EAST BAY MUNICIPAL UTILITY DISTRICT

October 9, 2024

ADDENDUM # 3

TO PROSPECTIVE BIDDERS OF SD-428, MWWTP OXYGEN PLANT REHABILITATION

Notice is hereby given that Volumes I-A, I-B, II-A, II-B, and III of the SD-428 Contract Documents have been revised as follows:

VOLUME I-A – BIDDING DOCUMENTS AND SPECIFICATIONS (DIVISIONS 00-01)

1. On the Cover of Volume I-A: **REMOVE** the bid opening date of "Wednesday, October 23, 2024." and **REPLACE** with new bid opening date "Wednesday, October 30, 2024."

2. Document 00 11 13 Notice to Contractors: In the first paragraph, **REMOVE** the bid opening date of "Wednesday, October 23, 2024" and **REPLACE** with new bid opening date "Wednesday, October 30, 2024."

3. Document 00 01 07 Professional Seals and Certifications: **REMOVE** and **REPLACE** with REVISED Document 00 01 07 Professional Seals and Certifications.

4. Document 00 01 10 Table of Contents: **REMOVE** and **REPLACE** with REVISED Document 00 01 10 Table of Contents.

5. Specification 01 75 17 Field Testing and Startup: **REMOVE** and **REPLACE** with REVISED Specification 01 75 17 Field Testing and Startup.

   NOTE: Changes to Document 00 01 10 Table of Contents and Specification 01 75 17 Field Testing and Startup are shown as follows: additions are underlined and deletions are crossed out.

VOLUME I-B – APPENDICES

6. On the Cover of Volume I-B: **REMOVE** the bid opening date of "Wednesday, October 23, 2024." and **REPLACE** with new bid opening date "Wednesday, October 30, 2024."

7. Document 00 01 07 Professional Seals and Certifications: **REMOVE** and **REPLACE** with REVISED Document 00 01 07 Professional Seals and Certifications.

8. Document 00 01 10 Table of Contents: **REMOVE** and **REPLACE** with REVISED Document 00 01 10 Table of Contents.

   NOTE: Changes to Document 00 01 10 Table of Contents are shown as follows: additions are underlined and deletions are crossed out.

VOLUME II-A – TECHNICAL SPECIFICATIONS (DIVISIONS 02-26)

9. On the Cover of Volume II-A: **REMOVE** the bid opening date of "Wednesday, October 23, 2024." and **REPLACE** with new bid opening date "Wednesday, October 30, 2024."

10. Document 00 01 07 Professional Seals and Certifications: **REMOVE** and **REPLACE** with REVISED Document 00 01 07 Professional Seals and Certifications.

11. Document 00 01 10 Table of Contents: **REMOVE** and **REPLACE** with REVISED Document 00 01 10 Table of Contents.

    NOTE: Changes to Document 00 01 10 Table of Contents are shown as follows: additions are underlined and deletions are crossed out.

VOLUME II-B – TECHNICAL SPECIFICATIONS (DIVISIONS 27-46)

12. On the Cover of Volume II-B: **REMOVE** the bid opening date of "Wednesday, October 23, 2024." and **REPLACE** with new bid opening date "Wednesday, October 30, 2024."

13. On the Cover of Volume II-B: **REMOVE** the heading:

    "TECHNICAL SPECIFICATIONS
    (DIVISIONS 27-40)"

    And **REPLACE** with:

    "TECHNICAL SPECIFICATIONS
    (DIVISIONS 27-46)"

14. Document 00 01 07 Professional Seals and Certifications: **REMOVE** and **REPLACE** with REVISED Document 00 01 07 Professional Seals and Certifications.

15. Document 00 01 10 Table of Contents: **REMOVE** and **REPLACE** with REVISED Document 00 01 10 Table of Contents.

16. Specification 40 05 13 Process Pipe and Fittings: **REMOVE** and **REPLACE** with REVISED Specification 40 05 13 Process Pipe and Fittings.

17. Specification 40 81 00 System Integrator Qualifications: **REMOVE** and **REPLACE** with REVISED Specification 40 81 00 System Integrator Qualifications.

18. Specification 46 31 48 Cleaning for Oxygen and Ozone Service: **REMOVE** and **REPLACE** with REVISED Specification 46 31 48 Cleaning for Oxygen and Ozone Service.

    NOTE: Changes to Document 00 01 10 Table of Contents, Specification 40 05 13 Process Pipe and Fittings, Specification 40 81 00 System Integrator Qualifications, and

Specification 46 31 48 Cleaning for Oxygen and Ozone Service are shown as follows: additions are underlined and deletions are crossed out.

VOLUME III – DRAWINGS

19. Drawing SD428-W4400-G002 DRAWING INDEX – VOLUME III: **INSERT** the following after row SD428-W4400-M901D under **MECHANICAL** drawings:

SD428-W4400-M102.7D	0	PHOTOS 1
SD428-W4400-M102.8D	0	PHOTOS 2
SD428-W4400-M103D	0	DEMOLITION PLAN LOX STORAGE AREA
SD428-W4400-M103	0	PIPING PLAN LOX STORAGE AREA

20. Drawing SD428-W4400-M103D: **REMOVE** the drawing name "PIPING PLAN LOX STORAGE AREA" and **REPLACE** with "DEMOLITION PLAN LOX STORAGE AREA".

21. Drawing SD428-W4400-E102.3D PARTIAL POWER AND SIGNAL DEMOLITION PLAN 3: **REMOVE** W-44-02-FY-600-1-1 and W-44-02-FY-600-2-1 from the scope of work. The midpoint temperature control solenoids are being removed from the work.

22. Drawing SD428-W4400-E102.3 PARTIAL POWER AND SIGNAL PLAN 3: **REMOVE** W-44-02-FY-600-1-1, W-44-02-FY-600-2-1, C301D, and C301E from the scope of work. The midpoint temperature control solenoids and associated conduits are being removed from the work.

23. Drawing SD428-W4400-E102.4D PARTIAL POWER AND SIGNAL DEMOLITION PLAN 4: **REMOVE** W-44-02-FY-600-2-1 and W-44-02-FY-600-1-2 from the scope of work. The midpoint temperature control solenoids are being removed from the work.

24. Drawing SD428-W4400-E102.4 PARTIAL POWER AND SIGNAL PLAN 4: **REMOVE** W-44-02-FY-600-1-2, W-44-02-FY-600-2-2, C351D, and C351E from the scope of work. The midpoint temperature control solenoids and associated conduits are being removed from the work.

25. Drawing SD428-W4400-E121 CONDUIT SCHEDULE 1 CONTROLS: **REMOVE** from the CONDUIT SCHEDULE – CONTROLS rows C301D, C301E, C351D, and C351E. The conduits are associated with midpoint temperature solenoids that are being removed from the work.

26. Drawing SD428-W4400-E507-517 RIO-15-3 TURBINE/CRYO PLANT 1 PANEL I/O MODULE SCHEMATIC: **REMOVE** solenoid W-44-02-FY-600-1-1 OXYGEN PRODUCT MID-POINT TEMPERATURE CONTROL VALVE #1 from the DCS output module circuit on branch 2, module 8, channel TB 1. **REMOVE** solenoid W-44-02-FY-600-1-2 OXYGEN PRODUCT MID-POINT TEMPERATURE CONTROL VALVE #2 from the DCS output module circuit on branch 2, module 8, channel TB.

27. Drawing SD428-W4400-E508-516 RIO-23-3 TURBINE/CRYO PLANT 2 PANEL I/O MODULE SCHEMATIC: **REMOVE** solenoid W-44-02-FY-600-2-1 OXYGEN PRODUCT MID-POINT TEMPERATURE CONTROL VALVE #1 from the DCS output module circuit on branch 2, module 5, channel TB 5. **REMOVE** solenoid W-44-02-FY-600-2-2 OXYGEN PRODUCT MID-POINT TEMPERATURE CONTROL VALVE #2 from the DCS output module circuit on branch 2, module 5, channel TB 6.

    NOTE: Edits to the drawings by this Addendum will be incorporated in the Conformed Set.

BIDDERS MUST ACKNOWLEDGE RECEIPT OF THIS ADDENDUM ON THE BID FORM FOR CONSIDERATION OF THE BID BY THE DISTRICT.

Garin Warren

GARIN D. WARREN
Manager of Wastewater Engineering

♦

MAIN WASTEWATER TREATMENT PLANT OXYGEN PLANT REHABILITATION (SD-428)

♦

CONTRACT DOCUMENTS

VOLUME II-B OF IV

TECHNICAL SPECIFICATIONS
(DIVISIONS 27-~~40~~46)

JUNE 2024

SPECIFICATION SD-428

EAST BAY MUNICIPAL UTILITY DISTRICT
SPECIAL DISTRICT NO. 1
OAKLAND, CALIFORNIA

Bids will be opened at 1:30 pm, Wednesday, October 23, 2024 in the Board Room, Second Floor of the District's Administration Building, 375 11th Street, Oakland, California

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EBMUD

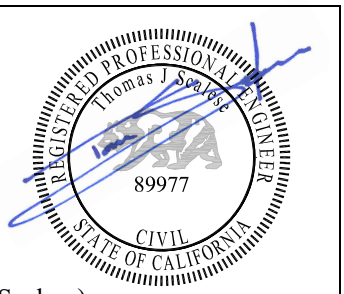
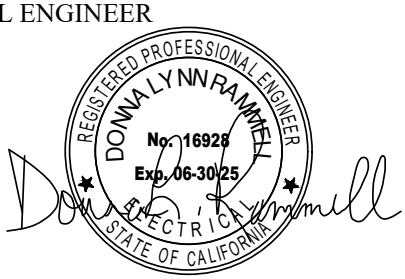
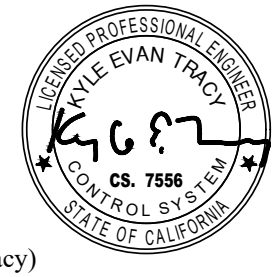
EAST BAY MUNICIPAL UTILITY DISTRICT
SPECIAL DISTRICT NO. 1
OAKLAND, CALIFORNIA

SECTION 00 01 07

PROFESSIONAL SEALS AND CERTIFICATIONS

GENERAL

The following design professionals have signed and sealed the original specifications for this project in accordance with the List of Specification Sections.

CIVIL ENGINEER  Dave Richardson (D. Richardson) Woodard & Curran California License: 37097	CIVIL ENGINEER  Thomas Scalese (T. Scalese) Woodard & Curran California License: 89977
ELECTRICAL ENGINEER  Donna Rammell (D. Rammell) Woodard & Curran California License: E16928	CONTROLS ENGINEER  Kyle Tracy (K. Tracy) Woodard & Curran California License: C7556
CIVIL ENGINEER  John Law (J. Law) East Bay Municipal Utility District California License: 95046	FIRE PROTECTION ENGINEER  Christian Ng (C. Ng) Fire & Risk Alliance, California License: 2132

SPECIFICATION SECTION AND TITLE	DESIGN PROFESSIONAL SEAL BY
DIVISION 00 – PROCURMENT AND CONTRACTING DOCUMENTS - ALL SECTIONS	D. Richardson
DIVISION 01 – GENERAL REQUIREMENTS – ALL SECTIONS	D. Richardson
DIVISION 02 - EXISTING CONDITIONS – ALL SECTIONS	D. Richardson
DIVISION 03 – CONCRETE – ALL SECTIONS	T. Scalese
DIVISION 05 – METALS – ALL SECTIONS	T. Scalese
DIVISION 07 – THERMAL AND MOISTURE INSULATION – ALL SECTIONS	D. Richardson
DIVISION 09 – FINISHES – ALL SECTIONS	J. Law
DIVISION 21 – FIRE SUPPRESSION – ALL SECTIONS	C. Ng
DIVISION 22 – PLUMBING	
22 05 00 Air Compressor Motors	D. Richardson
22 05 29 Hangers and Supports for Plumbing Piping and Equipment, 22 05 53.05 Pipe Identification, 22 11 16 Domestic Water Piping, 22 11 19 Domestic Water Piping Specialties	J. Law
DIVISION 26 – ELECTRICAL – ALL SECTIONS	D. Rammell
DIVISION 27 – COMMUNICATIONS – ALL SECTIONS	K. Tracy
DIVISION 28 – ELECTRONIC SAFETY AND SECURITY – ALL SECTIONS	C. Ng
DIVISION 40 – PROCESS INTEGRATION	
Sec. 40 05 13 - PROCESS PIPE AND FITTINGS	D. Richardson
Sec. 40 05 15 - PROCESS PIPE SUPPORTS	D. Richardson
Sec. 40 05 23 (a & b) - PROCESS VALVES	D. Richardson
All remaining sections – PROCESS INTEGRATION	K. Tracy
DIVISION 43 - PROCESS GAS AND LIQUID HANDLING, PURIFICATION, AND STORAGE EQUIPMENT – ALL SECTIONS	G. Warren

SPECIFICATION SECTION AND TITLE	DESIGN PROFESSIONAL SEAL BY
DIVISION 46 – WATER AND WASTEWATER EQUIPMENT – ALL SECTIONS	G. Warren

END OF SECTION

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SPECIFICATION SD-428

MAIN WASTEWATER TREATMENT PLANT OXYGEN PLANT REHABILITATION

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APPENDICES

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END OF SECTION

DOCUMENT 00 11 13

NOTICE TO CONTRACTORS

Sealed proposals will be received in the office of the Purchasing Division, East Bay Municipal Utility District, 375 11th Street, First Floor, Oakland, California 94607, until 1:30 p.m. Wednesday, October 30~~23~~, 2024, and will at that hour be publicly opened and read in the Board Room, Second Floor, of the District's Administration Building, for the Main Wastewater Treatment Plant Oxygen Plant Rehabilitation, under SD-428.

Work includes demolition and replacement of motors, valves, instruments, controls, and other appurtenances associated with the cryogenic oxygen production facility at East Bay Municipal Utility District's Main Wastewater Treatment Plant (MWWTP). Existing pneumatic controls will be replaced with new electronic instruments and controls. The work also includes re-coating of existing steel cold boxes, new controls, integration of controls into the MWWTP's distributed controls system (DCS), fire protection, fall protection, seismic retrofit of panels, and all materials, equipment, services, and construction inherent to the Work.

Estimated cost of this work is between $9.0M and $10.0M. All work covered by the contract shall be completed as follows: Operational Completion within 751 calendar days after the issuance of the Notice to Proceed, and Final Completion within 811 calendar days after issuance of the Notice to Proceed.

The District will conduct a MANDATORY pre-bid jobsite conference/inspection to familiarize prospective bidders with the project site and conditions. Bidders submitting a bid must attend the pre-bid conference for their bid to be responsive. Attendees will be required to sign a waiver prior to entering the plant site. See Appendix A for waiver. The pre-bid meeting will be conducted on July 30, 2024 at 9:00 a.m. Bidders/bid walk attendees (Attendees) shall assemble at 2020 Wake Avenue, Oakland, California 94607. This is the only time that the Oxygen Plant will be open for inspection. The conference/inspection will last approximately 2 hours. No photography by the Attendees will be allowed. The District will take photographs, as requested by the Attendees, restricted to the work zone. The District will release photographs to Attendees after the bid walk, pending review by District. All Attendees are required to have a photo ID and sign a confidentiality agreement not to share, sell, or publish photos.

The Prime Contractor and its subcontractors are strongly encouraged to attend the jobsite inspection where a "sign-in" sheet will be provided. Requirements of the District's Contract Equity Program, including the pilot Local Hire component, will be discussed and explained at the pre-bid meeting.

Project information, including plans, specifications, plan holders list, bid results, etc., can be found at https://construction-bids.ebmud.com/CurrentorFutureBid.aspx?BidMode=Current. The District will make its best efforts to include information provided by bidders obtaining plans and specifications, such as bidder's names, addresses, phone and fax numbers, and email and website addresses, on the website plan holders list.

For review purposes, prospective bidders may obtain the Contract Documents by downloading the files from the District's website. Prospective bidders who download the documents from the website shall register online or send an email to wwspecs@ebmud.com (include first and last name, business name, address, phone number, fax number, email address, MBE/WBE status if applicable, and the specification you wish to be listed for) in order to be included on the Plan Holders List. Hardcopy sets of the Contract Documents will not be provided. In order to submit a bid, prospective bidders shall request an electronic bid package (electronic copies of all forms required for submitting a bid) via email. Bidders shall print the forms out and submit their bid proposals via hardcopy. Wet-signed copies of all forms are required. To request the bid package, prospective bidders shall visit the project website at Current Construction Bids at https://construction-bids.ebmud.com/Request.aspx and submit a request through the "Request a Bid Set" link.

Proposals to perform the work shall be made on the forms provided and shall be submitted complete, including bid bond and list of subcontractors, in accordance with the requirements of the Specifications.

Refer to Appendix C in the Specifications for details pertaining to sole source products specified by the District.

Bidders shall have an active Class A (General Engineering) license from the Contractors' State License Board at the time of bid submission, which must remain valid throughout the duration of the contract. Refer to Article 21 of the Instruction to Bidders, Document 00 21 13.

A bidder's bond for not less than 10% of the total bid dollar amount is required. Performance and payment bonds for not less than 100% of the contract price are required. As provided in Section 22300 of the Public Contract Code of the State of California, the Contractor may substitute securities for monies withheld by the District to ensure performance of the work.

In accordance with Public Contract Code Section 3400, the District has established a procedure which permits bidders to have their proposed unlisted "or equal" product or service submittals evaluated prior to the project bid opening. See Instructions To Bidders, Document 00 21 13, Article 3 - "Submittals Prior To Opening Bid." This procedure does not apply where products or services have been limited by specific designation per Public Contract Code Section 3400 (c). The intent of the prequalification process is not for bidders to submit all of their proposed "or equal" products, but only those that would, if rejected, affect the bidder's bid amount.

This is a public works contract. Prevailing wages are required on this contract. The prevailing wage rates are available on the Internet at http://www.dir.ca.gov/dlsr/DPreWageDetermination.htm. A copy of the prevailing wage rates is on file and available for inspection by any interested party on request at the District's Wastewater Project and Construction Management Section. This project is subject to compliance monitoring and enforcement by the Department of Industrial Relations.

Davis-Bacon prevailing wages are required on this contract. The Davis-Bacon prevailing wage rates are available on the Internet at https://www.wdol.gov/dba.aspx . The Contractor and its subcontractor of any tier shall pay no less than the locally prevailing wages and fringe benefits paid on projects of a similar character. This project is subject to compliance monitoring and enforcement by the Department of Labor.

All Contractors bidding on a public works project and all Subcontractors of any tier shall be registered with the State Department of Industrial Relations pursuant to Section 1725.5 of the Labor Code. If awarded a contract, the Contractor and its subcontractors, of any tier, shall maintain active registration with the Department of Industrial Relations for the duration of the Project.

As provided in Section 22300 of the Public Contract Code of the State of California, the Contractor may substitute securities for monies withheld by the District to ensure performance of the work.

For information concerning this project, contact the District's Construction Manager, John Law, at 510-287-7186.

Rischa S. Cole
Secretary of the District
Oakland, California

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SECTION 01 75 17

FIELD TESTING AND STARTUP

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section covers general equipment and system testing and startup requirements, services of the manufacturer's representatives and special coordinating services required of the Contractor that shall apply during construction. Specific testing and tracking procedures and requirements found in the Technical Specifications shall also apply. Where testing and tracking procedures and requirements differ from requirements of this section, the more stringent shall apply.

B. The Contractor shall inform all subcontractors and manufacturers of the requirements herein and include the required services in the costs for the work specified in these Contract Documents. Where a minimum amount of time is stated in the Technical Specifications for manufacturers' services, any additional time required to perform the specified services shall be provided at no additional cost to the District.

C. Equipment testing and plant startup are requisite to satisfactory completion of the Contract and, therefore, shall be completed within the contract time. All equipment testing and plant startup activities shall be realistically allowed for and shown on the Contractor's Construction Progress Schedule, in accordance with Section 01 32 00 Construction Progress Documentation.

D. All equipment testing and plant startup activities shall be scheduled in conformance with the restrictions specified in Sections 01 14 00 Work Restrictions and 01 35 13 Special Project Procedures.

E. Equipment testing shall be satisfactorily completed prior to commencing plant startup associated with the particular equipment item or equipment package. The equipment shall not be considered ready for testing until the following conditions are satisfied:

1. Manufacturer's certification of equipment installation has been accepted by the Engineer.

2. Electrical and/or instrumentation subcontractor certification of motor control logic has been accepted by the Engineer.

3. Related Technical Submittals, O&M Manual and Final Shop Drawings have been accepted by the Engineer.

4. Operator training services have been furnished by the Contractor (must be completed prior to operational testing only), per Section 01 79 00 Demonstration and Training.

5. Testing procedures have been submitted in writing and accepted by the Engineer in accordance with Section 01 33 00, Submittal Procedures. All testing procedures and results shall be submitted in writing.

F. The requirements of plant startup specified herein shall also apply to the startup of individual treatment plant processes and facilities.

1.2 DEFINITIONS

A. Test Procedures: Test procedures shall include testing methods, acceptance criteria, procedures, and test data forms for functional, performance and startup tests.

B. Functional Test: The field testing required to determine if installed equipment or system will operate in a satisfactory manner and as specified. The Functional Test is a point-by-point test to confirm that all components associated with the equipment or system is operating properly. Functional testing is not intended to measure efficiency and performance.

C. Performance Test: The field testing required to demonstrate the individual equipment or system meets all of the specified performance requirements.

D. Startup Operational Test: A test of all systems operating together to demonstrate satisfactory performance of the facility as a whole for a continuous period.

E. Startup: The process of performing startup testing of the facility, which includes functional test, performance test, and startup/operational test.

1.3 FIELD TESTING INSTRUMENTS

A. Contractor shall provide all instruments and materials necessary to complete the field tests unless otherwise specified.

B. All instruments shall be calibrated. Certificates of calibration shall be current, and shall be at the job site during testing and provided upon request or when specified.

1.4 QUALITY ASSURANCE

A. All tests shall be subject to approval of the Engineer, and shall be witnessed by the District.

1.5 SUBMITTALS

A. Not less than ninety (90) calendar days prior to initial equipment or system startup, the Contractor shall submit to the Engineer for review, a detailed Facilities Startup Plan for the associated items of equipment and/or systems. The Plan shall be updated and/or revised as necessary prior to subsequent Construction Progress Meetings. Testing shall not be scheduled until the Plan is approved. Said Plan shall include:

1. A detailed sub-network of the Contractor's Construction Progress Schedule including the following activities: Manufacturer's Services; Installation Certifications; O&M Manual submittal; Functional Testing; Performance Testing; Operator Training; Startup Operational Testing; and all other activities necessary to effect a coordinated and successful Testing, Training and Startup.

2. Written test procedures with proposed checklists for each item of equipment to be tested and acceptance criteria indicating an acceptable test result. Separate procedures shall be provided for functional, performance, and operational testing.

3. A discussion of any coordination required with District staff and/or any system or equipment outage requirements.

B. Furnish names and telephone numbers of manufacturer's and vendor's current technical service representatives for use by the Engineer.

1. For preconstruction meetings, construction sequencing, outage of cryogenic equipment and process piping, functional testing, performance testing, and startup of the oxygen production system, including Main Air Compressors, cold boxes, and liquid oxygen process systems, Contractor shall employ a Cryogenic Oxygen Plant specialist firm with a record of having successfully executed startups at least five Union Carbide “U” series cryogenic oxygen plants in the previous five years. Submit firm’s qualifications, including reference contacts from at least five Union Carbide “U” series plants to the District for review.

2. The Contractor’s Cryogenic Oxygen Plant specialist shall at a minimum be involved in the following activities:

a. Reviewing Contractor’s submittals including work plans, baseline construction schedule/construction sequencing documents, project safety documents, and technical submittals.

b. Reviewing project test plans including start-up of major equipment, testing checklists, and system outage requests.

c. Attending training for cryogenic oxygen equipment provided in accordance with Section 01 79 00, Demonstration and Training.

C. At least sixty (60) calendar days prior to startup, provide a list of the manufacturer's recommended lubricants for use in the plant. All equipment lubrication shall be listed with the lubricant types and quantities recommended and approved by the equipment manufacturers. Provide the necessary lubricants for startup and the initial sixty (60) days of operation.

D. Upon completion of testing for each equipment item or system, the Contractor shall submit typewritten or word processed test reports and forms for review and acceptance. Submit test results with signed statement by manufacturer's representative that results meet specification requirements and manufacturer standards; when a manufacturer's representative is not required to be present during testing, this signed statement shall be provided by the Contractor. Upon acceptance, all test reports (including all factory and field testing) shall be inserted by the Contractor into their respective O&M manuals.

E. Final cold box leak check plan and P&ID markups of as-built conditions at least sixty (60) calendar days prior to startup of a cold box.

1.6 SYSTEM STARTUP AND TESTING

A. General:

1. The Contractor shall provide the effective coordination of all parties necessary for the successful project startup.

   The Engineer shall not be responsible to instruct the Contractor in the startup of the project, however, the Engineer will be available prior to and during startup to provide operational and technical support to the Contractor.

   The Engineer will be available to advise the contractor on any equipment or system startup that has, or could, have an effect on a plant operating process.

2. The Contractor shall furnish all labor, consumables (power, water, chemicals, air, etc.) tools, equipment, instruments, and services required and incidental to completing all functional, performance and operational testing of installed equipment.

3. The Contractor shall give the Engineer written notice confirming the date of testing at least five (5) working days before the time the equipment is scheduled to be tested.

4. All testing shall be witnessed by the Engineer to be considered valid.

5. Contractor shall submit written detailed results of all functional, performance and operational testing.

B. Functional Testing:

1. All items of mechanical and electrical equipment shall be functionally tested by the Contractor after installation for proper operation. A minimum of ten (10) days prior to the start of functional testing, the Contractor shall submit interconnection diagrams for the equipment and for the alarms, controls and instruments associated with the equipment. This requirement shall not relieve the Contractor of meeting any requirements in the technical specifications for earlier submittal of the interconnection diagrams.

2. The functional test of each piece of mechanical equipment shall continue for not less than eight (8) continuous hours without interruption.

3. The functional test, shall include checking for proper rotation, adjustment, alignment, mechanical and electrical connections, proper lubrication, speed, flows, pressure, vibration, sound level, etc. Initial equipment and system adjustment and calibrations shall be performed in the presence of and with the assistance of the manufacturer's representative.

4. The functional test shall include a demonstration of the proper performance of all alarms, local and remote controls (including DCS), instrumentation, equipment functions, and all other electrical, mechanical and piping systems.

5. All parts shall operate satisfactorily in all respects, under continuous full load, and in accordance with the specified requirements, for the full duration of the eight (8) hour test period.

6. If any part of a unit shows evidence of unsatisfactory or improper operation during the eight-hour test period, correction or repairs shall be made and the full eight (8) hour test operation, as specified herein, shall be repeated after all parts operate satisfactorily.

C. Performance Testing:

1. Where performance testing is required by the Technical Specifications, the testing shall be supervised by the manufacturer's representative. These services shall continue until such times as the applicable equipment or system has been successfully tested for performance and has been accepted by the Engineer for operational testing.

2. Performance testing shall take place after functional testing is successfully completed in accordance with Article 1.6 B.

3. Performance testing shall demonstrate that the equipment meets all performance requirements specified.

D. Startup/Operational Testing:

1. Upon successful completion of operator training and the functional, performance and leakage testing, the Contractor shall startup the plant facilities and test the equipment operation and performance by conducting a minimum seven (7) day, continuous operational test of the completed facilities as an operational process unit to demonstrate to the Engineer's satisfaction that all equipment and systems required by these specifications will operate in the manner in which they are intended to perform. Upon successful completion of operational testing, all equipment installation, testing, and maintenance records, shall be submitted to the Engineer. Said records shall be bound separately for each piece of equipment or system and shall be collected by type of record.

2. The District will provide Contractor-trained operating personnel for the duration of the operational test. Said operation shall be conducted and under the supervision and direction of the Contractor and/or manufacturer's representative.

3. All piping, conduit, equipment, and systems have been properly tagged and labeled.

4. All defects in materials or workmanship which appear during the operational test shall be immediately corrected by the Contractor. In the event of a malfunction or deficiency that results in shutdown or partial operation of a system or process unit or results in performance that is less than that specified, the startup duration shall be repeated for that corresponding system or process unit and any other affected equipment so its proper operation and performance as required by the Contract Documents is demonstrated for a minimum of seven (7) continuous and trouble free days.

5. If the operational test is interrupted through no fault of the Contractor, the test may resume at the earliest mutually agreeable time. The Contractor shall maintain a log of equipment or system deficiencies along with a description of required repairs to correct the problem.

6. No unit process or part thereof shall be placed in service until it has successfully completed operational testing.

7. During plant startup, the Contractor shall provide the appropriate construction trades and the services of authorized Manufacturer's representatives for operational testing and as necessary, to correct faulty equipment operation. All costs for corrective work and retesting shall be born by the Contractor.

8. After completion of all startup/operational testing, the Contractor shall repaint, hose, scrub, clean up and otherwise return the work to a "like new" condition, prior to District acceptance.

E. Factory testing:

1. The District reserves the right to witness manufacturer's factory testing. Costs associated with witnessing by two (2) District representatives shall be included in the Contractor's bid. These costs shall include travel costs, costs of transport to and from lodging, lodging, and a meal allowance per person per day. The lodging and meal allowance shall at minimum be the rates advertised by the U.S. General Services Administration for locations in the U.S and rates advertised by the U.S. Offices of Allowances for locations outside the U.S. The District reserves the right to witness factory testing of the following equipment:

   a. New DCS Control Panels – Panels to be witnessed by District at panel fabricator shop after installation of DCS equipment (provided by Emerson). See 40 95 13, Process Control Panels and Hardware for more details.

2. If any of the witnessed tests cannot be accomplished in five 8-hour working days, or a test or portion of a test fails to the point where it needs to be rescheduled at a later date, additional tests shall be required at the Contractor's expense. Included shall be expenses for the Engineer's travel, accommodations, and sustenance of the same quality used for the original test.

3. Written factory test results shall be submitted to the Engineer at least ten (10) days prior to shipment. Equipment requiring factory tests shall not be delivered to the job site until the Contractor submits acceptable certified test results to the Engineer.

PART 2 - NOT USED

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall perform all functional and performance testing of installed equipment unless other specified.

B. The Contractor, at a minimum, shall maintain and provide to the District, the following records:

1. Daily logs indicating all equipment testing and startup activities and activities of all manufacturer’s representatives.

2. Records of all tests, calibrations, inspections, adjustments, services and corrective actions taken

C. In addition to the tests specified in the individual technical specifications, the Contractor shall perform additional tests as required by the Engineer to demonstrate to the Engineer's satisfaction that all equipment and systems required by the specifications will operate as intended.

D. If the testing of any equipment may affect the operation of existing District facilities, the testing shall be done under direct supervision of the Engineer. The Contractor shall comply with directions given by the Engineer.

E. Table 1 and 2 are a summary of equipment/systems that require functional, and performance tests. Additional testing may be required when specified elsewhere.

Table 1: Testing Summary

(Additional tests may be required in other specification sections)

Specification Section & Paragraph	System/Equipment Name	Functional Test Required	Performance Test Required
26 08 00, Part 3	Commissioning of Electrical Systems	Refer to Section	Refer to Section
40 80 00, 3.2	Commissioning of Process Systems	Refer to Section	Refer to Section
All equipment/systems required by these specifications shall be included in the Startup Test.			

Table 2: Power Equipment Testing Summary

(Additional tests may be required in other specification sections)

System/Equipment Name	Associated Circuit Breaker or Component	Circuit Breaker Test Required	Thermographic Survey Required
Switchgear S-3	Main breaker for Bus A and Bus B and Tie Breaker	N/A	Yes
U10, U11, U10-U11 Tie	Breakers	NETA	No
Main Air Compressor Motor (Qty 4)	Motor Protection Termination Box	N/A	Yes
MCC-P15	Main breaker and all feeder breakers	NETA	Yes
MCC-P16	Main breaker and all feeder breakers	NETA	Yes

MCC-P17	Main breaker and all feeder breakers	NETA	Yes
Main Air Compressor Motor Starter (Qty 4)	New MV Cable lug connection	N/A	Yes

3.2 SERVICES DURING CONSTRUCTION

A. General:

1. The Contractor shall provide the services of competent and experienced technical representatives of the manufacturers of all equipment and systems furnished under the contract, for as many days as may be necessary for assembly, installation and testing assistance. In each case, the Contractor shall arrange to have the manufacturer's representative revisit the job site as often as necessary until testing and startup problems have been resolved to the satisfaction of the Engineer. This requirement applies to manufacturers of all equipment furnished (excluding manually operated valves smaller than twenty-four (24) inches in size, and any other items of equipment specifically exempted by the Engineer in writing), whether or not specifically set forth in the Technical Specifications. The Contractor shall maintain a service record on each item of equipment and shall deliver these service records to the Engineer prior to acceptance of operational testing.

B. Fulfillment of Specified Minimum Services:

1. The Contractor shall obtain prior written approval from the Engineer for providing manufacturers' services. All requests to the Engineer for prior approval shall 1) be in writing, 2) be submitted not less than ten (10) calendar days prior to providing of the subject services, 3) state the service to be provided, and 4) state the reason(s) why the timing of the service is appropriate. Request made to the Engineer less than ten (10) calendar days prior to the manufacturers' services may not receive consideration and response prior to the times the services are provided. Visits of manufacturers and their representatives to the jobsite or training classroom without prior approval as provided herein may not act to fulfill the specified minimum man-day requirements.

C. Certificate of Proper Installation:

1. Equipment shall not be considered ready for functional testing until after the following certifications have been submitted and accepted by the Engineer.

a. The Contractor shall require that each manufacturer's representative furnish to the Engineer a written and signed report addressed to the District certifying that the equipment has been properly installed, adjusted, lubricated, is in accurate alignment, is free from any undue stress imposed by connecting piping or anchor bolts, has been operated satisfactorily under full-load conditions and is ready for full-time operation. For pumps, compressors, blowers, engines, motors, and other rotating or reciprocating equipment, the report shall certify that the equipment operates within the manufacturer's allowable limits for vibration. The report shall also certify that all controls, protective devices, instrumentation, and control panels furnished as part of the manufacturer's equipment package are properly installed and calibrated; and that the control logic for equipment startup, shutdown, sequencing, interlocks, and emergency shutdown has been tested and is properly operating. The Contractor shall also sign said certification. The Contractor shall submit "Manufacturer's Certification of Proper Installation" on the District form, provided at the end of this Section.

b. The Contractor shall require that the electrical and/or instrumentation subcontractor furnish a written and signed report to the Engineer certifying that the motor control logic for the equipment item that resides in motor control centers, control panels, control boards, microprocessors, distributed processing units, computers, and the like furnished by the electrical and/or instrumentation subcontractor has been properly tested and calibrated. The report shall certify that the control logic for equipment startup, shutdown, sequencing, interlocks, and emergency shutdown has been tested and is properly operating. The Contractor shall also sign said certification.

3.3 RECORD KEEPING

A. The Contractor shall maintain as a minimum, the following records:

1. Equipment manufacturer's shop drawings
2. Daily logs indicating all equipment testing and startup activities.
3. Log and time sheets of all manufacturers' representatives performing services on the jobsite
4. Updated equipment testing and startup schedules
5. Records of system cleaning
6. Hydrostatic and pressure test records

7. Equipment alignment and vibration measurements and corrective actions

8. Equipment lubrication records

9. Insulation resistance measurements

10. Electrical phase, voltage and amperage measurements

11. Electrical breaker inspection, test, and adjustment records

12. Logs of abnormal circuits and lifted wires

13. Testing and validation of all central and alarm functions

14. Data sheets of all testing and calibration of instrumentation devices and control loops including documentation of set points

15. Equipment and system release logs (from construction to startup)

16. Daily work reports

17. Adequate manufacturer's instruction file so that the information will be readily available during equipment testing and startup.

18. A record of flushing and chemical/mechanical cleaning

19. Prior to startup, provide the Engineer with a record of all test data and the work completed.

3.4 CONSTRUCTION

A. Removal of temporary bracing:

1. Prior to equipment testing, remove all temporary supports, bracing, or other foreign objects that were installed in vessels, transformers, rotating machinery, or other equipment to prevent damage during shipping, storage, and erection, and repair any damage sustained.

3.5 FIELD QUALITY CONTROL

The general work procedures listed below outline the work to be performed by the Contractor. Additional procedures applicable to specific equipment items are specified elsewhere.

A. General

1. Operate the equipment and check for excessive vibration, abnormal operating noises, overheating and lubricant leakage, etc., and test any safety shutdown/alarm devices for proper operation, and make any

operating tests required by the Engineer. The adjustments required for proper operation shall be made prior to operational testing.

2. Prior to startup, all sidewalks, gratings, handrails, safety chains, safety shields, etc., shall be installed.

3. Prior to startup, demonstrate to the Engineer's satisfaction that all chemical solution pipelines are connected to the intended tank(s), feeder(s), pump(s), and application points, and that the pipes, appurtenances contained therein and diffusers will operate at the intended flow rates.

4. Prior to startup, the applicable safety equipment, emergency shower and eyewash units, fire extinguishers, fire suppression equipment, self-contained breathing apparatus, toxic and/or combustible gas detectors (including the respective personnel warning system), protective clothing, emergency repair kits, etc., shall be installed in an acceptable manner-subject to the Engineer's approval, and be fully ready for operation.

5. All safety hazards, e.g., exposed drive shafts or rotating equipment members, exposed electrical circuitry, open electrical junction boxes and panels, improperly supported piping and conduits, missing safety devices, etc., shall be corrected prior to supplier training of the District's personnel.

6. The Contractor shall perform a comprehensive safety inspection and correct any safety deficiencies found before implementing plant startup.

7. Roadways that are required for ambulance service, fire fighting access, delivery of treatment chemicals and supplies, and disposal of the treatment byproducts shall be completed prior to startup.

8. Prior to startup, install all warning and safety signs, labels, and devices.

9. Test all tanks and internals, as required to demonstrate conformance to the Contract Documents. Dispose of test media in a manner that is acceptable to and approved by the District and the applicable regulatory agencies.

B. Electrical power and lighting systems:

1. Provide the Engineer with 3-day advance notification in writing of the test schedule. The Contractor is advised that the tests shall be witnessed by the Engineer.

2. Perform insulation resistance tests on all wiring 120 volt and larger. Do not meggar instruments or solid-state devices.

3. Perform insulation resistance tests on all motor and transformer windings from phase to phase and phase to ground.

4. Perform grounding system tests to determine the continuity of connections and the value of resistance to ground.

5. Fill electrical gear with oil and/or other media as recommended by the equipment manufacturer.

6. Prior to substantial completion and startup, test and set switchgear and circuit breaker relays for proper coordination and operation.

7. The Contractor shall obtain the services of a qualified "independent testing service", member of the National Electric Testing Association, to perform a thermographic survey on all switchgear buses, insulators and power connections when energized and under at least 20 percent load. Significant hot spots shall be further checked by infrared pyrometer for exact temperature rise. The Contractor shall troubleshoot and correct the thermographic hot spots. Correction shall be verified by repeating the thermographic survey at no additional cost to the Owner.

8. The Contractor shall obtain the services of a qualified "independent testing service", member of the National Electric Testing Association, to inspect and test the protective relays and the 800-ampere and larger drawout breakers for proper installation, adjustment, and operation in accordance with the manufacturer recommendations.

9. The Contractor shall obtain the services of a qualified "independent testing service", member of the National Electrical Testing Association, to perform DC high potential tests on all cables that will operate at more than 2,000 volts to ground.

10. Obtain local electrical inspector's approval where required.

11. Energize all substations, with approval of the Utility Company and the Engineer after completion of all electrical testing.

12. Prior to startup, perform tests and adjustments on all switchgear and motor control equipment to demonstrate proper operation and conformance to the Contract Documents and manufacturer's recommended settings.

13. Prior to startup, test installation of emergency power and lighting systems for proper operation, including light intensity.

14. Vacuum clean all electrical equipment prior to startup and acceptance.

C. Cryogenic Oxygen Production Piping Systems and Valves Leak Testing:

1. Provide the Engineer with three (3) day advance notification in writing of the schedule for nonoperating field leak tests or field pressure tests on

piping and field fabricated equipment, unless otherwise directed by the Engineer.

2. Contractor shall submit their plan for leak testing at least 60 days prior to startup of a cold box. Contractor shall identify any existing leaks prior to start of Work that will not be repaired as part of the Work. Contractor shall repair any leaks found as a result of its Work.

3. Contractor shall submit sample test forms that will be used for all tests.

4. Pressure Zones in Cryogenic Oxygen Plant:

   a. There are two pressure zones in the cryogenic oxygen plant. They can be described as high pressure and low pressure.

   b. The high pressure passages and vessels of the plant operate at between 60-70 PSIG. The high pressure passages and vessels include, but are not limited to, the lower column, the cold end gel trap, the reversing heat exchanger, the switch valves, the cold end check valves, and the high pressure side of all the miscellaneous piping.

   c. The low pressure passages and vessels operate at between 4-6 PSIG. The low pressure passages and vessels include, but are not limited to, the upper column, the recirculating gel trap, the low pressure side of the cold end check valves and switch valves, and the low pressure side of all the miscellaneous piping and heat exchangers

5. Leak testing shall be performed before an isolated system of the plant is put online. Leak testing shall be performed around any breakage in process piping, flanges, or fittings throughout the project. All fittings, fasteners, and process piping and vessels that contain pressure shall be leak tested before access is lost to those areas of the plant. This applies both inside and outside the cold box. Leak testing shall occur for each individual valve, flange, and fitting included in the Work.

6. One final leak check of the cold box as a system is required prior to filling the cold box with insulation and proceeding with the start-up of the cold box.

7. Leak testing shall be performed by pressurizing the line associated with the flange, fitting, or valve which had undergone work. The line shall be pressurized to operating pressure using air from the main air compressor. Once the line is pressurized the entire area shall be sprayed with an approved leak check solution. The area shall then be monitored for a period of ten minutes for bubbles. Any bubbles are an indication of a leak. Areas with leaks shall be re-fastened and re-checked until no bubbles

appear. No leaks are acceptable. Testing pressures for low pressure areas of the plant shall not exceed 7 PSIG and higher pressure areas of the plant shall not exceed 70 PSIG.

8. Valve testing occurs when the valve is fully open and when the valve is fully closed. Both flanges shall be fully sprayed with a leak check solution. The valve packing shall be sprayed as well to ensure that there are no packing leaks. The valve shall be actuated twice during this process, fully open and fully closed, to ensure the valve is not being jarred into a leaking position.

9. All pressure vessels and process piping internal to the cold box shall be sprayed with leak check solution and check for full system integrity. This includes but is not limited to heat exchanger seams, thermowells, threaded fittings, compression fittings, flanges, valves, and welded caps to ensure absolutely no leaks are present inside the cold box.

10. Compression fittings shall be sprayed with a leak check solution on both sides of the fitting. It is important that the fittings are not applied incorrectly and not overtightened. If this occurs the Contractor shall replace the fitting.

11. Blind flanges inside the cold box shall be leak tested by spraying a leak check solution around the entire flange when the associated pressure vessel is at operating pressure or slightly below relief valve settings. Relief valve settings are 7-8 PSIG for low pressure passages and vessels, and 60-70 PSIG for high pressure passages and vessels. The area shall be monitored for a period of 10 minutes if any bubbles or leaks are formed or detected the blind flange should be re-fastened and re-tested.

12. A leak down test shall occur after all valves are installed to ensure that no valves are leaking across their seat. This test would show that pressure is not migrating across valve seats and into other areas of the plant. Measure pressure upstream and downstream of the valve.

13. Insulate or paint piping, flanges, threaded joints, or field welds after the specified testing of each item has been completed unless instructed otherwise by the Engineer.

14. Prior to substantial completion and startup, check pipehangers, supports, guides, and pipe specialties for the removal of all shipping and erection stops and for the correctness of the cold and hot settings for the design service. Make adjustments as necessary to obtain proper installation. Provide the Engineer with instructions for the hot settings.

15. Prior to startup, install all of the valve and piping system identification labels.

16. Prior to startup, check and record the position of all process system valves.

17. Prior to startup, correct support, vibration, and thermal expansion problems detected during the preliminary equipment testing.

18. Prior to the startup, retorque all hot and cold service bolting as required to ensure a permanent and proper installation.

19. Prior to startup, demonstrate to the Engineer's satisfaction that each piping system (e.g., chemical, sample, utility, irrigation process, etc.) functions as designed and required by the contract documents.

~~19.~~20. Compressed air used for leak testing shall be oil free.

D. Final Cryogenic Leak Check Procedure:

1. A final leak check shall take place after all valve and fitting work has been completed. This final leak check shall be fully documented and marked up on a copy of updated P&IDs to ensure that each valve, fitting, and fill port has been thoroughly checked and monitored for a ten minute period for any bubbling and leaking. In order to properly leak check valves in and around the cold box, the cold box must be set up properly in order to maintain proper pressure without setting off relief valves or putting low pressure components at risk. The Contractor shall work with the District during the leak check to assist in starting the compressor and operating various manual valves to complete the check. A sample procedure is provided below, Contractor may propose modifications to this procedure except where leak checks are called out.

    a. Align valves and remove any blind flanges blocking air flow from the chosen main air compressor to the cold box to be tested.

    b. Ensure that the interconnection valve between the two plants is closed so the running plant is not impacted by the leak test.

    c. Close all manual process valves including the cold end gel trap isolation valves.

    d. Ensure that all work in and around the cold box is completed and that valves are operational and in their fail-safe positions. All calibration of transmitters, valves, and flow meters should be completed to verify pressures throughout the plant.

    e. Start the intended main air compressor with the assistance from District and allow the compressor to come online. The compressor should be allowed to idle for ten minutes before loading to operating pressure.

f. After approximately ten minutes load the compressor to 60-65 PSIG. Once pressure has stabilized set the pressure in auto to maintain 60-65 PSIG throughout the leak check procedure.

g. Air should be flowing and pressurized at the inlet switch valves. Using a listening device check that no air is moving past the switch valves. If air is moving past the switch valves then the closed stop on the actuator will need adjusted to close the valve completely.

h. After checking that the inlet switch valves are leak free, introduce air through the switch valve bypasses and allow pressure in the reversing heat exchanger up to HV-X201A which should be closed, to balance with the MAC pressure. Air flow into the plant should stop when equalized.

i. Check that there is no air flowing out of the waste nitrogen switch valves with a listening device. If any air is flowing from these valves their closed stop will need to be adjusted prior to continuing with the test.

j. Spray both pairs of switch valves with leak check solution and ensure they are not leaking.

k. Spray the inlet check valves (HV-Y113A and HV-Y112A) on both flanges to ensure there are no leaks.

l. After waiting for the check to be completed the inlet air switch valves should be actuated and rechecked. The packings on all switch valves shall also be checked at this time.

m. Once the inlet check valve leak check is complete the cold end gel trap should be pressurized by cracking open HV-X201A to allow flow into the gel trap. Once pressurized close HV-X201A and keep track of how long it takes for pressure to drop in the cold end gel trap. Leak check HV-X201A while waiting for a pressure drop.

n. Once the leak check of HV-X201A is complete slowly open HV-B201A to allow air to flow into the lower column. Allow the lower column to pressurize to 60-65 PSIG. Once the lower column is pressurized check that no pressure or flow is going into the upper column which is the low-pressure column.

o. If pressure is flowing into the upper column, adjust FV-213A, LV-330A, and FV-340N until no flow is present.

p. Perform a flow test on FV-213A, LV-330A, and FV-340N.

q. To perform a flow test with the above valves, the upper column will need to be at or close to 0 PSIG. Slowly open the valve to be tested and wait for the upper column pressure to rise. Once the pressure has risen to 2-3 PSIG close the valve and vent out the FV-601X product oxygen vent valve. Repeat test for the above valves.

r. Once the flow test has been completed the entire system needs to be pressurized. Open FV-213A, LV-330A, and FV-340N about 15-20% and open FV-601X until the pressure in the upper column reaches at least operating pressure (5 PSIG) but no greater than 7 PSIG. At this time all valves all sides of the valves will be pressurized. Leak check all valves, fittings, fill ports, and valve packings including instrument tubing external to the cold box.

s. All found leaks shall be noted on approved test forms and corrected. After correcting the leaking point shall be rechecked to ensure proper seating.

t. After testing, close the switch valve bypasses and open the waste nitrogen switch valves (FCV-113N & FCV-114N) to depressurize the plant through the upper column. Check the packings on these valves to ensure they are not leaking.

u. Once the plant has depressurized close all valves and return them to their fail-safe position.

3.6 ADJUSTING AND CLEANING

A. Mechanical equipment:

1. Level baseplates and soleplates and grout under all load bearing surfaces.

2. Install suitable supports and flexible connections to alleviate any piping stresses that may be imposed on pumps, compressors, and drivers.

3. In accordance with the manufacturer's recommendations, chemically clean lube oil, seal oil, and cooling systems. Dispose of waste and cleaning media in a manner that is acceptable to and approved by the District and applicable regulatory agencies.

4. In accordance with the manufacturer's recommendations, charge the lube oil, seal oil, and cooling systems with flushing media and circulate for cleaning purposes. Dispose of any flushing media in a manner that is acceptable to and approved by the District and applicable regulatory agencies.

5. Charge the lube oil systems, seal oil systems, and cooling systems with the amount and type of operating oil or coolant recommended by the manufacturer.

B. Tanks:

1. Prior to startup, conduct chemical cleaning or flushing operations as specified. Dispose of wastes and cleaning media in a manner that is acceptable to and approved by the District and the applicable regulatory agencies.

2. Prior to startup, install all chemical identification, warning, and safety signs and labels.

C. Removal of rust preventives:

1. Prior to equipment testing, remove all rust preventives and oils used to protect the equipment during the construction period whenever these protective materials will be detrimental to operation or equipment maintenance.

D. Lubricants:

1. Flush systems and install the initial charge of all lubricants. Dispose of flushing oil in accordance with applicable regulations.

2. The Contractor shall lubricate the equipment in accordance with the manufacturer's recommendations until the equipment is accepted by the District.

3. Maintain a lubrication record for each item of equipment. The Contractor shall submit the lubrication records to the Engineer prior to equipment testing.

E. Packing and seals:

1. Install, adjust, and replace packing, mechanical seals, and accessories, as necessary, during the equipment testing and startup period.

2. Adjust seal water and flushing water flow rates in accordance with the equipment manufacturer's recommendations.

F. Rotation, alignment, and vibration:

1. Prior to equipment testing, check rotating machinery for correct direction of rotation and for freedom of moving parts before connecting the driver.

2. Prior to equipment testing, perform the cold alignment and hot alignment to the manufacturer's tolerances.

3. Prior to equipment testing, test equipment vibration and correct any vibration in excess of the manufacturer's recommendation.

G. Tie-ins at the contract limits:

1. Obtain approval and make the necessary tie-ins at the unit limits as required by the Contract Documents and as approved by the Engineer.

2. Prior to startup, remove the temporary blind flanges, plugs, bulkheads, seals, etc.

H. Pressure/vacuum safety relief devices:

1. Prior to equipment testing, test and adjust all safety devices as recommended by the equipment manufacturer.

2. Prior to plant startup, provide the Engineer with a list of all field or factory equipment settings.

I. Flushing and chemical/mechanical cleaning:

1. Prior to equipment operation, conduct all flushing, blowing, and chemical/mechanical cleaning operations without using the permanently installed equipment.

2. Provide any special media needed for flushing and/or cleaning purposes.

3. Dispose of all media in a manner that is acceptable to and approved by the District and the applicable regulatory agencies.

4. All systems shall be free of trash and construction debris before initiating startup.

J. Screens and strainers:

1. Provide and install temporary strainers and screens necessary to protect the equipment and to test the equipment and pipelines.

2. Prior to startup, remove all of the temporary blinds and temporary appurtenances.

3. Clean the screens and strainers as required during startup.

4. At the end of startup, clean all of the permanently installed screens and strainers.

K. Purging/inerting:

1. Prior to startup, purge and/or passivate the facilities as specified.

2. Install purge/inerting connections in accordance with the manufacturer's recommendations.

3. Provide purge or inerting materials and conduct the necessary operations as recommended by the equipment manufacturer.

L. Drying out:

1. Prior to startup, dry out the facilities as specified or recommended by the equipment manufacturer to prevent contamination of catalysts, operating materials, and/or product

2. Dry out systems, protective coatings, refractories, and linings as specified or recommended by the equipment manufacturers.

M. Cryogenic equipment and piping:

1. Prior to returning oxygen piping to service, clean all oxygen valves and piping in accordance with ASTM-G93-03.

END OF SECTION

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MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

This is to certify that the equipment supplied by (MANUFACTURER'S NAME) and described as (NAME OF EQUIPMENT) has been installed in accordance with manufacturer's recommendations. The equipment was inspected by an authorized manufacturer's representative on (DATE) and has been serviced with the proper initial lubricants and is free from any undue stress imposed by piping or supports. Applicable safety equipment has been properly installed and proper electrical and mechanical connections have been made. Proper adjustments have been made and the equipment and or system is ready for operation. All reports have been submitted to the District and the equipment and or system is certified for field testing and startup in accordance with Specification SD-[number] [project title], Section 01 75 17 Field Testing and Startup.

Authorized Manufacturer's Representative		Contractor's Representative	
Title	Date	Title	Date

MANUFACTURER'S CERTIFICATE OF FUNCTIONAL TESTING ASSISTANCE

Functional testing, including checks for proper rotation, alignment, speed, excessive vibration, and noisy operation has been performed The equipment has been operated under full-load conditions and is ready for full-time operation. Controls, protective devices, instrumentation, and control panels are properly installed and calibrated. The control logic for startup, shutdown, sequencing, interlocks, etc. has been tested and is properly operating. This testing, including initial equipment and system adjustment and calibrations, was performed in the presence of the manufacturer's representative on (DATE).

Authorized Manufacturer's Representative	
Title	Date

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SECTION 40 05 13

PROCESS PIPE AND FITTINGS

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes

1. Provide all labor, materials, equipment, incidentals, and appurtenances required for process pipe and fittings in accordance with this Section and applicable reference standards listed in Article 1.3.

2. Furnish, install, test and make ready for operation all process pipe and fittings of the type(s) and size(s) required as shown on the Drawings and as specified. Provide all related appurtenances, including but not limited to attachments, foundations, anchors, supports, couplings, restraints and all related accessories to provide complete operational piping systems as shown on the Drawings and as specified.

3. Unless otherwise indicated, all fittings and appurtenances shall be of the same type and grade of materials as the connecting pipe. All products provided under this section shall conform to current AWWA and ANSI specifications as appropriate to the type of pipe specified.

4. Furnish one set of all special tools required to completely assemble, disassemble, or maintain the process piping and appurtenances. Special tools shall refer to oversized or specially dimensioned tools, special attachments or fixtures, or any similar items.

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.3 REFERENCES

A. Reference Standards

1. ASME International (ASME)

a. ASME B1.1 Unified Inch Screw Threads (UN and UNR Thread Form)
b. ASME B1.20.1 Pipe Threads, General Purpose (Inch)
c. ASME B16.1 Cast Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
d. ASME B16.3 Malleable Iron Threaded Fittings Classes 150 and 300
e. ASME B16.9 Factory-Made Wrought Buttwelding Fittings
f. ASME B16.15 Cast Bronze Threaded Fittings Classes 125 and 250

g. ASME B16.18 Cast Copper Alloy Solder Joint Pressure Fittings
h. ASME B16.21 Nonmetallic Flat Gaskets for Pipe Flanges
i. ASME B16.22 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
j. ASME B16.26 Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
k. ASME B31.1 Power Piping
l. ASME B31.9 Building Services Piping

2. ASTM International (ASTM)

a. ASTM A193 Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
b. ASTM A269 Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
c. ASTM A307 Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
d. ASTM A479 Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels
e. ASTM A536 Standard Specification for Ductile Iron Castings
f. ASTM A632 Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing (Small-Diameter) for General Service
~~f.~~g. ASTM A967, Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts
~~g.~~h. ASTM B32 Standard Specification for Solder Metal
~~h.~~i. ASTM B61 Standard Specification for Steam or Valve Bronze Castings
~~i.~~j. ASTM B62 Standard Specification for Composition Bronze or Ounce Metal Castings
~~j.~~k. ASTM B88 Standard Specification for Seamless Copper Water Tube
~~k.~~l. ASTM B124 Standard Specification for Copper and Copper Alloy Forging Rod, Bar, and Shapes
~~l.~~m. ASTM B813 Standard Specification for L~~i~~equid and Paste Fluxes for Soldering of Copper

3. American Water Works Association (AWWA)

a. AWWA C104/A21.4 Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
b. ANSI/AWWA C110/A21.10 Ductile-Iron and Gray-Iron Fittings, 3 in through 48 in (76 mm through 1219 mm), for Water
c. ANSI/AWWA C111/A21.11 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
d. AWWA C115/A21.15 Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
e. AWWA C150/A21.50 Thickness Design of Ductile-Iron Pipe

f. AWWA C606 Grooved and Shouldered Joints

4. International Organization For Standardization (ISO)

a. ISO 228-1 Pipe Threads Where Pressure-Tight Joints Are Not Made on the Threads - Part 1: Dimensions, Tolerances and Designation

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.5 RELATED SECTION

~~B.~~A. Section 01 33 00 – Su~~m~~bmittal Procedures

~~C.~~B. Section 01 75 17 – Field Testing and Startup

~~D.~~C. Section 05 05 24 – Shop and Field Welding and Brazing

~~E.~~D. Section 05 50 00 – Metal Fabrications

~~F.~~E. Section 09 90 00 – Paintings and Coating

~~G.~~F. Section 22 05 53.05 – Pipe Identification

~~H.~~G. Section 22 11 15 – Domestic Water Piping

~~I.~~H. Section 22 11 19 – Domestic Water Piping Specialties

~~J.~~I. Section 46 31 58 – Cleaning for Oxygen and Ozone Service

1.6 DELIVERY, STORAGE, AND HANDLING

A. Delivery: All materials that will not be installed the same day as delivered to the site shall be stored in the original manufacturer's packaging. Loose items with no original packaging shall be boxed to protect the products from scratches, abrasion, or breakage.

B. Protection Prior to Installation

1. All products shall be transported, handled and stored in accordance with the manufacturer's recommendations.

2. All products shall be protected from excessive heat, moisture, and other adverse environmental conditions during storage and handling.

3. All plastic materials shall be stored out of direct sunlight.

1.7 SUBMITTALS

A. Submit the following in accordance with Division 01 General Requirements.

B. Shop Drawings

1. Shop Drawings for each type of process pipe shall be identified with the applicable style or series designation. Shop drawings shall show layout and dimensions of equipment, major components, key alignment locations and locations of bolt holes. Drawings shall show critical field dimensions identified by the Manufacturer.

2. Shop Drawings shall show layouts and dimensions of the piping, including actual pipe lengths, diameters, fittings and appurtenances.

C. Product Data

1. Submit sufficient product data to verify compliance with the specifications and to illustrate the construction and assembly of the products. Include compliance of materials and components with applicable standards. Product data shall include manufacturer's descriptive data, technical literature, performance charts, catalog cuts, and installation instructions.

2. Prior to shipment of pipe, submit a certified affidavit of compliance from the pipe manufacturer stating that the pipe, fittings, gaskets, linings and exterior coatings for this Project have been manufactured and tested in accordance with applicable AWWA, ASTM and other standards as well as the requirements specified.

D. Reports

1. Submit field test reports for each section of piping tested for pressure and leakage.

E. Calculations

1. Thermal expansion calculations: For cryogenic services 1” in diameter or greater, provide calculations to demonstrate that pipe supports used can accommodate thermal contraction and expansion of the piping (or tubing) system without damage to the pipe supports or piping. Temperatures may range from negative 300 degrees to plus 100 degrees Fahrenheit.

1.8 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

B. All welding and brazing shall be conducted under qualified welding procedures and in accordance with Section 05 05 24, Shop and Field Welding and Brazing. All welders, brazers, and operators shall be certified in accordance with the latest

applicable AWS and ANSI codes for shop and Project Site welding of piping work. Furnish written proof of certifications upon request from the Engineer.

1.9 DELIVERY, STORAGE AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. All equipment delivered and placed in storage shall be provided with protection from the weather, humidity and temperature variations, dirt and dust, or other contaminants in accordance with the Manufacturer's written instructions.

C. Finished surfaces of all exposed openings shall be protected by caps, wooden blanks or other suitable cover to prevent foreign material and debris from entering the equipment.

D. Off-load equipment at the installation site using equipment of sufficient size and design to prevent damage to the equipment. Immediately after off-loading, inspect all equipment for shipping damage or missing parts. Any damage or discrepancy shall be noted in a written claim with the shipper prior to accepting delivery. Validate all serial numbers and parts lists with the shipping documentation. Notify the Manufacturer of any unacceptable conditions with the shipper. Pipe which has been rejected after delivery shall be specifically marked for non-use and shall be removed from the Project Site at no additional cost to District. The acceptance of manufacturer's pipe samples prior to shipment shall not guarantee acceptance of all subsequent piping delivered to the job Site.

E. Where necessary to store outside, enclose with durable, waterproof wrapping. Store rubber products under cover out of direct sunlight. Do not store materials directly on the ground.

F. Stacking & Unloading

1. Unload all piping in strict accordance with the manufacturer's recommendations. Take care not to damage the pipe during unloading. Utilize padding on all hooks, slings, and pipe tongs used for unloading to prevent damage to the piping including exterior coating and interior lining. Damage to the interior lining of piping shall render it unfit for use. Dropping of pipe during unloading is not acceptable. Care shall be taken to not skid piping against stationary piping during unloading or stacking.

2. All piping shall be stacked in accordance within the limits recommended by its manufacturer. The piping shall be supported off the ground through the use on timbers, rails, or concrete as recommended by the piping manufacturer.

3. Avoid contact between stainless steel piping and ferrous surfaces or materials, which may lead to rusting of particles embedded in the walls of stainless steel piping. All stainless steel piping shall be stored on supports constructed of non-ferrous metal materials. All tools for stainless steel

piping installation shall be specifically designated for use on stainless steel piping to ensure no contamination from ferrous metals occurs. All piping storage and fabrication supports shall be constructed from non-ferrous metal, stainless steel, or provided with a rubber lining.

1.10 WARRANTY

A. Provide in accordance with Division 01 General Requirements.

1.11 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.

PART 2 – PRODUCTS

2.1 COPPER PIPE, TUBING & FITTINGS FOR DOMESTIC WATER PIPING

A. See 22 11 16, Domestic Water Piping. Pipe sizes and end connections shall be as shown on the Drawings or as specified. Provide all necessary end connections and appurtenances as required to connect to the end uses.

B. Press Fittings

1. Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of IAPMO PS 117. Sealing elements for press fittings shall be FKM (Viton). Sealing elements shall be factory installed or an alternative supplied by fitting manufacturer.

2. Press fittings shall be designed to assure leakage of liquids and/or gases from inside the system past the sealing element of an un-pressed connection. The function of this feature is to provide easy identification of connections which have not been pressed prior to putting the system into operation.

3. Press fittings shall be of the same Type and Temper of copper as the connecting pipe.

C. Flanged Joints

1. Where copper piping is connected to equipment the end connection shall be flanged. Flanges and flanged fittings shall be faced and drilled Class 125/150 in accordance with ASME B16.26. For tie-in to existing flanges, field check existing flanges for non-standard bolt-hole configurations. Provide adaptors and fittings to assure new pipes and flanges mate properly. All flanged joints shall be in alignment with the holes mating with the centerline of the piping.

2. All bolts for flanged connections shall be lubricated with a graphite and oil mixture prior to tightening. All bolts shall be tightened with proper tools to

avoid overstressing the piping, bolts, and sealing gaskets beyond the proper designed limits.

3. Alloy bolts ASTM A193, Grade B7 shall be tightened to obtain a stress of 45,000 psi. Carbon steel bolts ASTM A307, Grade B shall be tightened to obtain a stress of 15,000 psi based on the root thread area. All flange bolts shall be of sufficient length so as to allow a minimum of 2 full threads to extend beyond the fastening nut. Provide dielectric isolation between dissimilar metals.

D. Threaded Joints

1. Threaded joints shall be made with an Engineer approved joint compound applied to the male thread only. The use of caulking on the threaded joint shall not be acceptable. All threaded connections shall be in accordance with ASME B1.20.1. The threaded connections shall be full thread, true taper type, machined accurately to gauge. Size reductions shall be through the use of reducing fittings. All plugs shall be steel or brass with a square head design. Bushings and close nipples shall not be acceptable.

E. Solder & Flux

1. Solder and flux shall conform to ASTM B32. The solder alloy shall be 95 percent tin and 5 percent antimony on all pressure piping and potable water piping. No lead-bearing solder shall be permitted under any circumstances. All soldering shall conform to ASTM B813. Silver solder with 45 percent brazing silver alloy shall be utilized.

2. All tubing shall be square cut with reamed ends to prevent improperly sized ends or burrs prior to soldering. Prior to soldering all surfaces shall be cleaned to a bright metal finish and be free of dirt, grease, or other foreign materials prior to fluxing and soldering. All cleaning shall be conducted using an emery cloth, sandpaper, or steel wool.

3. Both the outside and inside ends of the pipe to be soldered shall be cleaned to a length of at least 3/4 inches greater than the depth of the fitting. All joints shall be assembled using non-corrosive flux. Acid solder or flux shall not be permitted under any circumstances. Any cracks, holes, areas of incomplete penetration, or other related defective connections shall not be acceptable. Peening of defects is not permitted under any circumstances.

4. All soldered joints shall be heated uniformly to the solder melting point to allow a complete draw of the solder into the connecting joint. All excess solder shall be completely removed with a cloth brush. A fillet shall be left around the end of the fitting. All connections shall be required to have full penetration of solder throughout the entire connection joint. The cooling of soldered joints via quenching is not permitted.

F. Brazing

1. All flux shall be applied in strict accordance with the recommendations of the brazing manufacturer. Flux is required when joining copper tubing to cast bronze fittings. Flux is not required when joining copper tubing to wrought copper fittings. Parts to be joined shall be heated 1 inch from the edge of the fitting. Once the flux has become transparent, the heating of the fitting at the base of the cup shall commence. The torch flame shall move continuously throughout the process.

2. Brazing materials shall be applied where the tubing enters the socket or fitting. Direct flames shall not be applied to the brazing material. Capillary action from the heated joint shall draw the brazing material into the joint. A properly made joint shall show a visible fillet completely around the pipe joint. No additional filler shall be added once a fillet has been formed.

3. All flux material shall be removed once the brazing material has solidified. All fittings shall be allowed to cool naturally without the aid of separate quenching. Any cracks, holes, areas of incomplete penetration, or other related defective connections is not acceptable. Peening of defects is not permitted under any circumstances.

G. Grooved Joint Couplings and Fittings

1. Grooved end copper fittings shall be ASME B16.22 wrought copper or ASME B16.18 cast bronze, manufactured to copper tube dimensions. Flaring of tube or fitting ends to accommodate alternate sized couplings shall not be permitted.

   a. Provide grooved end fittings for copper pipe of the same type, style, and duty. Acceptable level of quality: equivalent to Victaulic – Copper Connection.

2. Grooved joint couplings and associated fittings shall be ASTM A536, Grade 65-45-12 ductile iron, manufactured to copper tube dimensions. Couplings shall have two housing segments. Coupling gaskets shall be pressure responsive elastomer, center-leg type with pipe stop to ensure proper groove engagement, alignment, and pipe insertion depth. Fitting gaskets shall be Nitrile. The coupling system shall be rated to 300 psi (2065 kPa) with Type K or L Copper Tubing.

   a. Provide grooved joint couplings for copper pipe of the same type, style, and duty. Acceptable level of quality: equivalent to Victaulic - Style 607.

H. Copper Tubing

1. All seamless copper alloy tubing shall conform to ASTM B88, alloy C12200, Type L, with an O60 annealed temper. Copper tubing shall only be used where specified or specifically indicated on the Drawings.

I. Copper Joints

1. If the joint type is not specified elsewhere, use soldered joints or joining as directed by the Engineer. Dielectric fittings or isolation joints and materials shall be provided between all dissimilar metals.

2. Unions shall be installed to allow for ease of disassembly for any future piping alterations or repairs. All unions shall be installed as shown on the Drawings and as directed by the Engineer. Unions shall also be installed in in long piping runs, equipment bypasses, connections to equipment, pumps, tanks and between shutoff valves.

3. Unions or flanges for servicing and disconnect are not required in installations using grooved joint couplings.

J. Copper Fittings - General

1. All component castings of flanges and fittings shall be copper alloy and shall conform to ASTM B61 or ASTM B62. Solder joint fittings shall conform to ASME B16.22 and ASME B16.18. Fittings for flared copper tube shall conform to ASME B16.26. Cast bronze threaded fittings shall conform to ASME B16.15 and be threaded in accordance with ASME B1.20.1. Tubing compression fittings shall be forged brass alloy C37700, conforming to ASTM B124.

2. Flared fittings shall not be used without prior written approval from the Engineer.

3. Fittings shall match the type and grade of the connecting piping.

K. Bolting for Copper Piping

1. All bolting materials shall meet the requirements of ASME B31.1. Bolts shall be provided with washers of the same material as the bolts. Provide flange bolt isolators for all dissimilar metals.

L. Pipe Bending

1. All bending of copper piping shall be in accordance with the recommendations of the pipe manufacturer. All bends shall be free from damage including, but not limited to, holes, cracks, or buckles.

2.2 STAINLESS STEEL TUBING

A. All stainless steel tubing shall meet the requirements of ASTM A269 and ASTM A632. All tubing shall be seamless or welded, Type 316 with nominal size and wall thickness. Provide tubing sizes indicated on Drawings.

B. Fittings shall be compression style, constructed of ASTM A479 stainless steel, Type 316. All nuts, ferrules, and bodies shall be rated to a minimum 150 psi pressure. Threads shall be straight conforming to ISO 228-1 and ASME B1.1.

C. All tubing of the same type, style, and duty shall be supplied by a single manufacturer. Stainless steel tubing to be a product of one of the following manufacturers.

1. Swagelok Company, no substitutions allowed.

D. All tubing and fittings for cryogenic service shall be cleaned and suitable for use with the process fluid it is applied to. Provide stainless steel tubing for instrumentation and sample lines in accordance with the manufacturer's recommendations and these Specifications.

2.3 GASKETS

A. Gaskets shall conform to ANSI/AWWA C111/A21.11. Gaskets shall be provided by the pipe manufacturer unless otherwise noted. Unless otherwise noted, all gaskets 12 inches in diameter or less shall be a minimum of 1/8 inches thick. All gaskets larger than 12 inches in diameter shall be a minimum of 3/32 inches thick.

B. Gaskets to have a smooth finish, be designed for use in plastic, metal or plastic-lined metal piping systems as applicable and be compatible with the associated process fluid. Gaskets for use in potable water service shall have an NSF 61 listing. Gaskets for low pressure air piping shall be suitable for use at temperatures to 250 degrees F.

C. Gaskets for use on flanged piping shall be low torque, flat ring type, full face to ANSI B16.5 dimensions for 125/150-pound flanges and rated for a minimum pressure of 150 psi. Gaskets shall have two concentric, convex, molded rings between the center hole and bolt hole circle. For flanged CPVC piping, when the mating flange has a raised face an additional filler gasket shall be provided between the outer diameter of the raised face and outer diameter of the flange to protect the flange from bolting moments.

D. Gaskets for use on mechanical joint and push-on joint piping shall meet or exceed the minimum requirements of AWWA C111/A21.11 for styrene-butadiene rubber (SBR) gaskets. Gaskets for use on bell and spigot joint FRP piping shall be EPDM.

E. Gaskets for use with grooved end joints shall be pressure responsive elastomer. Gaskets for carbon steel grooved end piping shall be EHP and suitable for water service to 250 deg F. Gaskets for HDPE grooved end piping to be pre-lubricated.

F. If for a specific application a pipe or valve manufacturer recommends a different type of gasket than that specified, submit gasket information to the Engineer for review and approval.

G. Gaskets of the same type and material to be provided by a single manufacturer. Gaskets to be a product of one of the following manufacturers.

1. Asahi America, Inc.

2. Allstate Gasket & Packing, Inc.

3. Metro Industries, Inc.

4. Or equal

2.4 UNIONS

A. When joining pipe segments, provide unions where called for on the Drawings and as specified. Provide additional unions to allow for disassembly of piping segments. Provide unions at pumps, equipment and valves to allow for removal without disassembly of the piping systems.

B. Unions or flanges for servicing and disconnect are not required in installations using grooved joint couplings.

2.5 ATTACHMENT HARDWARE

A. Unless otherwise indicated, all attachment hardware, including but not limited to nuts, bolts, washers and all related fastening devices shall be 316 stainless steel. Threads shall be coated with mineral oil or another anti-seize compound prior to installation. Hardware for submerged applications shall be 316 stainless steel.

2.6 STAINLESS STEEL PIPE FOR LIQUID OXYGEN PROCESS PIPING

A. General:

1. Pipe sizes specified in the Specifications are nominal.

B. Wall thickness:

1. Schedule 40S.

C. Piping material and manufacturing:

1. Comply with the requirements outlined in the following table:

Service	Stainless Steel Grade	Pipe Manufacturing Process
Oxygen Service		
Piping 2 1/2 inches in nominal diameter and larger	Type 316L or LDX 2101 stainless steel in accordance with ASTM A 240	Type 316L in accordance with ASTM A 778
		Type LDX 2101 in accordance with ASTM A 790
Piping less than 2 1/2 inches in nominal diameter	Type 316L or LDX 2101 stainless steel in accordance with ASTM A 240	Type 316L in accordance with ASTM A 312
		Type LDX 2101 in accordance with ASTM A 790

D. Fittings for piping 2 1/2 inches in nominal diameter and greater:

1. Material: In accordance with ASTM A 240 stainless steel, grade to match the pipe.

2. Manufacturing standard: In accordance with ASTM A 774.

3. Wall thickness of fitting: In accordance with ASME B36.19 for the schedule of pipe specified.

4. End configuration: As needed to comply with specified type of joint.

5. Dimensional standards:

   a. Fittings with weld ends: In accordance with ASME B16.11.

   b. Fittings with flanged ends: In accordance with ASME B16.5, Class 150.

   c. Fittings for piping less than 2 1/2 inches in diameter D

6. Material: In accordance with ASTM A 240 stainless steel, grade to match the pipe.

7. Manufacturing standard: In accordance with ASTM A 403, Class WP.

8. Wall thickness and dimensions of fitting: In accordance with ASME B16.11 and as required for the schedule of pipe specified.

9. End configuration: As needed to comply with specified type of joint.

10. Forgings in accordance with ASTM A 182, or barstock in accordance with ASTM A 276. Match forging or barstock material to the piping materials.

E. Piping joints:

1. Joints in piping 2 inches in diameter and smaller: Flanged socket welded except threaded joints for relief valve installations 1 inches in diameter and smaller.

2. Welded joints:

   a. Piping less than 4 inches in diameter: Single butt-welded joints.

   b. Mark each weld with a symbol that identifies the welder.

3. Flanged joints: Conforming to the requirements in accordance with ASME B16.5, Class 150.

4. Flanges for Schedule 40S and Schedule 80S pipe:

   a. Provide forged stainless steel (type matching piping system) slip-on flanges in accordance with ASME B16.5 Class 150.

   b. Material: In accordance with ASTM A 182D.

F. Gaskets:

1. PTFE sheet with a minimum thickness of 1/8". Acceptable Manufacturers: Garlock Gylon Style 3502 or equal.

G. Bolts for flanges:

1. Bolts and nuts: Type 316 stainless steel in accordance with ASTM A 193 heavy hex head.

H. Bolt length such that after installation, end of bolt projects 1/8-inch to 3/8 inch beyond outer face of nut.

I. Nuts: In accordance with ASTM A 194 heavy hex pattern.

J. Fabrication of pipe sections:

1. Welding: Weld in accordance with ASME B31.3 and Section 05 05 24.

   a. Notify the Engineer when shop welding will be performed and facilitate Engineer inspection as specified in Section 05 05 24.

   b. Follow general welding procedures as specified in Section 05 05 24.

2. Weld seams:

   a. Full penetration welds, free of oxidation, crevices, pits and cracks, and without undercuts.

   b. Provide weld crowns of 1/16 inch with tolerance of plus 1/16 inch and minus 1/32 inch.

   c. Where internal weld seams are not accessible, use gas tungsten-arc procedures with internal gas purge.

d. Where internal weld seams are accessible, weld seams inside and outside using manual shielded metal-arc procedures.

3. Inspect and perform non-destructive examination on shop welds as specified in Section 05 05 24. Pay for non-destructive examination as specified in Section 05 05 24.

K. Cleaning:

1. Following shop fabrication of pipe sections, straight spools, fittings, and other piping components, clean fabricated pieces.

2. Clean (pickle) and passivate stainless steel piping as-needed to remove blemishes in accordance with ASTM A 380 or A 967:

a. If degreasing is required before cleaning to remove scale or iron oxide, cleaning (pickling) treatments with citric acid are permissible:

1) However, these treatments must be followed by inorganic cleaners such as nitric acid/hydrofluoric acid.

b. Field pickle and passivate any sections of piping delivered to the site with visible blemishes.

3. Clean (pickle) and passivate stainless steel piping welds after installation to remove blemishes in accordance with ASTM A 380 or A 967.

a. If degreasing is required before cleaning to remove scale or iron oxide, cleaning (pickling) treatments with citric acid are permissible:

1) However, these treatments must be followed by inorganic cleaners such as nitric acid/hydrofluoric acid.

4. Passivation treatments with citric acid are not allowed.

~~2. NOT USED.~~

5. Finish requirements: Remove free iron, heat tint oxides, weld scale, and other impurities, and obtain a passive finished surface.

~~3. NOT USED.~~

~~4.~~6. Oxygen clean and seal piping sections in accordance with Section 46 31 58 after pickling and passivation.

2.7 COPPER TUBING FOR LIQUID OXYGEN SERVICE

COPPER TUBING, [CU] Suitable for cryogenic liquid oxygen service and cleaned per ASTM B819 and Section 46 31 58.		
TUBING	Materials and Construction / Dimensions:	Exposed service: Seamless Copper Tube per ASTM B88, Type K, hard temper (no coils).
FITTINGS & UNIONS	Materials:	Cast copper or bronze: ASTM B584, Alloy C84400 (Lead-free) Wrought copper or bronze: ASTM B75, Alloy C12200 (Lead-free)
	Construction / Dimensions:	Fittings: Cast: ASME B16.18 Wrought: ASME B16.22 Wrought Radius Elbows: MSS-SP-104 Unions: MSS-SP-123 Contractor shall not use unions or flared fittings for copper tubing 1” and larger.
FLANGES	Materials and Construction/ Dimensions:	Flanges shall be bronze raised face and meet ANSI Class 150 and ASTM A 182, F-316 suitable for either slip-fit brazed to copper tubing Type K or threaded to threaded-by-slip fit copper fitting and specified as compatible with liquid oxygen service. Acceptable manufactures: NIBCO Style 771-LF (slip fit) and Style 775-LF (threaded) or equal, Valves shall be flanged except pressure relief valves which shall be threaded. Gaskets shall be PTFE sheet with a minimum thickness of 1/8". Acceptable Manufacturers: Garlock Gylon Style 3502 or equal.
JOINTS	Construction:	Soldered: per ASTM A5.3 and B828
SOLDER	Materials:	45% silver solder in accordance with AWS A5.8 BAg-5.
FLUX	Materials:	Appropriate for brazing filler material.
END OF [CU]		

PART 3 – EXECUTION

3.1 INSTALLATION - GENERAL

A. Piping systems shall be fabricated and installed in accordance with ASME B31.1. Install each run of piping with minimum joints and couplings, but with adequate and accessible unions for disassembly and maintenance or replacement of valves

and equipment. Reduce sizes, where indicated on the Drawings, by use of reducing fittings. Align piping accurately at connections, within 1/16-inch misalignment tolerances.

B. Locate piping runs, except as indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as shown, or, if not otherwise indicated, run piping in the shortest route which does not obstruct usable space or block access for servicing the building and its equipment. Hold piping close to walls, overhead construction, columns, and other structural and permanent-enclosure elements of buildings.

C. Provide unions in piping as shown on the Drawings and as specified. Unions shall be provided in locations, including but not limited to the following: equipment, pumps, tanks, valves, long piping runs, piping bypasses around equipment, or any other location as directed by the Engineer or District. Unions shall be located to allow for piping disassembly, alterations, and repairs.

D. Provide all field routing and coordination of process piping routing as required to accommodate all necessary coordination with other Work of the Contract, including, but not limited to heating, ventilating, and air-conditioning (HVAC), electrical, structural, architectural, plumbing, and civil work.

3.2 LIQUID OXYGEN PIPING

A. General:

1. Follow procedures in industry standards for cryogenic liquid oxygen systems including, but not limited to, ASME, ASTM, CGA, and Section 46 31 58 - Cleaning for Oxygen and Ozone Service, when modifying existing, and installing new, liquid oxygen piping and equipment.

2. Install piping in such a manner as not to impart strain to connected equipment.

3. Nitrogen purge connections to existing piping prior to hot work activities.

B. Stainless Steel Piping

1. Field Assembly of Shop-Fabricated Stainless Steel Piping Sections:

a. Join shop-fabricated piping sections together using flanges.

b. If field welding is required, pickle and passivate the field welds by using a cleaning process as specified in Section 46 31 58 where the Provider uses a cleaning process that also pickles and passivates the interior welds. Exterior field welds shall be pickled and passivated by using K-2 Pickling Paste and K-2 Passivation, or equal ~~as approved by the Engineer~~, in accordance with the manufacturer's instructions. Use only a stainless steel brush to clean the field welds.

2. Field Quality Control:

   a. Test stainless steel piping to 225 psi pressure and by method as specified in ASME B31.3.

   b. Visually inspect pipe for welding defects such as crevices, pits, cracks, protrusions, and oxidation deposits.

   c. Welds in liquid oxygen service piping: Examined and inspected in accordance with ASME B31.3.

   ~~c.~~d. Test stainless steel pipe welds using liquid dye penetrant method in accordance ASME B31.3.

3. Protection:

   a. Preserve appearance and finish of stainless steel piping by providing suitable protection during handling and installation and until final acceptance of the Work:

      1) Use handling methods and equipment to prevent damage to the coating, include the use of wide canvas slings and wide padded skids.

      2) Do not use bare cables, chains, hooks, metal bars, or narrow skids.

      3) Store stainless steel piping and fittings away from any other piping or metals. Storage in contact with ground or outside without projection from bad weather is prohibited.

      4) Protect stainless steel piping and fittings from carbon steel projections (when grinding carbon steel assemblies in proximity) and carbon steel contamination (do not contact stainless steel with carbon steel wire brush or other carbon steel tool).

C. Copper Piping and Tubing

1. Install in accordance with ASME B31.3, ASME B31.5, and ASTM B828.

2. See Section 05 05 24 Shop and Field Welding and Brazing for silver soldering certification requirements.

3. Contractor shall test piping and tubing for leaks by soap testing in attendance of the Engineer. District reserves the right to require 100% radiography testing in accordance with ASME B31.3 for failed soap tests.

4. Test copper tubing to 150 psi with nitrogen and by method as specified in ASME B31.3. Contractor shall provide all equipment and materials needed for the test.

a. Submit a test plan including layout of test apparatus and test method to the Engineer.

3.3 COPPER PIPE & TUBING INSTALLATION FOR DOMESTIC WATER PIPING

A. All threaded connections shall conform to ANSI B2 and ASME B1.20.1. All threaded connections shall be true, accurate, and of full thread. All threaded plugs shall be brass with a square head. All threaded joints shall be made with a joint compound approved by the piping manufacturer. The joint compound shall be applied to the male thread only. Caulking of threaded joints is not acceptable. All reductions and expansions in piping diameters shall be through the use of reducers and expansion fittings. Bushings or close nipples are not acceptable.

B. Soldering

1. Unless otherwise indicated all joints for copper pipe 2 inches and smaller shall be soldered. Prior to soldering, all surfaces shall be thoroughly cleaned and polished, and free from dirt, grease, grime or other foreign materials before fluxing and soldering. The cleaning shall be performed by using an emery cloth, sandpaper, or steel wool. Clean the outside end of the copper tubing for a length of a least 1/2 inch greater than the depth of the fitting. The inside of the fittings shall be cleaned in a similar manner. Apply non-corrosive flux and assemble the joint. Insert ends of tubes into fittings to the full depth of the sockets. Acid solder and acid flux are not acceptable.

2. The copper piping and tubing surfaces to be joined shall be heated up slowly and uniformly. The surface being soldered shall be heated to the melting point of the solder. Apply heating to draw the solder completely into the joint. Form continuous solder beads around the entire circumferences of the joints. Once solder is plasticized, remove all excess with a brush or other suitable cleaning device. Excess solder shall be removed from the interior and exterior of the piping. Provide a fillet around the end of all fittings and joints. Allow soldered joints to cool slowly in the air. The use of water for quenching is not acceptable. Provide full penetration of solder within all joints.

C. All cutting of copper tubing shall be square. The ends of all-cut piping shall be reamed or filed to remove burrs. The use of piping with out-of-round ends is not acceptable. Any type of defects, including but not limited to, cracks, holes, and incomplete solder penetration is not acceptable. Peening for the closing of defects is not acceptable under any circumstances.

D. Utilize heating torches of sufficient size based on the size of the piping to be joined. Utilize combination torches with ring burners or multiple tips for heating of copper fittings 1-3/4 inches and larger.

E. Brazing

1. All joints for interior copper pipe larger than 2 inches shall be brazed. Apply all flux in strict accordance with the recommendations of the manufacturer of brazing filler material. Apply flux to the outside of fittings and avoid allowing the flux to enter the inside of the tubing. Apply heat to the brazed sections of piping beginning 1 inch from the edge of each fitting.

2. Once the flux becomes transparent, heat the fitting at the base of the cup. All heating shall be conducted while continuously moving the torch flame. Continuously maintain heating along the joint between the fitting and tubing connection axis.

3. Apply the brazing material at the joint where the tubing enters the socket of a fitting. Heat the joint to melt the brazing material. Do not apply the torch flame directly on the brazing material. A properly assembled joint shall consist of a fillet of filler being visible around the complete circumference of the joint. Once a complete fillet is visible, stop adding filler metal. Remove any excess flux residue.

4. Allow all joints to cool slowly via the surrounding air. The use of water for quenching is not acceptable. Any type of defects, including but not limited to, cracks, holes, and incomplete filler material penetration is not acceptable. Peening for the closing of defects is not acceptable under any circumstances.

F. Flanges

1. Install flanged connections as required as shown on the Drawings and as approved by the Engineer. Install all flange faces in perfect alignment. The flange holes shall straddle the vertical center line of the piping.

2. Flange bolts shall be alloy steel, ASTM A193 Grade B7, or commercial grade carbon steel, ASTM A307, Grade B. Alloy steel bolts shall be tightened to obtain a stress of 45,000 psi and carbon steel bolts shall be tightened to obtain approximately 15,000 psi of stress. The stress shall be based on the root area of the bolt thread. Provide flange bolt isolators for dissimilar metals.

3. Lubricate all bolts over the entire thread length with a heavy graphite and oil mixture prior to tightening. Tighten bolts with proper wrenches. Secure flanges with uniform pressure on the bolts and gaskets. Flanged joints with flange dishing and over-compression of the gaskets due to overstressing of the bolts is not acceptable. Utilize bolts of adequate length to allow for a minimum of 2 full thread lengths to extend beyond the fastening nut.

3.4 STAINLESS STEEL TUBING INSTALLATION

A. Install all tubing and fittings in strict accordance with the recommendations of the pipe manufacturer. All tubing shall be pitched to low points and shall be provided

with condensate drains. All pipe supports and restraints shall be provided as recommended by the pipe Manufacturer.

B. If pipe cutting is required for installation, a machine shall be used. All cuts shall be neat, true, and smooth at 90-degree angles to the pipe longitudinal axis or center line.

C. Prior to assembly in the field, clean all flanges, gaskets or threads with a soap and warm water solution. All flanged bolts shall be tightened alternately and evenly to the manufacturer's required torque. Take care not to over-tighten any flange bolts. Do not utilize extension or pipe ratchet wrenches, which may cause over-torque of flange bolts. All flange joints shall be assembled with gaskets, bolts and nuts, bolt studs with a nut on each end, or studs and nuts when the pipe is tapped. Ensure all flange holes are provided with connectors.

D. Cut threads full and clean using sharp dies. Ream all threaded ends to remove burrs and restore the full inside pipe diameter. Apply pipe joint compound or Teflon pipe joint tape as recommended by the pipe and fitting manufacturer on male threads at each joint, and tighten the joint to leave not more than 3 threads exposed.

E. All pipe and fittings shall be cleaned of all dust, oil, grease, water, dirt or any other foreign matter prior to installation. Ensure no foreign matter, tools, or other construction materials are left in the tubing. All stainless steel tubing shall be washed clean with steam or warm water to remove any other remaining foreign matter or debris.

F. Stainless steel tubing used in low pressure air or other associated hot applications to be designed to account for thermal expansion and contraction over a temperature range of 0 degrees F to 200 degrees F.

G. Welding in the field shall only be conducted with prior written approved by the Engineer. All welds shall be made by welders certified under ASME Section IX and be equal or exceed shop welds in all respects. Field welding shall only be conducted after a demonstration weld is successfully completed by each welder, at no additional cost to the District or Engineer. All field-welded joints shall be thoroughly cleaned and buffed using deburring and finishing wheels.

H. Provide certifications that on-Site welders are qualified in accordance with ANSI B31.1, Paragraph 127.5 for shop and Project Site welding of pipe work. Provide certified copies of current welding certificates for welders on Site to Engineer and District.

I. If rusting of stainless steel tubing occurs after installation, remove at no additional cost to District or Engineer. Pickle the affected surface area of the tubing with a deoxidizer as recommended by the pipe manufacturer and approved by Engineer. Scrub affected areas of the tubing with stainless steel brushes and then thoroughly rinse the affected area.

3.5 INSTALLATION OF SLEEVES AND SEALS

A. Install pipe sleeves of types as indicated on the Drawings where piping passes through walls, floors, ceilings, and roofs. Do not install sleeves through structural members of Work, except as detailed on the Drawings, or as approved by the Engineer. Install sleeves accurately centered on pipe runs. Size sleeves so that piping and insulation will have free movement in the sleeve, including allowance for thermal expansion; but not less than 2 pipe sizes larger than the piping run. Install length of sleeve equal to thickness of construction penetrated, and finish flush to surface, except floor sleeves. Extend floor sleeves 4 inches above the level floor finish, and 4 inches above floor finishes sloped to drain. Provide temporary support of sleeves and provide temporary closure to prevent concrete and other materials from entering sleeves.

B. Sleeve Seals shall be installed in accordance with the following:

1. Mechanical Seals: Loosely assemble rubber links around the pipe with bolts and pressure plates located under each bolt head and nut. Push into sleeve and center. Tighten bolts until links have expanded to form a watertight seal.

2. Wall Pipe: Install wall pipe where indicated on Drawings. Joints shall be as indicated for connection to adjacent piping.

3.6 CLEANING

A. Thoroughly clean the interior and exterior of all piping prior to testing. Provide removal of all dirt, dust, oil, grease and other foreign materials from the piping. Exercise care while cleaning piping to avoid damage to linings and coatings. Clean all piping in strict accordance with the recommendation of the piping manufacturer.

B. Flush out piping systems, except odor control piping, with clean water prior to proceeding with the required tests. Inspect each run of piping for completion of joints, supports, accessory items, and appurtenances prior to testing.

C. For piping and tubing to be used for cryogenic service, see Section 46 31 58, Cleaning for Oxygen and Ozone Service.

3.7 PIPE SUPPORT SYSTEMS

A. No attempt has been made to show all required pipe supports in all locations on the drawings. The absence of pipe supports and details on any drawing shall not relieve the Contractor of the responsibility for providing them in accordance with the pipe manufacturer's written recommendations and these specifications.

B. Provide special pipe supports where shown.

C. General support spacing shall be at maximum distances as listed below (unless otherwise shown):

TYPE OF PIPE	1" SIZE AND SMALLER	1-1/4" SIZE AND LARGER
Stainless Steel	6'-0"	10'-0" *
Copper Tubing	5'-0"	8'-0"

* Except for the Make lines (insulated 2" LOX-STL between cold box and LOX tanks). Match existing support spacing for the Make lines.

D. Provide at least one pipe support at each change of direction of the pipe.

E. Provide additional pipe supports directly adjacent to valves and other operating devices so that piping does not move when the valve or device is operated.

F. Decrease spacing as necessary to prevent sagging and vibration.

G. Provide a minimum of two anchor bolts on each channel support attached to concrete.

H. Install supports to allow up to 0.25-inches of thermal expansion for liquid oxygen piping.

3.8 PIPE TESTING - GENERAL

A. Test all piping in the presence of the Engineer and the plumbing or building inspector if required by the State of the Project location or by the District. All testing shall be in accordance with the requirements of the local and state plumbing codes and the appropriate sections of these Specifications. All testing shall be conducted at no additional cost to the District or Engineer. Provide all labor, equipment, materials, taps, water, gauges, pumps, and appurtenances to conduct all piping tests.

B. When requested by the Engineer or local plumbing inspector, building gravity drains shall be tested prior to backfilling or concealing. All other piping may be tested after backfilling. Any deficiencies found during testing shall be repaired and retested at no additional cost to the Engineer or District. Provide lawful disposal of all waste after the testing.

C. Test all piping systems before insulation is installed. Remove all control devices before testing. Test each natural section of each piping system independently but do not use piping system valves to isolate sections where the test pressure exceeds the valve pressure rating. Test each section with water or other fluids as directed by the Engineer and District. Pressurize the pipe to the specified level for the required time period.

3.9 HYDROSTATIC PRESSURE TESTING

A. All liquid service pipe and fittings shall be pressure tested using water to the test pressures specified or as directed by the Engineer. All pipe and fittings shall be

pressure tested with water at the maximum service temperature specified or as directed by the Engineer. Test pressures for designations and systems not listed shall be as directed by the Engineer prior to testing. All testing shall be in accordance with the procedures of ASME B31.1.

B. Provide water or other test fluid as directed by the Engineer, of sufficient capacity to deliver the required test pressure specified. Provide all valves on the suction and discharge side of the pump as well as a strainer on the inlet side of the pump to prevent foreign matter from entering the system. Provide pressure gauges capable of reading 50 percent higher than the specified test pressure. The pressure gauges shall be located at the pump discharge and any other place as directed by the Engineer. Provide a pressure relief valve set at a pressure 20 to 25 percent above the specified test pressure. Provide heaters, if required, to heat the test water to the specified test temperature.

C. Preparation For Testing

1. Coordinate the testing fluid to be used with Engineer and District. When the fluid test temperature is not ambient, consult with Engineer for the appropriate test temperature. All testing equipment shall be compatible with the piping and test fluid. Provide vents at all high points of the system if not already installed. Provide drains in locations where venting or draining devices do not exist.

2. Remove all discs, pistons, and balls from check valves if they prohibit testing of the piping system. Ensure all valves and appurtenances are fully open within the section of piping to be tested. Remove all control instruments and alarms prior to testing. Block off or remove all pressure relief valves prior to testing and temporarily close all external openings of the piping section to be tested. All closures shall be specifically designed for the test pressure. All joints in the piping section to be tested shall be left exposed for examination and inspection during the test period. Pipe insulation shall not be installed prior to conducting pipe testing.

3. Provide temporary supports for vapor or gas piping to support the weight of the test fluid if the vapor or gas piping is directed to be hydrostatically tested.

4. Provide temporary support, restraint or isolation for all expansion joints.

D. Hydrostatic Test

1. Slowly fill the piping system, expelling entrapped air from all high points. The fill rate shall be controlled so that the fluid velocity within the pipe system is less than 2 feet per second. Once the filling process has been completed the piping system shall be brought up to the specified test temperature, if required or directed by the Engineer. The pressure shall be held at 20 percent less than the test pressure until the temperature has been

stabilized. Once the temperature has stabilized, raise the pressure to the test level as specified or as directed by the Engineer.

2. The pipe system shall be slowly brought up to the test pressure. Take care not to create shock, surge, or water hammer in the pipe system.

3. For pressure piping, test each piping system at 150 percent of the design operating pressure, but not less than 25 psig test pressure, whichever is greater. Pressure piping shall be defined as piping systems in which the process fluid does not flow via gravity. The minimum test pressure for all gravity piping shall be 10 psig. Provide the Engineer and District with a minimum 24-hour notice prior to the testing. Tests which are not witnessed by Engineer are not acceptable. In the absence of specified test pressures, consult the Engineer for determining the test pressure for each system. The required test period shall be a minimum of 2 hours.

4. The test duration time limit shall not begin until the full pressure specified or indicated by the Engineer has been reached and the system has been stabilized to within plus or minus 5 percent of the test temperature. The system temperature shall be maintained to within plus or minus 5 percent of the specified or Engineer indicated value for the entire duration of the test. The test pressure shall be maintained at plus or minus 5 psi of the specified or Engineer indicated test pressure for the entire duration of the test.

5. The pressure test to be monitored by a recording type pressure gauge. When temperature and pressure control is required, use a combination temperature and pressure recording gauge. Record the entire test process. The records shall include, but are not limited to, the date of testing, piping section tested, test pressure, testing equipment, testing results, test fluid, test temperature, and signatures of Engineer, Contractor, and District.

E. Inspection of Testing

1. Observe each test section for leakage during the test period. The hydrostatic test shall be deemed acceptable if no visible leaks are detected and the pipe system pressure can be maintained within plus or minus 1 percent but no more than 5 psi of the specified value.

2. Upon completion of the test, the pressure shall be slowly removed by opening a valve or other pressure-relieving device at a location remote to the location of the pressure and temperature monitoring equipment. The pressure shall be reduced to approximately 20 percent of the specified or Engineer indicated test pressure. Stabilize the system pressure at that point while the entire system is inspected for leaks, cracks, or other piping system defects. If any defects are found, alleviate pressure in the piping system, drain the test fluid, correct all defects, and retest the piping system.

3. Repair all piping system sections which fail the hydrostatic pressure piping test, by disassembly and re-installation using new materials to the extent

required to overcome leakage or pressure drop. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods. Repair and retest all defective piping sections at no additional cost to the District or Engineer. Drain and dispose of all fluids from the piping systems after testing and repair Work has been completed.

3.10 PNEUMATIC PRESSURE TESTING

A. All low-pressure air service pipe and fittings shall be pneumatically pressure tested using air to the test pressures specified or as directed by the Engineer. All pipe and fittings shall be pressure tested with air at the maximum service temperature specified or as directed by the Engineer. Test pressures for designations and systems not listed shall be as approved by the Engineer prior to testing. All testing shall be in accordance with the procedures of ASME B31.1.

B. Preparation For Testing

1. Coordinate testing pressure with Engineer. When the air test temperature is not ambient, consult the Engineer for the appropriate test temperature. All testing equipment shall be compatible with the piping. Provide vents at all high points of the system if not already installed.

2. Remove all discs, pistons and balls from check valves if they prohibit testing of the piping system. Ensure all valves and appurtenances are fully open within the section of piping to be tested. Remove all control instruments and alarms prior to testing. Block off or remove all pressure relief valves prior to testing and temporarily close all external openings of the piping section to be tested. All closures shall be specifically designed for the test pressure. All joints in the piping section to be tested shall be left exposed for examination and inspection during the test period. Insulation shall not be installed prior to conducting tests. Provide a soapy water solution and test all fittings, joints, couplings and valves for air leakage.

3. Personnel not directly involved in pneumatic pressure testing of piping shall be evacuated from the area. The maximum length of piping to be tested at 1 time shall be 400 feet. Examine all connections prior to testing to ensure proper fit and tightness. Determine the pressure rating for all connected devices and appurtenances to ensure they are rated for the required test pressure. Isolate all equipment and appurtenances, which may be damaged by testing. Plug all test, drain, and vent ports, which are not required for the test. If the section of pipe being tested is isolated from other sections by in-line valves, ensure that the portion not being tested is open to the atmosphere. Protect expansion joints against system pressures by suitable movement-limiting devices.

C. Pneumatic Pressure Test

1. Slowly fill the piping system. Each piping system shall be brought up to the specified test temperature. The pressure shall be held at 20 percent less than

the required test pressure until the temperature has been stabilized. Once the temperature has stabilized, raise the pressure to the test level as specified or as directed by the Engineer.

2. Test each piping system at 150 percent of the design operating pressure, but not less than 25 psi test pressure, whichever is greater. Provide the Engineer and District with a minimum of 24-hour notice prior to the testing. Tests which are not witnessed by Engineer are not acceptable. In the absence of specified test pressures, consult Engineer for determining the test pressure for each system. The required test period shall be 2 hours.

3. The test duration time limit shall not begin until the full pressure specified or indicated by the Engineer has been reached and the system has been stabilized to within plus or minus 5 percent of the test temperature. The system temperature shall be maintained to within plus or minus 5 percent of the specified or Engineer indicated value for the entire duration of the test. The test pressure shall be maintained at plus or minus 0.5 psi of the specified or Engineer indicated test pressure for the entire duration of the test.

4. The pressure test shall be monitored by a recording type pressure gauge. When temperature and pressure control is required, use a combination temperature and pressure recording gauge. Record the entire test process. The records shall include, but are not limited to, the date of testing, piping section tested, test pressure, testing equipment, testing results, test temperature, and signatures of the Engineer, Contractor, and District.

D. Inspection

1. Observe each test section for leakage during the test period. Once the test segment has been pressurized to the specified levels, the source of pressurization shall be isolated and all piping, connections shall be tested for leaks by swabbing with standard high film soap solution while also observing for the formation of air bubbles. Each pneumatic pressure test shall be deemed acceptable if no visible leaks (air bubbles) are detected and the pipe system pressure can be maintained to within plus or minus 1/2 percent but no more than 0.5 psi of the specified value.

2. Upon completion of the test, the pressure shall be slowly removed by opening a valve or other pressure-relieving device at a location remote to the location of the pressure/temperature monitoring equipment. If any defects are found, alleviate all pressure in the piping system, correct all defects, and retest the piping system.

3. Repair all piping system sections which fail the pneumatic pressure-piping test, by disassembly and re-installation, using new materials to the extent required to overcome leakage or pressure drop. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods. Repair and retest defective piping sections at no additional cost to District or Engineer.

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SECTION 40 81 00

SYSTEM INTEGRATOR QUALIFICATIONS AND SUMMARY OF WORK

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes

1. The system integrator shall provide a fully functioning instrumentation and control system as specified in the Contract Documents and shall integrate, test, start-up, and make operational a complete instrumentation and control system in accordance with the Contract Documents including this Section and applicable reference standards listed in Article 1.3.

2. The system integrator shall provide all labor and incidentals as required to configure, install, and calibrate all instrumentation as specified on the plans and Specification Section 40 70 00.

3. The system integrator shall be responsible for the design and manufacturing of the control system enclosures as specified on the plans and in Specification Section 40 95 13. The system integrator shall take delivery of specific DCS equipment provided by the District and integrate those components into the control system enclosures as specified. The system integrator shall coordinate and lead a Factory Acceptance Test of the enclosures prior to delivery to the site.

4. The Contractor shall be responsible for the placement and anchoring of the control system enclosures provided by the system integrator.

5. The system integrator shall coordinate and lead all site acceptance testing of the instrumentation and control system.

B. Related Sections:

1. Section 01 33 12 – Seismic Design Criteria.

2. Section 01 75 17 – Field Testing and Startup.

3. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.

4. Section 40 61 01 – Instrumentation – Controls General Requirements.

5. Section 40 70 00 – Instrumentation for Process Systems.

6. Section 40 80 00 - Commissioning of Process Systems.

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.3 REFERENCES

A. Reference Standards

1. The Instrumentation, Systems and Automation Society (ISA)
2. Underwriters' Laboratories, Inc. (UL)
3. American Water Works Association (AWWA)
4. National Electrical Manufacturer's Association (NEMA)
5. Occupational Safety and Health Administration (OSHA)
6. American National Standards Institute (ANSI)
7. National Fire Protection Association (NFPA)
8. National Fire Protection Association 79, Annex "D" Standards (NFPA)
9. Institute of Electrical and Electronic Engineers (IEEE)
10. National Electrical Code (NEC)
11. Factory Mutual (FM)

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.5 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.

B. Qualifications Package Submittal

1. The system integrator shall submit a qualifications package for review and approval to demonstrate compliance with the requirements described. The submittal shall include demonstration of all requirements, including but not limited to:

a. Include resumes for Project Manager, Field Engineers, and Technicians demonstrating comparable projects and field experience.

b. List the names and home office location of the Engineers and Technicians located within 100~~75~~ miles or~~and~~ within 2 hours travel time (by car) of the Project Site.

c. Project references for water or wastewater projects.

C. Instrumentation and Control System Testing Plan

1. The system integrator shall submit an instrumentation and control system testing plan that describes the testing process for all instrumentation and control equipment throughout the various stages of the project. At a minimum the procedure shall cover the following project stages:

a. Bench Testing

b. Factory Acceptance Testing

c. Loop Testing

d. Site Acceptance Testing and Functional Testing

e. Commissioning

f. Performance Testing

2. The system integrator shall coordinate all testing activities with the Contractor, the DCS equipment supplier, the District, and the Construction Manager. The system integrator shall provide advance notice for all testing activities.

1.6 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

B. Qualifications: per Division 01 General Requirements for System Integrator and as follows.

1. Employ personnel on this Project who have a minimum of 5 years' experience programming and starting up Instrumentation and Control related hardware;~~,~~ computers;~~,~~ integrating with Emerson ~~Ovation~~ DCS or DCS of similar size, complexity, and application;~~,~~ power monitors;~~,~~ communication with motor protection devices, and other network communications equipment.

2. Employ personnel on this Project who have completed factory training in development of the Instrumentation and Control software programming, alarm notification software, and reporting software.

3. Personnel shall be experienced configuring process instrumentation typically found in a water or wastewater treatment plant. Key personnel shall include, at a minimum, the lead field technician.

4. Personnel shall have ~~S~~successfully completed Work of equal or greater complexity on at least 3 other water or wastewater treatment projects within the last 5 years.

5. The system integrator shall maintain a permanent, fully staffed, and equipped office within 2 hours travel time of the Project Site with full time employees capable of programming, troubleshooting and testing the Instrumentation and Control system specified.

6. For the duration of the Project the system integrator shall provide an on Site response within 4 hours of notification. For the remainder of the Warranty Period, the system integrator shall provide on Site response within 1 business day.

7. The system integrator responsibilities include but are not limited to:

   a. Integrating all Instrumentation and Control equipment as specified in the Contract Documents.

   b. Integrating all communications equipment including serial, fiber optic, and Ethernet communication material and equipment.

   c. Integrating all instrumentation and process equipment, including packaged systems with the control panels required for the complete monitoring and control of the Instrumentation and Control system as described in the Contract Plans, equipment O&M manuals and submittals, Specifications and applicable codes.

   d. Conduct testing of all software provided by the DCS suppler required for the complete monitoring and control of the Instrumentation and Control system as described in the Contract Plans, Specifications and applicable codes by or under the supervision of qualified personnel.

   e. Preparation, assembly, and correction of all submittals in accordance with the Contract Documents.

   f. Supervision of the installation of control system panels, perform instrument tests, wiring checkout to the control system panels, and other components required by or under the supervision of qualified personnel.

   g. Documentation of I/O testing and startup of the Instrumentation and Control system.

   h. Training of the District's personnel in operation and maintenance of the Instrumentation and Control system. A minimum of 8 hours formal training is required for all Instrumentation and Control operations staff. Formal training can be a combination of on Site classroom style with handouts, whiteboard or projector and hands on usage of the Instrumentation and Control system. Training shall include one, 4-hour session, 1 week prior to system startup, as well

as two, 2-hour follow-up sessions after the system is successfully started up and accepted by the construction manager. The system integrator shall submit training agendas for all sessions to the construction manager for review and approval prior to scheduling the training sessions. The training shall be coordinated with other training provided under this project.

i. Coordination with the Contractor on handling of all warranty obligations for the Instrumentation and Control system components or any errors or omissions related to Instrumentation and Control programming for a period of 12 months.

j. Maintaining one on Site, up to date, copy of the integration plan and applications including fully documented programs for use in restoring the system during startup should part of the Instrumentation and Control system fail. The documented programs can be backups of the native electronic files.

k. One hard copy and one electronic copy, on USB flash drive, of the Instrumentation and Control Operations and Maintenance Manual.

8. System Integrator Project Personnel

a. Project Manager

1) The system integrator shall appoint a Project manager who shall coordinate and schedule all Instrumentation and Control Work and assure that the Project schedule is met.

2) The Project manager shall act as the liaison with the design-builder's installation Contractor and the construction manager, for the integration, testing and startup of the Instrumentation and Control system and shall assist in all matters required for proper coordination and interfacing of the equipment and processes.

b. Field Engineer

1) The system integrator shall appoint a field Engineer with responsibilities as follows:

a) Installed system checkout, adjustment, and start up including tuning of all control loops.

b) Instrumentation and Control support services for the duration of any equipment or system availability trials.

c) Involvement in the on Site system training of plant personnel.

d) Resolving of control problems encountered during initial startup and testing of all Instrumentation and Control equipment.

C. Integration

1. The integration tasks include, but are not limited to, the following

a. Calibration, installation, startup, and commissioning of all instrumentation.

b. Establish serial interface between MAC motor protection units and DCS.

c. Fiber optic routing and installation oversight.

d. The system integrator shall be responsible for configuration of all I/O within control panels required to provide a complete and functional Instrumentation and Control system.

e. Participate in startup testing of all equipment, instruments and controls to ensure operation of systems.

D. Testing

1. The system integrator shall allocate time for control panel testing, full field-testing of instrumentation, DCS, and reporting programs in accordance with the Contract Documents. The system integrator shall provide documentation as a record of testing I/O points through to OIT and HMI screens. The system integrator shall note any changes made in the field.

E. Coordination and Progress Meetings

1. The system integrator shall be responsible for the scheduling with the installation Contractor and coordinating the system integration with regard to all other Work on the Site and in accordance with the provisions of the General Conditions. The coordination shall be documented on the Project Schedule.

2. The system integrator shall be responsible for scheduling with the construction manager all DCS equipment startup and testing, and reporting submittal review meetings.

3. Routine progress and coordination meetings will be scheduled by the construction manager. The system integrator shall be required to attend weekly meetings, or as scheduled by the construction manager.

4. The purpose of the meetings shall be to review the progress of the Work involving the controls system and provide coordination for integration of the equipment to ensure Project schedule is met.

5. Representatives at the meetings shall have the authority to make all necessary decisions. Decisions and statements made at the meetings shall commit the system integrator to agreed procedures and schedules.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

1.8 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

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SECTION 46 31 58

CLEANING FOR OXYGEN AND OZONE SERVICE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included:

1. Materials, methods, and inspection procedure to be used in factory or field cleaning of the equipment and piping used with liquid oxygen, gaseous oxygen, ozone gas, and ozone off-gas.

~~a. Field passivation of stainless steel components is not anticipated for this project.~~

2. This section also includes requirements for post-cleaning protection, identification, and other functions related to cleaning.

3. After cleaning, the Contractor shall protect system components from recontamination until installed and successfully tested.

4. The Contractor shall provide cleaning in accordance with this section for any Contractor-provided or Contractor-modified piping and equipment used with liquid oxygen, gaseous oxygen, ozone gas, and ozone off-gas.

B. The Work in this Section shall be performed by a qualified provider of cleaning services. The term ‘Provider’ in this section shall refer to the cleaning services provider that performs field cleaning. This fieldwork can be performed on new equipment or piping delivered to site uncleaned or on existing equipment or piping involved with the project.

C. Related Sections:

1. Section 01 33 00 – Submittal Procedures.

1.2 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM):

1. A967, Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts

2. G93-03, Standard Practice for Cleaning Methods and Cleanliness Levels for Materials and Equipment Used in Oxygen-Enriched Environments

B. Compressed Gas Association (CGA):

1. G-4.1, Cleaning Equipment for Oxygen Service

1.3 SUBMITTALS

A. Provide in accordance with Section 01 33 00 Submittal Procedures.

B. Factory-cleaned equipment:

1. Inspection records:

a. The Ozone or Oxygen System Supplier (OSS) will submit to the Contractor a manufacturer's inspection record for each equipment cleaned for oxygen or ozone service.

b. The Contractor shall submit to the Engineer a copy of the manufacturer's inspection record for each Contractor-supplied equipment cleaned for oxygen or ozone service. The Contractor shall submit manufacturer's inspection records for all equipment cleaned for oxygen or ozone service.

c. The manufacturer's inspection record for each item shall include the following information:

1) A designation of the item covered

2) Serial number

3) Invoice number or other means of identification

4) Cleaning specification and method employed

5) Dates of inspection

6) Methods of inspection

7) Results of inspection

8) Inspector's signature and date signed.

C. Cleaning procedures:

1. Prior to cleaning, the Contractor shall submit cleaning specifications and standards for all equipment, piping, valves, fittings, and accessories to be cleaned for oxygen or ozone service. At a minimum, each cleaning specification shall include the following:

a. Degree of cleaning in measurable terms.

b. Acceptable cleaning procedures.

c. Inspection procedures required and method of inspection and testing to assure the desired level of cleaning.

d. Acceptable cleaning materials

e. Acceptable lubricants, sealants, and testing equipment

f. Procedures and requirements to assure that the equipment supplier has complied with the cleaning specifications

g. Packaging, protection, and storage of cleaned items

h. Whether item will be factory cleaned or field cleaned.

D. Field cleaning plan:

1. The name of the Provider.

2. The product information on all materials used, including, but not limited to:

a. Solvents

b. Detergents

c. Lubricants

d. Drying agents

e. Leak detection solutions

3. Field cleaning procedure including step-by-step actions.

4. Schedule of the Work including durations of required shutdowns.

a. Contractor shall provide an updated schedule if additional field cleaning is identified. All field cleaning activities shall require an approved System Outage Request (SOR) and hot work permit.

5. Lay down drawing of testing equipment with rough dimensions.

E. Provider qualifications:

1. Provider experience description

2. Provider references.

1.4 QUALITY CONTROL

A. Cleaning requirements:

1. All cleaning performed shall be in accordance with the requirements of the latest edition of CGA Publication No. G-4.1 and G-4.4 in addition to the specific requirements herein.

2. Stainless steel components shall be passivated in accordance with ASTM A967.

B. Provider qualifications:

1. Experience minimum: 5 years in providing field cleaning services for equipment in oxygen and ozone service in accordance with CGA Publication No. G-4.1.

C. The cleaning and passivation procedures shall be supervised and monitored by a person skilled and experienced in cleaning oxygen and ozone equipment cleaning:

1. This person shall be responsible for monitoring the cleaning and for determining whether a component is cleaned properly.

2. Any components for oxygen or ozone service that were delivered to the jobsite uncleaned shall either be returned to the manufacturer for cleaning or shall be cleaned in the field by the Provider at the option of Contractor at no additional cost to the District.

3. Cleaning in the field shall be done in accordance with the approved Provider's printed instructions.

4. A recalibration of the equipment components shall be done only by the manufacturer's representative.

D. Any equipment and in-line components that have been cleaned by the manufacturer before delivery to the jobsite shall be inspected by Contractor or the Provider for adequate cleaning and packaging:

1. Components which require recleaning shall be cleaned in the field by the Provider. Any cleaned components that are stored improperly shall be re-cleaned at no additional cost to the District.

E. The pressure of the nitrogen purge on skid-mounted equipment shall be checked in the field before removing the blind flanges and connections to the piping system:

1. If pressure has been reduced to less than 2 pounds per square inch or to a value unacceptable to the equipment supplier, the skid shall be recleaned in the field by the Provider.

PART 2 - PRODUCTS

2.1 FACTORY-CLEANED EQUIPMENT

A. The equipment furnished by the OSS, including but not limited to control valves, instrumentation, and stainless-steel piping, shall be factory cleaned before it is delivered to the site. The stainless-steel components shall be passivated prior to delivery.

B. NOT USED.

1. NOT USED.

C. Skid mounted equipment shall be bypassed until the connecting piping has been oxygen cleaned in the manner specified.

D. Each piece of factory cleaned equipment shall be labeled "CLEANED FOR OXYGEN SERVICE." and sealed by the manufacturer in clear polyethylene protective wrapping to prevent recontamination during shipping, storage, and handling.

2.2 FIELD CLEANING

A. Cleaning Services Provider:

1. Astro Pak

2. Clean Sciences, Inc.

3. Delta Tech Service Inc.

4. Or equal

B. Obtain approval of field cleaning plan from the Engineer before commencing work.

C. Field cleaning and passivation shall be performed by the Provider.

2.3 MATERIALS

A. The following materials shall be used for field cleaning, testing, and assembly of piping and equipment components:

1. No other materials may be used without the specific approval of the Engineer.

2. Contractor shall be responsible for proper disposal of all solvents, detergents, leak detection solutions, drying agents, and other fluids used in cleaning and testing.

3. Detergents:

   a. Any commercial alkaline or neutral water-soluble cleaner recommended by the cleaning company may be used provided that it is effective and is thoroughly flushed from the equipment item or pipe after cleaning.

   b. The cleaning shall be done according to the manufacturer's directions.

   c. Detergent shall be contained so that there is no discharge to the plant drainage systems.

4. Utilities:

   a. Contractor or Provider shall provide the compressed air or nitrogen for purging, drying, and testing the equipment after final cleaning.

   b. The air or nitrogen shall be dry, with a dewpoint of -30 degrees Fahrenheit or lower, and oil-free, or shall meet the Provider’s requirements, whichever are more stringent:

      1) The Contractor and the Provider shall closely monitor the operation of the gas filtering equipment.

   c. Water for preparing the solutions or for flushing, rinsing, or testing the system after final cleaning shall be deionized or shall be of equivalent or superior purity.

5. Tools and equipment used in cleaning the piping and system components:

   a. Store separately from other tools or thoroughly clean before each use.

   b. Wire brushes shall be of austenitic stainless steel or bronze to avoid introducing iron particles in the equipment being cleaned:

      1) Brushes made with natural bristles are preferred.

   c. Any tanks, pumps, instruments, shunts across valves or equipment, or temporary pipe supports used during cleaning shall be furnished by the Provider.

6. Lubricants:

   a. Lubricants shall be used sparingly and only to facilitate assembly or to lubricate packing.

   b. General lubricant:

      1) Manufacturers:

a) Montedison USA, Fomblin

b) Hooker Fluorolube, Halocarbon

c) DuPont, Krytox

d) 3M, Kel-F Fluorocarbon oils and greases

e) Oxweld, No. 64 Anti-Friction Compound

f) Or equal

c. Oxygen service lubricant:

1) Manufacturers:

a) Montedison USA, Fomblin

b) DuPont, Krytox

c) Or equal

7. Leak detection solutions:

a. General leak detection:

1) Manufacturers:

a) Glyco Chemicals, Sulfatate B-l (4 fluid ounces per pint of water)

b) American Gas & Chemical Company, Leak-Tec

c) Swagelok, Snoop

d) Ivory soap solution

e) Or equal

b. Leak detection chemical additives for uses at below freezing temperatures:

1) Manufacturers:

a) Swagelok, Real Cool Snoop

b) Commercial grade ethylene glycol

c) Methyl alcohol

d) Or equal

8. Drying agents: Isopropyl alcohol, if required

PART 3 - EXECUTION

3.1 SAFETY

A. Provider's personnel shall be thoroughly trained in the proper cleaning techniques, shall keep their clothing and hands free of oil and grease and, if necessary, wear clean gloves.

B. Flammable solvents such as gasoline, kerosene, naphtha, mineral spirits, or acetone shall not be used for cleaning.

C. Fire extinguisher fluids shall not be used for cleaning.

D. Contractor and Provider shall have full responsibility and liability for the safety aspects of the cleaning process.

3.2 COORDINATION

A. Contractor shall be fully and solely responsible for any damage resulting from inadequate cleaning of equipment or piping for ozone or oxygen service, and for any hazards associated with the cleaning process.

B. Contractor shall have sole responsibility for ensuring that all equipment, piping, tubing, instrumentation, vessels, and any combined systems thereof that will be used with liquid oxygen, gaseous oxygen, ozone gas, and ozone off-gas, have been cleaned and recleaned, if necessary, and meet the requirements of this Section when placed into service.

1. All high purity oxygen (>60%) and liquid oxygen piping and manufactured products such as valves, regulators, and turbines that are removed from service with the intent of returning them to service must be maintained in an oxygen clean state. Any sections of piping, valves, or other equipment that are modified and/or otherwise exposed to potential contaminants shall be cleaned in accordance with ASTM-G93-03 before being returned to service. Contractor shall verify that the entire length of pipe or any assembled product for any oxygen pipe worked on is free of debris and contaminants in accordance with ASTM-G93-03 prior to startup. When the components have been disassembled, parts shall be grouped according to cleaning method per ASTM-G93-03.

3.3 PROTECTION OF PIPING SYSTEM, VESSELS, AND EQUIPMENT

A. The factory or field cleaned piping, vessels, and equipment shall be protected from contamination until they are placed in service using the methods described below.

B. Short-term protection for periods up to 1 week:

1. Pipe ends and other openings may be covered with metal or plastic caps or plugs, or with a double layer of 6-mil polyethylene film, sealed to the pipe or nozzle with waterproof tape.

C. Medium-term protection for periods between 1 week and 1 month:

1. Welding ends: Ends shall be closed with clean Wedge Projects or equivalent galvanized steel caps, sealed with 2 turns of Tuck No. 90 or equivalent 2-inch waterproof tape.

2. Flanged ends: Flanged ends shall be closed with 10-gage or heavier oxygen-cleaned steel flange covers over solid neoprene or "Durabla" gaskets, held in place with at least 4 hex-head bolts.

D. Long-term protection for periods 1 month and longer:

1. The cleaned line shall be filled with dry nitrogen pressurized to 2 pounds per square inch.

2. Pressurized lines shall be identified at all significant flanges and valves.

E. Protection of small parts:

1. Small parts such as valves, expansion joints, pressure gauges, etc., should be kept in heavy polyethylene bags or wrapped and sealed in polyethylene sheeting until installation.

F. Equipment protection:

1. After cleaning, manholes, inspection ports, nozzles, and other openings shall be covered using blind flanges, plastic protectors, hardboard covers, or polyethylene sheets securely taped in place:

a. Larger pieces of equipment shall be completely covered with polyethylene sheeting.

G. Identification:

1. Any piping, equipment, or vessels cleaned in the field as specified in this Section shall be identified as follows: CLEANED FOR OXYGEN SERVICE. Contractor shall remove any temporary labeling and packaging after cleaned components are installed.

3.4 INSPECTION AND TESTS

A. The factory or field cleaned components of the oxygen, ozone, off-gas, or supplemental nitrogen system shall be inspected using black light where possible or by any of the methods specified below as applicable:

1. If the inspection reveals contaminants, the component shall be recleaned.

B. Direct visual inspection:

1. The cleaned components shall be free of observable residual oil, grease, lubricants, water, paint, coating, varnish, or other films; extensive adherent rust or mill scale; and loose rust, scale, abrasives, filings, loose weld spatter, chips, fluxes, dirt and any other particulate matter.

2. Marking materials, labels, and any other extraneous materials must be removed.

3. Sandblasted surfaces shall meet SSPC-The Society for Protective Coatings' Pictorial Standard CSa2.

C. Inspection by Ultraviolet or "Black Light":

1. The cleaned surfaces shall be examined in darkness or subdued light using a 3200-3800 AU wavelength black light to reveal common hydrocarbon oils or greases that fluoresce.

2. To detect nonfluorescent such as fish oil based rust preventives, or vegetable oil-based cutting emulsion the system supplier shall review the applicable manufacturing procedures to make sure that no such products have been used.

3. If fluorescence appears as a blotch, smear, smudge, or film, the affected component shall be recleaned.

D. Wipe test:

1. The component to be tested by wiping at least 1 square foot of its surface with clean white paper or an unbleached cloth, which shall then be examined under both normal ambient light and black light for signs of contamination.

2. If excessive discoloration or any fluorescence appears, the surface shall be recleaned.

3.5 CLEANING PROCEDURES FOR EQUIPMENT

A. All equipment requiring oxygen cleaning shall be furnished already cleaned and passivated by the equipment supplier:

1. If, for any reason, recleaning or repassivation in the field is required, it shall be done in accordance with the equipment manufacturer's printed instructions.

2. Any equipment recalibration required shall be done by the equipment manufacturer's representative.

3. After cleaning, the equipment shall be inspected and shall be installed immediately or shall be packaged and tagged.

3.6 CLEANING METHODS

A. The following methods shall be used either singly or in combination to clean the oxygen, ozone, ozone off-gas, and supplemental nitrogen supply equipment:

1. The actual choice will depend on the type and size of the component to be cleaned, the type and extent of contamination, and the facilities available.

B. The Provider shall provide temporary shunts for connecting sections of piping that are to be connected in the final installation by a factory cleaned valve or other connecting device.

C. The Provider shall also provide temporary supports for gas piping, where required, to help bear the additional weight of the water and other fluids used in cleaning the piping.

D. Mechanical cleaning:

1. Mechanical cleaning consists of physically removing contaminants from equipment by brushing, sweeping, blowing, scraping, chaining, sandblasting, agitating, or similar methods.

2. It is generally used for a preliminary cleaning or in combination with other methods.

E. Flushing:

1. Clean the equipment or piping section with detergent solution and followed by purging with dry, oil-free air or nitrogen.

2. The initial rinse with deionized water shall be followed by flushing with detergent solution.

3. If detergent solution is used in a closed piping system, it shall be circulated for at least 2 hours, followed by the final rinse which shall be continued until measurements by the Provider confirm that the system is clean:

a. Measurements shall include but shall not be limited to, the pH value and comparison between influent and effluent conductivity.

4. The system shall be dried using oil-less, dry air of the quality specified, or nitrogen or isopropyl alcohol, if required.

5. Any reference to detergent cleaning elsewhere in this Section implies both rinsing and drying.

6. NOT USED.

7. If the Provider prefers to use a different procedure than specified, the Contractor shall submit details of such a procedure to the Engineer for review.

8. All effluent used in the cleaning process shall be contained, removed, and disposed of off-site.

F. Immersion:

1. Cleaning by immersion involves submerging, and if possible scrubbing, the equipment to be cleaned in a bath selected detergent solution.

2. If many components are being cleaned, 2 baths shall be used:

a. First bath: Remove most of the contaminants.

b. Second bath: Remove the remainder of the contaminants.

3. When the first bath becomes heavily soiled, it shall be emptied and replaced with the second bath, and a new, clean second bath shall be provided.

4. Nonmetallic components shall be immersed briefly or wiped with a cloth as described below.

G. Wiping or mopping:

1. Large, readily accessible surfaces such as compressor parts or vessels that can be entered, may be cleaned by wiping with a detergent solution.

3.7 CLEANING PROCEDURE FOR PIPING SYSTEMS

A. The general concept of oxygen cleaning of piping systems is to clean each pipe section, fitting, valve, or other in-line component before it is installed except where such components can be pre-assembled into spools of a size and configuration suitable for cleaning, inspecting, and handling. Inspection for cleanliness shall be the final step before installation.

B. Items that have been cleaned in the shop by their equipment supplier shall be checked for cleanliness immediately before installation, and recleaned if necessary.

C. In-place cleaning of a preassembled piping or equipment system shall be done in accordance with the procedures used by the Provider for field cleaning and as recommended by Contractor:

1. The Provider shall access and prepare any line to be cleaned in accordance with the District's procedures.

2. All valves (other than full-port ball valves) and instruments shall be removed and replaced with temporary shunts while the cleaning fluid is circulated.

3. Valves shall be cleaned separately and the system reassembled using proper techniques, acceptable to the Contractor and the Provider.

4. Cleaning of skid-mounted, factory-assembled piping systems shall be in accordance with the equipment supplier's printed instructions, and only under the direct supervision of a representative of the equipment supplier.

D. Skid-mounted equipment which has been factory cleaned, such as ozone generators, destruction units, LOX tanks, vaporizers, oxygen filters, and skid-mounted pressure reducing stations shall be bypassed during pressure testing or startup until all piping has been cleaned.

E. Stainless steel and copper piping:

1. Small lines and fittings shall be flushed with detergent solution following cutting to size, preparing ends for welding, and fabrication, where possible.

2. The interior surface of larger lines and fittings shall be swabbed with a rag moistened with detergent solution.

3. After rinsing as described in this Section, the pipe shall be purged until dry and odor-free with dry oil-free air or nitrogen.

4. After cleaning, the pipe shall be inspected and, unless it is installed immediately, shall be protected as specified in this Section.

F. Valves:

1. All valves shall be cleaned at the factory before delivery to the project site.

2. However, if the valves require re-cleaning in the field, the cleaning shall proceed as follows.

3. Butterfly and ball valves:

a. The valve shall be disassembled and each part cleaned by immersion or by swabbing with detergent, rinsed, as specified, and dried with dry oil-free air or nitrogen.

b. They shall be inspected and reassembled using virgin Teflon packing, new gaskets, and approved lubricant.

c. The recleaned valve shall be installed immediately or shall be packaged and tagged.

4. All other valves:

a. Recleaning in the field shall be in accordance with the valve manufacturer's printed instructions.

b. If recalibration is required, it shall be done by the valve manufacturer's representative.

c. After cleaning, the valve shall be inspected and shall be installed immediately, or shall be packaged and tagged.

G. Miscellaneous in-line components:

1. In-line components such as strainers, orifice plates, etc., shall be cleaned, if required, by swabbing with detergent solution.

2. Expansion joints shall be cleaned by scrubbing and flushing and shall be inspected before installation.

H. Instrumentation tubing:

1. Stainless steel tubing shall be flushed with detergent solution, rinsed as specified in this Section, and blown dry with clean oil-free air or nitrogen.

2. Ends of tubing shall be capped until used.

3. Before use, tubing shall be tested for cleanliness.

END OF SECTION