utilize a two-piece headshaft, solid intermediate lineshafts supplied in nominal 10 foot lengths, and a single pump shaft shall be provided extending from the suction case through the discharge case or upper bowl case containing an upper pump shaft bearing. All shafts shall be threaded with left-handed threads.

E. Bearings:
   1. Suction case and bowl bearings shall be close tolerance, sleeve type. The suction case bearing shall be grease lubricated. Bowl sleeve bearings shall be lubricated by the pumped fluid.

F. Discharge Column:
   1. Discharge columns shall be fabricated with interchangeable pipe sections and shall be joined with threaded couplings. The column shall be supplied in sections not exceeding 10 feet in length.
   2. The water level access tube shall be strapped to the column pipe every 10-feet using Type 316 Stainless Steel straps and shall extend from the discharge head to the top of the bowl assembly.

G. Discharge Head:
   1. The fabricated steel discharge head shall be of the aboveground discharge type. The discharge elbow shall be long radius and form a smooth 90-degree transition. The discharge head shall provide a mounting base for the motor and be mounted to the existing concrete pad. Brackets, cartridges and drilled ports as required shall be provided for all monitoring devices.
   2. The surface discharge outlet shall be flanged. Flanges shall be ANSI B16.1, Class 300.
   3. Access to the stuffing box shall be placed 90-degrees from the discharge through windows. Fit hand-holes and/or windows with Type 304 stainless steel, hinged, expanded metal guards to protect the exposed shaft, coupling, and packing box.
   4. The base of the fabricated steel discharge head shall be provided with (1) separate 2-inch port for the water level access tube. (1) 1-1/4" diameter PVC SCH 80, solvent welded tube shall be installed for the water level measuring access installation.
   5. The discharge head shall be designed to support the entire weight of the pump, motor and discharge column, including water. All discharge head penetrations shall be sealed to prevent the entrance of surface water and contaminants.

6. The discharge head shall contain two lifting eyes, one on each side of the discharge elbow. Lifting eyes shall be capable of withstanding the full weight of the pump, motor, and discharge column.

H. Packing Box
   1. The pump lineshaft shall penetrate the discharge head through a high pressure (150#) type packing box.
   2. The design of the packing box shall provide space and clearance for removal and service of packing without moving or disconnecting the motor.
   3. The packing shall incorporate four rings (minimum) of packing, a lantern ring, a grease zerk, stuffing box bearing, a packing gland, and an "O" ring seal.
   4. The packing shall be of a regular braid, square cross-section and impregnated non-asbestos material, such as Garlock Style 8922, SEPCO ML2236, John Crane C1056, or approved equal.
   5. Provisions shall be made to drain the lubrication leakage from the discharge head.

I. Lineshaft Bearings
   1. The lineshaft shall be supported throughout the column pipe with bearing retainers. The bearing retainers shall be located at each column pipe joint, but in no case shall exceed more than 10-foot centers.
   2. Lineshaft bearings shall be ThorPlas-White or equal and be encapsulated in bronze bearing retainers.

J. Couplings:
   1. Lineshaft couplings shall be a perfect butt-fit. They shall be designed with a safety factor of 1.5 times the shaft safety factor and shall have a left-hand thread to tighten during pump operation.

K. Nameplates:
   1. A stainless steel nameplate shall be affixed to the pump discharge head, and shall contain the name and address of the pump manufacturer and shall have stamped thereon the serial number of the pump, the rated head and capacity, speed in rpm, the size and the catalog number of the bowl assembly, the month and year in which the pump was shipped to the Owner, and the number of stages in the bowl assembly.

L. Drive Unit:
   1. The pump shall be driven by a vertical motor conforming to paragraph 1.08 - Design Requirements and Section 43 05 21 - Common Motor Requirements for Equipment.
   2. Motors shall be provided with non-reverse ratchet device that prevents backspin of the pump.

2.07 GENERAL QUALITY

A. All equipment shall be designed to permit rapid and economical maintenance. Major parts, such as casing components and bearing housings, shall be designed and manufactured to ensure accurate alignment on reassembly. This may be accomplished by the use of dowels or keys.

2.08 BALANCE

A. Balancing for pumps with suction nozzle sizes 6 inches in diameter and greater and all associated components shall conform to the requirements set forth ISO 1940 or ANSI 2.19 Grade 2.5. Major rotating elements (e.g. impellers) and shafts shall be separately balanced and then together as an assembly or "rotor." All rotors shall be dynamically balanced to an ISO 1940 G6.3 minimum for rotating speeds up to 1800 RPM. For extended shaft pumps, the rotor is defined to be the impeller(s) and shaft(s) up to the first coupling with the line-shaft.

B. All balance logs, certified correct and signed by an officer of the manufacturing corporation, shall be furnished as an Information Submittal in accordance with paragraph 1.06 - Submittals.

PART 3 EXECUTION

3.01 INSTALLATION

A. Equipment shall be installed in accordance with Section 43 05 11.

B. The Manufacturer shall provide the Contractor with detailed recommendations and instructions for installation of the equipment specified in this Section.

3.02 MANUFACTURERS FIELD SERVICES

A. Manufacturer shall provide assistance during equipment instrumentation and controls systems installation as required by the Contractor.

B. The equipment provided under this section shall be started and tested only under the direction of personnel provided by the Manufacturer. Field services by the Manufacturer shall be provided as required to support the receipt/inspection upon arrival, installation, field testing and commissioning, and training of the equipment supplied in order to provide a fully functioning system in accordance with the Contract Documents. The following minimum field services shall be provided. These are set as minimum requirements and additional time may be required as deemed necessary by the Manufacturer and Contractor to provide a fully functioning system.

   1. Installation: 3 days
   2. Field Services and Commissioning: 1 days
   3. Training: Reference paragraph 3.07 - Training of this section.

3.03 FIELD TESTING

A. After the completion of installation, each pumping unit shall be field tested to demonstrate compliance with the requirements of Sections 01 45 20 and 01 45 23.

B. Disposal of water during the testing operation shall be discharged to an Owner-approved discharge location. Approval is required for each well site before disposal of water operations begin.

C. 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. Field tests shall consist of measuring flow, discharge pressure, and pumping water level at a minimum of five (5) points evenly spaced on the pump curve.

D. Each control device, item of mechanical, electrical, and instrumentation equipment, and control circuits shall be considered in the testing procedures to demonstrate that the equipment has been properly serviced, aligned, connected, calibrated, and adjusted prior to operation. Field vibration shall be confirmed by testing and shall conform to paragraph 3.06 - Field Vibration.

3.04 WATER QUALITY TESTING

A. The well shall be purged for a sufficient period of time so that construction sediments are removed from the casing per State and Federal requirements. The Contractor shall sample the well within the first minute of operation and then sample the well every ten minutes thereafter for a minimum of the first hour of operation. The well shall be pumped until the sample is clear and no sediment is observed as approved and directed by the Officer-in-Charge. The Contractor shall be responsible for all pumping costs, disposal or storage of water, and any associated permits.

3.05 FIELD VIBRATION

A. Pumps shall require field vibration testing per ANSI/HI 9.6.4. An independent testing laboratory specializing in this work, retained by the Contractor but acceptable to the Officer-in-Charge, shall perform the measurements and shall submit the results directly to the Officer-in-Charge.

B. The independent testing laboratory shall be fully equipped to provide continuous velocity and displacement values for all rotating equipment installed under the requirements of this section. Vibration readings shall be taken at all bearing pedestals in the horizontal and vertical radial direction and axial direction. Vibration testing equipment shall include sufficient calibrated pressure and flow monitoring devices to determine pump operating conditions as well as vibration levels. Overall (RMS) vibration velocity and discrete frequencies, when the pump is operating at any specified continuous duty operating condition, shall not exceed the limits established for the appropriate machine by ANSI/HI 9.6.4.4.

C. Vibration test reports shall be submitted as an informational submittal and shall bear the signature of the responsible vibration specialist. Vibration spectra shall be of sufficient resolution for legibility of magnitude and frequency data to be properly reviewed. Separate spectra shall be provided at the maximum and minimum operating speeds and any potential resonant frequencies.

3.06 TRAINING

A. Procedures: Section 01 79 00.

B. Provide a minimum of 8 hours classroom training for each training session. Conduct two training sessions, one training session per week on two consecutive weeks to accommodate the shift schedules of operation and maintenance staff. Certify completion of training on Form 43 05 11-B, Section 01 99 90.

3.07 MEASUREMENT AND PAYMENT

A. The work of this Section shall be paid for per the specified line item in the Proposal Schedule.

END OF SECTION

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