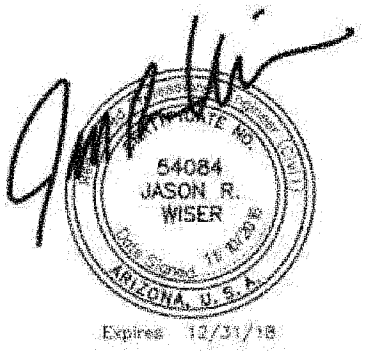
City of Flagstaff

Wildcat Hill Wastewater Treatment Plant
Digester Gas System Improvements

Technical Specifications

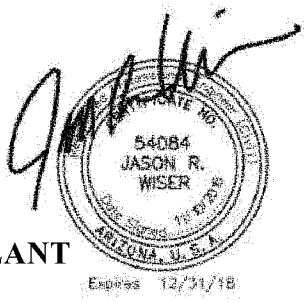
August 2018



Prepared by

Brown AND Caldwell

201 East Washington Street, Suite 500
Phoenix, Arizona 85004



CITY OF FLAGSTAFF
WILDCAT HILL WASTEWATER TREATMENT PLANT
DIGESTER GAS SYSTEM IMPROVEMENTS
100 PERCENT TECHNICAL SPECIFICATIONS

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

SECTION 01010

SUMMARY OF WORK

PART 1--GENERAL

The work covered under this contract will be performed at the site of the City of Flagstaff Wildcat Hill Wastewater Treatment Plant located at 2800 North El Paso Road, Flagstaff, Arizona 86001.

1.01 CONTRACTS

The Contract Documents associated with this project consist of two parts:

- Part A – Technical Specifications
-
- Part B – Drawings

1.02 WORK OF THIS CONTRACT

The work to be performed under this contract includes all labor, materials, and services required for providing the plant improvements defined by these Contract Documents.

The work shall be provided with all demolition and relocation of existing facilities, all temporary structures, piping, pumping, power, and control facilities required to maintain continuous plant operation; all concrete, support piping and equipment, electrical power, control, and lighting; instrumentation; architectural items; painting; and dewatering, demucking, excavation, backfill, grading, paving, fencing, and landscaping as shown and specified and shall include all specified delivery acceptance tests, inspections, operational testing, training, and commissioning.

The following major elements are a part of this contract. The work of this contract shall not be limited to the summary below. The work also includes restoration of those portions of the site that were damaged during construction to pre-construction conditions.

The major elements of the work include the following:

- Replacing portions of the existing underground digester piping with overhead stainless steel piping.

- Adding a hydrogen sulfide removal system to treat the raw digester gas. Installation of the hydrogen sulfide will require the partial excavation of a hill-side and the subsequent construction of a retaining wall.

- Adding a new booster blower to convey digester gas to the existing digester gas conditioning system located at the cogeneration facility.

- Adding a new air-cooled water chiller and heat exchanger for cooling and dehydrating the digester gas upstream of the existing conditioning system.
- Adding condensate collection and removal equipment and other necessary digester gas management appurtenances.

END OF SECTION

SECTION 01011

CONTRACT TIME

1.0 COMPLETION DATE SCHEDULE

Contract time for final completion from Notice to Proceed (days): 180

2.0 SPECIFIC DATE SCHEDULE

Specific dates are dependent on various construction activities and will be determined during the construction phase. Acceptable dates will be determined by the Owner and the Contractor.

END OF SECTION

SECTION 01014

WORK SEQUENCE

1.0 CONTINUITY OF PLANT OPERATIONS

A. GENERAL:

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

B. BYPASSING:

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

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

C. SUBMITTAL:

In accordance with Section 01300, the Contractor shall submit a detailed outage plan and time schedule for operations which will make it necessary to remove a tank, pipeline, channel, electrical circuit, equipment, or structure from service. The schedule shall be coordinated with the construction schedule and shall meet the restrictions and conditions specified in this section. The detailed plan shall describe the Contractor's method for preventing bypassing of other treatment units, the length of time required to complete said operation, the necessary plan, and equipment which the Contractor shall provide in order to prevent bypassing of associated treatment units.

The Contractor shall observe the following restrictions:

- ∞ Systems or individual equipment items shall be isolated, dewatered, decommissioned, de-energized, or depressurized in accordance with the detailed outage plan and schedule. The Construction Manager shall be notified in writing at least one week in advance of the planned operation.

2.0 SEQUENCE AND SCHEDULE OF CONSTRUCTION

To permit continuous treatment of wastewater and compliance with effluent quality requirements, the construction schedule required in paragraph 01011 2.0 shall provide for the following specific conditions:

1. In accordance with the contract drawings, excavate the requisite portion of the berm on the North side of Digester 2, cut and remove the north section of the existing retaining wall, and construct new retaining wall.

2. Prepare the area north of Digester 2 and construct a new equipment pad for the eventual installation of the new hydrogen sulfide removal system.

3. Grind, patch, level, and otherwise prepare the existing equipment pads located in the Digester Control Building and on the roof of the Digester Control Building for the eventual installation of a new digester gas booster blower and a new air-cooled water chiller, respectively.

4. Carefully and safely demolish and remove from the site all existing equipment and piping as indicated on the contract drawings.

5. Install all equipment, piping, and instrumentation in accordance with the contract drawings and specifications.

6. Fill the hydrogen sulfide removal vessel with the granular iron oxide media in accordance with the manufacturer's written instructions.

7. Pressure-test and clean the CWS/CWR piping.

8. Fill the chiller and glycol circulation system, including expansion tank and/or buffer tank, with 40 percent ethylene glycol solution and remove all air from the piping in accordance with the manufacturer's written instructions. Note: system shall be filled with glycol solution and pressurized prior to the installation of insulation on the glycol solution piping in order to detect possible leaks in the system.

9. Excavate and expose the existing, buried 8-inch HDPE digester gas piping at the designated location north of Digester 2 where the digester gas piping branches to the waste gas burner and cogeneration facilities.

10. Close and tag isolation valves on existing 4-inch digester gas laterals located in the Digester Control Building to temporarily stop the flow of digester gas to the common 8-inch digester gas manifold. Waste gas burner shall continue to operate until it automatically shuts off due to low gas pressure. Isolation valves shall remain closed during modifications to existing 8-inch digester gas piping and installation of new digester gas piping and equipment. Contractor shall perform all subsequent construction activities in such a manner as to limit the amount of time that the isolation valves are

closed in order to limit, to the maximum extent practical, the amount of digester gas vented to atmosphere. Contractor shall notify the Owner 1 week in advance of closing the isolation valves.

11. With the isolation valves closed and prior to cutting the existing digester gas piping and prior to connecting the existing piping with the new piping, carefully and safely purge digester gas from the piping with an inert gas such as nitrogen, carbon dioxide, or argon.

12. At the conclusion of the digester gas purge activity, remove the now exposed T-fitting located to the north of Digester 2 (described above) that directs digester gas from the Digester Control Building to the waste gas burner and the cogeneration facilities.

13. Connect the existing buried HDPE digester gas piping from the Digester Control Building to the existing buried HDPE digester gas piping that runs to the waste gas burner. Connect the new 4-inch HDPE piping for MSG service to the existing buried HDPE digester gas piping that extends to the cogeneration facilities. Make all necessary digester gas piping connections to the existing piping in the Digester Control Building. Install segment of MSG piping at the existing digester gas treatment skid to bypass the demolished blower and heat exchanger such that bypass piping connects the discharge of the inlet filter to the inlet of the siloxane removal vessels.

14. Carefully pressure-test the entire digester gas system. Pressure test shall be performed with air and in accordance with the contract documents. Provide the Owner with a certified test report.

15. In accordance with the contract documents, carefully and safely purge air from the complete digester gas system with natural gas.

16. At the conclusion of the purge activity, and with the digester gas system and piping intact, open the isolation valves on the 4-inch digester gas laterals in the Digester Control Building.

17. Start, test, and commission the digester gas treatment equipment, including the digester gas booster blower, digester gas cooling heat exchanger, and the hydrogen sulfide removal system per the manufacturers' written instructions.

18. Start, test, and commission the air-cooled water chiller and glycol circulation pump per the manufacturer's written instructions. Note: all glycol solution piping shall be insulated completely vapor-tight prior to chiller startup in order to prevent water vapor from condensing on the piping surface.

19. Tune and adjust equipment to ensure that the digester gas conveyance, pressurization, and treatment system operates in accordance with the contract specifications.

20. Safely and properly remove all construction equipment and debris from the site and return the site to its original condition as found prior to the start of construction activities.

21. Provide Owner's staff with training, as required in the contract specifications.

END OF SECTION

SECTION 01015

CONTRACTOR'S USE OF PREMISES

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

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

The Contractor shall notify the Owner, in accordance with Section 01014, 1 week in advance of the time it is necessary to take out of service any existing tank, pipeline, channel, electrical circuit, equipment or structure. The Contractor shall be responsible for providing whatever temporary piping, pumping, power, and control facilities as are required to maintain continuous plant operation and complete treatment except as otherwise specified. The integrity of existing plant utilities shall be maintained by the Contractor at all times.

END OF SECTION

SECTION 01040

COORDINATION WITH OPERATION OF EXISTING FACILITIES

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE OF WORK:

The existing wastewater treatment plant will be in continuous operation throughout the execution of this Contract. The Contractor, therefore, shall schedule and conduct his work so as to minimize interference with plant operation and maintenance. It is the intent of this Contract that the construction activity, insofar as possible, shall not interfere with the operation of the plant. The Contractor shall be responsible for coordinating and scheduling the Work in such a sequence that the existing and proposed plant will function properly with no disruption of treatment, bypassing or short-circuiting as specified in Section 01014, Work Sequence.

B. OPERATIONS WORK PLAN:

Contractor shall submit a written Work Plan for each area in specification Section 01014, Work Sequence, two weeks in advance of the time when construction operations will require connection to, or modification of, in-service portions of the existing facility. The plan shall describe the Contractor's method for preventing bypassing of other treatment units, the length of time required to complete Work for the said operations, activities requiring plant staff, and the necessary plant and other equipment which the Contractor shall provide in order to prevent bypassing of associated treatment units. The Work Plan shall address each of the following coordination, planning, and scheduling activities:

1. Emergency procedures to stop accidental bypassing.

2. Planned operational disruptions.

3. Planned utility interruptions including electrical power, natural gas, potable water, and telephone services.

4. Temporary facilities.

5. Process units to be taken out of service.

6. Demolition Plan.

7. Connection of new and existing facilities.

8. Impact on Work sequence and construction schedule.

C. COORDINATION WITH OWNER:

Delays in the construction schedule due to failure of the Contractor to adequately coordinate the Work with the Owner sufficiently in advance of the Work shall not be considered as cause for extension of the Contract Time. It shall be the Contractor's responsibility to continuously keep the Owner informed of the construction schedule as the Work progresses. Submittal of the construction schedule required in Section 01310 shall not relieve the Contractor of the responsibility to coordinate the Work with the Owner nor give advance notifications as specified.

1.02 PERFORMANCE REQUIREMENTS

A. GENERAL:

When modifications, additions, or connections to existing facilities are required, the Contractor shall schedule such activities with the Owner and Construction Manager. No system, structure, tankage, circuit, or individual process unit shall be modified, dewatered, drained, de-energized, or removed from existing facilities unless authorized, in writing, by the Construction Manager. Insofar as possible, no interconnections between existing systems and new systems shall be made until all the Work of the new system has been completed, and tested up to the point of interconnection to the existing system in accordance with specification Section 01660, Installation, Testing, and Commissioning.

B. OPERATIONAL DISRUPTIONS:

In addition to the normal schedule requirements as specified herein, the Contractor shall provide the Owner two weeks before event with a detailed breakdown and plan of Work activities to be conducted during a disruption period. The Owner will then review the plan and advise the Contractor as to its suitability. Submission of a plan and request for disruption does not require or constitute approval by the Owner. The Owner will evaluate operational impacts of the disruption against operational requirements and respond accordingly. Constraints regarding known disruptions are addressed under specification Section 01014, Work Sequence.

The Contractor is expected to take maximum advantage of any component or system disruption. When planning Work for a disruption, all possible Work that can be accommodated by the disruption should be accomplished if practicable. All necessary preparatory Work is to be completed prior to the planned disruption, and all equipment, materials, and personnel needed to satisfy the Work requirements scheduled for the disruption period are to be available prior to initiation of the event. All planned operational disruptions shall be scheduled between the hours of 12:00 a.m. and 8:00 a.m. Disruptions of longer duration or at other times shall require written approval of the Owner one month in advance of the event.

The Contractor shall connect new electrical equipment with a minimum of interruption to plant services. The Contractor shall inform the Owner in writing two weeks in advance of event, whenever the power supply must be interrupted to make required connections and shall inform him of the estimated duration of the interruption. In no case shall the Contractor cause an intentional power interruption without written authority from the Owner.

No extra payment will be made for any labor, materials, tools, equipment, or temporary facilities required during any disruption periods. All associated costs shall be included in the Contractor's GMP. The Contractor is responsible for damages suffered by the Owner as a result of the Contractor's failure to complete the required work within allotted disruption periods.

C. TEMPORARY FACILITIES:

Whenever disruption of routine plant operation is required to accomplish the Work, the Contractor shall provide temporary facilities to ensure that all plant flows are accommodated and that treatment requirements are satisfied to the same quality as existing prior to the start of construction. Adequacy of temporary facilities shall be determined by the Construction Manager.

The Contractor shall submit to the Construction Manager for approval all detailed drawings showing equipment, piping, power, controls, and weather protection for all proposed temporary systems whether described in this section or anticipated by the Contractor. The submittals shall indicate equipment capacities.

D. NOT USED

E. SUBMITTALS:

In accordance with specification Section 01300 and in addition to the requirements of that section, the following submittals shall be provided:

1. Area operations Work Plan.
2. Drawings of proposed temporary facilities.

1.03 GENERAL EXECUTION

A. OPERATION:

Unless otherwise specified, normal daily operation and maintenance of the existing wastewater treatment facilities will be performed by plant personnel. Whenever operational functions on existing facilities or new facilities which affect operating systems are required to permit construction operations, these functions will also be performed by plant personnel. The Owner shall be notified at least 72 hours in advance of the need to operate valves, gates, equipment, or other actions that could affect plant operations.

B. TEMPORARY FACILITIES:

The Contractor shall not use proposed new equipment in any temporary facility. Temporary facilities shall not be removed from service until the new proposed system has been satisfactorily tested and commissioned as specified in individual technical specification sections and Sections 01660, Installation, Testing, and Commissioning. All temporary facilities shall be removed from the site by the Contractor and shall remain the property of the Contractor when no longer required.

The Owner shall operate all temporary process facilities while they are needed. All maintenance shall be provided by the Contractor. During the time of use of the temporary facility, the Owner shall pay for all power and chemicals necessary to operate the systems.

C. NOT USED

D. MODIFICATION OF EXISTING STRUCTURES:

The Contractor shall alter or rework existing concrete structures as shown and specified. Generally, when items of equipment and piping are removed, the areas and surfaces from which items were removed shall be left with a neat appearance and finish compatible with surrounding areas, colors, and surfaces. Holes and pipe and conduit penetrations in walls and slabs shall be plugged smooth with grout. The Contractor shall do all painting, sanding, grouting, sacking, resurfacing, and other work as necessary to comply with the above requirements. Prior to structural modifications, all surfaces shall be subject to inspection by the Construction Manager. Colors shall match existing colors as closely as possible.

When removing materials or portions of existing structures and when making openings in walls and partitions, the Contractor shall take all precautions and use all necessary barriers and other protective devices so as not to damage the structures beyond the limits necessary for the new work, nor to damage the structures or contents by falling or flying debris.

All work of altering existing structures shall be done at such time and in such manner as will comply with the approved time schedule. So far as possible before any part of the work is started, all tools, equipment, and materials shall be assembled and made ready so that the work can be completed without delay.

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

Surfaces of seals visible in the completed work shall be made to match as nearly as possible the adjacent surfaces.

Non-shrink grout shall be used for setting wall castings, sleeves, leveling pump bases, doweling anchors into existing concrete and elsewhere as shown.

E. BURIED PIPELINES:

Buried pipelines 2 inches in diameter and larger to be abandoned during the course of the work shall be plugged at both ends with expanding grout as detailed on the drawings.

F. PERMITS AND EASEMENTS:

The Contractor will obtain the permits and the permanent easements required for the construction of the project. In addition, the Contractor shall obtain all temporary easements outside of the Owner's property required for the Contractor's operations. The Contractor shall notify the Owner immediately if it becomes apparent a permit or easement cannot readily be obtained.

G. DISPOSAL/HANDLING OF HAZARDOUS MATERIALS:

The Contractor is solely responsible for storage, use and disposal of materials, including subcontractor materials classified as hazardous substances in accordance with HSWA 1984 and RCRA regulations. The Owner reserves the right to designate the storage location of the hazardous materials and conduct periodic inspections on the site. The Contractor, after completion of construction shall remove and dispose of all construction related materials with hazardous waste classifications in accordance with local, state, and federal regulations.

H. SECURITY:

The Contractor shall at all times be responsible for the security of his facilities and equipment. The Owner will not take any responsibility for the Contractor's missing or damaged equipment, tools, or personal belongings.

END OF SECTION

SECTION 01050

SURVEY INFORMATION

The Owner will establish reference benchmarks and baselines as specified. From the information provided, the Contractor shall develop and make such additional surveys as are needed for construction, such as control lines, slope stakes, batter boards, stakes for pipe locations and other working points, lines, and elevations. Survey work shall be performed under the supervision of a licensed land surveyor or registered civil engineer. Contractor shall reestablish reference benchmarks and survey control monuments destroyed by his operations at no cost to the Owner.

END OF SECTION

SECTION 01060

SAFETY AND HEALTH

PART 1--GENERAL

1.01 GENERAL

Portions of the existing plant are exposed to wastewaters of varying degrees of treatment. The Contractor shall put in place the necessary safety plans, in accordance with applicable Federal, State, and local laws and regulations to safely perform the Work. As such, the Contractor acknowledges that he is experienced and qualified to anticipate and meet the safety and health requirements of this project.

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

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

1.02 SAFETY AND HEALTH REGULATIONS

The Contractor shall comply with Safety and Health Regulations for Construction, promulgated by the Secretary of Labor under Section 107 of the Contract Work Hours and Safety Standards Act, as set forth in Title 29, C.F.R. Copies of these regulations may be obtained from Labor Building, 14th and Constitution Avenue N.W., Washington, DC 20013.

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

END OF SECTION

SECTION 01071

STANDARD REFERENCES

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

AA	Aluminum Association Incorporated P.O. Box 753 Waldorf, MD 20604
AABC	Associated Air Balance Council 1518 K Street N.W. Washington, DC 20005
AAMA	American Architectural Manufacturers Association 1540 East Dundee Road, Suite 310 Palatine, IL 60067
AASHTO	American Association of State Highway and Transportation Officials 444 North Capitol Street, N.W., Suite 249 Washington, DC 20001
ABMA	American Bearing Manufacturers Association 1200 19th Street N.W., Suite 300 Washington, DC 20036
ACI	American Concrete Institute 22400 West Seven Mile Road P.O. Box 19150, Redford Station Detroit, MI 48219
AEIC	Association of Edison Illuminating Companies 600 North 18th Street P.O. Box 2641 Birmingham, AL 35291
AGA	American Gas Association ATTN: Records 1515 Wilson Boulevard Arlington, VA 22209
AGMA	American Gear Manufacturer's Association, Inc. 1500 King Street, Suite 201 Alexandria, VA 22314
AHA	American Hardboard Association 1210 West Northwest Highway Palatine, IL 60067
AISC	American Institute of Steel Construction One East Wacker Drive, Suite 3100 Chicago, IL 60601

AISI	American Iron and Steel Institute 1101 Seventeenth Street, NW, Suite 1300 Washington, DC 20036
AITC	American Institute of Timber Construction 7012 South Revere Parkway, Suite 140 Englewood, CO 80112
ALSC	American Lumber Standard Committee P.O. Box 210 Germantown, MD 20875
AMCA	Air Movement and Control Association, Inc. 30 West University Drive Arlington Heights, IL 60004
ANSI	American National Standards Institute 11 West 42nd Street, 13th Floor New York, NY 10036
APA	American Plywood Association 7011 South 19th Street Tacoma, WA 98466
API	American Petroleum Institute 1220 L Street N.W. Washington, DC 20005
ARI	Air-Conditioning and Refrigeration Institute 4301 North Fairfax Drive, Suite 425 Arlington, VA 22203
ASCE	American Society of Civil Engineers United Engineering Center 345 East 47th Street New York, NY 10017
ASCII	American Standard Code for Information Interchange United States of America Standards Institute 10 East 40th Street New York, NY 10016
ASE Code	American Standard Safety Code for Elevators, Dumbwaiter and Escalators American National Standards Institute 1430 Broadway New York, NY 10018
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers, Inc. 1791 Tullie Circle, NE Atlanta, GA 30329
ASME	American Society of Mechanical Engineers 345 East 47th Street New York, NY 10017
ASTM	American Society for Testing and Materials 100 Barr Harbor Drive West Conshohocken, PA 19428

AWPA	American Wood-Preservers' Association 9549 Old Fredrick Road Ellicott City, MD 21042 or P.O. Box 286 Woodstock, MD 21163-0286
AWS	American Welding Society 550 NW LeJeune Road P.O. Box 351040 Miami, FL 33135
AWWA	American Water Works Association 6666 West Quincy Avenue Denver, CO 80235
BOCA	Building Officials and Code Administrators, International, Inc. 4051 West Flossmoor Road Country Club Hills, IL 60478
CALTEST	Materials Manual, State of California, Business and Transportation Agency Department of Public Works State of California, Department of Transportation 6002 Folsom Boulevard Sacramento, CA 95819
CALTRANS	Standard Specifications, State of California, Department of Transportation State of California, Business and Transportation Agency P.O. Box 1499 Sacramento, CA 95807
CBM	Certified Ballast Manufacturers 2120 Keith Building Cleveland, OH 44115
CMAA	Crane Manufacturers Association of America, Inc. (Formerly called: Overhead Electrical Crane Institute) (OECI) 8720 Red Oak Boulevard, Suite 201 Charlotte, NC 28217
CRSI	Concrete Reinforcing Steel Institute 933 N Plum Grove Road Schaumburg, IL 60173
CSA	Canadian Standards Association 178 Rexdale Boulevard Rexdale, Ontario, M9W IR3, Canada
DEMA	Diesel Engine Manufacturer's Association 30200 Detroit Road Cleveland, OH 44145
DHI	Door and Hardware Institute 14170 Newbrook Drive Chantilly, VA 22021

DIS	Division of Industrial Safety California Department of Industrial Relations 2422 Arden Way Sacramento, CA 95825
EEI	Edison Electric Institute 90 Park Avenue New York, NY 10016
EIA	Electronic Industries Association Order from: Global Engineering Documents 18201 McDurmott West Irvine, CA 92714
EJMA	Expansion Joint Manufacturers Association 25 North Broadway Tarrytown, NY 10591
ESO	Electrical Safety Orders California Administrative Code, Title 8, Chap. 4, Subarticle 5 Office of Procurement, Publications Section P.O. Box 20191 8141 Elder Creek Road Sacramento, CA 95820
FEDSPEC	Federal Specifications General Services Administration Specification and Consumer Information Distribution Branch Washington Navy Yard, Bldg. 197 Washington, DC 20407
FEDSTDS	Federal Standards (see FEDSPECS)
FM	Factory Mutual Engineering and Research Corporation 1151 Boston-Providence Turnpike P.O. Box 9102 Norwood, MA 02062
HEI	Heat Exchange Institute 1300 Sumner Avenue Cleveland, OH 44115
HI	Hydraulic Institute 9 Sylvan Way, Suite 180 Parsippany, NJ 07054
HPVA	Hardwood Plywood & Veneer Association 1825 Michael Faraday Drive P.O. Box 2789 Reston, VA 22090-2789
IAPMO	International Association of Plumbing and Mechanical Officials 20001 Walnut Drive S Walnut, CA 91789

ICBO	International Conference of Building Officials 5360 Workman Mill Road Whittier, CA 90601
ICEA	Insulated Cable Engineers Association P.O. Box 440 South Yarmouth, MA 02664
IEEE	Institute of Electrical and Electronics Engineers 445 Hoes Lane P.O. Box 1331 Piscataway, NJ 08855
IES	Illuminating Engineering Society of North America 120 Wall Street New York, NY 10017
ISA	Instrument Society of America 67 Alexander Drive P.O. Box 12277 Research Triangle Park, NC 27709
JIC	Joint Industrial Council 7901 West Park Drive McLean, VA 22101
MFMA	Metal Framing Manufacturers Association 401 N. Michigan Avenue Chicago, IL 60611
MILSPEC	Military Specifications Naval Publications and Forms Center 5801 Tabor Avenue Philadelphia, PA 19120
MSS	Manufacturers Standardization Society of the Valve & Fittings Industry, Inc. 127 Park Street, N.E. Vienna, VA 22180
NAAMM	National Association of Architectural Metal Manufacturers 11 South La Salle Street, Suite 1400 Chicago, IL 60603
NACE	National Association of Corrosion Engineers 1440 South Creek Drive Houston, TX 77084
NBC	National Building Code Published by BOCA
NEC	National Electric Code National Fire Protection Association One Batterymarch Park P.O. Box 9101 Quincy, MA 02269
NELMA	Northeastern Lumber Manufacturers Association, Inc. P.O. Box 87A Cumberland Center, ME 04021

NEMA	National Electrical Manufacturer's Association 2101 L Street, NW, Suite 300 Washington, DC 20037
NESC	National Electric Safety Code American National Standards Institute 1430 Broadway New York, NY 10018
NFOR	National Forest Products Association (Formerly National Lumber Manufacturer's Association) 1111 19 Street NW, Suite 700 Washington, DC 20036
NFPA	National Fire Protection Association One Batterymarch Park P.O. Box 9101 Quincy, MA 02269
NHLA	National Hardwood Lumber Association 6830 Raleigh LaGrange P.O. Box 34518 Memphis, TN 38184-0518
NSF	National Sanitation Foundation 3475 Plymouth Road P.O. Box 130140 Ann Arbor, MI 48113
OSHA	Occupational Safety and Health Act U.S. Department of Labor Occupational and Health Administration San Francisco Regional Office 450 Golden Gate Avenue, Box 36017 San Francisco, CA 94102
PCI	Precast/Prestressed Concrete Institute 175 West Jackson Blvd., Suite 1859 Chicago, IL 60604
PPIC	The Plumbing & Piping Industry Council, Inc. 510 Shatto Place, Suite 402 Los Angeles, CA 90020
RIS	Redwood Inspection Service California Redwood Association 405 Enfrente Dr., Suite 200 Novato, CA 94949
RMA	Rubber Manufacturers Association 1400 K Street NW, Suite 900 Washington, DC 20005
SAE	Society of Automotive Engineers, Inc. 400 Commonwealth Drive Warrendale, PA 15096

SAMA	Scientific Apparatus Makers Association One Thomas Circle Washington, DC 20005
SBC	Standard Building Code Published by SBCCI
SBCCI	Southern Building Code Congress International Inc. 900 Montclair Road Birmingham, AL 35213
SCMA	Southern Cypress Manufacturers Association 400 Penn Center Boulevard, Suite 530 Pittsburg, PA 15235
SDI	Steel Door Institute 30200 Detroit Road Cleveland, OH 44145
SMACNA	Sheet Metal and Air Conditioning Contractors National Association, Inc. P.O. Box 221230 Chantilly, VA 22021
SPI	Society of the Plastics Industry, Inc. 1275 K Street NW, Suite 400 Washington, DC 20005
SPIB	Southern Pine Inspection Bureau 4709 Scenic Highway Pensacola, FL 32504
SSPC	Society for Protective Coatings 40 24th Street, 6th Floor Pittsburgh, PA 15222
SSPWC	Standard Specifications for Public Works Construction Building News, Inc. 3055 Overland Avenue Los Angeles, CA 90034
TEMA	Tubular Exchanger Manufacturer's Association 25 North Broadway Tarrytown, NY 10591
TPI	Truss Plate Institute 583 D'Onofrio Drive, Suite 200 Madison, WI 53719
UBC	Uniform Building Code Published by ICBO
UL	Underwriters Laboratories Inc. 333 Pfingsten Road Northbrook, IL 60062
UMC	Uniform Mechanical Code Published by ICBO
UPC	Uniform Plumbing Code Published by IAPMO

USBR	Bureau of Reclamation U.S. Department of Interior Engineering and Research Center Denver Federal Center, Building 67 Denver, CO 80225
WCLIB	West Coast Lumber Inspection Bureau 6980 SW Varns Street P.O. Box 23145 Portland, OR 97223
WWPA	Western Wood Products Association (Formerly called: West Coast Lumbermen's Association (WCLA)) Yeon Building 522 SW 5th Avenue Portland, OR 97204

END OF SECTION

SECTION 01300

SUBMITTALS

PART 1--GENERAL

Submittals covered by these requirements include manufacturers' information, shop drawings, test procedures, test results, samples, requests for substitutions, and miscellaneous work-related submittals. Submittals shall also include, but not be limited to, all mechanical, electrical and electronic equipment and systems, materials, reinforcing steel, fabricated items, and piping and conduit details. The Contractor shall furnish all drawings, specifications, descriptive data, certificates, samples, tests, methods, schedules, and manufacturer's installation and other instructions as specifically required in the contract documents to demonstrate fully that the materials and equipment to be furnished and the methods of work comply with the provisions and intent of the contract documents.

1.01 CONTRACTOR'S RESPONSIBILITIES

A. GENERAL:

The Contractor shall be responsible for the accuracy and completeness of the information contained in each submittal and shall assure that the material, equipment or method of work shall be as described in the submittal. The Contractor shall verify that all features of all products conform to the specified requirements. Submittal documents shall be clearly edited to indicate only those items, models, or series of equipment, which are being submitted for review. All extraneous materials shall be crossed out or otherwise obliterated. The Contractor shall ensure that there is no conflict with other submittals and notify the Owner in each case where his submittal may affect the work of another contractor or the Owner. The Contractor shall coordinate submittals among his subcontractors and suppliers including those submittals complying with unit responsibility requirements specified in applicable technical sections.

The Contractor shall coordinate submittals with the work so that work will not be delayed. He shall coordinate and schedule different categories of submittals, so that one will not be delayed for lack of coordination with another. No extension of time will be allowed because of failure to properly schedule submittals. The Contractor shall not proceed with work related to a submittal until the submittal process is complete. This requires that submittals for review and comment shall be returned to the Contractor stamped "No Exceptions Taken" or "Make Corrections Noted."

The Contractor shall certify on each submittal document that he has reviewed the submittal, verified field conditions, and complied with the contract documents.

The Contractor may authorize in writing a material or equipment supplier to deal directly with the Owner with regard to a submittal. These dealings shall be limited to contract interpretations to clarify and expedite the work.

B. REQUEST FOR SUBSTITUTION – SPECIAL EQUIPMENT:

Requests for substitution for equipment specified by manufacturer or manufacturer's model number shall be in writing and shall be accompanied with sufficient information to permit the Owner to identify the nature and scope of the request. Information to be provided along with the request for substitution shall include:

1. All submittal information required for the specified equipment, including all deviations from the specified requirements necessitated by the proposed substitution.

2. Materials of construction, including material specifications and references.

3. Performance data, including performance curves and guaranteed power consumption, over the range of specified operating conditions.

4. Dimensional drawings, showing required access and clearances, including any changes to the work required to accommodate the proposed substitution.

5. Where controls are a part of the proposed substitution, piping, process and instrumentation drawings (P&IDs), produced in the project format and with project-specific symbols, along with control descriptions.

6. Where controls specified in the project manual require modification to accommodate the proposed substitution, piping, process and instrumentation drawings (P&IDs), produced in project format and with project-specific symbols, with all required modifications clearly highlighted.

7. Information and performance characteristics for all system components and ancillary devices to be furnished as a part of the proposed substitution.

8. Reproducible contract drawings, marked up to illustrate the alterations to all structural, architectural, mechanical, electrical and HVAC systems required to accommodate the proposed substitution.

9. A list of installations of the proposed substitution indicating application, location, owner and date of first use.

Upon receipt of written application for substitution from the Contractor, including the information specified above, the Owner will estimate the cost of evaluating the request and present the estimate to the Contractor. The Contractor is advised that the estimate is based upon the best information available to the Owner at the time; however, the actual cost, based on time and expense, will be documented and applied in the final analysis of the substitution request. If the Contractor wishes to proceed with the request, he shall advise the Owner in writing and submit sufficient additional information as may be requested by the Owner. No evaluation will take place until such

time as the Contractor has agreed to the estimate in writing and has authorized the Owner to deduct the cost of the evaluation from monthly progress payments due the Contractor.

Cost for evaluating a requested substitution for any equipment item named below shall be borne by the Contractor as specified.

1.02 CATEGORIES OF SUBMITTALS

A. GENERAL:

Submittals fall into two general categories; submittals for review and comment, and submittals which are primarily for information only. Submittals which are for information only are generally specified as PRODUCT DATA in Part 2 of applicable specification sections.

At the beginning of work, the Owner will furnish the Contractor lists of those submittals specified in the project manual. Two separate lists will be provided: submittals for review and comment and product data (submittals) for information only.

B. SUBMITTALS FOR REVIEW AND COMMENT:

All submittals except where specified to be submitted as product data for information only shall be submitted by the Contractor to the Owner for review and comment.

C. SUBMITTALS (PRODUCT DATA) FOR INFORMATION ONLY:

Where specified, the Contractor shall furnish submittals (product data) to the Owner for Information only. Submittal requirements for operation and maintenance manuals, which are included in this category, are specified in Section 01730.

1.03 TRANSMITTAL PROCEDURE

A. GENERAL:

Unless otherwise specified, submittals regarding material and equipment shall be accompanied by Transmittal Form 01300-A specified in Section 01999. Submittals for operation and maintenance manuals, information and data shall be accompanied by Transmittal Form 01730-A specified in Section 01999. A separate form shall be used for each specific item, class of material, equipment, and items specified in separate, discrete sections, for which the submittal is required. Submittal documents common to more than one piece of equipment shall be identified with all the appropriate equipment numbers. Submittals for various items shall be made with a single form when the items taken together constitute a manufacturer's package or are so functionally related that expediency indicates checking or review of the group or package as a whole.

A unique number, sequentially assigned, shall be noted on the transmittal form accompanying each item submitted. Original submittal numbers shall have the following format: "XXX"; where "XXX" is the sequential number assigned by the Contractor. Resubmittals shall have the following format: "XXX-Y"; where "XXX" is the originally assigned submittal number and "Y" is a sequential letter assigned for resubmittals, i.e., A, B, or C being the 1st, 2nd, and 3rd resubmittals, respectively. Submittal 25B, for example, is the second resubmittal of submittal 25.

B. DEVIATION FROM CONTRACT:

If the Contractor proposes to provide material, equipment, or method of work which deviates from the project manual, he shall indicate so under "deviations" on the transmittal form accompanying the submittal copies.

C. SUBMITTAL COMPLETENESS:

Submittals which do not have all the information required to be submitted, including deviations, are not acceptable and will be returned without review.

1.04 REVIEW PROCEDURE

A. GENERAL:

Submittals are specified for those features and characteristics of materials, equipment, and methods of operation which can be selected based on the Contractor's judgment of their conformance to the specified requirements. Other features and characteristics are specified in a manner which enables the Contractor to determine acceptable options without submittals. The review procedure is based on the Contractor's guarantee that all features and characteristics not requiring submittals conform as specified. Review shall not extend to means, methods, techniques, sequences or procedures of construction, or to verifying quantities, dimensions, weights or gages, or fabrication processes (except where specifically indicated or required by the project manual) or to safety precautions or programs incident thereto. Review of a separate item, as such, will not indicate approval of the assembly in which the item functions.

When the contract documents require a submittal, the Contractor shall submit the specified information as follows:

1. Three copies (paper) and one electronic version (on CD or DVD) of all submitted information shall be transmitted with submittals for review and comment.

2. Unless otherwise specified, three copies (paper) and one electronic version (on CD or DVD) of all submitted information shall be transmitted with submittals (Product Data) for information only.

B. SUBMITTALS FOR REVIEW AND COMMENT:

Unless otherwise specified, within 35 calendar days after receipt of a submittal for review and comment, the Owner shall review the submittal and return 2 copies of the marked-up reproducible original noted in 1 above. The reproducible original will be retained by the Owner. The returned submittal shall indicate one of the following actions:

1. If the review indicates that the material, equipment or work method complies with the project manual, submittal copies will be marked "NO EXCEPTIONS TAKEN." In this event, the Contractor may begin to implement the work method or incorporate the material or equipment covered by the submittal.

2. If the review indicates limited corrections are required, copies will be marked "MAKE CORRECTIONS NOTED." The Contractor may begin implementing the work method or incorporating the material and equipment covered by the submittal in accordance with the noted corrections. Where submittal information will be incorporated in O&M data, a corrected copy shall be provided.

3. If the review reveals that the submittal is insufficient or contains incorrect data, copies will be marked "AMEND AND RESUBMIT." Except at his own risk, the Contractor shall not undertake work covered by this submittal until it has been revised, resubmitted and returned marked either "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED."

4. If the review indicates that the material, equipment, or work method does not comply with the project manual, copies of the submittal will be marked "REJECTED - SEE REMARKS." Submittals with deviations which have not been identified clearly may be rejected. Except at his own risk, the Contractor shall not undertake the work covered by such submittals until a new submittal is made and returned marked either "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED."

C. SUBMITTALS (PRODUCT DATA) FOR INFORMATION ONLY:

Such information is not subject to submittal review procedures and shall be provided as part of the work under this contract and its acceptability determined under normal inspection procedures.

1.05 EFFECT OF REVIEW OF CONTRACTOR'S SUBMITTALS

Review of contract drawings, methods of work, or information regarding materials or equipment the Contractor proposes to provide, shall not relieve the Contractor of his responsibility for errors therein and shall not be regarded as an assumption of risks or liability by the Owner or the Owner, or by any officer or employee thereof, and the Contractor shall have no claim under the contract on account of the failure, or partial failure, of the method of work, material, or equipment

so reviewed. A mark of "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED" shall mean that the Owner has no objection to the Contractor, upon his own responsibility, using the plan or method of work proposed, or providing the materials or equipment proposed.

END OF SECTION

SECTION 01310

CONSTRUCTION SCHEDULE

PART 1--GENERAL

1.01 SCOPE

This section specifies the procedures for preparing and revising the cost-loaded construction schedule used for planning and managing construction activities. The schedule provides a basis for determining the progress status of the project relative to the completion time, specific dates, and for determining the acceptability of the Contractor's progress payment estimates. This Section is intended as supplemental to the Construction Services Agreement which shall govern.

1.02 DESCRIPTION

The Contractor shall prepare a time scale network schedule using a critical path method. A general guide for preparing such a schedule is contained in "The Use of CPM in Construction, a Manual for Contractors," published by the Associated General Contractors of America.

The schedule shall depict all significant construction activities and all items of work listed in the breakdown of contract prices submitted by the Contractor in accordance with Part A, Construction Services Agreement. Assigned values for each part of the work shall be indicated. The dependencies between activities shall be indicated so that it may be established what effect the progress of any one activity has on the schedule.

Completion time and all specific dates given in Section 01011, and sequencing requirements described in Section 01014, shall be shown on the schedule. Activities making up the critical path shall be identified.

No activity on the schedule shall have a duration longer than 21 days or assigned value greater than $100,000, except activities comprising only fabrication and delivery may extend for more than 21 days. Activities which exceed these limits shall be divided into more detailed components. The scheduled duration of each activity shall be based on the work being performed during the normal 40-hour work week with allowances made for legal holidays and normal weather conditions.

1.03 SUBMITTAL PROCEDURES

Within 20 days after the date of the Notice to Proceed, the Contractor shall complete a construction schedule conforming to paragraph 01310.1.02 and representing in detail all planned procurement and on-site construction activities. The schedule shall be prepared on reproducible paper and may be in draft form with legible freehand lines and lettering. Upon completion of the schedule, the Contractor shall submit the original and two copies to the Owner in accordance with Section 01300.

Within 7 days after receipt of the submittal, the Owner shall review the submitted schedule and return one copy of the marked up original to the Contractor. If the Owner finds that the submitted schedule does not comply with specified requirements, the corrective revisions will be noted on the submittal copy returned to the Contractor for corrections and resubmittal as specified in Section 01300. Upon receipt of a schedule and breakdown of contract prices conforming to the contract, the Owner will computerize the Contractor's scheduling and cost data. Within 14 days, the Owner will deliver three computer reports to the Contractor. The reports shall contain the following:

1. Tabular listing of activities showing early and late start and finish dates.
2. Bar chart schedule of all activities.
3. Report on cost and payment status for each activity.

These reports will serve as the basis for the Contractor's progress payment requests. Computerization of the Contractor's schedule and furnishing reports to the Contractor by the Owner shall not relieve the Contractor of responsibility for the adequacy of the schedule and for managing all construction activities including those of subcontractors and suppliers.

1.04 SCHEDULE REVISIONS

Revisions to the accepted cost-loaded construction schedule may be made only with written approval of the Contractor and Owner. Changes in timing for activities which are not on the critical path may be modified with written agreement of the Contractor and Owner. A change affecting the contract value of any activity, the timing of any activity on the critical path, the completion time and specific dates (Section 01011) and work sequencing (Section 01014) may be made only in accordance with applicable provisions of the General Conditions to the contract agreement.

1.05 PROJECT STATUS UPDATE

Within 7 days of acceptance by the Owner of the Contractor's written progress report, the Owner will process the update data by computer and generate the reports outlined in paragraph 01310.1.03. These reports will reflect the current status of the work and will be provided to and used by the Contractor as the basis of his progress payment request.

END OF SECTION

SECTION 01400

QUALITY CONTROL

PART 1--GENERAL

1.01 SUMMARY

A. Specific quality control requirements for the Work are indicated throughout the Contract Documents. The requirements of this Section are primarily related to performance of the Work beyond furnishing of manufactured products. The Contractor shall provide a "Quality Control" program for their work. The term "Quality Control" includes inspection, sampling and testing, and associated requirements.

1.02 SUBMITTALS

A. Submit inspection, sampling and testing reports as required by individual technical specification sections in accordance with Section 01300 Submittal Procedures.

B. Submit notification of inspection, sampling and testing needs as specified in this Section.

1.03 NOT USED

1.04 NOT USED

1.05 PROJECT/SITE CONDITIONS

A. Unless otherwise indicated, all products, materials, and equipment shall be subject to inspection by the Owner at the place of manufacture.

B. The presence of the Owner at the place of manufacturer, however, shall not relieve the Contractor of the responsibility for furnishing products, materials, and equipment which comply with all requirements of the Contract Documents. Compliance is a duty of the Contractor, and said duty shall not be avoided by any act or omission on the part of the Owner.

C. Unless otherwise indicated, all sampling and testing shall be in accordance with the methods prescribed in the current standards of the ASTM, as applicable to the class and nature of the article or materials considered; however, the Owner reserves the right to use any generally-accepted system of sampling and testing which, in the opinion of the Owner will assure the Owner that the quality of the workmanship is in full accord with the Contract Documents.

D. Any waiver by the Owner of any specific testing or other quality assurance measures, whether or not such waiver is accompanied by a guarantee of substantial

performance as a relief from the specified testing or other quality assurance requirements as originally specified, and whether or not such guarantee is accompanied by a performance bond to assure execution of any necessary corrective or remedial Work, shall not be construed as a waiver of any requirements of the Contract Documents.

Notwithstanding the existence of such waiver, the Owner reserves the right to make independent investigations and tests, and failure of any portion of the Work to meet any of the requirements of the Contract Documents, shall be reasonable cause for the Owner to require the removal or correction and reconstruction of any such Work in accordance with the General Conditions.

E. Inspection and testing laboratory service shall comply with the following:

1. The Owner will appoint, employ and pay for services of an independent firm to perform testing and inspection of the Contractor's work. This does not relieve the Contractor from providing inspection and laboratory services to meet quality control requirements.

2. The Contractor shall utilize the services of the independent firm, Owner employed, to perform sampling and testing of their work to verify that quality of the workmanship is in full accord with the Contract Documents as part of their Quality Control.

3. The Contractor shall provide the Owner copies of all inspection, sampling and testing reports that the Contractor receives from the independent firm.

4. The Contractor shall cooperate with the Owner or independent firm and furnish samples of materials, design mix, equipment, tools, storage and assistance as requested.

5. The Contractor shall notify the Owner and independent firm a minimum of 24 hours prior to the expected time for operations requiring sampling and laboratory testing services.

6. Retesting required because of non-conformance to specified requirements shall be performed by the same independent firm on instructions by the Owner. The Contractor shall bear all costs from such retesting at no additional cost to the Owner.

7. For samples and tests required for Contractor's use, the Contractor shall make arrangements with an independent firm for payment and scheduling of testing. The cost of sampling and testing for the Contractor's use shall be included in the Contract Price.

F. Inspection, sampling and testing shall be as specified in the individual Sections.

PART 2--PRODUCTS (NOT USED)

PART 3--EXECUTION

3.01 INSTALLATION

A. INSPECTION:

The Contractor shall inspect materials or equipment upon the arrival on the job site and immediately prior to installation, and reject damaged and defective items.

B. MEASUREMENTS:

The Contractor shall verify measurements and dimensions of the Work, as an integral step of starting each installation.

C. MANUFACTURER'S INSTRUCTIONS:

Where installations include manufactured products, the Contractor shall comply with manufacturer's applicable instructions and recommendations for installation, to whatever extent these are more explicit or more stringent than applicable requirements indicated in Contract Documents.

END OF SECTION

SECTION 01500

CONTRACTOR'S UTILITIES

1.0 OFFICE

The Contractor shall maintain a suitable office at the site of the work.

2.0 POWER

The Contractor shall provide power for construction at the plant site. He shall make arrangements with the electrical utility and with the Owner for power takeoff points, voltage and phasing requirements, transformers and metering and shall pay the costs and fees arising therefrom. The Contractor shall provide the special connections required for his work.

3.0 TELEPHONE

The Contractor shall provide telephone service at his construction site office. Radio-telephone service is not acceptable as a substitute for telephone service.

4.0 SANITARY FACILITIES

The Contractor shall provide toilet and washup facilities for his work force at the site of work. The facilities shall comply with applicable laws, ordinances, and regulations pertaining to the public health and sanitation of dwellings and camps.

END OF SECTION

SECTION 01560

ENVIRONMENTAL CONTROLS

1.0 SITE MAINTENANCE

The Contractor shall keep the work site clean and free from rubbish and debris. Materials and equipment shall be removed from the site when they are no longer necessary. Upon completion of the work and before final acceptance, the work site shall be cleared of equipment, unused materials, and rubbish to present a clean and neat appearance.

2.0 TEMPORARY DAMS

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

3.0 AIR POLLUTION CONTROL

The Contractor shall not discharge smoke, dust, and other contaminants into the atmosphere that violate the regulations of any legally constituted authority. He shall also abate dust nuisance by cleaning, sweeping, and sprinkling with water, or other means as necessary. The use of water, in amounts which result in mud on public streets, is not acceptable as a substitute for sweeping or other methods.

4.0 NOISE CONTROL

Between 7:30 p.m. and 7:00 a.m., or times as agreed upon by the Owner, noise from Contractor's operations shall not exceed limits established by applicable ordinances, laws or regulations and in no event shall exceed 86 dBA at a distance of 50 feet from the noise source.

END OF SECTION

SECTION 01605

SHIPMENT, PROTECTION AND STORAGE

1.0 GENERAL

Equipment, products and materials shall be shipped, handled, stored, and installed in ways which will prevent damage to the items. Damaged items will not be permitted as part of the work except in cases of minor damage that have been satisfactorily repaired and are acceptable to the Owner.

2.0 PIPE

Pipe and appurtenances shall be handled, stored, and installed as recommended by the manufacturer. Pipes with paint, tape coatings, linings or the like shall be stored to protect the coating or lining from physical damage or other deterioration. Pipes shipped with interior bracing shall have the bracing removed only when recommended by the pipe manufacturer.

3.0 EQUIPMENT

A. PACKAGE AND MARKING:

All equipment shall be protected against damage from moisture, dust, handling, or other cause during transport from manufacturer's premises to site. Each item or package shall be marked with the number unique to the specification reference covering the item.

Stiffeners shall be used where necessary to maintain shapes and to give rigidity. Parts of equipment shall be delivered in assembled or subassembled units where possible.

B. IDENTIFICATION:

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

C. SHIPPING:

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

Damage shall be corrected to conform to the requirements of the contract before the assembly is incorporated into the work. The Contractor shall bear the costs arising out of dismantling, inspection, repair and reassembly.

D. FACTORY APPLIED COATINGS:

Unless otherwise specified, each item of equipment shall be shipped to the site of the work with the manufacturer's shop applied epoxy prime coating as specified in Section 09900. The prime coating shall be applied over clean dry surfaces in accordance with the coating manufacturer's recommendations. The prime coating will serve as a base for field-applied finish coats. Electrical equipment and materials shall be painted by manufacturer as specified in paragraph 09900-3.03 H.

E. STORAGE:

During the interval between the delivery of equipment to the site and installation, all equipment, unless otherwise specified, shall be stored in an enclosed space affording protection from weather, dust and mechanical damage and providing favorable temperature, humidity and ventilation conditions to ensure against equipment deterioration. Manufacturer's recommendations shall be adhered to in addition to these requirements.

Equipment and materials to be located outdoors may be stored outdoors if protected against moisture condensation. Equipment shall be stored at least 6 inches above ground. Temporary power shall be provided to energize space heaters or other heat sources for control of moisture condensation. Space heaters or other heat sources shall be energized without disturbing the sealed enclosure.

F. PROTECTION OF EQUIPMENT AFTER INSTALLATION:

After installation, all equipment shall be protected from damage from, including but not limited to, dust, abrasive particles, debris and dirt generated by the placement, chipping, sandblasting, cutting, finishing and grinding of new or existing concrete, terrazzo and metal; and from the fumes, particulate matter, and splatter from welding, brazing and painting of new or existing piping and equipment. As a minimum, vacuum cleaning, blowers with filters, protective shieldings, and other dust suppression methods will be required at all times to adequately protect all equipment. During concreting, including finishing, all equipment that may be affected by cement dust must be completely covered. During painting operations, all grease fittings and similar openings shall be covered to prevent the entry of paint. Electrical switchgear, unit substation, and motor load centers shall not be installed until after all concrete work and sandblasting in those areas have been completed and accepted and the ventilation systems installed.

END OF SECTION

SECTION 01660

EQUIPMENT AND SYSTEM PERFORMANCE AND OPERATIONAL TESTING

PART 1--GENERAL

1.01 DESCRIPTION

This section contains requirements for the Contractor's performance in documenting testing work required under this contract. In addition, this section contains requirements the for the Contractor's performance during installed performance testing of all mechanical, electrical, instrumentation, and HVAC equipment and systems, including structures for watertight construction, provided under this contract and all equipment furnished by the Owner. This section supplements but does not supersede specific testing requirements found elsewhere in this project manual.

1.02 QUALITY ASSURANCE

A. CONTRACTOR'S QUALITY ASSURANCE MANAGER:

The Contractor shall appoint an operations engineer or equally qualified operations specialist as Quality Assurance Manager to manage, coordinate, and supervise the Contractor's quality assurance program. The Quality Assurance Manager shall have at least 5 years of total experience, or experience on at least five separate projects, in managing the startup commissioning of mechanical, electrical, instrumentation, HVAC, and piping systems. Operations engineers shall be graduates from a minimum 4-year course in mechanical or civil engineering. Operations specialists shall have equivalent experience in plant operation and maintenance. The quality assurance program shall include:

1. A testing plan setting forth the sequence in which all testing work required under this project manual will be implemented.

2. A documentation program to record the results of all equipment and system tests.

3. An installed performance testing program for all mechanical, electrical, instrumentation, and HVAC equipment and systems installed under this contract.

4. A calibration program for all instruments, meters, monitors, gages, and thermometers installed under this contract.

5. A calibration program for all instruments, gages, meters, and thermometers used for determining the performance of equipment and systems installed under this contract.

6. A testing schedule conforming to the requirements specified in paragraph 01660-2.02 C.

For the purposes of this section, a system shall include all items of equipment, devices and appurtenances connected in such a fashion as their operation or function complements, protects or controls the operation or function of the others. The Quality Assurance Manager shall coordinate the activities of all subcontractors and suppliers to implement the requirements of this section.

B. CALIBRATION:

All test equipment (gages, meters, thermometers, analysis instruments, and other equipment) used for calibrating or verifying the performance of equipment installed under this contract shall be calibrated to within plus or minus 2 percent of actual value at full scale. Test equipment employed for individual test runs shall be selected so that expected values as indicated by the detailed performance specifications will fall between 60 and 85 percent of full scale. Pressure gages shall be calibrated in accordance with ANSI/ASME B40.1. Thermometers shall be calibrated in accordance with ASTM E77 and shall be furnished with a certified calibration curve.

Liquid flow meters, including all open channel flow meters and all meters installed in pipelines with diameters greater than 2 inches shall be calibrated in situ using either the total count or dye dilution methods. Gas flow meters installed in piping systems with diameters greater than 6 inches shall be calibrated in situ using the pitot tube velocity averaging method. Flow meter calibration work shall be performed by individuals skilled in the techniques to be employed. Calibration tests for flow metering systems shall be performed over a range of not less than 10 percent to at least 75 percent of system full scale. At least five confirmed valid data points shall be obtained within this range. Confirmed data points shall be validated by not less than three test runs with results which agree within plus or minus 2 percent.

C. REFERENCES:

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

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

following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI/ASME B40.1	Gauges Pressure Indicating Dial Type – Elastic Element
ASTM E77	Method for Verification and Calibration of Liquid-in-Glass Thermometers
ASHRAE 41.8	Standard Methods of Measurement of Flow of Gas
Dye Dilution Calibration Method	Flow Measurements in Sanitary Sewers by Dye Dilution, Turner Designs Mountain View, California
	Flow Measurement in Sewer Lines by the Dye Dilution Method, Journal of the Water Pollution Control Federation, Vol. 55, Number 5, May, 1983, pg. 531
	Flow Measurement in Open Channels and Closed Conduits, Vol 1, U.S. Department of Commerce, National Bureau of Standards, pg. 361
	Techniques of Water-Resources Investigations of the United States Geological Survey, Chapter 16, Measurement of Discharge Using Tracers

1.03 SUBMITTALS

Submittal material, to be submitted in accordance with Section 01300, shall consist of the following:

1. A complete description of the Contractor's plan for documenting the results from the test program in conformance with the requirements of paragraph 01660-2.02 A, including:

   a. Proposed plan for documenting the calibration of all test instruments.

   b. Proposed plan for calibration of all instrument systems, including flow meters and all temperature, pressure, weight, and analysis systems.

   c. Sample forms for documenting the results of field pressure and performance tests.

2. The credentials and certification of the testing laboratory proposed by the Contractor for calibration of all test equipment.

3. Preoperational check-out procedures, reviewed and approved by the respective equipment manufacturers.

4. Detailed testing plans, setting forth step-by-step descriptions of the procedures proposed by the Contractor for the systematic testing of all equipment and systems installed under this contract. Testing plans shall identify the specific methods and forms to be used for documenting test results for each equipment and system.

5. A schedule and subsequent updates, presenting the Contractor's plan for testing the equipment and systems installed under this contract.

6. A schedule establishing the expected time period (calendar dates) when the Contractor plans to commence operational testing of the completed systems, along with a description of the temporary systems and installations planned to allow operational testing to take place.

7. A summary of the Quality Assurance Manager's qualifications, showing conformance to paragraph 01660-1.02 A requirements.

PART 2--PRODUCTS

2.01 GENERAL

The Contractor shall prepare test plans and documentation plans as specified in the following paragraphs. The Owner will not witness any test work for the purpose of acceptance until all test documentation and calibration plans and the specified system or equipment test plans have been submitted and accepted.

2.02 DOCUMENTATION

A. DOCUMENTATION PLANS:

The Contractor shall develop a records keeping system to document compliance with the requirements of this Section. Calibration documentation shall include identification (by make, manufacturer, model, and serial number) of all test equipment, date of original calibration, subsequent calibrations, calibration method, and test laboratory.

Equipment and system documentation shall include date of test, equipment number or system name, nature of test, test objectives, test results, test instruments employed for the test, and signature spaces for the Owner's witness and the Contractor's quality assurance manager. A separate file shall be established for each system and item of equipment. These files shall include the following information as a minimum:

1. Metallurgical tests
2. Factory performance tests
3. Accelerometer recordings made during shipment
4. Field calibration tests[1]
5. Field pressure tests[1]
6. Field performance tests[1]
7. Field operational tests[1]

Section 01999 contains samples showing the format and level of detail required for the documentation forms. The Contractor is advised that these are samples only and are not specific to this project nor to any item of equipment or system to be installed under this contract. The Contractor shall develop test documentation forms specific to each item of equipment and system installed under this contract. Acceptable documentation forms for all systems and items of equipment shall be produced for review by the Owner as a condition precedent to the Contractor's receipt of progress payments in excess of 50 percent of the contract amount. Once the Owner has reviewed and taken no exception to the forms proposed by the Contractor, the Contractor shall produce sufficient forms, at his expense, to provide documentation of all testing work to be conducted as a part of this contract.

B. TEST PLANS:

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

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

2. Calibration of all analysis instruments and control sensors.

3. Performance testing of each individual item of mechanical, electrical, and instrumentation equipment. Performance tests shall be selected to duplicate the operating conditions described in the project manual.

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

4. System tests designed to duplicate, as closely as possible, operating conditions described in the project manual.

5. Specific methods and forms to be used for documenting test results for each equipment and system.

Test plans shall contain a complete description of the procedures to be employed to achieve the desired test environment.

As a condition precedent to receiving progress payments in excess of 75 percent of the contract amount, or in any event, progress payments due to the Contractor eight weeks in advance of the date the Contractor wishes to begin any testing work (whichever occurs earliest in the project schedule), the Contractor shall have submitted all test plans required for the systematic field performance and operational tests for all equipment and systems installed under this contract. Once the Owner has reviewed and taken no exception to the Contractor's test plans, the Contractor shall reproduce the plans in sufficient number for the Contractor's purposes and an additional ten copies for delivery to the Owner. No test work shall begin until the Contractor has delivered the specified number of final test plans to the Owner.

C. TESTING SCHEDULE:

The Contractor shall produce a testing schedule setting forth the sequence contemplated for performing the test work. The schedule shall be in bar chart form, plotted against calendar time, shall detail the equipment and systems to be tested, and shall be coordinated with the Contractor's construction schedule specified in Section 01310. The schedule shall show the contemplated start date, duration of the test and completion of each test. The test schedule shall be submitted no later than 4 weeks in advance of the date testing is to begin. The Owner will not witness any testing work for the purpose of acceptance until the Contractor has submitted a schedule to which the Owner takes no exception. The test schedule shall be updated weekly, showing actual dates of test work, indicating systems and equipment testing completed satisfactorily and meeting the requirements of this project manual.

2.03 SYSTEM AND EQUIPMENT PERFORMANCE TESTS

Each item of mechanical, electrical, instrumentation and HVAC equipment installed under this contract shall be tested to demonstrate compliance with the performance requirements of this project manual. Each electrical, instrumentation, mechanical, piping, and HVAC system installed or modified under this contract shall be tested in accordance with the requirements of this project manual.

2.04 OPERATIONAL TESTS

Once all equipment and systems have been tested individually, the Contractor shall fill all systems except wastewater, scum sludge and other wastewater derived systems with the intended process fluids. Wastewater-derived process systems shall be filled with water. After filling operations have been completed, the Contractor shall operate all systems for a continuous period of

not less than 7 days, simulating actual operating conditions to the greatest extent possible. The Contractor shall install temporary connections, bulkheads and make other provisions to recirculate process fluids or otherwise simulate anticipated operating conditions. During the operational testing period, the Contractor's Quality Assurance Manager and testing team shall monitor the characteristics of each machine and system and report any unusual conditions to the Owner.

2.05 PRODUCT DATA

Product data, to be provided in accordance with Section 01300, shall be the original and three copies of all records produced during the testing program.

PART 3--EXECUTION

3.01 GENERAL

The Contractor's quality control manager shall organize teams made up of qualified representatives of equipment suppliers, subcontractors, the Contractor's independent testing laboratory, and others, as appropriate, to efficiently and expeditiously calibrate and test the equipment and systems installed and constructed under this contract. The objective of the testing program shall be to demonstrate, to the Owner's complete satisfaction, that the structures, systems, and equipment constructed and installed under this contract meet all performance requirements and the facility is ready for the commissioning process to commence. In addition, the testing program shall produce baseline operating conditions for the Owner to use in a preventive maintenance program.

3.02 CALIBRATION OF FIXED INSTRUMENTS

Calibration of analysis instruments, sensors, gages, and meters installed under this contract shall proceed on a system-by-system basis. No equipment or system performance acceptance tests shall be performed until instruments, gages, and meters to be installed in that particular system have been calibrated and the calibration work has been witnessed by the Owner.

All analysis instruments, sensors, gages, and meters used for performance testing shall be subject to recalibration to confirm accuracy after completion, but prior to acceptance of each performance test. All analysis instruments, sensors, gages, and meters installed under this contract shall be subject to recalibration as a condition precedent to commissioning under the provisions of Section 01662.

3.03 PERFORMANCE TESTS

A. GENERAL:

Performance tests shall consist of the following:

1. Pressure and/or leakage tests.

2. Electrical testing as specified in Division 16.

3. Wiring and piping, individual component, loop, loop commissioning and tuning testing as described in Division 17.

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

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

In general, performance tests for any individual system shall be performed in the order listed above. The order may be altered only on the specific written authorization of the Owner after receipt of a written request, complete with justification of the need for the change in sequence.

B. PRESSURE AND LEAKAGE TESTS:

Pressure and leakage tests shall be conducted in accordance with applicable portions of Divisions 3 and 15. All acceptance tests shall be witnessed by the Owner. Evidence of successful completion of the pressure and leakage tests shall be the Owner's signature on the test forms prepared by the Contractor.

C. FUNCTIONAL CHECKOUT:

Prior to energization (in the case of electrical systems and equipment), all circuits shall be rung out and tested for continuity and shielding in accordance with the procedures required in Division 16.

D. COMPONENT CALIBRATION AND LOOP TESTING:

Prior to energization (in the case of instrumentation system and equipment), all loops and associated instruments shall be calibrated and tested in accordance with the procedures required in Division 17.

E. ELECTRICAL RESISTANCE:

Electrical resistance testing shall be in accordance with Division 16.

F. PREOPERATIONAL TESTS:

Preoperational tests shall include the following:

1. Alignment of equipment using reverse dial indicator method.

2. Preoperation lubrication.

3. Tests per the manufacturers' recommendations for prestart preparation and preoperational check-out procedures.

G. FUNCTIONAL TESTS:

1. GENERAL: Once all affected equipment has been subjected to the required preoperational check-out procedures and the Owner has witnessed and has not found deficiencies in that portion of the work, individual items of equipment and systems may be started and operated under simulated operating conditions to determine as nearly as possible whether the equipment and systems meet the requirements of these specifications. If available, plant effluent may be employed for the testing of all liquid systems except gaseous, oil, or chemical systems. If not available, potable water shall be employed as the test medium. Test media for these systems shall either be the intended fluid or a compatible substitute. The equipment shall be operated a sufficient period of time to determine machine operating characteristics, including noise, temperatures and vibration; to observe performance characteristics; and to permit initial adjustment of operating controls. When testing requires the availability of auxiliary systems such as looped piping, electrical power, compressed air, control air, or instrumentation which have not yet been placed in service, the Contractor shall provide acceptable substitute sources, capable of meeting the requirements of the machine, device, or system at no additional cost to the Owner. Disposal methods for test media shall be subject to review by the Owner. During the functional test period, the Contractor shall obtain baseline operating data on all equipment with motors greater than 1 horsepower to include amperage, bearing temperatures, and vibration. The baseline data shall be collected for the Owner to enter in a preventive maintenance system.

Test results shall be within the tolerances set forth in the detailed specification sections of this project manual. If no tolerances have been specified, test results shall conform to tolerances established by recognized industry practice. Where, in the case of an otherwise satisfactory functional test, any doubt, dispute, or difference should arise between the Owner and the Contractor regarding the test results or the methods or equipment used in the performance of such test, then the Owner may order the test to be repeated. If the repeat test, using such modified methods or equipment as the Owner may require, confirms the previous test, then all costs in connection with the repeat test will be paid by the Owner. Otherwise, the costs shall be borne by the Contractor. Where the results of any functional test fail to comply with the contract requirements for such test, then such repeat tests as may be necessary to achieve the contract requirements shall be made by the Contractor at his expense.

The Contractor shall provide, at no expense to the Owner, all power, fuel, compressed air supplies, water, and chemicals, all labor, temporary piping, heating, ventilating, and air conditioning for any areas where permanent facilities are not complete and operable at the time of functional tests, and all other items and work required to complete the functional tests. Temporary facilities shall be maintained until permanent systems are in service.

2. RETESTING: If under test, any portion of the work should fail to fulfill the contract requirements and is adjusted, altered, renewed, or replaced, tests on that portion when so adjusted, altered, removed, or replaced, together with all other portions of the work as are affected thereby, shall, unless otherwise directed by the Owner, be repeated within reasonable time and in accordance with the specified conditions. The Contractor shall pay to the Owner all reasonable expenses incurred by the Owner, including the costs of the Owner, as a result of repeating such tests.

3. POSTTEST INSPECTION: Once functional testing has been completed, all machines shall be rechecked for proper alignment and realigned, as required. All equipment shall be checked for loose connections, unusual movement, or other indications of improper operating characteristics. Any deficiencies shall be corrected to the satisfaction of the Owner. All machines or devices which exhibit unusual or unacceptable operating characteristics shall be disassembled and inspected. Any defects found during the course of the inspection shall be repaired or the specific part or entire equipment item shall be replaced to the complete satisfaction of the Owner at no cost to the Owner.

3.04 OPERATIONAL TESTS

The Contractor shall provide system operation testing. The operational testing shall reflect the staged construction, testing and commissioning requirements of this project. After completion of all performance testing and certification by the Owner that all equipment complies with the requirements of the specifications, the Contractor shall fill all process units and process systems, except those employing domestic water, oil, air, or chemicals, with plant effluent water. All domestic water, oil, air, and chemical systems shall be filled with the specified fluid.

Upon completion of the filling operations, the Contractor shall circulate water through the completed facility for a period of not less than 48 hours, during which all parts of the system shall be operated as a complete facility at various loading conditions, as directed by the Owner. The operational testing period shall commence after this initial period of variable operation. The operational testing shall be for a continuous period of not less than 7 days, simulating actual operating conditions to the greatest extent possible. Should the operational testing period be halted for any reason related to the facilities constructed or the equipment furnished under this contract, or the Contractor's temporary testing systems, the operational testing program shall be repeated until the specified continuous period has been accomplished without interruption. All process units shall be brought to full operating conditions, including temperature, pressure, and flow.

As-built documents specified in Section 01720 of facilities involved shall be accepted and ready for turnover to the Owner at the time of operational testing.

END OF SECTION

SECTION 01662

COMMISSIONING

PART 1--GENERAL

1.01 DESCRIPTION

This section contains requirements for the Contractor's performance during the commissioning of the structures, equipment and systems constructed and installed during the course of this contract. All commissioning work, as described in this section, shall be performed by the Contractor. Commissioning may be performed in phases of systems that are complete and in full operation.

1.02 QUALITY ASSURANCE

A. CLEANUP:

Following completion of the operational testing period, the Contractor shall dewater and clean all sumps; and dewater all process units for final inspection as a condition precedent to commissioning.

B. COMMISSIONING TEAM:

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

1.03 SUBMITTALS

The following information shall be submitted to the Owner in accordance with the provisions of Section 01300:

1. Detailed plans for commissioning each process unit and each system constructed or modified as a part of the work performed under this contract.

2. The Contractor's plan for providing a commissioning team conforming to the requirements of paragraph 01662-1.02 B during the commissioning period. The plan shall be complete with a daytime staffing plan and names,

qualifications, and telephone numbers of those assigned to off-hour standby duty.

PART 2--PRODUCTS

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

PART 3--EXECUTION

After completion of the equipment and system performance and operational testing, where required, and agreement on the part of the Owner that the systems did meet all test requirements, commissioning will begin. The commissioning period for each modified or new unit process system shall be 4 weeks. The Contractor shall remove all temporary piping, bulkheads, controls and other alterations to the permanent systems that may have been needed during the performance and operational testing and shall perform the tasks necessary to make the improvements constructed under this contract fully operational. The Owner shall confirm in writing the date(s) that the system is ready for commissioning and on which actual commissioning activities commence. Activities conducted prior to such written confirmation shall not constitute commissioning.

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

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

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

END OF SECTION

SECTION 01664

TRAINING

PART 1--GENERAL

1.01 DESCRIPTION

This section contains requirements for training the Owner's personnel, by persons retained by the Contractor specifically for the purpose, in the proper operation and maintenance of the equipment and systems installed under this contract.

1.02 QUALITY ASSURANCE

Where required by the detailed specifications, the Contractor shall provide on-the-job training of the Owner's personnel. The training sessions shall be conducted by qualified, experienced, factory-trained representatives of the various equipment manufacturers. Training shall include instruction in both operation and maintenance of the subject equipment.

1.03 SUBMITTALS

The following information shall be submitted to the Owner in accordance with the provisions of Section 01300. The material shall be reviewed and accepted by the Owner as a condition precedent to receiving progress payments in excess of 75 percent of the contract amount and not less than 3 weeks prior to the provision of training.

1. Lessons plans for each training session to be conducted by the manufacturer's representatives. In addition, training manuals, handouts, visual aids, and other reference materials shall be included.

2. Subject of each training session, identity and qualifications of individuals to be conducting the training, and tentative date and time of each training session.

PART 2--PRODUCTS

2.01 GENERAL

Where specified, the Contractor shall conduct training sessions for the Owner's personnel to instruct the staff on the proper operation, care, and maintenance of the equipment and systems installed under this contract. Training shall take place at the site of the work and under the conditions specified in the following paragraphs. Approved operation and maintenance manuals shall be available at least 30 days prior to the date scheduled for the individual training session.

2.02 LOCATION

Training sessions shall take place at the site of the work in the treatment plant's administrative building conference room.

2.03 LESSON PLANS

Formal written lesson plans shall be prepared for each training session. Lesson plans shall contain an outline of the material to be presented along with a description of visual aids to be utilized during the session. Each plan shall contain a time allocation for each subject.

One complete set of originals of the lesson plans, training manuals, handouts, visual aids, and reference material shall be the property of the Owner and shall be suitably bound for proper organization and easy reproduction. The Contractor shall furnish ten copies of necessary training manuals, handouts, visual aids and reference materials at least 1 week prior to each training session.

2.04 FORMAT AND CONTENT

Each training session shall be comprised of time spent both in the classroom and at the specific location of the subject equipment or system. As a minimum, training session shall cover the following subjects for each item of equipment or system:

1. Familiarization

    a. Review catalog, parts lists, drawings, etc., which have been previously provided for the plant files and operation and maintenance manuals.

    b. Check out the installation of the specific equipment items.

    c. Demonstrate the unit and indicate how all parts of the specifications are met.

    d. Answer questions.

2. Safety

    a. Using material previously provided, review safety references.
    b. Discuss proper precautions around equipment.

3. Operation

    a. Using material previously provided, review reference literature.
    b. Explain all modes of operation (including emergency).
    c. Check out Owner's personnel on proper use of the equipment.

4. Preventive Maintenance

   a. Using material previously provided, review preventive maintenance (PM) lists including:

      1) Reference material.

      2) Daily, weekly, monthly, quarterly, semiannual, and annual jobs.

   b. Show how to perform PM jobs.

   c. Show Owner's personnel what to look for as indicators of equipment problems.

5. Corrective Maintenance

   a. List possible problems.
   b. Discuss repairs--point out special problems.
   c. Open up equipment and demonstrate procedures, where practical.

6. Parts

   a. Show how to use previously provided parts list and order parts.

   b. Check over spare parts on hand. Make recommendations regarding additional parts that should be available.

7. Local Representatives

   a. Where to order parts: name, address, telephone.
   b. Service problems:

      1) Who to call.
      2) How to get emergency help.

8. Operation and Maintenance Manuals

   a. Review any other material submitted.
   b. Update material, as required.

2.05 VIDEO RECORDING:

The Owner may, at the sole discretion of the owner, retain the services of a commercial video recording service to record each training session. After recording, the material will be edited and supplemented with professionally produced graphics to provide a permanent record. The Contractor shall advise all manufacturers providing training sessions that the material will be videotaped. The Contractor shall make available to the Owner's video recording contractor such utility services and accommodations required to facilitate the recording of the video tape record.

PART 3--EXECUTION

Training shall be conducted in conjunction with the operational testing and commissioning periods. Classes shall be scheduled such that classroom sessions are interspersed with field instruction in logical sequence. The Contractor shall arrange to have the training conducted on consecutive days, with no more than 6 hours of classes scheduled for any one day. Concurrent classes shall not be allowed. Training shall be certified on Form 11000-B specified in Section 01999.

Acceptable operation and maintenance manuals for the specific equipment shall be provided to the Owner prior to the start of any training. Video recording shall take place concurrently with all training sessions.

The following services shall be provided for each item of equipment or system as required in individual specification sections. Additional services shall be provided, where specifically required in individual specification sections.

1. As a minimum, classroom equipment training for operations personnel will include:

    a. Using slides and drawings, discuss the equipment's specific location in the plant and an operational overview.

    b. Purpose and plant function of the equipment.

    c. A working knowledge of the operating theory of the equipment.

    d. Start-up, shutdown, normal operation, and emergency operating procedures, including a discussion on system integration and electrical interlocks, if any.

    e. Identify and discuss safety items and procedures.

    f. Routine preventative maintenance, including specific details on lubrication and maintenance of corrosion protection of the equipment and ancillary components.

g. Operator detection, without test instruments, of specific equipment trouble symptoms.

h. Required equipment exercise procedures and intervals.

i. Routine disassembly and assembly of equipment if applicable (as judged by the Owner on a case-by-case basis) for purposes such as operator inspection of equipment.

2. As a minimum, hands-on equipment training for operations personnel will include:

a. Identify location of equipment and review the purpose.

b. Identifying piping and flow options.

c. Identifying valves and their purpose.

d. Identifying instrumentation:

1) Location of primary element.

2) Location of instrument readout.

3) Discuss purpose, basic operation, and information interpretation.

e. Discuss, demonstrate, and perform standard operating procedures and round checks.

f. Discuss and perform the preventative maintenance activities.

g. Discuss and perform start-up and shutdown procedures.

h. Perform the required equipment exercise procedures.

i. Perform routine disassembly and assembly of equipment if applicable.

j. Identify and review safety items and perform safety procedures, if feasible.

3. Classroom equipment training for the maintenance and repair personnel will include:

   a. Theory of operation.

   b. Description and function of equipment.

   c. Start-up and shutdown procedures.

   d. Normal and major repair procedures.

   e. Equipment inspection and troubleshooting procedures including the use of applicable test instruments and the "pass" and "no pass" test instrument readings.

   f. Routine and long-term calibration procedures.

   g. Safety procedures.

   h. Preventative maintenance such as lubrication; normal maintenance such as belt, seal, and bearing replacement; and up to major repairs such as replacement of major equipment part(s) with the use of special tools, bridge cranes, welding jigs, etc.

4. Hands-on equipment training for maintenance and repair personnel shall include:

   a. Locate and identify equipment components.

   b. Review the equipment function and theory of operation.

   c. Review normal repair procedures.

   d. Perform start-up and shutdown procedures.

   e. Review and perform the safety procedures.

   f. Perform Owner approved practice maintenance and repair job(s), including mechanical and electrical adjustments and calibration and troubleshooting equipment problems.

END OF SECTION

SECTION 01700

RESTORATION OF IMPROVEMENTS

1.0 STRUCTURES

The Contractor shall take all precautions necessary to protect the integrity and usefulness of all existing plant facilities. If necessary, the Contractor may, with the approval of the Owner, remove such existing structures, including curbs, gutters, concrete slabs on grade, pipelines, irrigation systems and utility poles as may be necessary for the performance of the work, and shall rebuild the structures thus removed in as good a condition as found with the requirements specified. The Contractor shall also repair existing structures which may be damaged as a result of the work under this contract.

2.0 ROADS AND STREETS

Unless otherwise specified, roads and streets in which the surface is removed, broken, or damaged, or in which the ground has caved or settled during the work under this contract, shall be resurfaced and brought to the original grade and section. Roadways used by the Contractor shall be cleaned and repaired. Before resurfacing material is placed, edges of pavements shall be trimmed back far enough to provide clean, solid, vertical faces, and shall be free of loose material. All paved surfaces shall be cut with a pavement saw. Rough cuts are not allowed. Repair work shall conform to the paving and grading specifications in the Contract Documents.

3.0 CULTIVATED AREAS AND OTHER SURFACE IMPROVEMENTS

Cultivated or planted areas and other surface improvements which are damaged by actions of the Contractor shall be restored as nearly as possible to their original condition. Restoration shall take place within 1 week or sooner as directed by the Owner.

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

4.0 PROTECTION OF EXISTING INSTALLATIONS

The Contractor shall protect all existing operating facilities and structures from damages. However, if damage occurs, the Contractor shall immediately correct or replace existing equipment, controls, systems, structures, or facilities which are damaged in any way as a result of his operations.

END OF SECTION

SECTION 01720

RECORD DRAWINGS

Record drawings refer to those documents maintained and annotated by the Contractor during construction and are defined as (1) a neatly and legibly marked set of contract drawings showing the final location of piping, equipment, electrical conduits, outlet boxes and cables; (2) additional documents such as schedules, lists, drawings, and electrical and instrumentation diagrams included in the specifications; and (3) Contractor layout and installation drawings.

Unless otherwise specified, record drawings shall be full size and maintained in a clean, dry, and legible condition. Record documents shall not be used for construction purposes and shall be available for review by the Owner during normal working hours at the Contractor's field office. At the completion of the work, prior to final payment, all record drawings shall be submitted to the Owner.

Marking of the drawings shall be kept current and shall be done at the time the material and equipment are installed. Annotations to the record documents shall be made with an erasable colored pencil conforming to the following color code:

Additions - Red
Deletions - Green
Comments - Blue
Dimensions - Graphite*

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

END OF SECTION

SECTION 01730

OPERATING AND MAINTENANCE INFORMATION

1.0 SCOPE

Operation and maintenance (O&M) instructions shall be provided in accordance with this section and as required in the technical sections of this project manual. O&M information shall be provided for each maintainable piece of equipment, equipment assembly or subassembly, and material provided or modified under this contract.

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

2.0 TYPES OF INFORMATION REQUIRED

A. GENERAL:

O&M information shall contain the names, addresses, and telephone numbers of the manufacturer, the nearest representative of the manufacturer, and the nearest supplier of the manufacturer's equipment and parts. In addition, one or more of the following items of information shall be provided as applicable.

B. OPERATING INSTRUCTIONS:

Specific instructions, procedures, and illustrations shall be provided for the following phases of operations:

1. SAFETY PRECAUTIONS: List personnel hazards for equipment and list safety precautions for all operating conditions.

2. OPERATOR PRESTART: Provide requirements to set up and prepare each system for use.

3. START-UP, SHUTDOWN, AND POSTSHUTDOWN PROCEDURES: Provide a control sequence for each of these operations.

4. NORMAL OPERATIONS: Provide control diagrams with data to explain operation and control of systems and specific equipment.

5. EMERGENCY OPERATIONS: Provide emergency procedures for equipment malfunctions to permit a short period of continued operation or to shut down the equipment to prevent further damage to systems and equipment. Include emergency shutdown instructions for fire, explosion, spills, or other foreseeable contingencies. Provide guidance on emergency

operations of all utility systems including valve locations and portions of systems controlled.

6. OPERATOR SERVICE REQUIREMENTS: Provide instructions for services to be performed by the operator such as lubrication, adjustments, and inspection.

7. ENVIRONMENTAL CONDITIONS: Provide a list of environmental conditions (temperature, humidity, and other relevant data) which are best suited for each product or piece of equipment and describe conditions under which equipment should not be allowed to run.

C. PREVENTIVE MAINTENANCE:

The following information shall be provided for preventive and scheduled maintenance to minimize corrective maintenance and repair:

1. LUBRICATION DATA: Provide lubrication data, other than instructions for lubrication in accordance with paragraph 2.0-B6.

   a. A table showing recommended lubricants for specific temperature ranges and applications;

   b. Charts with a schematic diagram of the equipment showing lubrication points, recommended types and grades of lubricants, and capacities; and

   c. A lubrication schedule showing service interval frequency.

2. PREVENTIVE MAINTENANCE PLAN AND SCHEDULE: Provide manufacturer's schedule for routine preventive maintenance, inspections, tests, and adjustments required to ensure proper and economical operation and to minimize corrective maintenance and repair. Provide manufacturer's projection of preventive maintenance man-hours on a daily, weekly, monthly, and annual basis including craft requirements by type of craft.

D. CORRECTIVE MAINTENANCE:

Manufacturer's recommendations shall be provided on procedures and instructions for correcting problems and making repairs.

1. TROUBLESHOOTING GUIDES AND DIAGNOSTIC TECHNIQUES: Provide step-by-step procedures to promptly isolate the cause of typical malfunctions. Describe clearly why the checkout is performed and what conditions are to be sought. Identify tests or inspections and test equipment

required to determine whether parts and equipment may be reused or require replacement.

2. WIRING DIAGRAMS AND CONTROL DIAGRAMS: Wiring diagrams and control diagrams shall be point-to-point drawings of wiring and control circuits including factory-field interfaces. Provide a complete and accurate depiction of the actual job-specific wiring and control work. On diagrams, number electrical and electronic wiring and pneumatic control tubing and the terminals for each type identically to actual installation numbering.

3. MAINTENANCE AND REPAIR PROCEDURES: Provide instructions and list tools required to restore product or equipment to proper condition or operating standards.

4. REMOVAL AND REPLACEMENT INSTRUCTIONS: Provide step-by-step procedures and list required tools and supplies for removal, replacement, disassembly, and assembly of components, assemblies, subassemblies, accessories, and attachments. Provide tolerances, dimensions, settings, and adjustments required. Instructions shall include a combination of test and illustrations.

5. SPARE PARTS AND SUPPLY LISTS: Provide lists of spare parts and supplies required for maintenance and repair to ensure continued service or operation without unreasonably delays. Special consideration is required for facilities at remote locations. List spare parts and supplies that have a long lead time to obtain.

6. CORRECTIVE MAINTENANCE MANHOURS: Provide manufacturer's projection of corrective maintenance man-hours including craft requirements by type of craft. Corrective maintenance that requires participation of the equipment manufacturer shall be identified and tabulated separately.

E. APPENDICES:

The following information shall be provided; include information not specified in the preceding paragraphs but pertinent to the maintenance or operation of the product or equipment.

1. PARTS IDENTIFICATION: Provide identification and coverage for all parts of each component, assembly, subassembly, and accessory of the end items subject to replacement. Include special hardware requirements, such as requirement to use high-strength bolts and nuts. Identify parts by make, model, serial number, and source of supply to allow reordering without further identification. Provide clear and legible illustrations, drawings, and exploded views to enable easy identification of the items. When illustrations omit the part numbers and description, both the illustrations and separate listing shall show the index, reference, or key number which will cross-

reference the illustrated part to the listed part. Parts shown in the listings shall be grouped by components, assemblies, and subassemblies.

2. WARRANTY INFORMATION: List and explain the various warranties and include the servicing and technical precautions prescribed by the manufacturers or contract documents to keep warranties in force.

3. PERSONNEL TRAINING REQUIREMENTS: Provide information available from the manufacturers to use in training designated personnel to operate and maintain the equipment and systems properly.

4. TESTING EQUIPMENT AND SPECIAL TOOL INFORMATION: Provide information on test equipment required to perform specified tests and on special tools needed for the operation, maintenance, and repair of components.

3.0 TRANSMITTAL PROCEDURE

Unless otherwise specified, O&M manuals, information, and data shall be transmitted in accordance with Section 01300 accompanied by Transmittal Form 01730-A and Equipment Record Forms 01730-B and/or 01730-C, as appropriate, all as specified in Section 01999. The transmittal form shall be used as a checklist to ensure the manual is complete. Only complete sets of O&M instructions will be reviewed for acceptance.

Submittals for review shall include two copies (paper) and one electronic version (on CD or DVD) of the specified O&M information. After the O&M information has been reviewed and approved by the Owner, three copies (paper) and two electronic versions (on CD or DVD) of the specified O&M information shall be provided. For ease of identification, each manufacturer's brochure, manual and CD/DVD shall be appropriately labeled with the equipment name and equipment number as it appears in the project manual. The information shall be organized in the binders in numerical order by the equipment numbers assigned in the project manual. The binders shall be provided with a table of contents and tab sheets to permit easy location of desired information. Binders shall be heavy-duty, 3-ring or 3-post style suitable for bookshelf storage.

If manufacturers' standard brochures and manuals are used to describe O&M procedures, such brochures and manuals shall be modified to reflect only the model or series of equipment used on this project. Extraneous material shall be crossed out neatly or otherwise annotated or eliminated.

4.0 PAYMENT

Acceptable O&M information for the project must be delivered to the Owner prior to the project being 65 percent complete. Progress payments for work in excess of 65 percent completion will not be made until the specified acceptable O&M information has been delivered to the Owner.

5.0 FIELD CHANGES

Following the acceptable installation and operation of an equipment item, the item's instructions and procedures shall be modified and supplemented by the Contractor to reflect any field changes or information requiring field data.

END OF SECTION

SECTION 01800

ENVIRONMENTAL CONDITIONS

This section describes the environmental conditions which have been observed at the site of the work and which may reasonably be anticipated throughout the life of the project.

The site of the work in Flagstaff, AZ is at an elevation of approximately 6,750 feet above mean sea level. Climate conditions are described as follows:

Description	Range of Conditions
Annual Average Precipitation, inches	20 to 25
Air Temperature, degrees F	
Outdoors – annual averages	17 to 82
Outdoors – extremes (for period of record)	-30 to 97
Indoors	50 to 70
Winter	Cold/Stormy with Frequent Snowfall
Summer	Mild
Relative Humidity, percent	
Indoors	10 to 70
Average Outdoors	15 to 87

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

END OF SECTION

SECTION 01900

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

PART 1 GENERAL

1.01 SUMMARY

A. SCOPE

This section specifies the minimum structural requirements for the design, anchorage and bracing of mechanical/ electrical components, equipment, and systems, and nonbuilding structures. Design of supports, attachments and bracing for all parts or elements of the mechanical, and electrical systems shall be provided in accordance with this section. The requirements of this section shall apply to the design of the structural elements and features of equipment and to platforms/walkways that are provided with equipment or nonbuilding structures.

This section applies to nonstructural components that are permanently attached to structures, and nonbuilding structures as defined below in paragraph 1.01-B and ASCE 7-10. Note that equipment is defined as a non-structural component and tanks are defined as a nonbuilding structure.

Design shall be in accordance with the criteria listed within this section and shall conform to the provisions of the design codes listed within this section. Engineering design is not required for attachments, anchorage, or bracing detailed on the drawings or where the size of attachments, anchorage, or bracing is defined in the technical specification sections.

The following nonstructural components are exempt from the seismic design loading requirements of this section.

1. Mechanical and electrical components in Seismic Design Category B.

B. DEFINITIONS:

1. STRUCTURES: The structural elements of a building that resist gravity, seismic, wind, and other types of loads. Structural components include columns, posts, beams, girders, joists, bracing, floor or roof sheathing, slabs or decking, load-bearing walls, and foundations.

2. NONSTRUCTURAL COMPONENTS: The nonstructural portions of a building include every part of the building and all its contents, except the structural portions, that carry gravity loads and that may also be required to resist the effects of wind, snow, impact, temperature and seismic loads.

Nonstructural components include, but are not limited to, ceilings, partitions, windows, equipment, piping, ductwork, furnishings, lights, etc.

3. NONBUILDING STRUCTURES: All self-supporting structures that carry gravity loads and that may also be required to resist the effects of wind, snow, impact, temperature and seismic loads. Nonbuilding structures include, but are not limited to, pipe racks, storage racks, stacks, tanks, vessels and structural towers that support tanks and vessels.

1.02 QUALITY ASSURANCE

A. QUALITY CONTROL BY OWNER:

Special Inspection of nonstructural components and nonbuilding structures, and their anchorages shall be performed by the Special Inspector under contract with the Owner and in conformance with IBC Chapter 17. Special Inspector(s) and laboratory shall be acceptable to the Owner in their sole discretion. Special Inspection is in addition to, but not replacing, other inspections and quality control requirements herein. Where sampling and testing required herein conforms to Special Inspection standards, such sampling and testing need not be duplicated.

B. REFERENCES:

Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly.

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

Reference	Title
ACI 318	Building Code Requirements for Structural Concrete
ACI 350	Code Requirements for Environmental Engineering Concrete Structures
AISC 341	Seismic Provisions for Structural Steel Buildings
ACI 360	Specification for Structural Steel Buildings
ASCE 7	Minimum Design Loads for Buildings and Other Structures
AWS D1.1	Structural Welding Code – Steel

Reference	Title
AWS D1.2	Structural Welding Code - Aluminum
AWS D1.2	Structural Welding Code – Stainless Steel
IBC	International Building Code with local amendments
OSHA	U.S. Dept. of Labor, Occupational Safety and Health Administration
SMACNA	Seismic Restraint Manual Guidelines for Mechanical Systems

1.03 SUBMITTALS

For structural elements of nonstructural components and nonbuilding structures required to be designed per this specification section, drawings and design calculations shall be stamped by an Arizona licensed professional engineer qualified to perform structural engineering.

Submit drawings and calculations no less than four weeks in advance of the installation of any component to be anchored to the structure or installation of any structural member to which the component will be attached.

A. The following submittals shall be provided in accordance with Section 01300:

1. List of all nonstructural components and nonbuilding structures requiring wind and seismic design and anchorage.

2. Shop drawings showing details of complete wind and seismic bracing and anchorage attachment assemblies including connection hardware, and embedment into concrete.

3. Shop drawings showing plans, elevations, sections and details of equipment support structures and nonbuilding structures, including anchor bolts, structural members, platforms, stairs, ladders, and related attachments.

4. Identify all interface points with supporting structures or foundations, as well as the size, location, and grip of all required attachments and anchor bolts. Clearly indicate who will be providing each type of attachment/anchor bolt. Equipment vendor shall design anchor bolts, including embedment into concrete, and submit stamped calculations.

5. Calculations for all supports, bracing, and attachments shall clearly indicate the design criteria applied in the design calculations. Concrete embedment calculations shall be coordinated with thickness and strength of concrete members. Submit a tabulation of the magnitude of unfactored (service level) equipment loads at each support point, broken down by type of loading (dead, live, wind, seismic, etc.). Indicate impact factors applied to these loads in the design calculations.

6. Product Data: Manufacturer's certificates of compliance with the seismic force requirements of this section.

1.04 DESIGN CODES

The following standard codes have application at this site for:

Buildings/Structures:	International Building Code 2012 and ASCE 7-10
Reinforced concrete:	ACI 350-06 for Concrete Liquid Containing Tanks, ACI 318-08 for all other reinforced concrete
Structural steel:	AISC 360-10 and AISC 341-10
Welding:	AWS Welding Codes, Latest Edition
Occupational health and safety requirements:	U.S. Dept. of Labor, Occupational Safety and Health Administration (OSHA)

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

1.05 DESIGN LOADS

All nonstructural components and nonbuilding structures shall be designed for the following loads. Wind and snow loads shall not be applied to nonstructural components and nonbuilding structures that are located inside buildings.

A. SNOW LOADS:

Code:	IBC 2012 & ASCE 7-10
Ground Snow Load (p_g)	50 psf
Exposure:	C
Importance Factor (I):	1.1

B. WIND LOADS:

Code:	IBC 2012 & ASCE 7-10
Ultimate Wind Speed (3-second gust):	120 mph
Exposure:	C
Topographic Factor (K_{zt})	1.0
Risk Category	III

All exterior nonstrutural components and nonbuilding structures, unless located in a pit or basin, shall be designed to withstand the design wind loads without consideration of shielding effects by other structures.

C. SEISMIC LOADS:

Code:	IBC 2012 & ASCE 7-10
0.2 Sec. Mapped Spectral Response, S_S:	0.36 g
1.0 Sec. Mapped Spectral Response, S_1:	0.10 g
Site Class:	C
0.2 Sec. Design Spectral Response, S_{DS}:	0.29 g
1.0 Sec. Design Spectral Response, S_{D1}:	0.12 g
Importance Factor (I):	1.25 (Wastewater Treatment facilities are Occupancy Category III)
Component Importance Factor (I_p):	1.0, except I_p=1.5 for fire protection sprinkler systems or components containing hazardous materials
Seismic Design Category	B

Seismic loads shall be calculated on the basis of the governing building code. The structure dead load shall include equipment operating loads.

Individual members shall be checked for seismic and full member live load acting simultaneously, except that flooded equipment loads (infrequent occurrence) need not be combined with seismic loads. Equipment operating loads shall be combined with seismic loads.

D. TEMPERATURE:

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

1.06 LOAD COMBINATIONS

All nonstructural components and nonbuilding structures shall be designed to withstand the load combinations as specified in the governing building code. Where the exclusion of live load or impact load would cause a more severe load condition for the member under investigation, then the load shall be ignored when evaluating that member.

1.07 DESIGN CONSIDERATIONS

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

A. CLIMATIC CONDITIONS:

Maximum design temperature:	100	degrees Fahrenheit
Minimum design temperature:	-25	degrees Fahrenheit

B. FOUNDATIONS:

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

Frost line for foundations:	30 inches

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

1.08 COLUMN BASE FIXITY

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

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

1.09 DEFLECTIONS

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

PART 2--PRODUCTS

2.01 GENERAL

Materials shall be in conformance with information shown on the drawings and in other technical specification sections. See individual component and equipment specifications for additional requirements.

PART 3 EXECUTION

3.01 GENERAL

A. Attachments and braces shall be made in such a manner that the component force is transferred to the lateral force-resisting system of the structure. Attachment requirements and size and number of braces shall be based on the calculations submitted by the Contractor.

B. All anchorage of equipment is specified to be made by cast-in anchor bolts in concrete elements unless specifically noted otherwise on the drawings or other specification Sections. Contractor shall be responsible for any remedial work or strengthening of concrete elements because of superimposed seismic loading if anchor bolts are improperly installed or omitted due to lack of submittal review or improper placement for any reason, at no additional cost to the Owner.

C. Anchor bolts shall be provided and installed by the Contractor. Size of anchor bolts and embedment of anchor bolts shall be based on the calculations submitted by the Contractor.

D. Details of and calculations for all anchorages shall be submitted and accepted in accordance with paragraph 1.03 prior to placement of concrete or erection of other structural supporting members. Submittals received after structural supports are in place will be rejected if proposed anchorage method would create an overstressed condition of the supporting member. The Contractor shall be responsible for revisions to the anchorages and/or strengthening of the structural support so that there is no overstressed condition at no additional cost to the Owner.

END OF SECTION

SECTION 01999

REFERENCE FORMS

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

Form No.	Title
01300-A	Submittal Transmittal Form
01660-A	Equipment Test Report Form
01730-A	Operation and Maintenance Transmittal Form
01730-B	Equipment Record Form
01730-C	Equipment Record Form
09900-A	Coating System Inspection Checklist
11000-A	Manufacturer's Installation Certification Form
11000-B	Manufacturer's Instruction Certification Form
11000-C	Unit Responsibility Certification Form
11002-A	Rigid Equipment Mount Installation Inspection Checklist
11060-A	Motor Data Form
16000-A	Wire and Cable Resistance Test Data Form
16000-B	Installed Motor Test Data Form
16000-C	Dry Transformer Test Data Form
16000-D	Motor Control Center Test Form
16000-E	Medium Voltage Motor Starter Test Form
16000-F	Medium Voltage Switchgear Test Form
16000-G	Protective Relay Test Form
16000-H	Low Voltage Switchgear Test Form
16000-I	Medium Voltage Load Interrupter Switch Test Form
16000-J	Liquid-Filled Transformer Test Form
16000-K	Automatic Transfer Switch Test Form
16000-L	Neutral Grounding Resistor Test
17000-A	Loop Wiring and Insulation Resistance Test Data Form
17000-B	Control Circuit Piping Leak Test Form
17000-C	Controller Calibration Test Data Form
17000-D	Panel Indicator Calibration Test Data Form
17000-E	Recorder Calibration Test Data Form
17000-F	Signal Trip Calibration Test Data Form
17000-G	Field Switch Calibration Test Data Form
17000-H	Transmitter Calibration Test Data Form
17000-I	Miscellaneous Instrument Calibration Test Data Form
17000-J	Individual Loop Test Data Form
17000-K	Loop Commissioning Test Data Form

01300-A. SUBMITTAL TRANSMITTAL FORM

SUBMITTAL TRANSMITTAL

Submittal Description: _____ Submittal No:[1] _____

Spec Section: _____

	Routing	Sent	Received
OWNER:	Contractor/CM		
PROJECT:	CM/Engineer		
	Engineer/CM		
CONTRACTOR:	CM/Contractor		

We are sending you ☐ Attached ☐ Under separate cover via _____
☐ Submittals for review and comment ☐ Product data for information only

Remarks: _____

Item	Copies	Date	Section No.	Description	Review action[a]	Reviewer initials	Review comments attached

[a]**Note: NET = No exceptions taken; MCN = Make corrections noted; A&R = Amend and resubmit; R = Rejected** Attach additional sheets if necessary.

Contractor

Certify either A or B:

☐ A. We have verified that the material or equipment contained in this submittal meets all the requirements, including coordination with all related work, specified (no exceptions).

☐ B. We have verified that the material or equipment contained in this submittal meets all the requirements specified except for the attached deviations.

No.	Deviation

Certified by: _____
Contractor's Signature

[1]See paragraph 01300-4.0 A, Transmittal Procedure.

01660-A. EQUIPMENT TEST REPORT FORM

NOTE: This example equipment test report is provided for the benefit of the Contractor and is not specific to any piece of equipment to be installed as a part of this project. The example is furnished as a means of illustrating the level of detail required for the preparation of equipment test report forms for this project.

CITY OF SAMPLE

EXAMPLE WATER TREATMENT PLANT
STAGE IV EXPANSION PROJECT

ABC Construction Company, Inc., General Contractor
XYZ Engineering, Inc., Construction Manager

EQUIPMENT TEST REPORT

Equipment Name: Sludge Pump 2
Equipment Number: P25202
Specification Ref: 11390
Location: East Sedimentation Basin Gallery

	Contractor		Construction Manager	
	Verified	Date	Verified	Date
PREOPERATIONAL CHECKLIST				
Mechanical				
Lubrication				
Alignment				
Anchor bolts				
Seal water system operational				
Equipment rotates freely				
Safety guards				
Valves operational				
Hopper purge systems operational				
Sedimentation tank/hopper clean				
O&M manual information complete				
Manufacturer's installation certificate complete				
Electrical (circuit ring-out and high-pot tests)				
Circuits:				
Power to MCC 5				
Control to HOA				

	Contractor		Construction Manager	
	Verified	Date	Verified	Date
Indicators at MCC:				
Red (running)				
Green (power)				
Amber (auto)				
Indicators at local control panel				
Wiring labels complete				
Nameplates:				
MCC				
Control station				
Control panel				
Equipment bumped for rotation				
Piping Systems				
Cleaned and flushed:				
Suction				
Discharge				
Pressure tests				
Temporary piping screens in place				
Instrumentation and Controls				
Flowmeter FE2502F calibration				
Calibration Report No.				
Flow recorder FR2502G calibrated against transmitter				
VFD speed indicator calibrated against independent reference				
Discharge overpressure shutdown switch calibration				
Simulate discharge overpressure Shutdown				
FUNCTIONAL TESTS				
Mechanical				
Motor operation temperature satisfactory				
Pump operating temperature satisfactory				
Unusual noise, etc?				
Pump operation: 75 gpm/50 psig				
Measurement:				
Flow:				
Pressure:		Test gage number:		
Alignment hot				
Dowelled in				
Remarks:				

	Contractor		Construction Manager	
	Verified	Date	Verified	Date
Electrical				
Local switch function:				
Runs in *HAND*				
No control power in *OFF*				
Timer control in *AUTO*				
Overpressure protection switch PS2502C functional in both *HAND* and *AUTO*				
Overpressure protection switch PS2502C set at 75 psig				
PLC 2500 set at 24-hour cycle, 25 min *ON*				
OPERATIONAL TEST				
48-hour continuous test. Pump cycles as specified, indicators functional, controls functional, pump maintains capacity, overpressure protection remains functional, hour meter functional				

RECOMMENDED FOR BENEFICIAL OCCUPANCY

_____ _____

Construction Manager _____ Date _____

ACCEPTED FOR BENEFICIAL OCCUPANCY

_____ _____

Owner's Representative _____ Date _____

01730-A. OPERATION AND MAINTENANCE TRANSMITTAL FORM

Date: _____ Submittal No:[2] _____

To: _____ Contract No: _____

_____ Spec. Section: _____

_____ Submittal Description: _____

_____ From: _____

Attention: _____ _____

Checklist	Contractor		Construction manager	
	Satisfactory	N/A	Accept	Deficient
1. Table of contents				
2. Equipment record forms				
3. Manufacturer information				
4. Vendor information				
5. Safety precautions				
6. Operator prestart				
7. Start-up, shutdown, and postshutdown procedures				
8. Normal operations				
9. Emergency operations				
10. Operator service requirements				
11. Environmental conditions				
12. Lubrication data				
13. Preventive maintenance plan and schedule				
14. Troubleshooting guides and diagnostic techniques				
15. Wiring diagrams and control diagrams				
16. Maintenance and repair procedures				
17. Removal and replacement instructions				
18. Spare parts and supply list				
19. Corrective maintenance man-hours				
20. Parts identification				
21. Warranty information				
22. Personnel training requirements				
23. Testing equipment and special tool information				

Remarks: _____

_____

Contractor's Signature

[2]See paragraph 01300-4.0 A, Transmittal Procedure.

01730-B. EQUIPMENT RECORD FORM

EQUIP DESCRIP		EQUIP LOC	
EQUIP NO.	SHOP DWG NO.	DATE INST	COST
MFGR		MFGR CONTACT	
MFGR ADDRESS			PHONE
VENDOR		VENDOR CONTACT	
VENDOR ADDRESS			PHONE

MAINTENANCE REQUIREMENTS	D	W	M	Q	S	A	Hours
LUBRICANTS: RECOMMENDED:							
ALTERNATIVE:							
MISC. NOTES:							

RECOMMENDED SPARE PARTS			
PART NO	QUAN	PART NAME	COST

ELECTRICAL NAMEPLATE DATA			
EQUIP			
MAKE			
SERIAL NO.		ID NO.	
MODEL NO.		FRAME NO.	
HP	V	AMP	HZ
PH	RPM	SF	DUTY
CODE	INSL. CL	DES	TYPE
NEMA DES	C AMB	TEMP RISE	RATING
MISC.			
MECHANICAL NAMEPLATE DATA			
EQUIP			
MAKE			
SERIAL NO.		ID NO.	
MODEL NO.		FRAME NO.	
HP	RPM	CAP	SIZE
TDH	IMP SZ	BELT NO.	CFM
PSI	ASSY NO.	CASE NO.	
MISC			

01730-C. EQUIPMENT RECORD FORM

EQUIP DESCRIP		EQUIP LOC	
EQUIP NO.	SHOP DWG NO.	DATE INST	COST
MFGR		MFGR CONTACT	
MFGR ADDRESS			PHONE
VENDOR		VENDOR CONTACT	
VENDOR ADDRESS			PHONE

MAINTENANCE REQUIREMENTS	D	W	M	Q	S	A	Hours

09900-A COATING SYSTEM INSPECTION CHECKLIST

09900-A Coating System Inspection Checklist			
Project Name			
Owner		Coating System Manufacturer (CSM)	
General Contractor (GC)		Coating System Applicator (CSA)	
Area or Structure		Location within Structure	
Coating System (eg E-1)		Coating Type (eg Epoxy, etc.)	

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

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

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

11000-A. MANUFACTURER'S INSTALLATION CERTIFICATION FORM

Contract No: _____ Specification section: _____

Equipment name: _____

Contractor: _____

Manufacturer of equipment item: _____

The undersigned manufacturer of the equipment item described above hereby certifies that he has checked the installation of the equipment and that the equipment, as specified in the project manual, has been provided in accordance with the manufacturer's recommendations, and that the trial operation of the equipment item has been satisfactory.

Comments: _____

_____

_____

_____

_____

_____ _____

Date Manufacturer

_____

Signature of Authorized Representative

_____ _____

Date Contractor

_____

Signature of Authorized Representative

11000-B. MANUFACTURER'S INSTRUCTION CERTIFICATION FORM

Contract No: _____ Specification section: _____

Equipment name: _____

Contractor: _____

Manufacturer of equipment item: _____

The undersigned manufacturer certifies that a service engineer has instructed the wastewater treatment plant operating personnel in the proper maintenance and operation of the equipment designated herein.

Operations Check List (check appropriate spaces)	
Start-up procedure reviewed	
Shutdown procedure reviewed	
Normal operation procedure reviewed	
Others:	
Maintenance Check List (check appropriate spaces)	
Described normal oil changes (frequency)	
Described special tools required	
Described normal items to be reviewed for wear	
Described preventive maintenance instructions	
Described greasing frequency	
Others:	

_____ _____

Date Manufacturer

_____

Signature of Authorized Representative

_____ _____

Date Signature of Owner's Representative

_____ _____

Date Signature of Contractor's Representative

11000-C. UNIT RESPONSIBILITY CERTIFICATION FORM

(Project Title)

CERTIFICATE OF UNIT RESPONSIBILITY
for Specification Section _____

_____
(Section title)

In accordance with paragraph 11000-1.02 C of the contract documents, the undersigned manufacturer of driven equipment ("manufacturer") accepts unit responsibility for all components of equipment furnished to the Project under specification Section_____ ,and for related equipment manufactured under Sections___ ____, _____, and _____ .

We have reviewed the requirements for Sections 11000 (and 11050 where applicable) and all sections referencing this (these) section(s), including but not limited to drivers, supports for driving and driven equipment and all other specified appurtenances to be furnished to the Project by manufacturer. And, we have further reviewed, and modified as necessary, the requirements for associated variable speed drives and motor control centers. We hereby certify that all specified components are compatible and comprise a functional unit suitable for the specified performance and design requirements whether or not the equipment was furnished by us. We will make no claim nor establish any condition that problems in operation for the product provided under this specification Section _____ are due to incompatibility of any components covered by this Certificate of Unit Responsibility. Nor will we condition or void any warranty for the performance of the product of this specification Section _____ due to incompatibility of any components covered under this Certificate of Unit Responsibility.

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

_____
Notary Public

_____
Commission expiration date

Seal:

_____
Name of Corporation

_____
Address

By: _____
Duly Authorized Official

_____
Legal Title of Official

Date: _____

11002-A. RIGID EQUIPMENT MOUNT INSTALLATION CHECKLIST

(CLIENT, PROJECT NAME)

Equipment Tag No.: _____ Date: _____

Grout Product Name and Type: _____

Grouting System Manufacturer: _____

Grouting Application Contractor: _____

General Contractor: _____

Step 1: Verify Equipment Anchor Installation Conformance to Equipment Pad Details

Name: _____ Date___/___/___
Contractor Rep.

Name: _____ Name: _____
Construction Manager Millwright

Step 2: Completion of Cleaning and Concrete Substrate Preparation Prior to Grouting

Name: _____ Date___/___/___
Contractor Rep.

Name: _____ Name: _____
Construction Manager Grouting Contractor Rep.

Name: _____
Grout Manufacturer's Technical Rep.

Step 3: Equipment Leveling

Name: _____ Date___/___/___
Contractor Rep.

Name: _____ Name: _____
Construction Manager Millwright

Step 4: Installation of Protection of Adjacent Surfaces or Structures NOT TO BE GROUTED

Name: _____ Date___/___/___
Contractor Rep.

Name: _____ Name: _____
Construction Manager Grouting Contractor Rep.

Name: _____
Grout Manufacturer's Technical Rep.

Step 5: Preparation and Construction of Forms and Epoxy Grout Filling Standpipes

Name: _____ Date___/___/___
Contractor Rep.

Name: _____ Name: _____
Construction Manager Grouting Contractor Rep.

Name: _____
Grout Manufacturer's Technical Rep.

Step 6: Completion of Ambient Condition Control in Structure or Building Area and Acceptance of Ambient Conditions as They Apply to Application and Curing Requirements for the Grouting System

Name: _____ Date___/___/___
Contractor Rep.

Name: _____ Date___/___/___
Grouting Contractor Rep.

Name: _____ Date___/___/___
Grout Manufacturer's Technical Rep.

Name: _____ Date___/___/___
Construction Manager

Step 7: Epoxy Grout Installation

Name: _____ Date___/___/___
Contractor Rep.

Name: _____ Name: _____
Construction Manager Grouting Contractor Rep.

Name: _____
Grout Manufacturer's Technical Rep.

Step 8: Completion of Full and Proper Cure of Epoxy Grout

Name: _____ Date___/___/___
Contractor Rep.

Name: _____ Date___/___/___
Grouting Contractor Rep.

Name: _____ Date___/___/___
Grout Manufacturer's Technical Rep.

Name: _____ Date___/___/___
Construction Manager

Step 9: Completion of Localized Repair of Grout Voids

Name: _____ Date___/___/___
Contractor Rep.

Name: _____ Date___/___/___
Grouting Contractor Rep.

Name: _____ Date___/___/___
Grout Manufacturer's Technical Rep.

Name: _____ Date___/___/___
Construction Manager

Step 10: **Final Acceptance of Grouting System Installation Including Final Clean-Up of the Work Site Complying with All Specification Requirements and the GSM's Quality Requirements**

Name: _____ Date___/___/___
Contractor Rep.

Name: _____ Date___/___/___
Grouting Contractor Rep.

Name: _____ Date___/___/___
Grout Manufacturer's Technical Rep.

Name: _____ Date___/___/___
Construction Manager

11060-A. MOTOR DATA FORM

Equipment Name: _____ Equipment No(s): _____

Project Site Location: _____

Nameplate Markings

Mfr:		Mfr Model:		Frame:		Horsepower:	
Volts:		Phase:		RPM:		Service Factor:	
FLA:		LRA:		Frequency:		Amb Temp Rating:	°C
Time rating:				Design Letter:			
	(NEMA MG1-10.35)				(NEMA MG-1.16)		
KVA Code Letter:				Insulation Class:			

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

A. Approved by UL for installation in Class _____, Div _____, Group _____

B. UL frame temperature code ____ (NEC Tables 500-8B)

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

A. Guaranteed minimum efficiency _____
(Paragraph 11060-2.04 G)

B. Nameplate or nominal efficiency _____

Data Not Necessarily Marked on Nameplate

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

Provide information on other motor features specified:

_____

A. WIRE AND CABLE RESISTANCE TEST DATA FORM

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

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

.

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

16000-B. INSTALLED MOTOR TEST FORM

Motor Equipment Number: _____ Date of test: _____

Equipment Driven: _____

MCC Location: _____

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

Motor Nameplate Markings:

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

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

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

16000-C. DRY TRANSFORMER TEST DATA FORM

(Note: Use Data Form for dry type transformers with voltage rating of 600 Vac or less and sizes to 167 kVA single phase and 500 kVA three phase. Use NETA Test Forms and Test Procedures for higher voltages and larger transformers.)

Equipment Tag No.: _____ Temperature Rating: _____

Description/Location: _____ Feeder size/Source: _____

Primary Voltage: _____ Secondary Voltage: _____ Winding Connection: _____

A. VISUAL INSPECTION

Transformer Inspection	Pass	Fail	Note
1. Nameplate data as specified			
2. Mechanical condition			
a. Free of dents and scratches			
b. Anchored properly			
c. Shipping brackets removed			
d. Spacing from wall per nameplate			
3. Grounding *			
a. Equipment grounding			
b. System grounding			

B. INSULATION-RESISTANCE TESTS:

Perform tests with calibrated megohmeter. Apply 1000 Vdc test voltage for 60 seconds and record readings in megohms at 30-seconds and 60-seconds intervals.

Test Group	Resistance between		30-second reading	60-second reading	Absorption Ratio Index 60-sec. / 30-sec.
Primary Winding to ground	A	GRD			
	B	GRD			
	C	GRD			
Secondary Winding to ground with * N-G Bond removed	a	GRD			
	b	GRD			
	c	GRD			
Primary Winding to Secondary Winding	A	a			
	B	b			
	C	c			

Submit resistance readings to the Construction Manager immediately after the tests that are less than the manufacturer's recommended value or less than 10-megohms. Record the Absorption Ratio Index values for future reference. Ratio must be 1.0 or greater, with infinity (∞) equal to 1.0.

Contractor Representative Certified: _____ Date _____

Owner Representative Witnessed: _____ Date _____

16000-D. MOTOR CONTROL CENTER TEST FORM

Equipment No.: _____ Ambient room temperature: _____

Location: _____

A. MECHANICAL CHECK:

All bolted connections either bus to bus or cable to bus shall be torqued to the manufacturer's recommendations.

B. ELECTRICAL TESTS:

1. Measure insulation resistance of each bus section phase to phase and phase to ground for 1 minute using a megohmmeter at 1000 volts.

Test results (megohms)			
Phase		Phase	
A-GRD		A-B	
B-GRD		B-C	
C-GRD		C-A	

2. Set the circuit breaker in the starter unit to comply with the requirements of NEC, Article 430-52 and Table 430-152.

3. Motor overload heater elements shall be sized and installed based on the actual nameplate full load amperes of the motor connected to the starter.

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

16000-E. MEDIUM VOLTAGE MOTOR STARTER TEST FORM

Equipment No.: _____

Location: _____

Room Temperature: _____

The protective devices shall be set in accordance with the specification before the tests are performed.

1. Measure contact resistance (micro-ohms)

Phase:	A		B		C	

Contacts shall be replaced if resistance exceeds 50 micro-ohms.

2. Perform an insulation resistance test (1000 volts DC for 1 minute).

Phase	A		B		C		
Pole to ground							megohms
Across open pole							megohms
Pole to pole	AB		BC		CA		megohms

3. Perform minimum pickup voltage tests on trip and close coils.

4. Motor RTDs shall be tested by using a hot oil bath. The temperature at which the sensor trips shall be recorded for each RTD.

5. The Contactor shall be tripped by operation of each protective device.

16000-F. MEDIUM VOLTAGE SWITCHGEAR TEST FORM

Equipment No.: _____

Location: _____

Room Temperature: _____

The protective devices shall be set in accordance with the specification before the tests are performed.

1. Measure contact resistance (micro-ohms).

Phase:	A		B		C	

Contacts shall be replaced if resistance exceeds 50 micro-ohms.

2. Perform an insulation resistance test (1000 volts DC for 1 minute).

Phase	A		B		C		
Pole to ground							megohms
Across open pole							megohms
Pole to pole	AB		BC		CA		megohms

3. Perform minimum pickup voltage tests on trip and close coils.

4. Verify the instrument transformer ratios. Check the transformer's polarity electrically.

5. The Contactor shall be tripped by operation of each protective device.

16000-G. PROTECTIVE RELAY TEST FORM

Location: _____

Switchgear Breaker No.: _____

Protective Relay Description: _____

The protective relays shall be tested in the following manner:

1. Each protective relay circuit shall have its insulation resistance tested to ground.

2. Perform the following tests on the specified relay setting:

   a. Pickup parameters on each operating element.

   b Timing test shall be performed at three points on the time dial curve.

   c. Pickup target and seal-in units.

The results shall be recorded and signed. A copy shall be given to the Construction Manager in accordance with paragraph 16000-1.05 B.

16000-H. LOW VOLTAGE SWITCHGEAR TEST FORM

Equipment No.: _____

Location: _____

Room Temperature: _____

The protective devices shall be set in accordance with the specification before the tests are performed.

1. Measure contact resistance (micro-ohms).

Phase:	A		B		C	

Contacts shall be replaced if resistance exceeds 50 micro-ohms.

2. Perform an insulation resistance test (1000 volts DC for 1 minute).

Phase	A		B		C		
Pole to ground							megohms
Across open pole							megohms
Pole to pole	AB		BC		CA		megohms

3. Minimum pickup current shall be determined by primary current injection.

4. Long time delay shall be determined by primary injection at three hundred percent (300%) pickup current.

5. Short time pickup and time delay shall be determined by primary injection of current.

6. Instantaneous pickup current shall be determined by primary injection.

7. Trip unit reset characteristics shall be verified.

8. Auxiliary protective devices, such as ground fault or under voltage relays, shall be activated to ensure operation of shunt trip devices.

16000-I. MEDIUM VOLTAGE LOAD INTERRUPTER SWITCH TEST FORM

Equipment Number: _____

Location: _____

Date: _____

1. Measure switch blade resistance (micro-ohms).

Phase:	A		B		C	

Contacts shall be replaced if resistance exceeds 50 micro-ohms.

2. Perform an insulation resistance test (1000 volts DC for 1 minute).

Phase	A		B		C		
Pole to ground							megohms
Across open pole							megohms
Pole to pole	AB		BC		CA		megohms

The results shall be recorded and signed. A copy shall be given to the Construction Manager in accordance with paragraph 16000-2.06 B.

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

16000-J. LIQUID-FILLED TRANSFORMER TEST FORM

Equipment Number: _____

Location: _____

Date/Weather Conditions: _____

A. Perform the "Insulation-Resistance Test" and "Dielectric Absorption Test" using Form 16000-C, Dry Transformer Test Data Form.

B. Perform an applied voltage (low frequency dielectric) test in accordance with ANSI C57.12.90, paragraph 10.5, Applied Voltage Test. Applied voltage levels shall be 75 percent of recommended factory test levels or recommended test levels of ANSI C57.12.00, Table 5.

C. Insulating oil shall be sampled and shall be laboratory tested for the following:

1. Dielectric strength.

2. Acid neutralization.

3. Interfacial tension.

4. Color.

5. Power factor.

D. Perform a turns ratio test between the windings for all tap positions.

E. The temperature and pressure switches shall be tested using a hot oil bath and air pump.

F. The results shall be recorded and signed by the Contractor and Construction Manager. A copy shall be given to the Construction Manager in accordance with paragraph 16000-2.06 D. Any readings which are abnormal to ANSI industry standards shall be reported to the Construction Manager.

16000-K. AUTOMATIC TRANSFER SWITCH TEST FORM

Equipment Number: _____

Location: _____

Date: _____

1. Perform an insulation resistance test (1000 volts DC for 1 minute):

Phase	A		B		C		
Pole to ground							megohms
Pole to pole	AB		BC		CA		megohms

2. Perform the following operations and initial:

   a. Manual transfer _____

   b. Loss of normal power; _____sec delay

   c. Return to normal power; _____sec delay

The results shall be recorded and signed. A copy shall be given to the Construction Manager in accordance with paragraph 16000-2.06 B.

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

16000-L. NEUTRAL GROUNDING RESISTOR TEST

Equipment No.: _____

Location: _____

The pickup and time delay setting on the ground fault relay shall be set in accordance with Section 16431.

1. The transformer neutral insulation resistance shall be measured with and without the grounding resistor connected to insure no parallel ground paths exist.

2. The protective relay pickup current shall be determined by injecting test current into the current sensor. The pickup current should be within 10 percent of the dial setting. Record the dial setting and actual pickup tie.

3. The relay timing shall be tested by injecting 150 and 300 percent of pickup current into the current sensor. The relay timing shall be in accordance with the manufacturer's published time-current characteristic curves. Record the relay timing at 150 and 300 percent of pickup current.

4. The circuit interrupting device shall be operated by operating the relay.

The results shall be recorded and signed by the Contractor and Construction Manager. A copy shall be given to the Construction Manager in accordance with paragraph 16000-2.06 B.

17000-A. LOOP WIRING AND INSULATION RESISTANCE TEST DATA FORM

Loop No.: _____

List all wiring associated with a loop in table below. Make applicable measurements as indicated after disconnecting wiring.

Wire No.	Panel Tie	Field TB	Continuity Resistance[a]		Insulation Resistance[b]			
			Cond./ Cond.	Cond./ Shield	Shield/ Gnd.	Shield/ Cond.	Cond./ Gnd.	Shield/ Shield
A			--	(A/SH)				
B			(A/B)	--				
C			(A/C)	--				
D			(A/D)	--				
etc.								

NOTES:

a. Continuity Test. Connect ohmmeter leads between wires A and B and jumper opposite ends together. Record resistance in table. Repeat procedure between A and C, A and D, etc. Any deviation of ±2 ohms between any reading and the average of a particular run indicates a poor conductor, and corrective action shall be taken before continuing with the loop test.

b. Insulation Test. Connect one end of a 500 volt megger to the panel ground bus and the other sequentially to each completely disconnected wire and shield. Test the insulation resistance and record each reading.

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

17000-B. CONTROL CIRCUIT PIPING LEAK TEST FORM

Loop No.:_____

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

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

NOTES:

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

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

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

17000-C. CONTROLLER CALIBRATION TEST DATA FORM

Tag No. and Description: _____

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

Input: _____ Process Variable (PV) Scale: _____

Output: _____ Output Scale: _____

PV Scale Calibration

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

Connect output to PV for following tests:

Set Point (SP) Indicator Accuracy			Output Meter Accuracy			Controller Accuracy		
SP	PV Reading	Expected % Dev.	Actual Reading	Expected Reading	Actual % Dev.	Output	Output	% Dev.
(0%)								
(50%)								
(100%)								
% Deviation Allowed:			% Deviation Allowed:			% Deviation Allowed:		

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

17000-D. PANEL INDICATOR CALIBRATION TEST DATA FORM

Tag No. and Description: _____

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

Input: _____

Scale: _____ Range: _____

PV Scale Calibration

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

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

17000-E. RECORDER CALIBRATION TEST DATA FORM

Tag No. and Description: _____

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

Input: _____ Chart: _____

Scale: _____ Range: _____

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

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

17000-F. SIGNAL TRIP CALIBRATION TEST DATA FORM

Tag No. and Description: _____

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

Input: _____

Scale: _____ Range: _____

Set Point(s): _____

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

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

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

17000-G. FIELD SWITCH CALIBRATION TEST DATA FORM

Tag No. and Description: _____

Make & Model No.: _____ Serial No: _____

Input: _____

Range: _____

Set Point(s): _____

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

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

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

17000-H. TRANSMITTER CALIBRATION TEST DATA FORM

Tag No. and Description: _____

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

Input: _____

Output: _____

Range: _____ Scale: _____

Simulate process variable (flow, pressure, temperature, etc.) and measure output with appropriate meter.

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

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

17000-I. MISCELLANEOUS INSTRUMENT CALIBRATION TEST DATA FORM

(For instruments not covered by any of the preceding test forms, the Contractor shall create a form containing all necessary information and calibration procedures.)

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

17000-J. INDIVIDUAL LOOP TEST DATA FORM

Loop No.: _____

Description: (Give complete description of loop's function using tag numbers where appropriate.)

P&ID No.: (Attach copy of P&ID.)

a. Wiring tested:
(Attach test form 17000-A)

b. Instrumentation tubing/piping tested:
(Attach test form 17000-B)

c. Instruments calibrated:
(Attach test forms 17000-C through I)

d. List step-by-step procedures for testing loop parameters. Test loop with instruments, including transmitters and control valves, connected and functioning. If it is not possible to produce a real process variable, then a simulated signal may be used with the Construction Manager's approval.

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

17000-K. LOOP COMMISSIONING TEST DATA FORM

Loop No.: _____

a. Loop tested:
(Attach test form 17000-J)

b. Controlled or connected equipment tests confirmed:

c. Give complete description of loop's interface with process.

d. With associated equipment and process in operation, provide annotated chart trace of loop response to changes in set points for verification of performance. This chart should demonstrate 1/4-amplitude damping as output adjusts to set point change. Show set points, starting and finishing times on chart, as well as any other pertinent data.

Connect 2-pen recorder to process variable (PV) and to controller output. Use 1 inch/second chart speed.

Pen 1 - PV - Connections:

Pen 2 - Output - Connections:

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
Owner's Representative

SECTION 02100

SITE PREPARATION

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies site preparation which consists of clearing, grubbing and demolition.

B. EXISTING CONDITIONS:

The Contractor shall determine the actual condition of the site as it affects this portion of work.

C. PROTECTION:

Site preparation shall not damage structures, landscaping or vegetation adjacent to the site. The Contractor shall repair or replace any damaged property.

PART 2--PRODUCTS

No products are included in this section.

PART 3--EXECUTION

3.01 CLEARING AND GRUBBING

Unless otherwise specified, the Contractor shall remove obstructions such as brush, trees, logs, stumps, roots, heavy sod, vegetation, rock, stones larger than 6 inches in any dimension, broken or old concrete and pavement, debris, and structures where the completion of the work require their removal.

Material that is removed and is not to be incorporated in the work shall be disposed of off the site.

3.02 DEMOLITION AND REMOVAL

A. STRUCTURES:

Demolition and removal of structures consist of removal of abandoned superstructures, foundation walls, footings, slabs and any other structures. Excavations caused by existing foundations shall be cleared of waste, debris and loose soil, and refilled as specified.

B. PAVEMENT:

When portions of asphalt pavements and concrete pads are to be removed and later construction is to be connected, edges shall be saw-cut, on a neat line at right angles to the curb face.

C. SALVAGE:

The Owner has the right to salvage any items scheduled for removal. The Contractor shall notify the Owner 5 days prior to any salvage or demolition work to determine the disposition of items to be removed. The Owner will mark items to be salvaged. Such items shall be properly disconnected, removed from their foundations, cleaned, and stored at a location on the site as specified.

3.03 UTILITY INTERFERENCE

Where existing utilities interfere with the prosecution of the work, the Contractor shall relocate them at no additional cost to the Owner.

END OF SECTION

SECTION 02200

EARTHWORK

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies earthwork which consists of excavation, filling, grading, and disposal of excess material.

B. DEFINITIONS:

1. COMPACTION: The degree of compaction is specified as percent compaction. Maximum or relative densities refer to dry soil densities obtainable at optimum moisture content.

2. EXCAVATION SLOPE: Excavation slope shall be defined as an inclined surface formed by removing material from below existing grade.

1.02 QUALITY ASSURANCE

A. REFERENCES:

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

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM C136	Standard Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort
MAG	Maricopa Association of Governments Uniform Specifications and Details for Public Works Construction, current edition and revisions.
ASTM D1556	Test Method for Density of Soil in Place by the Sand-Cone Method
ASTM D1557	Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.5-kg) Rammer and 18-in. (457-mm) Drop
ASTM D2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM D3017	Test Method for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

B. TESTS:

The Owner will take samples and perform moisture content, gradation, compaction, and density tests during placement of backfill materials to check compliance with these specifications. The Contractor shall remove surface material at locations designated by the Owner and provide such assistance as necessary for sampling and testing. The Owner may direct the Contractor to construct inspection trenches in compacted or consolidated backfill to determine that the Contractor has complied with these specifications.

Tests will be made by the Owner in accordance with the following:

Test	Standard Procedure
Moisture content	ASTM D3017
Gradation	ASTM C136
Density in-place	ASTM D1556
Moisture-density relationships	ASTM D1557

1.03 SUBMITTALS

Samples of fill materials to be used shall be submitted 2 weeks in advance of use. Samples shall consist of 0.5 cubic feet of each type of material.

PART 2--MATERIALS

2.01 BEDDING AND BACKFILL

Bedding and backfill shall meet the requirements of MAG Section 601.4.

2.02 CRUSHED ROCK

Crushed rock shall meet the requirements of MAG Section 701.2.

2.03 AGGREGATE BASE

Aggregate base shall meet the requirements of MAG Section 702.2.

2.04 SITE FILL

Unless otherwise specified, site fill shall be unclassified material which is free from peat, wood, roots, bark, debris, garbage, rubbish, or other extraneous material. The maximum size of stone shall not exceed 6 inches. If the material excavated from the site meets these requirements, it may be classified as this type.

2.05 TYPE D:

Type D material shall be granular material commonly known as pea gravel and shall conform to the following gradation:

U.S. standard sieve size	Percent by weight passing
1/4 inch	100
No. 8	0-5

PART 3--EXECUTION

3.01 GENERAL

A. CONTROL OF WATER:

The Contractor shall keep excavations reasonably free from water during construction. The static water level shall be drawn down a minimum of 1 foot below the bottom of excavations to maintain the undisturbed state of natural soils and allow the placement of any fill to the specified density. Disposal of water shall not damage property or create a public nuisance. The Contractor shall have on hand pumping equipment and machinery in good working condition for emergencies and shall have workmen available for its operation. Dewatering systems shall operate continuously until backfill has been completed to 1 foot above the normal static groundwater level.

Groundwater shall be controlled to prevent softening of the bottom of excavations, or formation of "quick" conditions. Dewatering systems shall not remove natural soils. The Contractor shall control surface runoff to prevent entry or collection of water in excavations.

Release of groundwater to its static level shall be controlled to prevent disturbance of the natural foundation soils or compacted fill and to prevent flotation or movement of structures or pipelines.

B. OVEREXCAVATION:

Where the undisturbed condition of natural soils is inadequate for support of the planned construction, the Owner will direct the Contractor to overexcavate to adequate supporting soils. The excavated space shall be filled to the specified elevation with backfill. The overexcavated space under footings may be filled with concrete. The quantity and placement of such material will be paid for as extra work.

C. SURPLUS MATERIAL:

Unless otherwise specified, surplus excavated material shall be disposed of offsite in accordance with applicable ordinances and environmental requirements.

Material shall not be stockpiled to a depth greater than 5 feet above finished grade within 25 feet of any excavation or structure, except for those areas designated to be preconsolidated. For these areas, the depth of stockpiled material shall be as specified. The Contractor shall maintain stability of the soil adjacent to any excavation.

D. HAULING:

When hauling is done over highways or city streets, the loads shall be trimmed and the vehicle shelf areas shall be cleaned after each loading. The loads shall be watered after trimming to eliminate dust.

E. FINISH GRADING:

Finished surfaces shall be smooth, compacted and free from irregularities. The degree of finish shall be that normally obtainable with a blade-grader.

Finished grade shall be as specified by the contours plus or minus 0.10 foot except where a local change in elevation is required to match sidewalks, curbs, manholes and catch basins, or to ensure proper drainage. Allowance for topsoil and grass cover, and subbase and pavement thickness shall be made so that the specified thickness of topsoil can be applied to attain the finished grade.

When the work is an intermediate stage of completion, the lines and grades shall be as specified plus or minus 0.5 foot to provide adequate drainage.

If the soil is to be cultivated or straw is to be incorporated into the surface, rocks larger than 2-1/2 inches in maximum dimension, roots and other debris on the surface of the slope shall be removed and disposed of prior to cultivation or placement of straw.

F. CONTROL OF EROSION:

The Contractor shall maintain earthwork surfaces true and smooth and protected from erosion. Where erosion occurs, the Contractor shall provide fill or shall excavate as necessary to return earthwork surfaces to the grade and finish specified.

3.02 EARTHWORK FOR STRUCTURES

A. STRUCTURE EXCAVATION:

The bottom shall not be more than 0.15 foot above or below the lines and grades specified. If the elevation of structure excavation is not specified, the excavation shall be not more than 0.15 foot above or below the elevation specified for fill material below the structure. Slopes shall vary no more than 0.5 foot from specified grade, unless the excavation is in rock where the maximum variation shall be 2 feet.

Should the excavation be carried below the lines and grades specified on the drawings or should the bottom of the excavation be disturbed because of the Contractor's operations and require overexcavation and backfill, the Contractor shall refill such excavated space to the proper elevation in accordance with the procedure specified for backfill. The cost of such work shall be borne by the Contractor.

Unless otherwise specified, excavations shall extend a sufficient distance from walls and footings to allow for placing and removal of forms, installation of services, and for inspection, except where concrete is specified to be placed directly against excavated surfaces.

B. FOUNDATION TREATMENT

Whenever any structure excavation is substantially completed to grade, the Contractor shall notify the Owner who will make an inspection of the foundation. No concrete shall be placed until the foundation has been inspected by the Owner.

C. STRUCTURE BACKFILL:

Unless otherwise specified, structure backfill shall be per MAG Section 206.

After completion of construction below the elevation of the final grade, and prior to backfilling, forms shall be removed and the excavation shall be cleaned of debris.

Backfill material shall be placed in uniform layers and shall be brought up uniformly on all sides of the structure. Unless otherwise specified, backfill around and above pipelines within the excavation line of any structure shall be the same as that specified for structures.

3.03 EARTHWORK FOR PIPELINES AND CONDUITS

A. GENERAL:

Earthwork for pipelines and conduits is specified in MAG 601and in the following paragraphs.

B. PIPELINE EXCAVATION:

The bottom of the trench shall be carried to the specified lines and grades with proper allowance for pipe thickness and for bedding as specified in MAG 601.

C. PIPELINE BACKFILL:

1. BEDDING: The Contractor shall not proceed with backfill placement in excavated areas until the subgrade has been inspected by the Owner. All pipe shall have a minimum thickness of bedding material below the barrel of the pipe as specified in MAG Section 601. Bedding material shall be placed in the bottom of the trench, leveled and compacted. Bell holes shall be excavated at each pipe joint to permit proper inspection and uniform bearing of pipe on bedding material.

After the pipe has been laid to alignment and grade, unless otherwise specified, additional bedding material shall be placed in layers the full width of the trench and compacted up to the specified level. Bedding shall be placed simultaneously on both sides of the pipe, keeping the level of backfill the same on each side. The material shall be carefully placed and compacted around the pipe to ensure that the pipe barrel is completely supported and that no voids or uncompacted areas are left beneath the pipe. Contractor shall use particular care in placing material on the underside of the pipe to prevent lateral movement during backfilling.

2. INITIAL BACKFILL: After pipe has been properly bedded, Contractor shall place and compact initial backfill as specified. Initial backfill, where specified below the springline of the pipe, shall be placed and compacted in accordance with paragraph 02200-3.03 C.1 for additional bedding material.

3. SUBSEQUENT BACKFILL:

a. GENERAL: Backfill material, placement and compaction above the pipe zone shall be as specified. Backfill above the pipe zone shall not commence until pipe zone backfill has been inspected and accepted by the Owner.

b. IMPROVED AREAS: Unless otherwise specified, select granular backfill per MAG Section 702.2, Type A, shall be used under all paved and unpaved roadways and paved and unpaved roadway shoulders, roadway embankments, and in all public right-of-ways and easements. The trench shall be backfilled to an elevation which will permit the placement of the specified surface or paving. Other surfaces shall be restored, including compaction, to the condition existing prior to construction, including restoration of yard areas.

3.04 SITE FILL

Fill material shall be placed in horizontal layers and compacted with power-operated tampers, rollers, idlers or vibratory equipment. Maximum layer depth and relative compaction is specified in the following table:

Maximum uncompressed layer depth, inches	Minimum relative compaction, percent	Application
8	90	Site fill
8	95	Below equipment pads with fill depths < 5'-0"
8	100	Below equipment pads with fill depths > 5'-0"

If the existing slope in an area to be filled is greater than 5:1, the Contractor shall bench the area prior to filling.

3.05 SUBGRADE FOR PAVEMENT

The prepared subgrade shall be scarified to a depth of at least 12 inches and recompacted to at least 95 percent of the maximum density.

END OF SECTION

SECTION 11069

ADJUSTABLE FREQUENCY DRIVES

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies 480-Vac rated adjustable frequency drive motor controller systems using insulated gate bipolar transistors (IGBT) for pulse-width modulation technology (PWM).

The AFDs specified in this section shall be the product of a single vendor and mounted in the specified cabinet enclosure.

The terms AFD (adjustable frequency drive), ASD (adjustable speed drive), VFD (variable frequency drive), and VSD (variable speed drive) are interchangeable for the purposes of this specification.

Refer to the drawings for control and monitoring requirements including special interlocking requirements.

B. SYSTEM REQUIREMENTS:

The AFD system shall convert 460-volt, 60-Hertz nominal input to a suitable voltage and frequency to cause a premium-efficient, inverter-duty, squirrel-cage induction motor to run at a speed proportional to an external input analog 4- to 20-mAdc or digital input command as specified for the required AFD speed range.

The AFD system shall include rectifier units, inverter units, control circuitry, protective equipment, input line reactors and output load reactors and other filters and accessories as necessary to provide the specified functions to meet voltage and current harmonics at the specified point of common connection and to mitigate the motor reflected voltage wave.

The point of common connection for AFDs shall be the 480 distribution bus of the motor control center (MCC) immediately upstream of the AFD.

The AFD system torque requirement shall match the pump torque requirement. Verify the pump type and select variable torque (VT) as specified in the AFD Schedule.

C. AFD SCHEDULE:

Equipment Name & Tag Number	Drive Number	Drive Horse Power	Drive Speed Range[1]	Driven Equipment Specification	AFD Type	AFD Enclosure & Mounting	Distance (ft) from AFD to Driven Equipment Motor
Cogen Gas Blower	VFD-8770	15	1800-3600	11466	6-pulse, variable-torque	NEMA-1 gasketed, floor mount in electrical room	140

[1] Verify minimum speed range with Mechanical Engineer based on submittal information prior to VFD setup and testing.

D. ENVIRONMENTAL CONDITIONS:

Ambient conditions are specified in Section 01800.

E. SEISMIC:

Freestanding AFDs shall be braced per Section 01900.

1.02 QUALITY ASSURANCE

A. REFERENCES:

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

References to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
IEEE 519	IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power System
NEMA 250	Enclosures for Electrical Equipment (1000 Volts Maximum)

NEMA ICS 2	Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts
NEMA ICS 6	Industrial Control and Systems: Enclosures
NEMA ICS 7	Industrial Control and Systems: Adjustable-Speed Drives
NEMA ICS 7.1	Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable-Speed Drive Systems
NFPA 70	National Electrical Code (NEC)
UL Standard 508	Industrial Control Equipment

B. INDUSTRY STANDARDS:

The AFD shall be UL 508 listed and shall conform to the requirements specified in NEMA ICS 2, 6, 7 and 7.1.

C. UNIT RESPONSIBILITY:

The Contractor shall assign unit responsibility for the AFDs in this section as specified in paragraph 11000-1.02 C.

The Contractor shall submit letters of certification with the shop drawings from the AFD manufacturer, the motor manufacturer, and the driven equipment manufacturer stating that they have reviewed each application and that the combination will satisfy the application duties required, for the actual motor sizes required, regardless of deviations from the scheduled "nominal horsepower."

1.03 PRODUCT HANDLING

AFD units shall be shipped in air-cushion vans to ensure against shipping damage and packed in suitable protective containers. The units shall be inspected upon receipt for damage.

1.04 SUBMITTALS

The following information shall be provided in accordance with Section 01300:

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.

   Check marks shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation.

The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications.

Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

2. A copy of the Contract Document drawing E-013, and process and instrumentation diagram P-030A relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal.

   If no changes are required, the drawing or drawings shall be marked *"no changes required"*. Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.

3. Certificate of Unit Responsibility attesting that the Contractor has assigned, and that the manufacturer accepts, unit responsibility in accordance with the requirements of this section and paragraph 11000-1.02 C. No other submittal material will be reviewed until the certificate has been received and found to be in conformance with these requirements.

4. Catalog and technical data, including outline dimensions, shipping section dimensions, weight, and foundation requirements for all assemblies.

5. Schematic diagrams and wiring connection diagram showing functions and identification of terminals.

6. Voltage and current total harmonic distortion (THD) calculations with line reactors or filter design to mitigate harmonics to meet IEEE-519, if applicable.

PART 2--PRODUCTS

2.01 MANUFACTURERS

The Owner and Construction Manager believe the following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this section.

This statement, however, shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed that named manufacturers' standard equipment or products will comply with the requirements of this section.

AFDs shall be installed in the custom enclosures that are 90-inches high installed next to the MCC in the air-conditioned electrical enclosure as specified in Division 16 and as shown on the drawings.

The candidate manufacturers include:

1. SVX9000 6-pulse variable torque.

2.02 ENCLOSURES

Provide AFD in NEMA-1 gasketed or NEMA-12 enclosures with top or front discharge cooling fans.

A. GENERAL:

Provide enclosures with AFDs and custom control as required for the project and as indicated on the drawings. Each drive shall be designed for stand-alone operation and multiple drives shall not utilize shared components.

Review the project site location, elevation, temperature, humidity, plant atmosphere, and load current-torque requirements to size the AFD and its associated enclosure with requirements specified herein and the control and monitoring devices and interlocks as indicated.

Enclosures shall be designed for indoor service. Each AFD system shall be mounted in a NEMA 250 internally force-ventilated enclosure with UL-approved Class 1 filters on ventilation openings. Enclosures shall be fabricated from 12-gage minimum thickness sheet steel with an interior frame or formed to provide a rigid structure.

Provide enclosure size to allow entry of power source and motor load cables as indicated on the drawings. Submit drawing of the source and load power cable location within the enclosure and indicated barriers from control and instrument wiring.

Door width shall not exceed 30 inches and shall be hung on removable-pin hinges, with three-point latch hardware, and handle latch for 3/8-inch-shackle padlock.

C. FINISH AND COATINGS:

The AFD floor-mounted cabinet enclosure color shall match the MCC color and submit the color and finish systems selected.

2.03 AFD ASSEMBLIES

A. GENERAL:

AFDs shall include the following assemblies:

1. Lockable power disconnect using a thermal magnetic circuit breaker or motor protection device that is sized for the specific application by the manufacturer.

2. Line reactor and load reactor.

3. Control-circuitry interface with keypad type of Operator Interface Unit (OIU) mounted on the front of the AFD enclosure.

4. Output protection, including phase overload.

5. Enclosure Door Devices: Alarms, selector switch, speed potentiometer, as shown on the P&ID and electrical schematic.

B. AFD FEATURES:

Provided with the following features as shown on the drawings:

1. Fused control circuit transformer and microprocessor for system logic sequencing functions. Provide fuses with blown fuse indicator lamps.

2. Accept 4- to 20-mAdc speed reference signal.

3. A 4- to 20-mAdc output signal proportional to inverter output frequency for the speed range specified.

4. Adjustable minimum/maximum frequency limits:

   a. Minimum frequency shall be adjustable from 6 to 40 Hertz.
   b. Maximum frequency shall be adjustable from 48 to 90 Hertz.

5. Adjustable and independent-timed linear acceleration and deceleration functions, adjustable from 6 to 20 seconds.

6. Current limiting.

7. Automatic restart.

8. Control Wiring:

   a. 600-volt stranded copper.
   b. 90-degrees C, color-coded insulation.
   c. No. 16 AWG.

9. Wiring Identification and Termination: Crimp-type wire lugs with sleeve-type markers at each termination point and numbered terminal blocks for external connections.

10. Electrically isolated, discrete output contacts for ready, running, remote mode status and trouble alarm.

11. Control Power: Provide a 120-Vac, triple-fused, control power transformer for cooling fans and external control circuits when required. Control circuits shall be isolated from power circuits by distance and by insulated barriers.

12. Provide 120 -ac or 24-Vdc as required for OIU.

C. FUNCTIONAL REQUIREMENTS:

1. Supply Power: Operate continuously with supply power of 480 volts plus or minus 10 percent, 60 Hertz plus or minus 3 percent and remain on line and operate without damage to the AFD or connected load during a supply power under-voltage variation to the drive up to 85 percent of its nominal value for 30 milliseconds at full load.

   a. Flagstaff, Arizona outdoor ambient temperature: 0 to 100 degrees F.

2. Load: Capable of driving the specified maximum motor load continuously and under the following conditions:

   a. Deliver 110 percent of the specified load for up to 60 seconds in variable torque applications.

3. Efficiency: Not less than 95 percent at 60-Hertz output driving the specified maximum load at rated torque and speed at 40-degrees C ambient based on measured input power versus output power with all specified components in the system.

4. Frequency and Voltage Regulation: Output frequency regulated to within 0.6- Hertz of the signal/output frequency relationship. Output voltage regulated to within 1 percent to produce minimum motor heating at any operating frequency within the specified range.

5. Frequency Range: AFD shall be capable of continuous operation with the specified load at any frequency between 6 and 60 Hertz, unless noted otherwise.

6. Space and AFD Access:

   a. Enclosure size shall not exceed a height of 90 inches.

   b. Front accessible only and shall not require rear access.

   b. Mount against the wall without any clearance for ventilation or other purposes.

c. Submit AFD in the enclosure drawing with the detail of front door and the internal arrangement, including the feeder and motor cables, and the control cables, and the instrument cable location and terminations.

8. Ambient Noise: Free field noise generated shall not exceed 85-dBA at 3 feet out from any point on the AFD enclosure under any normal operating condition.

9. Motor Coordination:

   a. AFDs shall be configured for high motor winding temperature switch for shutdown and alarm, as shown.

D. PROTECTION AND ANNUNCIATION:

1. Overcurrent Protection: Electronic current limit at 150 percent of motor-nameplate current and provide motor-running overcurrent protection in compliance with NFPA 70.

2. Short Circuit Protection: Protected against load faults: bolted faults, phase-to-phase or phase-to-ground shall not damage the unit. Fault protection based on a power source short circuit capacity of 42,000 amperes RMS symmetrical at the AFD power input terminals, with impedance or current limiting device provided.

3. Line Voltage: Protected against high- and low-line voltage on one or more phases.

4. Internal Faults: Internal fault monitoring system to detect malfunctions to protect from transient and sustained faults and to limit damage that may be caused.

5. Motor Over Temperature: Interface to motor over-temperature device 2-ampere output contact to shut down and alarm if the motor becomes overheated.

6. Fault Alarm: Indicates the cause of any shutdown visible on the AFD keypad/display without opening the AFD enclosure. As a minimum, the following faults shall be alarmed:

   a. Motor over-temperature.

   b. Motor over-current.

   c. Incoming power line over/under/unbalanced-voltage.

   d. AFD over-temperature.

   e. AFD over-voltage.

f. AFD control failure.

6. Process Alarms: The AFD shall include the following additional shutdown alarms:

   a. Motor over-temperature.
   b. High gas temperature.

8. Safety Features: The AFD shall include:

   a. Padlock main disconnect handle in the "OFF" position.

   b. Mechanical interlock to prevent opening enclosure door with disconnect in the "ON" position while the unit door is open.

   c. Auxiliary contact on main disconnect to isolate 120-Vac control power when fed from external source.

   d. Barriers and warning signs on terminals that are energized with the power disconnect "OFF".

   e. Separation and insulated barriers between the power and control and instrument products.

   f. External emergency stop input

8. Reverse Direction Protection: Provide protection from inadvertent operation in reverse where reverse rotation can damage the driven equipment.

9. Critical Speed Bypass: Provide capability to program speed bypass for minimum two critical speed points.

9. Transient Voltage Protection: Provide solid-state, transient-voltage protection to meet or exceed ANSI C37.90.

2.04 CONTROL AND MONITORING DEVICES

A. OPERATOR INTERFACE UNIT:

1. Digital keypad/display for monitoring and controlling the drive and to input drive parameter settings with a backlit LCD or equally visible display with a minimum of 16 characters per line.

2. Digital keypad for numerical settings in English engineering units and a guide to parameter settings. Setup operations and adjustments stored in non-volatile EEPROM memory transferable to new and spare boards. Settings shall be

protected from unauthorized tampering, revision, or adjustment by a personal lockout code.

3. The digital keypad to provide programming of the drive and include:

   a. Up and Down arrow keys: Increase or decrease output frequency or data values.

   b. Monitor key: Selection of control mode.

   c. Run and Stop keys: Starting and stopping in the manual mode.

   d. Fault clear/Enter keys: Reset fault conditions and enter change

   e. Program key: Enter the program mode and adjust parameters.

   f. Remote/Local location keys: Operation location and local speed control.

   g. Auto/Manual mode keys: Program mode.

   h. Number keys: 0 through 9 keys to access specific parameters.

   i. Keypad digital illustrations: English and display the last 5 faults.

   j. Frequency/Motor Speed Indication: Calibrated in Hertz and RPM.

   k. Run Status Indication.

   l. Ready Status Indication.

   m. Fault Alarm Indication.

C. CONTROL AND MONITORING COMMUNICATION

1. Analog 4-20mA output proportional to motor speed.
2. Analog 4-20mA input proportional to motor speed set point.
3. Ethernet IP communications card.

2.05 KEYPAD FUNCTIONS AND OPERATION

A. Adjustment of the following parameters through the OIU digital keypad:

1. Current limit and torque boost.

2. Maximum voltage level.

3. Minimum/Maximum speed, Volts/Hertz, Upper and Lower limit.

4. Adjustable acceleration rate and deceleration rate.

5. Electronic thermal overload setting.

6. Coast, controlled ramp or DC injection selectable modes of stopping.

7. PID setpoint and time-function selection.

8. Critical frequency avoidance: Three setpoints selectable from 0 to maximum frequency with setpoints adjustable from 0-30 Hertz.

2.05 SPARE PARTS

The following spare parts shall be supplied with each type or frame size AFD:

A. Three sets of all replaceable fuses.
B. Copy of VFD setup parameters on USB flash drive.

2.06 PRODUCT DATA

The following information shall be provided in accordance with Section 01300:

A. Operation and maintenance information as specified in Section 01730, including:

1. Final reviewed submittal.
2. As-built drive configuration settings.

B. Installation certification Form 11000-A as specified in paragraph 11069-3.01.

C. Training certification Form 11000-B as specified in paragraph 11069-3.03.

PART 3--EXECUTION

3.01 FIELD INSTALLATION

Each adjustable-speed controller shall be installed and tested by the Contractor with the assistance of factory-trained pump manufacturer engineer/technician and AFD engineer/technician in accordance with the manufacturer's specifications and Section 11069, and witnessed by the Construction Manager.

Manufacturers' factory representatives shall provide field testing for devices, including the setup of the OIU and the setup of the data communication devices, where used. Upon satisfactory

completion of the testing, the Contractor shall submit two certified copies of the test report to the Construction Manager.

Component failure during testing will require repeating any test associated with the failure or modified components to demonstrate proper operation.

The installation shall be certified on Form 11000-A specified in Section 01999.

1. Adjust drive and perform "start-up" tests as recommended by manufacturer. Set parameters and carrier frequency for existing motors to avoid insulation damage.

2. Establish proper direction of rotation for the motor controlled by the drive. Verify that the AFD is precluded from operating in a direction that can damage the driven equipment. Change motor or AFD power lead connection and not the AFD direction, where rotation is incorrect.

3. Verify that the drive will operate properly both in the "manual speed control mode" and in the "remote or automatic mode" from a remote speed signal input.

4. Set the maximum "locked rotor" current drawn during start-up recommended by the manufacturer and approved by the Construction Manager.

5. Set the minimum and maximum speeds and the acceleration and deceleration "ramps" recommended by the Construction Manager. Configure minimum speed for both Local and Remote operations per Paragraph 1.01 C to prevent under-speed operation.

6. Verify the motor high-temperature switch contacts are wired into the AFD 120-Vac control circuit and will trip on high-winding temperature. Test or simulated the alarm and trip feature at the motor for high temperature and for high vibration, where used.

7. Operate the drive at 100 percent speed for one hour and monitor output current. The output current shall remain below the full load current listed on the motor nameplate.

8. Check for excessive heating of the drive and motor. Report any discrepancies to the Construction Manager.

3.02 HARMONIC TESTING

The Testing Firm specified in Section 16030 shall perform a harmonics acceptant test with all AFD motor controllers operating to verify compliance with IEEE-519 of less than 5 percent voltage THD and 12 percent current THD at the defined point of common connection when running from power utility power source with a BMI-Dranetz or equal harmonic test set that provides a hard-copy record of the test results.

The test shall also be run with power sourced from the standby generator where such a power source is being used at the project site. THD shall be limited to a maximum level of 8 percent voltage THD on standby generator operation.

Submit the test performance to the Construction Manager and Plant Manager per latest version NETA ATS Acceptance Testing Specifications. Refer to the electrical testing specification Section 16030.

3.03 TRAINING

A. Two hours of onsite AFD operation and maintenance training shall be provided for the Owner's Operation and Maintenance Staff.

B. Two hours of on-site advanced AFD operation-and-maintenance training shall be provided for the Owner's Operation and Maintenance Staff Administration /Managers.

C. Manufacturers' factory representative shall conduct the training, upon acceptance of a resume submitted by the trainer.

D. Training shall be certified on Form 11000-B specified in Section 01999.

END OF SECTION

SECTION 11466

DIGESTER GAS BOOSTER BLOWER

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies a digester gas booster blower, complete with an electric motor and all specified appurtenances. Blower and motor shall be installed indoors and mounted on a common baseplate.

B. TYPE:

The gas blower specified in this section may be met with either:

1. A hermetically sealed, centrifugal gas blower with low-flow bypass piping and control valve.

2. A hermetically sealed, regenerative turbine blower with magnetic drive and variable frequency drive (VFD) for capacity control. VFD specified in 11069.

C. EQUIPMENT LIST:

Equipment furnished under this section as follows

Item	Equipment Number
Digester Gas Booster Blower	BL-8770

D. DEFINITIONS:

1. Raw Digester Gas: A water-saturated mixture of several constituents including methane, carbon dioxide, nitrogen, sulfides, siloxanes, and water in vapor phase, produced by the anaerobic digestion of municipal wastewater sludge. The raw digester gas is expected to contain small amounts of fine particulate matter and approximately 7.7 percent water vapor, by volume. The dry digester gas, as determined by laboratory analysis, has the following properties:

Parameter, by volume	Units	Design Value	Range
Methane[1]	Percent	62.0	56 to 68
Carbon Dioxide[1]	Percent	35.5	35 to 44
Nitrogen[1]	Percent	2.0	0 to 2

Oxygen[1]	Percent	0.5	0 to 1
Sulfides[2]	ppm_v	1,750	1,500 to 2,000
Siloxanes[3]	ppm_v	8	6 to 10

[1] Methane, carbon dioxide, nitrogen, and oxygen values represent percent by volume as a dry gas.
[2] Sulfides are expected to comprise 90 percent or more hydrogen sulfide.
[3] Siloxanes: Volatile silicon based compounds including hexamethyldisiloxane (L2), octamethylcyclotetrasiloxane (D4), and decamethylcyclopentasiloxane (D5).

2. Treated Digester Gas: Raw digester gas will be treated upstream of the gas blower to reduce sulfides to approximately 50 ppm_v.

1.02 SYSTEM DESIGN AND PERFORMANCE

A. GENERAL:

Size and select the blower to accommodate the digester gas flows and inlet pressures specified.

B. OPERATING CONDITIONS:

Depending on ambient conditions, digester gas temperature at the blower inlet could vary from 40 to 100 degrees Fahrenheit. Operating requirements for the centrifugal blower to be installed at a site elevation of approximately 6,750 feet above mean sea level shall be as follows:

Item	Value
1. Inlet gas temperature, maximum, degrees Fahrenheit	90
2. Gas flow, maximum, scfm	90
3. Gas flow, minimum, scfm	50
4. Inlet gas pressure, design, psia	11.34
5. Discharge gas pressure, design, psia	15.34
6. Discharge temperature, maximum, degrees Fahrenheit	245
7. Motor horsepower, maximum, HP	15
8. Motor speed, maximum, rpm	3,600

C. ELECTRIC MOTORS:

The blower's electric motor shall be designed for hermetically-sealed duty. The motor shall be sized to be non-overloading with the blower operating over the specified conditions. The motor shall be de-rated for the environmental conditions as specified in Section 1.02B.

1.03 QUALITY ASSURANCE

A. REFERENCES:

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

case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether or not the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI H35.1	Alloy and Temper Designation Systems for Aluminum
ASTM A36	Carbon Structural Steel
ASTM A276	Stainless Steel Bars and Shapes
NFPA 70	National Electrical Code (NEC)

B. UNIT RESPONSIBILITY:

The Contractor shall assign unit responsibility to the manufacturer of the blower provided under this section. This manufacturer is the unit responsibility manufacturer and has unit responsibility for both the equipment assembly specified in this section, the control panel, the VFD (applicable for the regenerative turbine blower option), and all other equipment assembly components specified elsewhere but referenced in this section. A completed, signed, and notarized Certificate of Unit Responsibility shall be provided.

C. FACTORY TESTING:

Blower shall be factory-tested and certified to meet the design operating requirements.

1.04 SUBMITTALS

The following information shall be provided:

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in

the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

2. Manufacturer's type designation and catalog data confirming rated capacity, horsepower, efficiency, electrical requirements, dimensions, weight, construction, and installation details.

3. Predicted performance curves for the specified operating requirements showing pressure-capacity, power-capacity, and efficiency-capacity curves and surge points. Capacity shown in inlet cfm. All performance parameters are to reflect site conditions. Sample inlet/standard cfm conversion calculations shall also be provided.

4. Drawing and catalog information detailing all control devices in the control cabinets as well as overall panel layout interconnection diagrams and construction.

5. Any exceptions to these specifications along with justification for each exception.

6. Motor data.

7. Details and catalog data for all accessories.

8. Manufacturer's catalog information confirming interface requirements between programmable logic controller (PLC) and the plant computer system.

10. A copy of the Contract Document control diagrams and process and instrumentation diagrams relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked *"no changes required"*. Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.

11. Complete control system schematic diagrams and wiring diagrams, list of instrumentation and control devices, and description of operations for the control system. Specific circuit details and descriptions of the interface circuits and devices between the blower controls and the separate blower starter and the Plant Control System shall be provided.

1.05 ENVIRONMENTAL CONDITIONS

All equipment specified in this section will be located indoors at a wastewater treatment plant at a site elevation of approximately 6,750 feet above mean sea level. The area within 5 feet of the gas blower is considered hazardous in accordance with NFPA 820 Class I, Division 1, Group D. The area beyond 5 feet and within 10 feet is considered hazardous in accordance with NFPA 820 Class I, Division 2, Group D.

1.06 WARRANTY

Provide a two year 100 percent parts and labor warranty against manufacturing defects or failure of the equipment specified in this section caused by normal wear and tear shall be provided. The warranty period shall start from the date of final acceptance of the cogeneration facility.

PART 2--PRODUCTS

2.01 MANUFACTURERS

The Owner and Engineer believe the following candidate manufacturers are capable of providing equipment and/or products that will satisfy the requirements of this section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's product, nor shall it be construed that a named manufacturer's standard product will comply with the requirements of this section. Candidate centrifugal blower manufacturers include Spencer Turbine. Candidate regenerative turbine blower manufacturers include Airtech.

2.02 MATERIALS

Blower Option	Component	Material
Centrifugal type	Casing and heads	Stainless steel, type 304 or 304L
	Impeller	Cast aluminum, ANSI H35.l, Type 443
	Shaft	Carbon steel, integral with the motor
	Baseplate	Structural steel, ASTM A36, galvanized
Regenerative type	Casing and heads	Cast aluminum, ANSI H35.1, Type 443
	Impeller	Cast aluminum, ANSI H35.1, Type 443
	Shaft	Stainless steel, Type AISI 316
	Baseplate	Structural steel, ASTM A36, galvanized

Note: Unless otherwise specified, all aluminum, carbon steel or ductile iron blower components, including the base, shall be coated with Heresite P-403L, Chem-Tough, ceramic or equivalent heavy-duty coating for corrosion protection. Heresite or other heavy-duty coating shall be applied by a licensed representative of the coating manufacturer.

2.03 EQUIPMENT

A. CENTRIFUGAL BLOWER OPTION:

1. Type: The blower shall be of the direct-drive, hermetically-sealed, multistage centrifugal type, designed to deliver digester gas at any volume within the specified operating range of the blower, at the temperature specified, with a relatively constant pressure and without encountering any surge characteristics. The centrifugal blower shall be hermetically sealed for completely gas-tight operation with zero gas leakage.

2. Casing: Casing shall be cast aluminum. Sheet metal casings are not acceptable. Internal coating thickness shall be 3 to 6 mils. Process connections shall be ANSI flanged connections. The lowest part of the blower casing shall include a 1/2-inch NPT stainless steel drain connection with isolation valve.

3. Impeller: Aluminum impeller shall be keyed and locked to the shaft in a suitable manner. Ample clearance shall be provided between the impeller and all stationary blower parts. Impeller coating thickness shall be 3 to 6 mils.

4. Shaft and Bearings: The motor shall have an extended shaft supported by two oversized, grease-lubricated thrust and radial bearings designed for all loads imposed by the specified service and rated for Class M3 (50,000 hour) bearing life. The shaft shall be coated for corrosion resistance to the digester gas.

5. Common Steel Baseplate: Factory mount blower and motor, coupled together, on a common base, properly braced to form a rigid support for the entire unit. Steel base shall be hot-dip galvanized.

6. Motor: The electric motor shall be 460-Volt, 3-phase, 60-Hz and shall be designed for hermetically-sealed duty. The motor shall be sized to be non-overloading with the blower operating over the conditions specified. The motor shall be installed with a motor enclosure-high temperature switch that shall be provided with an enclosure suitable for installation in a Class I, Division 1, Group D area in accordance with NFPA 820.

B. REGENERATIVE TURBINE BLOWER OPTION:

1. Type: The blower shall be of the regenerative type with a magnetic electric motor designed to deliver oil-free digester gas at any volume within the capacity range of the blower, with a relatively constant pressure down to a minimum 20 percent flow. The blower shall be of non-sparking design. A VFD shall be provided to modulate digester gas flow, sized and selected for the intended service. The regenerative turbine blower shall be hermetically sealed for completely gas-tight operation with zero gas leakage.

2. Casing: Casing shall be cast aluminum. Sheet metal casings are not acceptable. Internal coating thickness shall be 3 to 6 mils. Process connections shall be ANSI flanged connections. The lowest part of the blower casing shall include a 1/2-inch NPT stainless steel drain connection with isolation valve.

3. Impeller: Aluminum impeller shall be keyed and locked to the shaft in a suitable manner. Ample clearance shall be provided between the impeller and all stationary blower parts. Impeller coating thickness shall be 3 to 6 mils.

4. Shaft and Bearings: Shaft shall have sufficient diameter to operate at no greater than 80 percent of its first critical speed and shall be made of ground and polished high-grade stainless steel. Shaft shall be machined to accurate dimensions and all corners at change of diameter shall have ample fillets. Bearings shall be grease-lubricated, anti-friction type sized for an L 10 bearing life of 100,000 hours. Bearings shall be replaceable without disconnecting any piping.

5. Common Steel Base: Factory mount blower and motor, coupled together, on a common base, properly braced to form a rigid support for the entire unit. Steel base shall be hot-dip galvanized.

6. Motor: The electric motor shall be 460-Volt, 3-phase, 60-Hz, inverter duty, with a VFD drive and shall be designed for hermetically-sealed duty. The motor shall be sized to be non-overloading with the blower operating over the conditions specified. The motor shall be installed with a motor enclosure high- temperature switch that shall be provided with an enclosure suitable for installation in a Class I, Division 1, Group D area in accordance with NFPA 820.

7. VFD: A VFD shall be provided with the blower to modulate the flow of digester gas based on an external low-pressure digester gas signal, as required to maintain constant discharge pressure from the system. The VFD shall be selected for the conditions and duty required here. The VFD shall be free-standing and located in the Digester Control/Thickening Building.

C. CONTROLS:

The logic and controllers shall interface with the plant computer system via hardwired dry contacts connected by others. The blower controls at the VFD or in the MCC, depending on the option chosen as listed in section 2.03A and 2.03B within, shall provide the following interface signals for communication with the SCADA Panel:

1. RUN ENABLE (dry contact output from SCADA).
2. RUNNING (dry contact input from blower control panel to SCADA).
3. BLOWER READY (dry contact output to SCADA).
4. BLOWER FAIL (dry contact output to SCADA).

5. HIGH MOTOR TEMPERATURE (dry contact output to SCADA).
6. HIGH GAS TEMPERATURE.

The blower controls shall be provided with a RESET pushbutton accessible from the front of the panel and required for clearing all shutdown functions. The blower controls shall provide the following front-of-panel indicating lights with shutdown functions where shown:

1. Control Power On.
2. System Fail.
3. High motor temperature (shutdown).
4. High gas temperature (shutdown).

A HAND/OFF/AUTO selector switch shall be provided. In the AUTO position, the equipment shall be controlled from a remote location. The equipment shall run in the HAND position. Under no condition shall the safety interlocks specified herein be bypassed.

2.04 ACCESSORIES

The blower shall be provided with the following:

1. Inlet and discharge piping and valves shall be as specified for sludge gas piping.

2. The lowest parts of the blower casing shall include stainless steel drain connections for the removal of gas condensate. Drain connections shall be piped together to allow condensate to flow to a single stainless steel, electrically actuated drip trap.

    a. Pressure Gauges: Two dial-type 4 1/2-inch stainless steel pressure gauges shall be provided with the blower unit. One pressure gauge shall be located on the blower inlet piping. One pressure gauge shall be located on the blower discharge piping. Pressure gauges shall have a scale of -15 inches WC vacuum to 15 inches WC pressure on the suction side, and 0 to 10 psig on the discharge side.

    b. Pressure Transmitter (PIT 8740): Provide a pressure transmitter and isolation valve on the lower pressure digester gas manifold.

    c. Temperature Transmitter or RTD (TE/TT 8770): Provide a temperature element and transmitter or RTD at the discharge of the blower.

    d. Temperature Gauges: A temperature gauge with a range of 20 to 250 degrees Fahrenheit shall be provided downstream of the blower in the digester gas piping to monitor the blower discharge temperature.

    e. Start-up/Recirculation Valve (Centrifugal Blower Option): A reduced-size bypass piping arrangement with ball valve shall be provided. The start-up piping shall be sized at 1-inch diameter and originate downstream of the digester gas heat exchanger and return to the blower suction. The start-up valve shall be a manually actuated

ball valve. Valve type and materials of construction shall be as indicated on the Contract Drawings.

f. Pressure Relief/Recirculation Valve (Regenerative Blower Option): A reduced-size bypass piping arrangement with pressure-relief valve shall be provided. The start-up piping shall be sized at 1-inch diameter and originate downstream of the digester gas heat exchanger. The pressure relief shall be piped to the blower suction.

g. Spare Parts: Supply the manufacturer's standard spare parts for the blower, including, but not limited to:

   i. Two sets, all bearings and packing.
   ii. One total shaft seal assembly.
   iii. Two sets of all gaskets.
   iv. Any special maintenance tools.

2.05 INSTRUMENTS AND CONTROL DEVICES

A. PROTECTIVE DEVICES:

A motor enclosure high-temperature sensor shall be provided suitable for installation in a Class I, Division 1, Group D area in accordance with NFPA 820.

B. WIRING:

Raceway wiring, instruments, and the terminal box shall comply with NFPA 820 requirements for a Class I, Division 1, Group D hazardous area.

2.06 PRODUCT DATA

The following product data shall be provided:

1. Certification of satisfactory testing.

2. Applicable operating and maintenance information.

3. Equipment control device product data.

4. Certification of proper installation.

5. Complete control system schematic diagrams and wiring diagrams, list of instrumentation and control devices, and description of operations for the control system. Provide specific circuit details and descriptions of the interface circuits and devices between the blower controls and the separate blower starter and the Plant Control System.

6. Certification of training.

7. Spare parts listing.

2.07 SPARE PARTS

Provide a total of one pig tail, one set of gaskets, and one motor.

PART 3--EXECUTION

3.01 INSTALLATION

All equipment shall be aligned, connected, and installed at the locations specified and in accordance with the manufacturer's recommendation. The installation and initial operation of all components shall be certified as specified. Field-insulate the blower housing and hot-discharge piping for personnel protection.

3.02 FIELD TESTING

After completion of installation, the blower shall be completely field-tested with digester gas to demonstrate compliance with the performance requirements as specified. Inspection, testing, and certification shall be provided, and testing procedures and forms shall be submitted and used.

Testing procedures shall duplicate as nearly as possible the conditions of operation and shall be selected to demonstrate that the equipment is operational and free from damage. Each control device, item or mechanical, electrical, and instrumentation equipment, and control circuits shall be considered in the testing procedures to demonstrate that the equipment has been properly serviced, aligned, connected, calibrated, and adjusted prior to operation.

3.03 TRAINING

During the commissioning period, a factory-trained representative of the manufacturer shall conduct training for the Owner's staff. A minimum of 4 hours of training shall be provided. Maintenance manuals shall be provided to the Owner a minimum of one week prior to staff training.

Training sessions shall be scheduled with the Owner to be at a time starting after successful commissioning and not to exceed 4 months after final acceptance of the equipment specified in this section.

END OF SECTION

SECTION 13578

HYDROGEN SULFIDE REMOVAL SYSTEM FOR DIGESTER GAS

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies a modular prefabricated vessel with granular iron oxide media to remove hydrogen sulfide and sulfide mercaptans from low-pressure municipal wastewater digester gas.

B. TYPE:

The granular media shall be impregnated with hydrated iron oxide and shall be non-binding. Iron sponge and clay-based media are not acceptable. The granular iron oxide media shall be specifically manufactured to chemically remove hydrogen sulfide and other vapor-phase malodorous compounds of the type typically found in anaerobic digester gas.

C. EQUIPMENT LIST:

Item	Equipment Number
Hydrogen Sulfide Removal Vessel	T - 8750

D. DEFINITIONS:

Raw Digester Gas: A water-saturated mixture of several constituents, including methane, carbon dioxide, nitrogen, sulfides, siloxanes, and water in vapor phase, produced by the anaerobic digestion of municipal wastewater sludge. The raw digester gas is expected to contain small amounts of fine particulate matter and 7.7 percent water vapor by volume. The dry digester gas, as determined by laboratory analysis, has the following properties:

Parameter	**Units**	**Value**	**Range**
Methane[1]	Percent	62.0	56 to 68
Carbon Dioxide[1]	Percent	35.5	35 to 44
Nitrogen[1]	Percent	2.0	0 to 2
Oxygen[1]	Percent	0.5	0 to 1
Sulfides[2]	ppm_v	1,750	1,500 to 2,000
Siloxanes[3]	ppm_v	8	6 to 10

[1] Methane, carbon dioxide, nitrogen, and oxygen values represent percent by volume as a dry gas.

[2] Sulfides are expected to comprise 90 percent or more hydrogen sulfide.

[3] Siloxanes: Volatile silicon based compounds including hexamethyldisiloxane (L2), octamethylcyclotetrasiloxane (D4), and decamethylcyclopentasiloxane (D5).

1.02 SYSTEM AND PERFORMANCE

A. GENERAL:

The hydrogen sulfide removal vessel shall be specifically designed and selected for continuous exposure to moist digester gas generated from the anaerobic digestion of municipal wastewater sludge. As produced, digester gas is water-saturated.

B. OPERATING/PERFORMANCE:

1.	Gas flow, cubic feet per minute, maximum	100
2.	Gas temperature, maximum, degrees F	100
3.	Gas temperature, minimum, degrees F	70
4.	Inlet hydrogen sulfide concentration, ppm, design	2,000
5.	Outlet hydrogen sulfide concentration, ppm, maximum	50
6.	Media bed life, days, minimum	275

C. DESIGN FEATURES:

1.	Inlet/outlet nominal gas pipe size, inches	8
2.	Pressure drop at rated flow, inches W.C., maximum	5
3.	Operating pressure, psia	11.6
4.	Number of vessels	1
5.	Vessel diameter, feet, maximum	8

The hydrogen sulfide removal system shall not require nor include an air blower for increasing the oxygen content of the raw digester gas.

1.03 QUALITY ASSURANCE

A. SUPPLIER QUALIFICATIONS:

The hydrogen sulfide removal system supplier shall have a minimum of 5 years of experience in supplying equipment designed specifically for the removal of hydrogen sulfide from biogas. The equipment supplier shall also provide a list of 5 references, with full contact information, of biogas purification installations using granular iron oxide media.

1.04 SUBMITTALS

The following information shall be provided:

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a

whole. If deviations from the specifications are indicated, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

2. Any exceptions to these specifications along with justification for each exception.

3. Drawings showing internal configurations of media bed and support system for bed.

4. Predicted performance curves showing pressure drop through bed at the flow rate specified.

5. Material safety data sheet (MSDS) for the iron oxide laden media.

6. Schedule of material used for all components.

7. Anchor bolt design calculations and details.

8. Manufacturer's type designation and catalog data and drawings confirming requirements for the regeneration air compressor.

9. Complete media replacement instructions, from vessel lid removal through safe media disposal.

10. Detailed description of the procedures for installation, commissioning, and handling of the hydrogen sulfide removal system.

11. Welded joint quality assurance (for stainless steel vessel option).

12. A copy of the contract document control diagrams and process and instrumentation diagrams that apply to the equipment in this section marked to show specific changes necessary for the supplied equipment. If no changes are required, the drawing shall be marked "No Changes Required."

13. Complete fiberglass grating materials, support details, and temperature rating.

14. Manufacturer's catalog and/or other data confirming conformance to specified design, material and equipment requirements.

15. Predicted performance data as applicable developed for the specific site conditions and design application, confirming conformance to specified design and operating requirements and characteristics.

16. Installation requirements, showing clearance required for maintenance purposes.

17. List of at least two alternative granular iron oxide suppliers and full contact information.

1.05 ENVIRONMENTAL CONDITIONS

Equipment will be located outdoors and exposed to direct sunlight and freezing at a wastewater treatment plant at an elevation of approximately 6,750 feet above sea level with a nominal barometric pressure of 11.3 psia. Equipment will be exposed to direct sunlight. Ambient air temperatures at the site range from minus 10 to 90 degrees Fahrenheit.

1.06 WARRANTY

Provide a complete written 1-year warranty for the complete hydrogen sulfide system, including vessel and all appurtenances.

PART 2--PRODUCTS

2.01 MANUFACTURERS

The Owner and Engineer believe the following candidate manufacturers are capable of providing equipment and/or products that will satisfy the requirements of this section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's product, nor shall it be construed that a named manufacturer's standard product will comply with the requirements of this section. Candidate manufacturers include MV Technologies and Unison Solutions.

2.02 MATERIALS

Component	Material
Media	Granular iron oxide
Vessel	FRP or 316L stainless steel
Gasket material	Neoprene
Media support grating	FRP
Vessel base support (for elevated vessel)	304 Stainless steel
Anchor bolts, fasteners, misc. supports	304 Stainless steel

2.03 EQUIPMENT

A. VESSEL:

The hydrogen sulfide removal system shall consist of a pre-insulated FRP vessel or a 316L stainless steel vessel to be field insulated. Vessel shall be equipped with 36-inch top and 24-inch side manways. The vessel shall be equipped with a removable cover and quick access bolt-type closing ring with a neoprene gasket. Provisions shall be included to adequately ground the vessel.

If a stainless steel vessel is provided, it shall be insulated and clad with aluminum.

B. CONNECTIONS:

1. The vessel shall be provided with ANSI Class 150 flanged inlet and outlet fittings for connection to digester gas piping.

2. A drain connection shall be provided at the base of the vessel.

3. A valved water fill connection, with quick-connection type fitting, shall be provided at the base of the vessel.

4. The vessel shall have a gas sample ports with ball valve and internal tubing located for convenient access and use on the inlet and outlet gas piping.

C. VESSEL BASE SUPPORT:

If an FRP vessel is supplied, it shall be anchored directly to the concrete equipment pad.

If a stainless steel vessel is supplied, the manufacturer shall provide a structural support system for the vessel. The vessel base shall support the weight of the vessel when filled with media and water, and appurtenances, and shall restrain the vessel from horizontal motion.

2.04 ACCESSORIES

The following accessories shall be provided as part of the hydrogen sulfide removal system:

1. Pressure gauges for monitoring digester gas pressures upstream and downstream of the hydrogen sulfide removal vessel.

2. Lifting lugs on the vessel cover, if removable cover is provided.

4. All other necessary appurtenances included with the manufacturer's standard design (e.g., P-trap drain piping, etc.).

2.05 PRODUCT DATA

The following product data shall be provided:

1. Operations and maintenance manuals.

2. Detailed description of the procedures for installation, commissioning, and handling of the hydrogen sulfide removal system.

3. Media fill, removal, and disposal instructions.

4. Anchor bolt design calculations and details.

2.06 SPARE PARTS

A full extra charge of replacement media shall be provided in a sealed leak-proof container with appropriate storage guidelines and MSDS.

Provide two complete sets of all gaskets or seals.

PART 3--EXECUTION

3.01 INSTALLATION

Unit shall be installed in strict accordance with the manufacturer's recommendations. A manufacturer's trained representative shall be present at the job site for 2 working days for assistance in training, safety troubleshooting, and start-up of the hydrogen sulfide removal system.

The equipment manufacturer shall provide the initial charge of granular iron oxide media for the unit. Media shall be shipped in sealed water-proof and leak-proof Super Sack or similar type bags. Granular iron oxide media shall be distributed uniformly within the vessel as recommended by the media manufacturer.

3.02 FIELD TESTING

After completion of the installation, the unit shall be subjected to testing to demonstrate compliance with the specified performance requirements.

3.03 TRAINING

During the commissioning period, a factory-trained representative of the manufacturer shall conduct training for the Owner's staff. A minimum of 4 hours of training shall be provided. Maintenance manuals shall be provided to the Owner a minimum of one week prior to staff training.

Training sessions shall be scheduled by the Owner at a time starting after successful commissioning and not to exceed four months after final acceptance of the equipment specified in this section.

3.05 MEDIA REPLACEMENT

The equipment supplier shall return to the jobsite and perform the first media replacement once the media has become exhausted and can no longer meet the specified performance criteria. The equipment supplier shall provide instruction for plant personnel during the media replacement process.

END OF SECTION

SECTION 15096

PIPE HANGERS AND SUPPORTS

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies hangers and supports for all piping systems shown on the drawings. This section does not include pipe supports for fire sprinkler systems, pipe anchors, guides or seismic restraints.

B. OPERATING CONDITIONS:

The hangers and supports specified in this section are provided to resist pipe loads occurring primarily in the downward (gravity) direction. For the purpose of pipe hanger and support selection, this section establishes pipe support classifications based on the operating temperatures of the piping contents. Pipe support classifications are as follows:

1. Hot Systems

   A - 1. 120 degrees F to 450 degrees F
   A - 2. 451 degrees F to 750 degrees F
   A - 3. Over 750 degrees F

2. Ambient Systems

   B. 60 degrees F to 119 degrees F

3. Cold Systems

   C - 1. 33 degrees F to 59 degrees F
   C - 2. -20 degrees F to 32 degrees F

C. HANGER AND SUPPORT SELECTION:

The Contractor shall select pipe hangers and supports as specified in the contract documents. Selections shall be based upon the pipe support classifications specified in this section, the piping insulation thickness, and any special requirements which may be specified in the contract documents.

The Contractor shall review the piping layout in relation to the surrounding structure and adjacent piping and equipment before selecting the type of support to be used at each hanger point.

Hangers and supports shall withstand all static and specified dynamic conditions of loading to which the piping and associated equipment may be subjected. As a minimum, consideration shall be given to the following conditions:

1. Weights of pipe, valves, fittings, insulating materials, suspended hanger components, and normal fluid contents.

2. Weight of hydrostatic test fluid or cleaning fluid if normal operating fluid contents are lighter.

3. Reaction forces due to the operation of safety or relief valves.

4. Wind, snow or ice loadings on outdoor piping.

Hangers and supports shall be sized to fit the outside diameter of pipe, tubing, or, where specified, the outside diameter of insulation.

Where negligible movement occurs at hanger locations, rod hangers shall be used for suspended lines, wherever practical. For piping supported from below, bases, brackets or structural cross members shall be used.

Hangers for the suspension of size 2 1/2 inches and larger pipe and tubing shall be capable of vertical hanger component adjustment under load.

The supporting systems shall provide for and control the free or intended movement of the piping including its movement in relation to that of connected equipment.

Where there is horizontal movement at a suspended type hanger location, hanger components shall be selected to allow for swing. The vertical angle of the hanger rod shall not, at any time, exceed 4 degrees.

There shall be no contact between a pipe and hanger or support component of dissimilar metals. Prevent contact between dissimilar metals when supporting copper tubing by use of copper-plated, rubber, plastic or vinyl coated, or stainless steel hanger and support components.

Unless otherwise specified, existing pipes and supports shall not be used to support new piping.

Unless otherwise specified, pipe support components shall not be attached to pressure vessels.

Stock hanger and support components shall be used wherever practical.

1.02 REFERENCES

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

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

Reference	Title
AISC Manual of Steel Construction	American Institute of Steel Construction, Manual of Steel Construction, Allowable Stress Design - 9th Ed.
FEDSPEC WW-H-171e-78	Hangers and Supports, Pipe
MFMA-2-91	Metal Framing Standards Publication
MSS SP-69-91	Pipe Hangers and Supports - Selection and Application
MSS SP-58-93	Pipe Hangers and Supports - Materials, Design and Manufacture

PART 2--PRODUCTS

2.01 ACCEPTABLE PRODUCTS

Standard pipe supports and components shall be manufactured by B-Line, Carpenter & Patterson, Kin-Line, Grinnell, Michigan, Pipe Shields Incorporated, Superstrut, Unistrut, or equal. Pipe support components shall conform to the requirements of MSS SP-69 and FEDSPEC WW-H-171e. Pipe support materials shall conform to the requirements of MSS SP-58. Metal framing system components shall conform to the metal framing manufacturers' Association Standard MFMA-2.

2.02 MATERIALS

A. GENERAL:

Unless otherwise specified, pipe hangers and supports, structural attachments, fittings and accessories shall be hot-dip or mechanically galvanized after fabrication. Nuts, bolts and washers

may be zinc-plated except for those subject to moisture or corrosive atmosphere, which shall be type 304 or 316 stainless steel. Pipe hangers and supports, structural attachments, fittings, bolt and accessories for in submerged conditions, subject to moisture or corrosive atmosphere or for stainless steel piping shall be type 304 or 316 stainless steel.

B. PIPE HANGERS AND SUPPORTS:

1. TYPE 1 - CLEVIS PIPE HANGER: Clevis hangers shall be carbon steel with configuration and components equivalent to MSS and FEDSPEC Type 1.

a. Steel pipe (insulated) - shall be B-Line B3100, Grinnell Fig. 260, or equal, with insulation shield.

b. Steel pipe (uninsulated) - shall be B-Line B3100, Grinnell Fig. 260, or equal.

c. Cast and ductile iron pipe - shall be B-Line B3102, Grinnell Fig. 590, or equal.

d. Copper pipe (uninsulated) - shall be B-Line B3104 CT, Grinnell Fig. CT-65, or equal.

e. Copper pipe (insulated) - shall be B-Line B3100, Grinnell Fig. 260, or equal, with insulation shield.

f. Plastic pipe - shall be B-Line B3100 C, Carpenter & Patterson Fig. 100PVC, or equal.

2. TYPE 2 - "J" PIPE HANGER: Hangers shall be carbon steel with configuration and components equivalent to MSS Type 5.

a. Steel pipe - shall be B-Line B3690, Grinnell Fig. 67, Michigan model 418, or equal.

b. Copper and plastic pipe - shall be Michigan model 419, Unistrut J 1205N series, or equal.

3. TYPE 3 - DOUBLE BOLT PIPE CLAMP: Pipe clamp shall be carbon steel, with configuration and components equivalent to MSS and FEDSPEC Type 3.

a. Steel pipe (insulated) - shall be B-Line B3144, Grinnell Fig. 295, or equal, with insulation shield. Insulation shield is optional for hot and ambient systems.

b. Steel pipe (uninsulated) - shall be B-Line B3144, Grinnell Fig. 295, or equal.

c. Copper pipe (insulated only) - shall be B-Line B3144, Grinnell Fig. 295, or equal, with insulation shield.

4. TYPE 4 - ADJUSTABLE ROLLER HANGER: Rollers shall be cast iron, yoke and cross bolt shall be carbon steel. Configuration and components shall be equivalent to MSS Type 43 and FEDSPEC Type 44.

a. Steel pipe (insulated) - shall be B-Line B3110, Grinnell Fig. 181, or equal, with insulation shield.

b. Steel pipe (uninsulated) - shall be B-Line B3110, Grinnell Fig. 181, or equal.

c. Copper pipe (insulated only) - shall be B-Line B3110, Grinnell Fig. 181, or equal, with insulation shield.

d. Plastic pipe - shall be B-Line B3110, Grinnell Fig. 181, or equal.

5. TYPE 5 - SINGLE PIPE ROLL: Rollers and sockets shall be cast iron, cross rod shall be steel. Configuration and components shall be equivalent to MSS Type 41 and FEDSPEC Type 42.

a. Steel pipe (insulated) - shall be B-Line B3114, Grinnell Fig. 171, or equal, with insulation shield.

b. Steel pipe (uninsulated) - shall be B-Line B3114, Grinnell Fig. 171, or equal.

c. Plastic pipe - shall be B-Line B3114, Grinnell Fig. 171, or equal.

6. TYPE 6 - FRAMING CHANNEL PIPE CLAMP: Pipe clamps shall be steel with galvanized finish and material thickness as listed below:

a. Steel pipe (uninsulated) - Pipe size 3/8 inch and 1/2 inch shall be 16 gage; 3/4 inch through 1 1/4 inches shall be 14 gage; 1 1/2 inches through 3 inches shall be 12 gage; 3 1/2 inches through 5 inches shall be 11 gage; 6 and 8 inches shall be 10 gage; Michigan model 431, Powerstrut PS 1100, Unistrut P 1109 series, or equal.

b. Steel pipe (insulated) - Pipe clamp shall be as described in paragraph 15096-2.02 B.6.a with insulation shield.

c. Copper (uninsulated) and plastic pipe - Pipe size 3/8 inch and 1 inch shall be 16 gage; 1-1/4 inches and 1-1/2 inches shall be 14 gage; 2 inches through 3 inches shall be 12 gage; 4 inches shall be 11 gage;

clamp shall be copper-plated, plastic coated or lined with dielectric material; Michigan model 432, Powerstrut PS 1200, Unistrut P 2024C and P 2024PC series, or equal.

d. Copper pipe (insulated) - Pipe clamp shall be as described in paragraph 15096-2.02 B.6.a with insulation shield.

7. TYPE 7 - U-BOLT: U-bolts shall be carbon steel with configuration equivalent to MSS and FEDSPEC Type 24.

a. Steel pipe (uninsulated) - shall be Grinnell Fig. 137, B-Line B3188, or equal.

b. Steel pipe (insulated) - shall be Grinnell Fig. 137, B-Line B3188, or equal, with insulation shield.

c. Cast and ductile iron pipe - shall be Grinnell Fig. 137, B-Line B3188, or equal.

d. Copper pipe (uninsulated) - shall be Carpenter & Patterson Fig. 222 CT, B-Line B3501 CT, Grinnell Fig. 137C, or equal.

e. Copper pipe (insulated) - shall be Grinnell Fig. 137, B-Line B3188, or equal, with insulation shield.

f. Plastic pipe - shall be Grinnell Fig. 137C, Michigan model 151, B-Line B3188 C, or equal.

8. TYPE 8 - ADJUSTABLE PIPE ROLL SUPPORT: Rollers and sockets shall be cast iron, cross rod and support rods shall be carbon steel.

a. Steel pipe (insulated) - shall be B-Line B3122, Grinnell Fig. 177, or equal, with insulation shield.

b. Steel pipe (uninsulated) - shall be B-Line B3122, Grinnell Fig. 177, or equal.

c. Copper pipe (insulated only) - shall be B-Line B3122, Grinnell Fig. 177, or equal, with insulation shield.

d. Plastic pipe - shall be B-Line B3122, Grinnell Fig. 177, or equal.

9. TYPE 9 - WELDED PIPE STANCHION: Minimum material thickness shall be standard schedule carbon steel pipe, cut to match contour of the pipe elbow. Use of this support shall be limited to ambient systems only.

10. TYPE 10 - PIPE STANCHION SADDLE: Saddles and yokes shall be carbon steel and comply with MSS Type 37 and FEDSPEC Type 38.

a. Steel pipe (insulated) - shall be Carpenter & Patterson Fig. 125, B-Line B3090, or equal, with insulation shield.

b. Steel pipe (uninsulated) - shall be Carpenter & Patterson Fig. 125, B-Line B3090, or equal.

c. Cast and ductile iron pipe - shall be Carpenter & Patterson Fig. 125, B-Line B3090 NS, or equal.

d. Copper pipe (uninsulated) - shall be Carpenter & Patterson Fig. 125, B-Line B3090, or equal, with insulation shield or lined with dielectric material.

e. Copper pipe (insulated) - shall be Carpenter & Patterson Fig. 125, B-Line B3090, or equal, with insulation shield.

f. Plastic pipe - shall be Carpenter & Patterson Fig. 125, B-Line B3090, or equal.

11. TYPE 11 - OFFSET PIPE CLAMP: Pipe clamp shall be carbon steel with configuration and components as specified and shall be of standard design manufactured by a pipe hanger component manufacturer.

a. Steel pipe (insulated) - shall be B-Line B3148, Grinnell Fig. 103, or equal, with insulation shield.

b. Steel pipe (uninsulated) - shall be B-Line B3148, Grinnell Fig. 103, or equal.

c. Cast and ductile iron pipe - shall be B-Line B3148 NS, Grinnell Fig. 103, or equal.

d. Copper pipe (insulated) - shall be B-Line B3148, Grinnell Fig. 103, or equal, with insulation shield.

e. Copper pipe (uninsulated) - shall be B-Line B3148, Grinnell Fig. 103, or equal, lined with dielectric material.

f. Plastic pipe - shall be B-Line B3148, Grinnell Fig. 103, or equal.

Vertical pipe support applications shall be as specified above except that insulation shields shall not be used for insulated pipe.

12. TYPE 12 - RISER CLAMP: Riser clamp shall be carbon steel with configuration and components equivalent to MSS and FEDSPEC Type 8.

a. Steel pipe (insulated) - shall be B-Line B3373, Grinnell Fig. 261, or equal.

b. Steel pipe (uninsulated) - shall be B-Line B3373, Grinnell Fig. 261, or equal.

c. Cast and ductile iron pipe - shall be B-Line B3373, Grinnell Fig. 261, or equal.

d. Copper pipe (insulated) - shall be B-Line B3373 CT, Grinnell Fig. CT-121, Michigan model 511, or equal.

e. Copper pipe (uninsulated) - shall be B-Line B3373 CT, Grinnell Fig. CT-121, Michigan model 511, or equal.

f. Plastic pipe - shall be B-Line B3373, Grinnell Fig. 261c, or equal.

13. TYPE 13 - FRAMING CHANNEL PIPE STRAP: Pipe strap shall be carbon steel, with configuration equivalent to MSS Type 26.

a. Steel pipe (uninsulated) - shall be Superstrut No. C-708-U, Powerstrut PS 3126, Kin-Line No. 477, or equal.

b. Steel pipe (insulated) - shall be Superstrut No. C-708-U, Powerstrut PS 3126, Kin-Line No. 477, or equal, with insulation shield.

c. Copper pipe (uninsulated) - shall be Superstrut No. C-708-U, Powerstrut PS 3126, Kin-Line No. 477, or equal, with insulation shield or lined with dielectric material.

d. Copper pipe (insulated) - shall be Superstrut No. C-708-U, Powerstrut PS 3126, Kin-Line No. 477, or equal, with insulation shield.

e. Plastic pipe - shall be Superstrut No. C-708-U, Powerstrut PS 3126, Kin-Line No. 477, or equal.

C. RACK AND TRAPEZE SUPPORTS:

1. GENERAL: Unless otherwise specified, trapeze and pipe rack components shall have a minimum steel thickness of 12 gage, with a maximum deflection 1/240 of the span.

2. TYPE 20 - TRAPEZE PIPE SUPPORT: Trapeze pipe support cross members shall be framing channel as specified in paragraph 15096-2.02 E.5. Flat plate fittings shall be 1 5/8-inch square carbon steel of standard design manufactured by framing channel manufacturer, Unistrut P2471, B-Line B202-2, or equal.

3. TYPE 21 - PIPE RACK SUPPORT: Post and cross members shall be framing channel as specified in paragraph 15096-2.02 E.5. Pipe rack fittings shall be carbon steel, of standard design manufactured by framing channel manufacturer. 90-degree fittings shall be gusseted Unistrut P2484, B-Line B844, or equal. Post base fittings shall be as specified in paragraph 15096-2.02 D.5.

D. STRUCTURAL ATTACHMENTS:

1. TYPE A - MALLEABLE IRON CONCRETE INSERT: Concrete inserts shall be malleable iron and comply with MSS and FEDSPEC Type 18. Grinnell Fig. 282, Carpenter & Patterson Fig. 108, or equal.

2. TYPE B - SIDE BEAM BRACKET: Bracket shall be malleable iron and comply with MSS Type 34 and FEDSPEC Type 35. Grinnell Fig. 202, B-Line B3062, or equal.

3. TYPE C - MALLEABLE BEAM CLAMP WITH EXTENSION PIECE: Clamp and extension piece shall be malleable iron, tie rod shall be steel. Beam clamp shall comply with MSS and FEDSPEC Type 30. Grinnell Fig. 218 with Fig. 157 extension piece, B-Line B3054, or equal.

4. TYPE D - STEEL BEAM CLAMP WITH EYE NUT: Beam clamp and eye nut shall be forged steel. Configuration and components shall comply with MSS and FEDSPEC Type 28. Grinnell Fig. 292, Carpenter & Patterson Fig. 297, or equal.

5. TYPE E - FRAMING CHANNEL POST BASE: Post bases shall be carbon steel, of standard design manufactured by framing channel manufacturer. Single channel: Unistrut P2072A, B-Line B280, or equal. Double channel: Unistrut P2073A, B-Line B281, or equal.

6. TYPE F - WELDED BEAM ATTACHMENT: Beam attachment shall be carbon steel and comply with MSS and FEDSPEC Type 22. B-Line B3083, Grinnell Fig. 66, or equal.

7. TYPE G - WELDED STEEL BRACKET: Bracket shall be carbon steel and comply with MSS Type 32 and FEDSPEC Type 33 for medium welded bracket. Heavy welded bracket shall comply with MSS Type 33 and FEDSPEC Type 34.

8. TYPE H - CAST IRON BRACKET: Bracket shall be cast iron, Carpenter & Patterson Fig. 340, or equal.

9. TYPE J - ADJUSTABLE BEAM ATTACHMENT: Beam attachment shall be carbon steel, Carpenter & Patterson Fig. 151, B-Line B3082, or equal.

10. TYPE K - DOUBLE CHANNEL BRACKET: Wall channel shall be single channel framing channel as specified in paragraph 15096-2.02 E.5. Cantilever bracket shall be a carbon steel double framing channel assembly, Unistrut P2542 through P2546, B-Line B297-12 through B297-36, or equal.

11. TYPE L - SINGLE CHANNEL BRACKET: Wall channel shall be single channel framing channel as specified in paragraph 15096-2.02 E.5. Cantilever bracket shall be a carbon steel single framing channel assembly, Unistrut P2231 through P2234, B-Line B198-6, B198-12, B196-18 and B196-24, or equal.

12. TYPE M - WALL MOUNTED CHANNEL: Wall channel shall be single channel framing channel as specified in paragraph 15096-2.02 E.5.

13. TYPE N - PIPE STANCHION FLOOR ATTACHMENT: Baseplate shall be carbon steel with 1/2 inch minimum thickness. Anchor bolt holes shall be 1/16 inch larger than the anchor bolt diameter. The space between the baseplate and the floor shall be filled with nonshrink grout.

E. ACCESSORIES:

1. HANGER RODS: Rods shall be carbon steel, threaded on both ends or continuous threaded and sized as specified.

2. WELDLESS EYE NUT: Eye nut shall be forged steel and shall comply with MSS and FEDSPEC Type 17. Eye nut shall be Grinnell Fig. 290, B-Line B3200, or equal.

3. WELDED EYE ROD: Eye rod shall be carbon steel with eye welded closed. Inside diameter of eye shall accommodate a bolt diameter 1/8 inch larger than the rod diameter. Eye rod shall be Grinnell Fig. 278, B-Line B3211, or equal.

4. TURNBUCKLE: Turnbuckle shall be forged steel and shall comply with MSS and FEDSPEC Type 13. Turnbuckle shall be Grinnell Fig. 230, B-Line B3202, or equal.

5. FRAMING CHANNEL: Framing channel shall be 1 5/8 inches square, roll formed, 12-gage carbon steel. Channel shall have a continuous slot along one side with in-turned clamping ridges. Single channel: Unistrut P1000, B-Line B22, or equal. Double channel: Unistrut P1001, B-Line B22A, or equal. Triple channel: Unistrut P1004A, B-Line B22X, or equal.

2.03 THERMAL PIPE HANGER SHIELD

Thermal shields shall be provided at hanger, support and guide locations on pipe requiring insulation. The shield shall consist of an insulation layer encircling the entire circumference of the pipe and a steel jacket encircling the insulation layer. The thermal shield shall be the same thickness as the piping system insulation. The standard shield shall be used for hot systems and the

vapor barrier shield shall be used for cold systems. Stainless steel band clamps shall be used where specified to ensure against slippage between the pipe wall and the thermal shield.

A. STANDARD SHIELD:

1. INSULATION:

a. Hydrous calcium silicate, high density, waterproof
b. Compressive strength: 100 psi average
c. Flexural strength: 75 psi average
d. K factor: 0.38 at 100 degrees F mean
e. Temperature range: 20 degrees F to 500 degrees F

2. STEEL JACKET: Galvanized steel. Gage shall be the manufacturer's standard supplied for the given pipe size.

3. CONNECTION: Shield shall have butt connection to pipe insulation. Steel jacket and insulation shall be flush with end.

B. VAPOR BARRIER SHIELD:

1. INSULATION:

a. Hydrous calcium silicate, high density, waterproof
b. Compressive strength: 100 psi average
c. Flexural strength: 75 psi average
d. K factor: 0.38 at 100 degrees F mean
e. Temperature range: 20 degrees F to 500 degrees F

2. STEEL JACKET: Galvanized steel. Gage shall be the manufacturer's standard supplied for the given pipe size.

3. CONNECTION: Shield shall have butt connection to pipe insulation. Insulation shall extend 1 inch each side of steel jacket for vaportight connection to pipe insulation vapor barrier.

2.04 PRODUCT DATA

Hanger and support locations and components shall be indicated on the piping layout drawings.

PART 3--EXECUTION

3.01 HANGER AND SUPPORT LOCATIONS

The Contractor shall locate hangers and supports as near as possible to concentrated loads such as valves, flanges, etc. Locate hangers, supports and accessories within the maximum span lengths specified in the contract documents to support continuous pipeline runs unaffected by concentrated loads.

At least one hanger or support shall be located within 2 feet from a pipe change in direction.

The Contractor shall locate hangers and supports to ensure that connections to equipment, tanks, etc., are substantially free from loads transmitted by the piping.

Where piping is connected to equipment, a valve, piping assembly, etc., that will require removal for maintenance, the piping shall be supported in such a manner that temporary supports shall not be necessary for this procedure.

Pipe shall not have pockets formed in the span due to sagging of the pipe between supports caused by the weight of the pipe, medium in the pipe, insulation, valves and fittings.

3.02 INSTALLATION

Welded and bolted attachments to the building structural steel shall be in accordance with the requirements of the AISC Manual of Steel Construction. Unless otherwise specified, there shall be no drilling or burning of holes in the building structural steel.

Hanger components shall not be used for purposes other than for which they were designed. They shall not be used for rigging and erection purposes.

The Contractor shall install items to be embedded before concrete is poured. Fasten embedded items securely to prevent movement when concrete is poured.

Embedded anchor bolts shall be used instead of concrete inserts for support installations in areas below water surface or normally subject to submerging.

The Contractor shall install thermal pipe hanger shields on insulated piping at required locations during hanger and support installation. Butt joint connections to pipe insulation shall be made at the time of insulation installation in accordance with the manufacturer's recommendations.

Hanger and support components in contact with plastic pipe shall be free of burrs and sharp edges.

Rollers shall roll freely without binding.

Finished floor beneath Type N structural attachments and framing channel post bases shall be roughed prior to grouting. Grout between base plate and floor shall be free of voids and foreign material.

Baseplates shall be cut and drilled to specified dimensions prior to welding stanchions or other attachments and prior to setting anchor bolts.

Plastic or rubber end caps shall be provided at the exposed ends of all framing channels that are located up to 7 feet above the floor.

3.03 ADJUSTMENTS

The Contractor shall adjust hangers and supports to obtain required pipe slope and elevation. Shims made of material that is compatible with the piping material may be used. Stanchions shall be adjusted prior to grouting their baseplates.

END OF SECTION

SECTION 15097

SEISMIC RESTRAINTS FOR PIPING

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies seismic restraints for bracing all piping systems shown on the drawings. This section does not include seismic restraints for fire sprinkler systems.

B. DEFINITIONS:

Longitudinal direction--direction parallel to the pipe axis.
Lateral direction--direction perpendicular to the pipe axis.

C. OPERATING CONDITIONS:

The seismic restraints specified in this section are provided to resist pipe movements and loads occurring as a result of an earthquake or other seismic event.

Unless otherwise specified, all piping shall have bracing to resist seismic loading caused by forces applied at the individual pipe's center of gravity. Seismic loading shall be per Section 01900.

D. RESTRAINT SELECTION:

Unless otherwise specified, the Contractor shall select, locate and provide seismic restraints for piping in accordance with the contract documents.

The Contractor shall review the piping layout in relation to the surrounding structure and adjacent piping and equipment before selecting the restraint to be used at each point.

Seismic restraints may be omitted from the following installations:

1. Gas piping less than 1-inch inside diameter.

2. Piping in boiler and mechanical rooms less than 1 1/4-inch inside diameter.

3. All other piping less than 2 1/2-inch inside diameter.

4. All piping suspended by individual hangers 12 inches or less in length from the top of the pipe to the bottom of the support for the hanger.

Piping systems shall not be braced to dissimilar parts of a building or to dissimilar building systems that may respond in a different mode during an earthquake. Examples: wall and a roof; solid concrete wall and a metal deck with lightweight concrete fill.

Restraints shall be sized to fit the outside diameter of the pipe, tubing, or, where specified, the outside diameter of insulation.

There shall be no contact between a pipe and restraint component of dissimilar metals. The contractor shall prevent contact between dissimilar metals when restraining copper tubing by the use of copper-plated, rubber, plastic or vinyl coated, or stainless steel restraint components.

Branch lines shall not be used to brace main lines.

Seismic bracing shall not limit the expansion and contraction of the piping system.

1.02 QUALITY ASSURANCE

A. REFERENCES:

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

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

Reference	Title
ANSI A58.1-82	Minimum Design Loads for Buildings and Other Structures
AISC Manual of Steel Construction	American Institute of Steel Construction, Manual of Steel Construction, Allowable Stress Design - 9th Edition
FEDSPEC WW-H-171e-78	Hangers and Supports, Pipe
MFMA-2-91	Metal Framing Standards Publication
MSS SP-58-93	Pipe Hangers and Supports - Materials, Design and

	Manufacture
MSS SP-69-91	Pipe Hangers and Supports - Selection and Application
SMACNA, PPIC	Guidelines for Seismic Restraints of Mechanical Systems and Plumbing Piping Systems

B. APPROVAL:

Seismic restraint load calculations specified in paragraph 15097-3.01 shall be reviewed and signed by a structural engineer registered in the State of Utah.

PART 2--PRODUCTS

2.01 ACCEPTABLE PRODUCTS

Standard pipe restraints and components shall be manufactured by Carpenter & Patterson, B-Line, Kin-Line, ITT Grinnell, Michigan, Pipe Shields Incorporated, Superstrut, Unistrut, or equal. Pipe restraint materials shall conform to the requirements of MSS SP-58 and MFMA-1.

2.02 MATERIALS

A. GENERAL:

Unless otherwise specified, restraints, including braces, pipe and structural attachments, shall be hot-dip galvanized after fabrication. Nuts, bolts and washers, fittings and accessories, may be mechanically zinc-coated except for those subject to moisture or corrosive atmosphere, which shall be type 304 stainless steel. Restraints, including braces, pipe and structural attachments, shall be type 304 or 316 for submerged locations, locations subject to moisture or corrosive atmosphere or for stainless steel piping.

B. PIPE ATTACHMENTS:

1. TYPE 1s: CLEVIS RESTRAINT ATTACHMENT: Clevis attachment shall be Type 1, clevis pipe hanger, as specified in paragraph 15096-2.02 B.

2. TYPE 3s: DOUBLE BOLT RESTRAINT CLAMP: Restraint clamp shall be Type 3, double bolt pipe clamp, as specified in paragraph 15096-2.02 B.

3. TYPE 4s: ROLLER RESTRAINT ATTACHMENT: Roller attachment shall be Type 4, adjustable roller hanger, as specified in paragraph 15096-2.02 B. Hold down strap shall be carbon steel and sized as follows: pipe size 1 inch through 2 inch shall be 1 inch by 1/8 inch thick, pipe sizes 2 1/2-inch through 4 inch shall be 1 1/4-inch by 3/l6 inch thick, 6 inch pipe shall be 2 inch by 3/l6 inch thick, 8 inch pipe shall be 2 1/2-inch by 3/16 inch thick, 10-inch through 16-inch pipe shall be 2 1/2-inch by 1/4 inch thick, 20-inch pipe shall be 3 inch by 1/4 inch thick, and 24-inch pipe shall be 3 inch by 3/8 inch thick.

4. TYPE 7s: U-BOLT RESTRAINT: U-bolt restraint shall be Type 7, U-bolt, as specified in paragraph 15096-2.02 B.

5. TYPE 13s: FRAMING CHANNEL STRAP RESTRAINT: Strap restraint shall be Type 13, framing channel pipe strap, as specified in paragraph 15096-2.02 B.

6. TYPE 14s: PIPE CLAMP RESTRAINT: Pipe clamp shall be carbon steel, with configuration and components equivalent to MSS and FEDSPEC Type 4. Rod attachment and longitudinal brace connection stud shall be carbon steel, fabricated and welded by the manufacturer.

a. Steel pipe (insulated)--shall be Superstrut No. S-720, Kin-Line No. S475, or equal, with insulation shield.

b. Steel pipe (uninsulated)--shall be Superstrut No. S-720, Kin-Line No. S475, or equal.

c. Cast and ductile iron pipe--shall be Superstrut No. S-720, Kin-Line No. S475, or equal.

d. Copper pipe (insulated)--shall be Superstrut No. S-720, Kin-Line No. S475, or equal, with insulation shield.

e. Copper pipe (uninsulated)--shall be Superstrut No. S-720, Kin-Line No. S475, or equal, with insulation shield or dielectric lining.

f. Plastic pipe--shall be Superstrut No. S-720, Kin-Line No. S475, or equal.

C. TRAPEZE RESTRAINTS:

1. GENERAL: Unless otherwise specified, trapeze members shall have a minimum steel thickness of 12 gage, with a maximum deflection 1/240 of the span.

2. TYPE 20s: SINGLE CHANNEL LATERAL RESTRAINT: Trapeze restraint cross member shall be 1 5/8-inch square carbon steel framing channel, Unistrut P1000, B-Line B22, Superstrut A-1200, or equal. Pipe attachments shall be Type 13s or Type 7s specified in paragraph 15097-2.02 B. Rod stiffeners and lateral brace shall be as specified in paragraph 15097-2.02 D.

3. TYPE 21s: DOUBLE CHANNEL LATERAL RESTRAINT: Trapeze restraint cross member shall be a double channel manufactured assembly such as Unistrut P1001, B-Line B22A, Superstrut A-1202, or equal. Pipe attachments shall be Type 13s or Type 7s specified in paragraph 15097-2.02 B. Rod stiffeners and lateral brace shall be as specified in paragraph 15097-2.02 D.

4. TYPE 22s: DOUBLE CHANNEL LONGITUDINAL RESTRAINT: Trapeze restraint cross member shall be a double channel manufactured assembly such as Unistrut P1001, B-Line B22A, Superstrut A-1202, or equal. Pipe attachments shall be Type 13s or Type 7s specified in paragraph 15097-2.02 B. Rod stiffeners, longitudinal and lateral braces shall be as specified in paragraph 15097-2.02 D.

D. BRACES AND FITTINGS:

1. SEISMIC BRACE FITTING: Seismic brace fitting shall be manufactured for use with industry standard framing channel. The fitting shall be carbon steel, welded construction, two-piece linked fitting. A means to reduce noise and vibration transmission between the linked fitting parts shall be provided. Seismic brace fittings shall be Superstrut C-749N series seismic brace, Kin-Line No. 633 seismic connector fitting, or equal.

2. HANGER ROD STIFFENER ASSEMBLY: Rod stiffener channel shall be 1 5/8-inch square carbon steel framing channel, Unistrut P1000, B-Line B22, Superstrut A-1200, or equal. Rod stiffener clamps shall be complete with channel nut and shall be Superstrut ES-142, Kin-Line No. 635, or equal.

3. TYPE A1 SEISMIC BRACE: Seismic brace shall be 1 5/8-inch square carbon steel framing channel, Unistrut P1000, B-Line B22, Superstrut A-1200, Kin-Line No. 4112, or equal.

4. TYPE A2 SEISMIC BRACE: Seismic brace shall be 1 5/8-inch wide by 3 1/4-inch deep carbon steel framing channel, Unistrut P5000, B-Line B11, Superstrut H-1200, Kin-Line No. 8212, or equal.

E. STRUCTURAL ATTACHMENTS:

1. GENERAL: Unless otherwise specified, hanger rod structural attachments shall be as specified in Section 15096. Structural attachments for longitudinal and lateral seismic braces shall be as specified in paragraph 15097-2.02 E.

2. TYPE SA-1 ATTACHMENT: Brace fitting shall be as specified in paragraph 15097-2.02 D. Concrete anchors shall be installed with embedment and location dimensions as shown.

3. TYPE SA-2 ATTACHMENT: Brace fitting shall be as specified in paragraph 15097-2.02 D. Concrete anchors shall be installed with embedment and location dimensions as shown. Framing channel shall be as specified in paragraph 15097-2.02 F.

4. TYPE SA-3 ATTACHMENT: Brace fitting shall be as specified in paragraph 15097-2.02 D. Cap screw, lockwasher and hex nut materials and finish shall be compatible with structural steel material.

5. TYPE SA-4 ATTACHMENT: Brace fitting shall be as specified in paragraph 15097-2.02 D.

6. TYPE SA-5 ATTACHMENT: Brace fitting shall be as specified in paragraph 15097-2.02 D. Four-inch x 3-inch x 3/8-inch angle shall be carbon steel.

F. ACCESSORIES:

1. HANGER RODS: Rods shall be carbon steel, threaded on both ends or continuous threaded and sized as specified.

2. FRAMING CHANNEL: Framing channel shall conform to the Metal Framing Manufacturers Association standard MFMA-1. Framing channel shall be roll formed, 12-gage carbon steel. Channel shall have a continuous slot along one side with in-turned clamping ridges. Channel shall be Unistrut P1000 series, B-Line B22 series, Superstrut A-1200 series, or equal.

3. ROD COUPLING: Rod coupling shall be carbon steel, with sight hole in center of coupling body, Grinnell Fig. 135, Superstrut H-119, or equal.

2.03 THERMAL PIPE HANGER SHIELD

Thermal shields shall be provided at seismic restraint locations on pipe requiring insulation. Thermal pipe hanger shields shall be as specified in paragraph 15096-2.03. Stainless steel band clamps shall be provided on thermal shields at longitudinal pipe restraint locations.

2.04 PRODUCT DATA

The following information shall be provided as specified in Section 01300:

1. Seismic restraint locations and legend as specified in paragraph 15097-3.01.

2. Load calculations as specified in paragraph 15097-1.02 B.

PART 3--EXECUTION

3.01 PIPE RESTRAINT LOCATIONS

The first seismic restraint on a piping system shall be located not more than 10 feet from the main riser, entrance to a building or piece of equipment.

Cast iron pipe shall be braced on each side of a change in direction of 90 degrees or more. Joints in risers shall be braced or stabilized between floors.

No-hub and bell and spigot cast iron soil pipe shall be braced longitudinally every 20 feet and laterally every 10 feet.

Lateral bracing for one pipe section may also act as longitudinal bracing for the pipe section connected perpendicular to it, if the bracing is installed within 24 inches of the elbow or tee of the same size.

Seismic restraint locations and components shall be indicated on the piping layout drawings. The Contractor shall provide a legend giving load information and restraint component selection at each restraint location.

3.02 INSTALLATION

Rod stiffener assemblies shall be used at seismic restraints for hanger rods over 6 inches in length. A minimum of two rod stiffener clamps shall be used on any rod stiffener assembly.

Lateral and longitudinal bracing shall be installed between 45 degrees above and 45 degrees below horizontal, inclusive, relative to the horizontal centerline of the pipe.

Welded and bolted attachments to the building structural steel shall be in accordance with the requirements of the AISC Manual of Steel Construction. There shall be no drilling or burning of holes in the building structural steel without approval of the Construction Manager.

Embedded anchor bolts shall be used instead of concrete inserts for seismic brace installations in areas below water surface or normally subject to submerging.

The Contractor shall install thermal pipe hanger shields on insulated piping at required locations during restraint installation. Butt joint connections to pipe insulation shall be made at the time of insulation installation in accordance with the manufacturer's recommendations.

Restraint components in contact with plastic pipe shall be free of burrs and sharp edges.

Rollers shall roll freely without binding.

Plastic or rubber end caps shall be provided at the exposed ends of all framing channels that are located up to 7 feet above the floor.

END OF SECTION

SECTION 15697

AIR-COOLED WATER CHILLER

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies a packaged, outdoor, surface-mounted, air-cooled water chiller complete with condensers, circulation pump, expansion tank and/or buffer tank along with accessories, control panel, and control and monitoring devices for chilling a 50 percent ethylene glycol solution. Chiller shall be oversized for duty at an elevation of approximately 7,010 feet above mean sea level (MSL) and for cooling the ethylene glycol solution to 33 degrees Fahrenheit (°F).

B. TYPE:

Chiller shall be the heavy-duty, industrial type for continuous 24/7 year-round operation. Compressors shall be the screw, reciprocating or scroll-type. Chiller shall be suitable for continuous duty over a range of 20 to 100 percent full load. Chiller, circulation pump, and associated electrical equipment shall be designed for explosion service in a Class I Division 2 classified area per NFPA 820.

C. EQUIPMENT LIST:

Item	Equipment Number
Air-Cooled Water Chiller	CHR – 8790

1.02 SYSTEM DESIGN AND PERFORMANCE

A. GENERAL:

Chiller shall be designed and selected to constantly supply chilled glycol/water solution to a process heat exchanger for cooling digester gas at a wastewater treatment facility at ambient temperatures up to 90° F. Chiller shall be designed, tested and rated in accordance with ASME Unfired Pressure Vessel Code and shall meet AHRI 550/590 rated capacity. Components shall be UL-labeled where available.

B. OPERATING CONDITIONS:

Chillers shall be designed to comply with the following:

Nominal Capacity, tons	Actual Operating Output, tons	EWT[a], F	LWT[b], F	GPM[c]	Liquid PD[d], max, ft	OSA[e] temp, °F	Nominal Electrical input, kW	Volts/ϕ
5	1.8 to 3.3	40	33	15	45	90	7.5	480/3

[a]EWT = Entering chilled water temperature.
[b]LWT = Leaving chilled water temperature.
[c]GPM = Approximate fluid flow rate, (chilled 50% ethylene glycol solution), gallons per minute.
[d]PD = Evaporator water pressure drop.
[e]OSA = Outside air temperature ranges from minus 10 degrees F to 90 degrees F.

1.03 QUALITY ASSURANCE

A. FACTORY TESTING:

Chiller shall be factory-tested and certified to meet the design operating requirements.

1.04 SUBMITTALS

Submittals shall be provided and shall include the following information:

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections along with justification for any requested deviation to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

2. Predicted performance data, as applicable, developed for the specific application, confirming conformance to specified design and operating requirements and characteristics.

3. Manufacturer and manufacturer's type designation.

4. Manufacturer's catalog and/or other data confirming conformance to specified design, material and equipment requirements.

5. Control diagrams and process and instrumentation diagrams relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked “No

Changes Required." Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.

6. Water flow switch wiring diagrams and installation requirements.

7. Installation requirements, showing clearance required for maintenance purposes.

8. Equipment cutsheets, motor data, and local control panel drawings.

9. Detailed summary of the site elevation, low temperature fluid, and 50 percent ethylene glycol solution deration factors to ensure adequate capacity.

10. Headloss (feet) through the evaporator.

1.05 ENVIRONMENTAL CONDITIONS

Equipment shall be designed for continuous outdoor duty in an extreme weather-exposed, environment at approximately 6,750 feet above MSL. Outside air temperature ranges from minus 10° to 90° F. De-rate the air-cooled condenser equipment for the site elevation and ambient conditions.

1.06 WARRANTY

A two-year 100 percent parts and labor warranty against manufacturing defects or failure of the equipment specified in this section caused by normal wear and tear shall be provided. The warranty period shall start following successful demonstration of performance testing.

PART 2--PRODUCTS

2.01 MANUFACTURERS

The following candidate manufacturers are believed to be capable of producing equipment and/or products that will satisfy the requirements of this section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed that named manufacturer's standard equipment or products will comply with the requirements of this section. Candidate manufacturers include Johnson Thermal Systems, Filtrine, or equal with the features and modifications specified.

2.02 MATERIALS

Component	Material
Evaporator and condenser tubes	Aluminum or copper with Heresite coating
Evaporator and condenser fins	Aluminum or copper with Heresite coating
Header	Copper with Heresite coating

Component	Material
Shells	Steel
Frame	Steel
Tube sheets	Steel

Tubes and fins shall be of the same material.

2.03 EQUIPMENT

A. GENERAL:

Water chiller shall be of the air-cooled type using screw, reciprocating or scroll-type compressors as the motive force. Chiller and all electrical components shall be rated for Class I Division 2 explosion-proof service per NFPA 820.

Chiller shall be a completely package unit, with all components and controls factory-assembled and tested. Chiller shall have multiple motor compressors units, evaporator, refrigeration circuits, control panel and controls, full factory refrigerant (R-134a or R-410A) and oil charge for field installation, and accessories.

Provide stainless steel enclosure or epoxy-treated metals to protect the chiller equipment and the electrical equipment.

B. COMPRESSOR AND MOTOR:

Compressors shall be direct-drive, hermetically sealed type easily accessible for service. The lubrication system shall be force-fed. There shall be a crank-case heater, multistep capacity control, and oil-level sight glass.

The motor shall be suction gas cooled with overload protection, suitable for nameplate voltage ±10 percent, sized to match compressor torque and horsepower curves. Compressor motor power factor shall be 0.9 or greater. Provide vibration isolation between motor compressor unit and frame. Provide motor winding high-temperature switch wired to the starter for alarm and shutdown.

C. COMPRESSOR MOTOR STARTER:

The starter shall be the full-voltag,e non-reversing type with motor-circuit protector for each compressor motor.

D. EVAPORATOR:

The evaporator shall be shell-and-tube design with seamless copper tubes expanded into steel tube sheets. The heads shall be removable. The evaporator shall be ASME-rated at 225-psi on refrigerant side and 150 psi-on waterside. Provide a minimum of fully sealed and vapor-tight, 1-

inch closed-cell foam insulation, Armaflex II (k = 0.28), on shell, suction lines, and heads and on all other cold surfaces.

E. REFRIGERANT CIRCUIT:

The chiller shall have two independent refrigeration circuits, each with a separate single compressor for standby operation. Manifolded compressors are not acceptable. Each refrigerant circuit shall include moisture indicator and liquid line sight glass, filter dryer, liquid line shutoff valve, thermal expansion valve, charging valve, discharge and oil-line check valves, compressor suction and discharge service valves, insulated suction lines, and flex connections. Refrigerant shall be R-134a or R-410A.

F. AIR-COOLED CONDENSER:

The condenser shall be of the air-cooled type designed and selected to reject the heat from the chiller.

G. CASINGS:

The casing shall be 12-gage galvanized steel, finished with a factory-coating system for corrosion protection. The unit frame and fan guards shall be galvanized steel. Unit base shall be 1/4-inch galvanized steel. Provide removable access panels and coil guards.

H. CONDENSER FANS AND MOTORS:

The fan shall be vertical discharge, direct-driven type, statically and dynamically balanced, with steel fan blades and zinc-plated hubs. The motors shall have permanently lubricated ball bearings, with built-in current and thermal overload protection.

I. CONDENSER COIL:

The coil shall be constructed of aluminum fin secondary surface mechanically bonded to primary surface of 5/8-inch O.D. seamless copper tubing. Sub-cooling circuit shall have a liquid accumulator. The coil shall be factory tested at 450 psig.

J. CHILLER CIRCULATION PUMP:

A glycol circulation pump shall be provided as part of the chiller package specified in this section. The pump shall be designed to circulate the specified flow of glycol solution between the chiller and a new digester gas cooling heat exchanger that will be located in the Digester Control Room. The total pump head shall be the sum of the pressure losses through the chiller plus 10 feet of head for pressure losses through the heat exchanger and piping system.

K. CHILLED GLYCOL EXPANSION TANK:

An ASME expansion tank and means of filling the glycol circulation system shall be included with the chiller. The expansion tank shall be sized for the volume of glycol solution in the system, including:

1. 100 feet of 1-1/2-inch schedule 40 pipe.
2. The chilled glycol solution volume of the heat exchanger.
3. The held-up glycol solution volume of the chiller.
4. The volume of the glycol solution holding tank if required and provided by the chiller supplier.

L. BALANCING VALVE:

A manual incline hydronic balancing valve to adjust and lock in the desired flow rate shall be provided downstream of the glycol circulation pump. The valve shall be designed for this service and shall be supplied with installation data.

M. CONTROLS:

The condenser controls shall be factory-assembled and mounted in the chiller control panel and shall contain fan contactors, fan-cycling thermostats, compressor interlock and 120-Volt control thermostats, and compressor interlock.

Provide heavy-duty control panel electrical devices and products for the outdoor chiller location that shall resist weather and corrosion.

The pump shall be wired to operate concurrently with the chiller and shall have a manual test button for independent testing without chiller operation.

2.04 ACCESSORIES

A. LOAD LIMIT THERMOSTAT:

Load limit thermostat shall unload the compressor if condenser temperature is too high.

B. TIME DELAY:

Time delay shall prevent rapid starting of all chiller compressors by causing an adjustable time delay between chiller stages. Delay shall be as recommended by the manufacturer.

C. ANTI-RECYCLE TIMER:

Anti-recycle timer shall prevent rapid cycling of compressor and liquid slugging by time between shutdown and start-up. Provide timer with 30-minute range; delay shall be initially set as recommended by the manufacturer.

D. SOUND ATTENUATOR ENCLOSURE:

Provide 1-inch thick, 1-1/2-pound per cubic foot, density-lined, 16-gage steel compartment.

E. VIBRATION ISOLATORS:

Provide spring or rubber-in-shear vibration isolators for field installation to reduce vibration transmission through the unit base.

F. GAGES:

Include high-side and low-side refrigerant pressure gages per refrigerant circuit and oil-pressure gages per compressor. Include local temperature gages on suction and discharge of chiller. The gages shall be factory-mounted on service gage connections.

Temperature gages with a range of 20° to 80° F shall be provided as part of the chiller package to monitor the supply and return glycol solution temperature.

G. WATER FLOW SWITCHES:

Provide a water flow safety switch within the chiller system or on the chilled glycol piping to prevent cooler freeze-up under low- or no-flow conditions. Provide terminals in the unit control center for field hook-up of the water flow safety switch. Factory technician shall provide the flow-switch wiring and adjustments.

H. HIGH AMBIENT UNLOADER:

Provide a pressure stat to unload the compressor to control head pressure and prevent high-pressure trip-outs on days that exceed design high-ambient conditions.

I. AUTO LEAD-LAG FUNCTION:

Auto lead-lag function shall start compressors automatically and even out operation hours of compressors.

J. CONDENSER FAN SEQUENCING:

Condenser fan sequencing shall automatically cycle fan operation to optimize efficiency at high- and low-ambient conditions.

K. HOUR METER:

Hour meter shall indicate hours of chiller operation.

L. CHILLED GLYCOL BUFFER TANK:

If a glycol solution holding tank is required, provide the tank fully insulated and piped with all necessary features at no extra cost to the Owner.

2.05 COATING

Because of the continuous presence of hydrogen sulfide and moist air at the site, all copper pipe or exposed copper equipment components must have Heresite or equivalent coating.

A. CASINGS:

The unit frame, fan guards, and unit base shall be Heresite-coated or equivalent.

B. CONDENSER COIL:

Aluminum fins shall be Heresite-coated or equivalent.

2.06 ELECTRICAL AND CONTROLS

A. CONTROL PANEL:

Electric and refrigerant controls shall be mounted in a vendor-provided panel on chiller.

The NEMA-7 disconnect switch shall be properly sized for model, and the voltage rating shall be 480-Vac. At a minimum, the control system shall contain the following components:

1. Motor starter(s).
2. 480:120-volt control power transformer.
3. High- and low-pressure cut-out switches for the refrigerant circuit.
4. Manual reset low-water temperature cut-out switch.
5. Multistep chilled-water temperature controller.
6. Oil pressure safety switch for each compressor.
7. Compressor ON indicator light.
8. START-STOP button.
9. Control power circuit breaker.
10. Circuit breaker for each compressor.
11. Suction, discharge, and oil pressure gages.

12. Over/under voltage indicator.

At a minimum, the control system shall include hard-wired signals into the local control panel for:

1. HAND/OFF/REMOTE with IN-REMOTE switch position indication.
2. READY signal.
3. RUNNING/OFF status.
4. NORMAL/FAIL alarm.
5. START/STOP remote control.

The panel shall be UL-508 listed. The monitoring and control functionality shall be as shown on the P&IDs.

B. CAPACITY MODULATION AND TEMPERATURE CONTROL:

Capacity control shall be in variable-step modulation in response to cooling load and shall be provided by either slide valves or un-loader valves. Chiller shall be capable of operation down to 20 percent of peak load.

C. ALARM:

A general alarm shall be provided for chiller failure status and high outlet temperature.

2.07 PRODUCT DATA

Submit the following product data:

1. Spare parts list.
2. Warranty.
3. Anchor-bolt design calculations and details.
4. Manufacturer's recommended storage, installation, and start-up procedures.
5. Operation and maintenance manuals.
6. Refrigerant- and glycol-solution filling and replacement instructions.

PART 3--EXECUTION

3.01 INSTALLATION

The chiller and all associated equipment shall be installed and field-insulated according to manufacturer's printed instructions. All cold surfaces shall be fully insulated, completely vapor-tight, and all damaged factory-installed insulation shall be replaced or completely repaired and fully vapor-tight to be in like-new condition.

Provide and install Heresite-coated products as specified herein, if not factory applied.

A trained manufacturer's representative shall be provided for start-up and testing of the equipment.

3.02 FIELD TESTING

The chiller unit supplier shall provide the services of a factory-trained field technician for a minimum of 3 working days in two separate trips to supervise the water chiller installation, control wiring, start-up, and field testing, and training of the Owner's staff.

Final adjustments and inspections shall be made by the water-chiller supplier's factory-trained and authorized service representative.

3.03 TRAINING

During the commissioning period, a factory-trained representative of the manufacturer shall conduct training for the Owner's staff. A minimum of 4 hours of training shall be provided. Maintenance manuals shall be provided to the Owner a minimum of 1 week prior to staff training.

Training sessions shall be scheduled by the Owner at a time starting after successful commissioning and not to exceed 4 months after final acceptance of the equipment specified in this section.

END OF SECTION

SECTION 15753

SHELL AND TUBE HEAT EXCHANGER

PART 1--GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies an all stainless steel gas-to-water shell-and-tube heat exchanger for cooling a water-saturated digester gas.

B. TYPE:

Heat exchanger shall be the one-pass, counterflow, all stainless steel horizontal shell and straight-tube type with condensate drain connections, removable tube bundles, and mounting brackets.

C. EQUIPMENT LIST:

Item	Equipment Number
Digester Gas Cooling Heat Exchanger	HEX - 8780

D. DEFINITIONS:

1. Raw Digester Gas: A water-saturated mixture of several constituents, including methane, carbon dioxide, nitrogen, sulfides, siloxanes, and water-in-vapor phase, produced by the anaerobic digestion of municipal wastewater sludge. For this project, the raw digester gas is expected to contain small amounts of fine particulate matter and 7.7 percent water vapor by volume, as produced within the digesters at 98 degrees Fahrenheit (°F). The dry digester gas, as determined by laboratory analysis, has the following properties:

Parameter	**Units**	**Value**	**Range**
Methane[1]	Percent	62.0	56 to 68
Carbon Dioxide[1]	Percent	35.5	35 to 44
Nitrogen[1]	Percent	2.0	0 to 2
Oxygen[1]	Percent	0.5	0 to 1
Sulfides[2]	ppm	1,750	1,500 to 2,000
Siloxanes[3]	ppm	8	6 to 10

[1] Methane, carbon dioxide, nitrogen, and oxygen values represent percent by volume as a dry gas.
[2] Sulfides are expected to comprise 90 percent or more hydrogen sulfide.
[3] Siloxanes: Volatile silicon based compounds including hexamethyldisiloxane (L2), octamethylcyclotetrasiloxane (D4), and decamethylcyclopentasiloxane (D5).

2. Treated Digester Gas: Raw digester gas will be treated to reduce sulfides to approximately 50 ppmv. Following treatment, the digester gas will be pressurized to approximately 15.4 psia immediately upstream of the heat exchanger specified in this section.

3. Inlet Digester Gas: Treated digester gas will enter the heat exchanger at a pressure of 15.4 psia and a temperature of approximately 245° F. Prior to treatment and compression, the raw digester gas was initially water-saturated as produced within the digesters, and thus contained 7.7 percent water vapor at 98° F and 11.62 psia.

1.02 SYSTEM DESIGN AND PERFORMANCE

A. GENERAL:

The heat exchangers shall be constructed and designed per the following parameters:

1.	Construction code	ASME, Section VIII, Div. 1
2.	Mounting arrangement	Horizontal
3.	Mounting support type	U-bolt saddle
4.	Flow direction	Counterflow
5.	Tube shape	Straight
6.	Tube passes, maximum	One
7.	Overall length, maximum, feet	7
8.	Working pressure, psig	50
9.	Test pressure, psig	75
10.	Fouling factor	0.004
11.	Tube diameter, O.D., maximum, inches	3/8
12.	Gas connection, minimum, inches	4
13.	Glycol connection, maximum, inches	2
14.	Drain connection, both bonnets, minimum, inches	3/4
15.	Gas connection type	ANSI flanged
16.	Drain and vent connection type	Threaded, NPT

B. OPERATING AND PERFORMANCE REQUIREMENTS:

The heat exchanger shall be sized and selected for the following:

<u>Tube-side Fluid</u>

1.	Tube fluid name	Digester Gas
2.	Volumetric composition, wet gas, percent	
	a. Methane	57.2
	b. Carbon Dioxide	32.8
	c. Water Vapor	7.7
	d. Nitrogen	1.8
	e. Oxygen	0.5
	f. Hydrogen Sulfide	0.05

Tube-side Fluid

3.	Raw Gas Moisture Content Saturation, percent	
	a. Fluid saturation	100
	b. Expected moisture in gas (as produced)	7.7
4.	Fluid density, approximate, lb/ft^3	0.063
5.	Fluid specific heat, approximate, Btu/lb-F	0.35
6.	Fluid (compressed) entering temperature, degrees F	245
7.	Fluid leaving temperature, degrees F	40
8.	Fluid flow, maximum, scfm	90
9.	Fluid flow, average, scfm	60
10.	Fluid flow, minimum, scfm	50
11.	Fluid mass flow, maximum, lb/hr	338
12.	Fluid mass flow, average, lb/hr	225
13.	Fluid mass flow, minimum, lb/hr	188
14.	Water condensed, approximate, lb/hr	16
15.	Total heat load, approximate, Btuh	44,900
16.	Latent heat load, approximate, Btuh	16,900
17.	Sensible heat load, approximate, Btuh	28,000
18.	Atmospheric air pressure, psia	11.4
19.	Entering fluid pressure, psia	15.4
20.	Pressure drop allowed, maximum, inches, W.C.	3.0
21.	Pressure drop allowed, average flow, inches, W.C.	2.0

Shell-side Fluid

21.	Shell fluid name	Ethylene Glycol Solution
22.	Fluid composition, percent	50
23.	Fluid flow, approximate, gpm	15
24.	Fluid entering temperature, degrees F	33
25.	Fluid leaving temperature, approximate, degrees F	40
26.	Fluid pressure, psig, approximate	25
27.	Fluid pressure drop allowable, maximum, psig	3.0

1.03 QUALITY ASSURANCE

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASME Pressure Vessel Code	ASME Boiler and Pressure Vessel and Code, Section VII, Pressure Vessels Division 1, with Addenda
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fitting
TEMA	Tubular Exchangers Manufacturing Association

1.04 SUBMITTALS

The following submittals shall be provided:

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

2. Catalog information for each item of equipment furnished.

3. Complete dimensional drawings for each item of equipment including all interconnection sizes.

4. Rated performance information sufficient to assess compliance with the specifications.

1.05 ENVIRONMENTAL CONDITIONS

Equipment shall be designed for continuous outdoor duty in an extreme weather-exposed, environment at approximately 6,750 feet above sea level. As produced within the digester head space at 98° Fahrenheit, the raw digester gas is fully water-saturated at an approximate pressure of 11.6 psia. Outside air temperature ranges from minus 10° to 90° Fahrenheit.

PART 2--PRODUCTS

2.01 MANUFACTURERS

The Owner and Engineer believe the following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's product, nor shall it be construed that a named manufacturer's standard product will comply with the requirements of this section. Candidate manufacturers include API Heat Transfer, Bos-Hatten, Doyle & Roth, Enerquip, Xylem, or equal.

2.02 MATERIALS

Component	Gas-to-water HEX
Shell	Type 304 stainless steel
Tubes	Type 316 stainless steel
Tube Sheets	Type 316 stainless steel
Heads	Type 316 stainless steel
Mounting Saddle or Bracket	Type 304 stainless steel

2.03 EQUIPMENT

Heat exchangers shall be manufactured and tested in accordance with the ASME Pressure Vessel Code and TEMA. Each unit shall bear an ASME inspector's stamp, complete with design working pressure and date and place of manufacture.

All welding shall conform to the latest standards of the American Welding Society.

Tubes shall be seamless metal. Flanged connections shall be provided, oriented as shown for connection to external piping systems. Tube bundles shall be held in place by baffles for more efficient heat transfer, and bolted covers shall be provided for tube cleaning.

Inlet and discharge heads shall have minimum 3/4-inch diameter drains located to remove the condensed gas condensate.

2.04 ACCESSORIES

The heat exchanger shall have drain and vent connections and saddle-type support with U-clamp for rack/floor mounting as shown. Saddle-type supports shall accommodate the heat exchanger with insulation, and shall not compromise the vapor tightness of the insulation jacket.

2.05 PRODUCT DATA

The following product data shall be:

1. Manufacturer's recommended storage, installation and start-up procedures.

2. Applicable operation and maintenance information.

2.06 PROTECTIVE COATING

The heat exchanger shall be unpainted and free from grease-pen notations or hand-applied markings.

PART 3--EXECUTION

3.01 INSTALLATION

Installation shall be as shown and shall be in accordance with the manufacturer's printed instructions.

The Contractor shall route piping, provide takedown fittings, make piping connections and provide access room for removal of the tube bundle for the specific heat exchanger selected.

Heat exchanger shall be field-insulated. All cold fluid sections of the heat exchanger and the gas condensate piping shall be fully and carefully insulated and jacketed to be completely vapor-tight. Insulation thickness shall be as required for the hottest fluid and for the coldest fluid entering the heat exchanger.

3.02 FIELD TESTING

After completion of installation, each shell and tube heat exchanger shall be completely field tested to demonstrate compliance with the performance requirements as specified. Inspection, testing, and certification shall be provided, and testing procedures and forms shall be submitted and used.

Testing procedures shall duplicate as nearly as possible the conditions of operation and shall be selected to demonstrate that the equipment is operational and free from damage. Each control device, item or mechanical, electrical, and instrumentation equipment, and control circuit shall be considered in the testing procedures to demonstrate that the equipment has been properly serviced, aligned, connected, calibrated, and adjusted prior to operation.

3.03 TRAINING

During the commissioning period, a factory-trained representative of the manufacturer shall conduct training for the Owner's staff. A minimum of 4 hours of training shall be provided. Maintenance manuals shall be provided to the Owner a minimum of 1 week prior to staff training.

Training sessions shall be scheduled by the Owner at a time starting after successful commissioning and not to exceed 4 months after final acceptance of the equipment specified in this section.

END OF SECTION