

SECTION 15010

GENERAL REQUIREMENTS FOR MECHANICAL WORK

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Provide all labor, materials, and equipment required to perform and complete the mechanical work specified in this Section and this Division and on the Drawings.
- B. Be aware that the General Requirements for Mechanical Work by reference, are a part of all subsequent sections of Division 15 and apply as fully as if repeated in each.
- C. Advise subcontractors, suppliers, and vendors involved in the work specified in this section of the applicable requirements.
- D. Include the services of manufacturer's representatives where required to place equipment into proper operation or for advice on installation procedures, or where specifically called for in the Specifications.
- E. Comply with manufacturer's requirements over and above those shown on the Drawings or specified with respect to connections, servicing and installation of the particular equipment.

1.2 CODES

- A. Codes having jurisdiction include, but are not limited to:
 - Life Safety Code, NFPA 101
 - International Building Code with Oregon Amendments
 - International Mechanical Code with Oregon Amendments
 - Uniform Plumbing Code with Oregon Amendments
 - National Electrical Code
- B. All work must be performed in accordance with the requirements of all pertinent National, State, and local building codes and regulations. Furnish specialties and make mechanical installations in conformance with applicable codes and regulations.
- C. This specification section is developed to provide the general requirements for the mechanical trade portions of the Work. Failure to comply with the requirements

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of the other Divisions of the specifications shall not relieve the Contractor of responsibility or be used as a basis for additional compensation due to omission of civil, architectural and structural details from the mechanical and electrical drawings.

- D. Where requirements of specifications exceed code or regulations requirements, specifications will govern. Where requirements of code or regulations exceed specifications, code or regulations will govern.
- E. Notify Owner in advance of ordering or fabrication of any materials or apparatus believed to be inadequate, unsuitable, in violation of laws, ordinances, rules or regulations of authorities having jurisdiction.

1.3 DRAWINGS

- A. The accompanying drawings in some instances are diagrammatic and are intended to show the general arrangement and the extent of the work that, when completed, shall be complete in every respect. They do not show every offset, bend or elbow which may be required in the Work for installation in the space allotted. The Contractor shall follow the Drawings as closely as practical and shall install additional bends, offsets, etc. as may be required for proper installation of the Work. The exact location and arrangement of all parts shall be determined after equipment has been selected and as the work progresses to conform, in the opinion of the Engineer, the best possible manner with the surroundings. Figured dimensions shall be followed without regard to scale.
- B. Minor details, special conditions, and additional details as well as materials and equipment usually furnished with the systems specified shall be included in the work as if herein specified whether mentioned or not. Items of equipment and fixtures are specified in singular; however, the Contractor shall provide the numbers of such items as are indicated on the Drawings, and as required for a complete system.

1.4 MANUALS

- A. Provide operating and maintenance data in accordance with SECTION 01730.

1.5 PERMITS AND INSPECTIONS

- A. Contractor shall:
 - 1. Obtain and pay for all permits and licenses required by codes and ordinances and not provided by Owner
 - 2. Obtain amounts of respective levied costs prior to bidding and include in bid. Verification of costs quoted by respective bureau is Contractor's

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responsibility; additional compensation to the Contractor by Owner for differences between quoted and actual costs will not be considered.

3. Request, arrange and schedule required code inspections as work progresses and at final completion of the work. Deliver copies of inspection certificates to the Engineer.

1.6 REFERENCES

- A. This section references the latest edition and amendments of the following documents. They are a part of this section as specified and modified. In a case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

<u>Reference</u>	<u>Title</u>
ABAI	American Boiler and Affiliated Industrial
ADC	Air Diffusion Council
AGA	American Gas Association
AMCA	Air Moving and Conditioning Association
ANSI	American National Standards Institute
ARI	Air Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
CISP	Cast Iron Soil Pipe Institute
HI	Hydronics Institute
ISO	International Standards Organization
MSS	Manufacturers Standardization Society of the Valve & Fittings Industry
NEMA	National Electric Manufacturers' Association
NPFU	National Board of Fire Underwriters
NBS	National Bureau of Standards
NFPA	National Fire Protection Association
NSF	National Sanitation Foundation
SAMA	Scientific Apparatus Makers Association
SBI	Steel Boilers Institute
SMACNA	Sheet Metal and Air Conditioning Contractors National Association, Inc.
TEMA	Tubular Exchanger Manufacturer's Association
UL	Underwriter's Laboratories

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PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. General. Like materials shall be identical with multiple items coming from the same product line and the same manufacturer.
- B. Miscellaneous steel. Provide structural steel as required for adequate support of all mechanical equipment. The structural steel shall be angle, channel, plate I or H sections suitable for the application. Support holes shall be drilled or burned only in flanges of structural shapes. Holes shall be drilled or burned in only one leg of any one angle and as far from the center of length as possible.

2.2 MATERIALS

- A. Identification of materials. The Contractor shall deliver materials to the project site with the manufacturer's labels intact and legible.
- B. Material storage and handling. Materials shall be handled with care to avoid damage. Materials shall be stored protected by the weather, dirt, construction dust, and potential damage.
- C. Contractor shall be responsible for all damage or vandalism to equipment while stored at the job site.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Locating and positioning equipment: Observe all OSHA and State of Idaho safety codes and regulations and use good construction practices in locating and installing mechanical equipment and material so that the completed installation presents the least possible hazard. Maintain adequate clearances for repair and service to all equipment. The installation of any equipment with less than the minimum clearances indicated by the manufacturer as required for proper maintenance will not be accepted. Set fixtures, valves, and equipment to provide for ready access to any parts requiring inspection and service.
- B. Cutting and patching. The Contractor shall not cut, burn, drill, excavate or otherwise weaken building structural members and underpinning without the written permission of the Engineer. Any structural members or structural surfaces adversely impacted by the Contractor's work will be corrected. Surfaces damaged by the Contractor shall be patched and refinished to match adjacent surfaces.

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- C. Protection. Protect equipment and materials during installation to prevent damage. Temporarily cap or plug all pipe openings.
- D. Safety requirements. Belts, pulleys, chains, gears, couplings, and other rotating parts located so that any person can come in close proximity thereto shall be fully enclosed or properly guarded in accordance with state safety codes and OSHA requirements.
- E. Electrical requirements. Electrical wiring of mechanical equipment and systems such as motors, starters, and controls shall be provided as necessary for complete and operable systems from the power source indicated on the specification drawings.
- F. Equipment, valve, and accessories labeling. Label all mechanical equipment, equipment starters, equipment switches, and exposed valves and piping accessories, with equipment identification name and mark number as indicated.
- G. Where dissimilar metals meet, provide protection to prevent galvanic action.
- H. Review Architectural, Structural, and Electrical Drawings and Specifications, become familiar with the building construction and finishes, the work of other trades, space available for mechanical equipment and installations, and obvious interferences requiring special attention.
- I. Coordinate the work of the various mechanical trades, mechanical subcontractors, and the general mechanical work with the work of other trades and subcontractors to avoid interferences between piping, ductwork, equipment, architectural, electrical, and structural work.
- J. Finish necessary offsets in piping and ductwork together with fittings and connections required to properly install the work complete in place
- K. Install piping and ducts as close as possible to ceilings, walls, and columns, to utilize a minimum amount of space and to not obstruct any portion of windows, light fixtures, doorways or passages.
- L. In case interferences develop, the Engineer will decide which equipment or installation must be relocated regardless of which apparatus was first installed. Such work shall be accomplished at no additional cost.
- M. Locate and install valves, thermometers, gauges, fittings, filters, or other equipment or specialties requiring frequent reading, adjustment, inspection, repair, removal, or replacement conveniently and accessibly with reference to the finished building.

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- N. If necessary, make alterations and/or repairs to mechanical work and/or work specified in other divisions of the specifications because of lack of proper mechanical supervision and/or failure to coordinate work, and/or failure to direct locations of necessary openings, or framing. Pay all costs related to alterations or repair.

3.2 CLEANING

- A. The Contractor shall clean all dirt, construction dust, and debris from all mechanical facilities and equipment leaving them in a new condition. Touch up paint shall be applied where ever necessary.

3.3 EXECUTION

- A. No information given on the plans or in the specifications shall relieve the Contractor of the responsibility or coordination of the work. Each Contractor shall cooperate with the General Contractor and all other Contractors to coordinate their work, avoid interferences and delays, and coordinate all parts of the work in service and appearance with all other parts.
- B. Locate equipment which must be serviced, operated or maintained, in fully accessible positions. Equipment includes, but is not limited to, valves, cleanouts, motors, pumps, controllers, switchgear, filters and drain points. Minor deviations from the Drawings may be made to allow for better accessibility; however, changes must be reviewed and accepted by the Engineer prior to installation.

END OF SECTION

SECTION 15043

BALANCING AND TESTING OF HVAC SYSTEMS

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Work includes furnishing of all test equipment, materials and labor required to balance all air distribution and exhaust systems as specified herein and as shown on the Drawings.

1.2 QUALITY ASSURANCE

- A. The contractor shall obtain the services of an Engineer-accepted independent balancing and testing firm, which specializes in and whose primary (at least 90%) business is limited to the testing and balancing of HVAC systems. The company must meet the requirements for certification by the Associated Air balance Council. Copies of certification shall be provided to Owner as a partial condition for acceptance.
- B. The testing entity must have had experience balancing at least twenty-five (25) systems of similar size and complexity.
- C. The right to witness a verification of the readings during the Final Acceptance Walkthrough is reserved for the Engineer. The particular readings to be verified will be determined during the Final Acceptance Walkthrough.

1.3 SUBMITTALS

- A. Test Reports
 - 1. The Contractor shall submit copies of a plan indicating the procedures for review and acceptance for the testing and balancing of the air systems in accordance with SECTION 01340 at least 30 days in advance of balancing and testing activities.
 - 2. A final report listing all equipment Balanced and Tested under this Specification shall be prepared on company letterhead paper per the requirements of this paragraph. The Balancing and Testing report is to have a separate section for each site. Each section shall list all pieces of equipment for that particular site. The report shall be organized in a tabular format and shall contain the Name-Plate data and manufacturer's cut sheet

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for each piece of equipment, the first-pass data on the as-installed pre-balanced condition, the final data in the as-accepted condition and a column of remarks recording all the specific testing accomplished, all problems encountered and corrective action taken. Each entry shall also include names (printed) of testers involved with each specific piece of equipment. Each entry shall be signed and dated by the tester(s) involved. The test report shall (include at a minimum) the flows, voltage, current, speed, dry-bulb and wet-bulb temperatures, refrigerant suction and discharge pressures, coil temperature in both cooling and heating mode, control system operation and louver air velocity plus any other common trade data. The testing shall include all air handling appliances, air distribution systems, heating and ventilating equipment shown on the drawings and installed on site. Six (6) copies of the test report shall be submitted to the Engineer for review and acceptance prior to substantial completion.

3. A list of all equipment used in testing and balancing and the latest date of calibration of each piece shall be submitted. Equipment is to be calibrated no less than 6 months previous to the date of the balancing. A certificate from the testing agency shall be submitted as evidence to this.

1.4 WARRANTY

- A. The testing and balancing shall be warranted in accordance with SECTION 01605 of this Specification.

PART 2 PRODUCTS

2.1 RELATED EQUIPMENT

- A. Provide necessary dampers, throttling valves, thermometer wells and other equipment items as may be required to complete the work. The Contractor shall coordinate with the testing and balancing sub-contractor as construction progresses to avoid disturbance of new work for testing and balancing operations.

PART 3 EXECUTION

3.1 GENERAL

- A. Balance and testing shall not begin until the system has been completed, cleaned and is in full working order. The Contractor shall put all mechanical systems and equipment into full operation and shall continue the operation of same during each working day of testing and balancing.

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- B. Balance and testing shall be completed prior to the 120-hour test described in SECTION 01410.

3.2 AIR BALANCE AND TESTING

- A. The following tests, adjustments and records establish the minimum requirements for the contractor and pretesting entity.
1. Test and adjust blower rpm to design requirements; record final rpm.
 2. Test and record motor full load amperes and voltage.
 3. Make pitot tube traverse of main supply and obtain design cfm at fans.
 4. Test and record system static pressure suction and discharge of air handling units.
 5. Test and adjust system for design cfm recirculated air.
 6. Test and record entering air temperature (dry bulb heating and cooling).
 7. Test and record leaving air temperature (dry bulb heating and cooling).
 8. Adjust all main supply and return air ducts to proper design cfm.
 9. Test and adjust each diffuser, to within 5% of design requirements: may be done in branch duct with adjustment of volume extractor.
 10. Identify each diffuser and opening as to location and area.
 11. Identify and list size, type and manufacturer of diffuser and all testing equipment. Use manufacturer's rating on all equipment to make required calculations.
 12. In readings and tests of diffusers and registers, include required fpm velocity and test fpm velocity and required cfm and test cfm after adjustments.
 13. Adjust all diffusers, grilles and registers to minimize drafts in all areas.
 14. Test function of VVT system to include zone and bypass dampers.
 15. Test and record cfm of all exhaust fan grills.
- B. As part of this contract, the Contractor shall make any changes in the pulleys, belts and dampers or add any dampers as required for correct balance as recommended by the air balance and testing agency at no additional cost.

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3.3 CLEANING AND ADJUSTING

- A. The Contractor shall:
1. Lubricate all fan and heat pump bearings with oil or grease as recommended by manufacturer. Tighten belts to proper tension. Adjust fans to the speed indicated by the manufacturer to meet specified conditions. Adjust miscellaneous equipment to setting indicated or directed.
 2. Coordinate with the manufacturer's representative to adjust the automatically operated dampers and valves for required operation and to check all controls for proper calibration, operation, and function.

3.4 TESTING

- A. General: Conduct tests in the presence of the Engineer who shall be given a one week notice before any testing is to be conducted.

3.5 PERFORMANCE TESTS

- A. After cleaning, pressure testing and other such tests, and adjusting and balance are complete, each system shall be performance tested as whole to verify that all components perform as integral parts of the system, and temperatures and environmental conditions are evenly controlled throughout the building. Make corrections and adjustments as required to produce the conditions indicated.

END OF SECTION

SECTION 15050

BASIC MECHANICAL MATERIALS AND METHODS

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Work includes furnishing all materials, equipment and/or operations shown, and/or scheduled in the Contract Documents, including all labor necessary required to perform and complete the mechanical work specified herein and as noted on the Drawings.

1.2 RELATED REQUIREMENTS

- A. See DIVISION 9 - FINISHES
- B. See DIVISION 16 - ELECTRICAL

PART 2 PRODUCTS

2.1 MATERIALS

- A. Materials shall be new and of the best grades specified. Receive and be responsible for all Owner-furnished equipment and provide rough-in and final connections for all mechanical equipment furnished under this Contract or by others.

2.2 CURBS, BASES AND SUPPORTS

- A. Major curbs, openings, and equipment supports will be provided under the SECTION 15010 only where shown on the drawings. All other supports, anchors, and bases shall be provided by the mechanical contractor for all mechanical equipment. Equipment shall be supported per manufacturer's written recommendations for minimal noise and vibration from operations.
- B. Curbs, bases and supports shall be coated per SECTION 09900.

2.3 ANCHORS, HANGERS AND SLEEVES

- A. Provide and arrange for installation of required bolts, anchors, hangers, inserts, sleeves, etc., properly located for the work. Tape or wire hangers are not acceptable.

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B. MANUFACTURED UNITS

1. Hanger Rods:
 - a. Material:
 - 1) ASTM A36.
 - 2) ASTM A575, Grade M1020.
 - 3) ASTM A576, Grade 1020.
 - 4) Minimum allowable tensile stress of 12,000 psi at 650 DegF per MSS SP-58.
 - b. Continuously threaded.
 - c. Electro-galvanized or cadmium plated after threads are cut.
 - d. Load limit:

NOMINAL ROD DIAMETER	MAXIMUM SAFE LOAD, (LBS)
3/8 IN DIA (min)	610
1/2 IN DIA	1,130
5/8 IN DIA	1,810
3/4 IN DIA	2,710
7/8 IN DIA	3,770
1 IN DIA	4,960

2. Hangers:
 - a. Hangers for use directly on copper pipe: Copper or cadmium plated.
 - b. Hangers for use other than directly on copper pipe: Cadmium plated or galvanized, unless otherwise indicated on Drawings.
 - c. Hanger type schedule:

APPLICATION	PIPE SIZE	HANGER TYPE
All except noted	4 IN and less	ANVIL Figure 108 with Figure 114
All except noted	Over 4 IN	ANVIL Figure 590
Steam, condensate and hot water	All	ANVIL Figure 181 Figure 82 or equal

3. Concrete Inserts for Hanger Rods:
 - a. Continuous slots: Unistrut #P1000.
 - b. Individual inserts: ANVIL Figure 281.
 - c. Self-drilling expansion anchors: Phillips flush-end or snap-off end type.
4. Beam Clamps for Hanger Rods:
 - a. Heavy duty.
 - b. ANVIL Figure 133 or 134.
5. Trapeze Hangers for Suspended Piping:
 - a. Material: Steel.
 - b. Galvanized.

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- c. Angles, channels, or other structural shapes.
- d. Curved roller surfaces at support point corresponding with type of hanger required.
- 6. Vertical Pipe Supports:
 - a. At base of riser.
 - b. Lateral movement:
 - 1) Clamps or brackets as recommended by pipe support manufacturer.
- 7. Expanding Pipe Supports:
 - a. Spring hanger type.
 - b. MSS SP-58.
- 8. Pipe Support Saddle:
 - a. For pipe located 3 FT or less from floor elevation, except as otherwise indicated on Drawings.
 - b. ANVIL Figure 264.
- 9. Pipe Support Risers:
 - a. Schedule 40 pipe.
 - b. Galvanized, unless otherwise indicated on Drawings.
 - c. As recommended by saddle manufacturer.
- 10. Pipe Support Base Plate:
 - a. 4 IN larger than support.
 - b. Collar 3/16 IN thickness, circular in shape, and sleeve type connection to pipe.
 - c. Collar fitted over outside of support pipe and extended 2 IN from floor plate.
 - d. Collar welded to floor plate.
 - e. Edges ground smooth.
 - f. Assembly hot dipped galvanized after fabrication, unless otherwise indicated on Drawings.
- 11. Pipe Covering Protection Saddle:
 - a. For insulated pipe at point of support.
 - b. ANVIL Figure 167, Type B.
- 12. Wall Brackets:
 - a. For pipe located near walls and 8 FT or more above floor elevation or as otherwise indicated on the Drawings.
 - b. ANVIL Figure 199.
- 13. Pipe Anchors:
 - a. For locations shown on the Drawings.
 - b. 1/4 IN steel plate construction.
 - c. Hot dipped galvanized after fabrication unless otherwise indicated on Drawings.
 - d. Designed to prevent movement of pipe at point of attachment.
- 14. Pipe Guides:
 - a. For locations on both sides on each expansion joint or loop.
 - b. To ensure proper alignment of expanding or contracting pipe.
 - c. ANVIL Figure 256.

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15. Substitutions:
 - a. Submit request for substitutions in accordance with Specification Section 01640.

C. DESIGN REQUIREMENTS

1. Supports capable of supporting the pipe for all service and testing conditions.
 - a. Provide 2 to 1 safety factor.
2. Allow free expansion and contraction of the piping to prevent excessive stress resulting from service and testing conditions or from weight transferred from the piping or attached equipment.
3. Design supports and hangers to allow for proper pitch of pipes.
4. For chemical and waste piping, design, materials of construction and installation of pipe hangers, supports, guides, restraints, and anchors:
 - a. ASME B31.3.
 - b. MSS SP-58 and MSS SP-69.
 - c. Except where modified by this Specification or the Drawings.
5. For hot and cold water piping, design, materials of construction and installation of pipe hangers, supports, guides, restraints, and anchors:
 - a. ASME B31.1.
 - b. MSS SP-58 and MSS SP-69.
6. Check all physical clearances between piping, support system and structure.
 - a. Provide for vertical adjustment after erection.
7. Support vertical pipe runs in pipe chases at base of riser.
 - a. Support pipes for lateral movement with clamps or brackets.
8. Place hangers on outside of pipe insulation.
 - a. Use a pipe covering protection saddle for insulated pipe at support point.
 - b. Insulated piping 1-1/2 IN and less: Provide a 9 IN length of 9 LB density fiberglass insulation at saddle.
 - c. Insulated piping over 1-1/2 IN: Provide a 12 IN length of 9 LB density fiberglass insulation on saddle.
9. Provide 20 GA galvanized steel pipe saddle for fiberglass and plastic support points to ensure minimum contact width of 4 IN.
10. Pipe Support Spacing:
 - a. General:
 - 1) Factor loads by specific weight of liquid conveyed if specific weight is greater than water.
 - 2) Locate pipe supports at maximum spacing scheduled unless indicated otherwise on the Drawings.
 - 3) Provide at least one support for each length of pipe at each change of direction and at each valve.
 - b. Steel, stainless steel, cast-iron pipe support schedule:

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PIPE SIZES - IN	MAXIMUM SPAN - FT
1-1/2 and less	5
2 thru 4	10
5 thru 8	15
10 and greater	20

- c. Copper pipe support schedule:

PIPE SIZES - IN	MAXIMUM SPAN - FT
2-1/2 and less	5
3 thru 6	10
8 and greater	15

- d. PVC pipe support schedule:

PIPE SIZES - IN	MAXIMUM SPAN - FT*
1-1/4 and less	3
1-1/2 thru 3	4
4 and greater	5**

* Maximum fluid temperature of 120 DegF.

** Unless otherwise indicated on Drawings.

- e. Support each length and every fitting:
- 1) Bell and spigot piping:
 - a) At least one hanger.
 - b) Applied at bell.
 - 2) Mechanical coupling joints:
 - a) Place hanger within 2 FT of each side of fittings to keep pipes in alignment.
- f. Space supports for soil and waste pipe and other piping systems not included above every 5 FT.

- D. Anchors, hangers, and sleeves shall be coated as per SECTION 09900.

2.4 ELECTRICAL WIRING

- A. All line voltage wiring including switches, disconnects, conduits and starters will be as scheduled in DIVISION 16 or shown on the Drawings.
- B. Automatic control wiring and interlock wiring for Mechanical Equipment shall be as required for proper installation, and shall be inserted into conduit and meet the requirements of DIVISION 16.

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PART 3 EXECUTION

3.1 PIPE AND EQUIPMENT IDENTIFICATION

A. Valve Tags

1. All valves and covers (for buried installation) shall be identified with a brass tag secured to the valve or cover with brass or stainless steel wire S-hooks or chain. Tags shall be made of 19 gauge brass with stamped, black filled letters. Tags shall not be less than 1-1/2 inch size and be round with 3/16-inch top hole.
2. Valve tags shall be marked with 1/4-inch high letters that designate the pipe system at the top and 1/2-inch high numbers that designate the valve number at the bottom. Numbering shall be consecutive starting at one. Letters shall designate the piping system as indicated on the Drawings. For example, the letters "OF" refer to overflow piping.
3. A complete directory of valves giving use, location size, letter designation and number shall be prepared by the Contractor with permanent ink and framed with 8 1/2" x 11" aluminum frame. Frames shall be mounted on mechanical room wall where directed by the Engineer.
4. Manufacturers:

Seton Name Plate Corp., New Haven, CT.
Mechanical Tag System, Cedar Rapids, Iowa
Tags & Plates, Champaign, IL
or equivalent

B. Pipe Identification Markers for Viable Indoor and Above Grade Pipe

1. Provide printed identification markers at 20 foot intervals and at directional changes as directed by the Engineer to identify all visible indoor above ground piping.
2. Identification markers shall be all-temperature vinyl printed cloth markers with adhesive back or acrylic plastic "snap around" type for application on insulated and bare piping.
3. Provide direction arrows on all markers. All markers shall be color coded with black letters per the uniform plumbing code and applicable state amendments to the code. Non potable water lines shall have the words "Caution Non Potable Water, Do Not Drink" stamped on the markers.

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4. Letters on markers for use on 3 inch and larger diameter pipe shall be 2 inches high letters. Markers for use on pipe less than 3 inch diameter shall be 1 inch high.
5. Manufacturers and Models:

W.H. Brady Company, Z400 Indoor
Elcen, E-Z Mark
Seton Name Plate Corp., Set Mark
Or approved equal

C. Pipe Identification for Buried Pipe

1. Place markers at all angle points, intersections, and at 500' intervals along pipelines.
2. The markers shall be stamped and colored as indicated in pipe schedule and as indicated below, unless required otherwise by local codes:
 - a. Surface Water (SW) and Surface Water/Reuse Overflow (SW/RO) Piping shall have pipe caps stamped "SW" and painted blue.
 - b. Ground Water (GW), Aerated Ground Water (AGW), Chilled Water (CW) and heated Water (HW) Piping shall have pipe caps designated "WW" and painted orange.
 - c. Overflow (OF), Reuse Overflow (RO), Waste Drain (WD) and Combined Facility Drain Piping shall have pipe caps stamped "D" and painted yellow.
 - d. Sanitary Sewer (SS) Piping shall have pipe caps stamped "S" and painted yellow.
 - e. Potable Water (PW, PCW or PHW) Piping shall have pipe caps stamped "PW" and painted green.
 - f. Compressed Air (CA), Instrument Air (IA) and Low Pressure Air (LPA) Piping shall have pipe caps stamped "CA" and painted white.
3. All trimmed pipe shall be installed with detection or locator tape as shown on the Drawings. The detection tape shall be "Alarm-Line" underground warning tape by Alarm-Tapes, Inc., available from Hamilton Associates, Inc., 5160 Parfet, Unit B2, Wheatridge, CO 80033, (303) 940-0629, or approved equal. The tape shall consist of a flexible plastic sheath; permanently color-coded (impregnated) APWA Blue containing a solid aluminum foil core. The tape legend shall read "Buried Water Line Below" upon the 2 inch wide material (if tape is buried less than 30 inches deep).

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3.2 INSTALLATION

- A. Persons skilled in the installation of the various parts specified in this Division shall perform work throughout.
- B. Pipe Support System Installation
 - 1. Provide piping systems exhibiting pulsation, vibration, swaying, or impact with suitable constraints to correct the condition.
 - a. Included in this requirement are movements from:
 - 1) Trap discharge.
 - 2) Water hammer.
 - 3) Similar internal forces.
 - 2. Weld Supports:
 - a. AWS D1.1.
 - b. Weld anchors to pipe in accordance with ASME B31.3.
 - 3. Locate piping and pipe supports as to not interfere with open accesses, walkways, platforms, and with maintenance or disassembly of equipment.
 - 4. Inspect hangers for:
 - a. Design offset.
 - b. Adequacy of clearance for piping and supports in the hot and cold positions.
 - c. Guides to permit movement without binding.
 - d. Adequacy of anchors.
 - 5. Inspect hangers after erection of piping systems and prior to pipe testing and flushing.
 - 6. Install individual or continuous slot concrete inserts for use with hangers for piping and equipment.
 - a. Install concrete inserts as concrete forms are installed.
 - 7. Welding:
 - a. Welding rods: ASTM and AWS standards.
 - b. Integral attachments:
 - 1) Include welded-on ears, shoes, plates and angle clips.
 - 2) Ensure material for integral attachments is of good weldable quality.
 - c. Preheating, welding and postheat treating: ASME B31.3, Chapter V.
 - 8. Field Painting:
 - a. Comply with Section 09900.
- C. Before final acceptance, all mechanical equipment shall operate without objectionable noise or vibration. All equipment shall be adjusted to capacities shown on drawings. Contractor shall make all corrections for above conditions to provide a system acceptable to the Engineer at no additional cost to Owner.

END OF SECTION

SECTION 15060

PIPES AND FITTINGS

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. The work includes furnishing all labor, materials and equipment required to provide and install piping systems as indicated on piping schedule shown on the Drawings.
- B. Related sections:
 - 1. SECTION 15100 - Valves
 - 2. SECTION 02660 - Potable Water Distribution System
 - 3. SECTION 02665 - Potable Water Storage and Pumping
 - 4. SECTION 02730 - Sanitary Sewage System
 - 5. SECTION 15480 - Compressed Air System
 - 6. SECTION 15481 - Oxygen Systems

1.2 REFERENCES

AASHTO M 36	Corrugated Steel Culverts and Underdrains
ASTM A 47	Ferritic Malleable Iron Castings
ASTM A 53	Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless
ASTM A 74	Cast Iron Soil Pipe and Fittings
ASTM A 283	Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes and Bars
ASTM A 312	Seamless and Welded Austenitic Stainless Steel Pipe
ASTM A.376	Seamless Austenitic Steel Pipe for High Temperature Central Control Station
ASTM A 536	Ductile Iron Castings
ASTM A 570	Steel, Sheet and Strip, Carbon, Hot Rolled, Structural Quality
ASTM A 778	Welded, Unannealed Austenitic Stainless Steel Tubular Products
ASTM B 88	Seamless Copper Water Tube

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ASTM C 14	Concrete, Sewer, Storm Drain and Culvert Pipe
ASTM C 76	Reinforced Concrete Culvert, Storm Drain and Sewer Pipe
ASTM C 443	Gypsum Backing Board and Coreboard
ASTM C 564	Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM D 1248	Polyethylene Plastics Molding Extrusion Materials
ASTM D 1784	Rigid Poly Vinyl Chloride (PVC) Compounds and Chlorinated Poly Vinyl Chloride (CPVC) Compounds
ASTM D 1785	Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2122	Polyethylene Film and Sheeting
ASTM D 2321-89	Underground Installation of Flexible Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D 2467	Poly Vinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2564	Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 2665	Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D 2672	Joints for IPS PVC Pipe Using Solvent Cement
ASTM D 2729	Poly (Vinyl Chloride)(PVC) Sewer Pipe and Fittings
ASTM D 3034	Type PSM Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings
ASTM D 3035	Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
ASTM D 3139	Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D 3212	Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D 3261	Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM F 405	Corrugated Polyethylene (PE) Tubing and Fittings
ASTM F 437	Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F 439	Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F 441	Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
ASTM F 477-76	Elastomeric Seals (Gaskets) for joining Plastic Pipe

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ASTM F 493	Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings
ASTM F 667	Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings
ASTM F 714	Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
AWWA C 104	Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C 105	Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C 110	Ductile-Iron and Gray-Iron Fittings, 3 in through 48 in, for Water
AWWA C 151	Ductile Iron Pipe, Centrifugally Cast for Water or Other Liquids
AWWA C 200	Steel Water Pipe – 6in. (150 mm) and Larger
AWWA C 203	Coal-Tar Protective Coatings and Linings for Steel Water Pipelines-Enamel and Tape-Hot Applied
AWWA C 206	Field Welding of Steel Water Pipe
AWWA C 209	Cold Applied Tape Coatings for the Exterior of Sections, Connections, and Fittings for Steel Water Pipelines
AWWA C 210	Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines
AWWA C 213	Fusion Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipeline
AWWA C 606	Grooved and Shouldered Joints
AWWA C 900	Polyvinyl Chloride (PVC) Pressure Pipe, 4 in. through 12 in.
AWWA C 905	Polyvinyl Chloride (PVC) Water Transmission Pipe, Nominal Diameters 14 in. through 36 in.
AWWA M 11	Steel Pipe - A Guide for Design and Installation
ANSI/ASTA B16.1	Cast Iron Pipe Flanges and Flanged Fittings
ANSI/ASME B16.3	Malleable Iron Threaded Fittings
ANSI/ASME B16.9	Factory Made Wrought Steel Butt Welding Fittings
ANSI/ASME B16.11	Forged Fittings Socket Welding and Threaded
CISP 301	Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain Waste and Vent Piping Applications
CISP 310	Neoprene Rubber Gaskets for Hub and Spigot Cast Iron Soil Pipe and Fittings

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NFPA 54	National Fuel Gas Code
NFPA 58	LP - Gas Code
NSF 61	(ANSI) Drinking Water System Components – Health Effects

1.3 SUBMITTALS

- A. Provide submittals in accordance with instructions given in SECTION 01340.
1. Manufacturer's descriptive literature and recommended methods of installation. The descriptive literature shall designate the piping system in which it is to be used and include pipe sizes, wall thickness, piping schedule, standards of compliance, material of construction and any other pertinent data for the various piping systems.
 2. Shop drawings: The Contractor shall provide shop drawings and product data in accordance with SECTION 01340, showing laying diagram fabrication, joint details, and each special fitting to be furnished. These details and drawings shall be submitted to the Engineer for review and acceptance prior to ordering and fabrication.
 3. Manufacturer's certification that products meet specification requirements.

1.4 HANDLING OF PIPE

- A. The pipe shall not be dropped or subjected to any unnecessary jar, impact or other treatment that might damage the pipe. Any unit of pipe that in the opinion of the Engineer is damaged beyond repair shall be replaced by another unit. Any pipe that is damaged and repairable shall, at the discretion of the Engineer, either be disallowed for use on this project or repaired in the field to the Engineer's satisfaction.

PART 2 PRODUCTS

2.1 PIPING MATERIALS

- A. Piping materials and classifications shall be as indicated on the Drawings. Specifications for the piping materials and classifications shall be as specified herein except as noted below:
1. Below grade potable water (PW) piping shall be as specified in SECTION 02660.
 2. Below grade Sanitary Sewer Piping (SS or S) shall be as specified in SECTION 02730.

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3. Oxygen (O) piping shall be as specified in SECTION 15481.
4. Compressed Air (CA), Instrument Air (IA), Low Pressure Air (LPA), and Condensate Drain Piping (CD) shall be as specified in SECTION 15480.
5. Potable Water (PW), Potable Hot Water (PHW) and Potable Cold Water (PCW) Piping inside buildings and under building slabs shall be as specified in SECTION 15400 except as noted in paragraph 2.1.A.1 above.
6. Sanitary Sewer (SS) and vents for the Sanitary Sewer System inside buildings shall be as specified in SECTION 15400.

2.2 SCHEDULE 40 AND SCHEDULE 80 PVC PIPE (PIPE GROUP 8 AND 9 IN PIPE SCHEDULE)

- A. PVC pipe shall be manufactured by Certainteed, Diamond Plastics, J-M Manufacturing, Scepter, or approved equal.
- B. Pipe and fittings shall conform to ASTM D 1785 and shall be made from Class 12454-A or 12454-B virgin compounds in accordance with ASTM D 1784. Pressure pipe shall have the NSF seal of approval and shall be installed with solvent weld joints and fittings. Joints shall meet ASTM D 2672. Solvent cement shall meet ASTM D 2564. Socket type fittings shall meet ASTM D 2467.

2.3 DR SCHEDULE PVC PIPE (PIPE GROUP 10, 11 AND 12 IN PIPE SCHEDULE)

- A. Pipe 12" and smaller shall be in accordance with AWWA C 900 and have the DR rating or class as indicated on the Drawings.
- B. Pipe larger than 12" shall be in accordance with AWWA C 905 and shall have the DR rating as indicated on the Drawings.
- C. All DR schedule PVC pipe shall be constructed of cell class 12454B PVC compound in accordance with ASTM D 1784.
- D. Joints shall be bell and spigot type with thickened internal bells conforming to ASTM D 3139 and measured in accordance with ASTM D 2122. Gaskets shall meet the requirements of ASTM F 477.
- E. Fittings shall be ductile or cast iron conforming to AWWA C 110/ANSI A 21.10 with Bell and Spigot or mechanical joint.
- F. Fittings shall be mortar lined in accordance with AWWA C 104/ANSI A 21.4. Fittings shall be polyethylene encased in accordance with AWWA C 105.

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2.4 PVC SEWER PIPE (PIPE GROUP 13 IN PIPE SCHEDULE)

- A. PVC sewer pipe and fittings shall conform to ASTM D 3034 and F 679, SDR-35. Joints shall comply with ASTM D 3212 for bell and spigot joints using flexible elastomeric seals.
- B. Minimum slope:
 - 3" and under = 1/4" per foot.
 - 4" and above = 1/8" per foot or as shown on drawings
- C. Change in direction of sanitary sewer piping shall be made with 45° bends, 1/8 bends, long sweep 1/4 bends, combination wye and 1/8 bend. No sanitary tees or double hubs shall be used in horizontal sewers.
- D. Pipe joints, meeting ASTM D 3139, shall be made using an integral bell with an elastomeric gasket push-on type joint or using machined couplings of a sleeve type with rubber ring gaskets and machined pipe ends to form a push-on type joint. Rubber ring gaskets shall meet ASTM F 477. Furnish adequate gasket lubricant for connections and joints.

2.5 GALVANIZED STEEL PIPE (PIPE GROUP 2 IN PIPE SCHEDULE)

- A. Pipe
 - 1. Galvanized pipe shall be in accordance with ASTM A53. Minimum wall thickness shall be schedule 40. Pipe and fittings shall be hot dip galvanized.
- B. Fittings
 - 1. Fittings 2 1/2" and smaller shall be threaded in accordance with ANSI B16.11. Fittings shall be of galvanized malleable iron conforming to ASTM A47 and ANSI B16.3.
 - 2. Fittings larger than 2 1/2" shall be cast iron conforming to ANSI B16.1, 125 psi rated, with flanged or mechanical joints.

2.6 SCHEDULE 40, SCHEDULE 80 STEEL AND BLACK STEEL PIPE (PIPE GROUP 1 AND 3 IN PIPE SCHEDULE)

- A. Pipe
 - 1. Steel pipe shall be provided in accordance with ASTM A53 in conjunction with AWWA M11. Pipe shall be seamless, Type S and be constructed of Grade A steel.

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B. Joints

1. Buried pipe 2 1/2" or larger shall be provided with butt welded joints unless plain ends are required for connection to flexible couplings.
2. Buried pipe 2 1/2" or smaller shall be provided with threaded joints unless plain ends are required for connecting to flexible couplings.
3. Joints for above grade or exposed or interior pipe 2 1/2" or larger shall be butt welded, flanged or grooved joints. Grooved piping shall meet the requirements of the grooved coupling manufacturer.
4. Joints for above grade or exposed or interior pipe 2 1/2" or smaller shall be threaded joints.

C. Fittings

1. Welded fittings shall be factory made wrought steel butt welded fittings in accordance with ANSI/ASME B16.9.
2. Grooved fittings shall be rigid style couplings with malleable iron bodies conforming to ASTM A47 or ductile iron conforming to ASTM A536. Gaskets shall be molded or extruded elastomer as recommended by the coupling manufacturer for the intended use. Grooved couplings shall be provided by the Victolic Company of America or ITT General Gruvlock or approved equal.
3. Threaded fittings shall be threaded in accordance with ANSI B16.11 and constructed of malleable iron in accordance with ANSI/ASME B16.3. Fittings shall be class 150.

D. Coatings

1. Buried steel pipe and fittings less than 2 1/2" in diameter shall receive hot applied coal tar coating conforming to AWWA C203, with one coat of coal tar primer and two coats of coal tar enamel.
2. Buried steel pipe and fittings greater than 2 1/2" shall receive hot applied coal tar enamel coating with Kraft paper wrap, in accordance with AWWA C203.
3. Exteriors of exposed, submerged or interior steel pipe and fittings shall be factory cleaned and primed and field painted in accordance with SECTION 09900.

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E. Lining

1. Steel pipe and fittings less than 4 inches in diameter and shall not be lined. Pipe and fittings 4 inches and larger shall be lined with liquid epoxy lining suitable for piping 4 inches and larger and in accordance with NSF 61. Linings shall conform to AWWA D 102 inside systems No. 1 or No. 2.

F. Field Repair Work

1. Field repair of buried welded joints shall comply with AWWA C 206. Field repair of lining shall be in accordance with AWWA D 102 and the lining manufacturer's recommendations. Field repair of coating shall use cold-applied primer and tape in accordance with AWWA C 209.

2.7 AWWA SCHEDULE STEEL PIPE (PIPE GROUP 4 IN PIPE SCHEDULE)

A. Steel Pipe shall be designed in accordance with AWWA C200. Unless otherwise specified, buried pipe and fittings shall be designed for a maximum deflection of 5 percent of the internal diameter for the trench conditions specified plus an imposed wheel load equal to H-20 truck loading. Minimum cylinder thickness shall be as indicated in the Pipe Schedule. The diameter specified for pipe and fittings shall be the nominal inside diameter after lining.

1. Steel shall conform to the requirements of ASTM A570 Grade 30 or ASTM A283 Grade C. Pipe shall be straight or spiral seam in accordance with AWWA C200. Complete pipe manufacturing shall be performed at a single pipe production facility.

B. Joints

1. Buried pipe shall have welded joints conforming to AWWA C200 and AWWA C206, except where grooved type joints or plain ends for flexible couplings are shown or required for proper installation. Grooved type joints shall comply with AWWA C606.
2. Exposed pipe shall have grooved or shoulder type joints complying with AWWA C606, or welded joints complying with AWWA C200 and AWWA C206, except as noted on the Drawings or required for proper installation. Flanges, where specified, shall conform to ANSI B16.1 with a pressure class equal to or exceeding the pressure rating of the pipe, and have rubber gaskets. Plain ends shall be provided where connecting to flexible couplings.

C. Fittings

1. Fittings shall be in accordance with AWWA C200 and C208. Fittings shall have 2-piece elbows for 0-30° bends, 3-piece elbows for 31-45° bends, and

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4-piece elbows for 46-90° bends. The joint type for the fitting shall comply with joint specifications stated for the pipe material.

D. Lining

1. Steel pipe and fittings less than 4 inches in diameter and shall not be lined. Pipe and fittings 4 inches and larger shall be lined with liquid epoxy lining suitable for piping 4 inches and larger and in accordance with HSF 61. Linings shall conform to AWWA D 102 inside systems No. 1 or No. 2.

E. Coating

1. Steel pipe and fittings shall receive hot applied coal tar enamel coating with kraft paper wrap, in accordance with AWWA C203.
2. Exteriors of exposed or submerged pipe and fittings shall be factory cleaned and primed and field painted in accordance with Section 09900.

F. Field Repair Work

1. Field repair of buried welded joints shall comply with AWWA C206. Field repair of lining shall be in accordance with AWWA D 102 and the lining manufacturer's recommendations.. Field repair of coating shall use cold-applied primer and tape in accordance with C209.

2.8 HIGH DENSITY POLYETHYLENE (HDPE) PIPE (PIPE GROUP 14 AND 15 IN PIPE SCHEDULE)

- A. High density polyethylene pipe and fittings shall conform to ASTM D 3035 and shall comply with the requirements for Type III Class C, Category 5, Grade P34, as tabulated in ASTM D1248, PS11-70, WSF 14 and have the PPI designation of PE 3408.
- B. HDPE shall be flexible, non-toxic and black. The pipe shall have a minimum wall thickness corresponding to the DR designation shown on the Drawings. Pipe shall be accordance with ASTM F714.
- C. The material shall be of virgin quality.
- D. Pipe diameters shown on the Drawings shall be minimum inside diameter of pipe.
- E. Pipe and fittings shall be in accordance with ASTM D3261 and have ends butt-fused except where flanged ends are shown on the Drawings or required. Flanged ends shall have flange adapters made from a flange adapter fitting butt-fused to the pipe with a slip on flange for bolting to mating flange. Slip flange shall be steel per ANSI B16.1, with class having the same pressure rating as the pipe.

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Expansion and contraction shall be provided for as required by the piping manufacturer.

- F. Fittings shall be the same material, thickness, and joint type as pipe to which it is connected and in accordance with ASTM D3261.
- G. All internal weld beads shall be smooth and shall protrude into the pipe no more than 1/8 inch.

2.9 CORRUGATED POLYETHYLENE PIPE (PIPE GROUP 16 IN PIPE SCHEDULE)

- A. Pipe, corrugations and fittings shall be high density, high molecular weight polyethylene material (HDPE) conforming to the requirements of Type III, Category 4 or 5, Grade P33, Class C, or Grade P34, Class C polyethylene as described in ASTM D 1248. Corrugated polyethylene pipe in nominal diameters of 3 inch through 6 inch shall be manufactured in accordance with ASTM F 405. Larger diameter corrugated pipe shall be manufactured in accordance with ASTM F 667.

2.10 STAINLESS STEEL PIPE (PIPE GROUP 7 IN PIPE SCHEDULE)

- A. Stainless pipe shall conform to ASTM A 778 and have Schedule 40 wall thickness, size as indicated on the Drawings. Pipe shall be type 304 stainless steel and conform to ASTM 312 or ASTM 376, and shall have welded joints and fittings.

2.11 CAST IRON AND SOIL PIPE (PIPE GROUP 6 IN PIPE SCHEDULE)

- A. Cast iron soil pipe shall be standard weight and provided with Hub and Spigot or hubless end connections.
- B. Hub and Spigot Pipe and fittings shall conform to ASTM A-74. Gaskets for Hub and Spigot piping shall conform to ASTM C-564.
- C. Hubless pipe and fittings shall conform to CISP 301 and CISPI 310.
- D. Vent stacks through the roof shall be of the sizes indicated on the plans and extend above the roof a minimum of 12 inches.
- E. Vent piping shall be installed to meet the requirements of the current Uniform Plumbing Code.
- F. Vent or revent connections into waste or vent stacks shall be made at a point not less than 5'-0" above the highest served.

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- G. Wherever soil or vent pipes pass through the roof, an absolutely watertight joint shall be made by means of flashing and counter flashing made with 2-1/2 pound sheet lead. The flashing shall extend at least 12" on all sides of the pipe and shall extend up, over and down inside the pipe. The exact method of joining the flashing to various types of roofs and roofing materials shall be submitted for approval and coordinated with building manufacturer.

2.12 CONCRETE PIPE (PIPE GROUP 20 IN PIPE SCHEDULE)

- A. Concrete pipe shall be constructed of reinforced concrete, class as indicated in the Pipe Schedule.
- B. Concrete pipe shall have bell and spigot joints conforming to ASTM C14, class 3 with a rubber gasket conforming to ASTM C443.

2.13 COPPER PIPING (PIPE GROUP 21 AND 22 IN PIPE SCHEDULE)

- A. Copper Pipe:
 - 1. Pressure non-buried: ASTM B88, Type L hard.
 - 2. Pressure buried: ASTM B88, Type K.
 - 3. Non-pressure: ASTM B306.
- B. Fittings:
 - 1. Pressure non-buried: ANSI B16.22.
 - 2. Pressure buried: ANSI B16.22 or B16.26.
 - 3. Non-pressure: ANSI B16.23
- C. Soldering and Brazing:
 - 1. Non-buried:
 - a. ASTM B32 solder with a tin/antimony ratio of 95/5 and non-corrosive flux up to 180 DegF water temperature.
 - b. At 180 DegF and above, use brazing alloy with melting temperature above 1000 DegF and suitable flux.
 - 2. Buried: Silver solder per AWS A5.8.
 - 3. Oxygen Piping; See Section 15481
- D. See Piping Schedules on the Drawings.
- E. Unions:
 - 1. Pipe sizes 2 IN and smaller:
 - a. Copper, ground joint.
 - 2. Pipe sizes 2-1/2 IN and larger:
 - a. Brass flanged unions.

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2.14 DUCTILE IRON PIPE (PIPE GROUP 5 IN PIPE SCHEDULE)

- A. Ductile Iron Pipe:
 - 1. AWWA C151.

- B. Fittings and Flanges:
 - 1. AWWA C110.
 - 2. AWWA C115.
 - 3. Flanges drilled and faced per ANSI B16.1 for both 125 and 250 psi applications.

- C. Nuts and Bolts:
 - 1. Buried: Cadmium-plated meeting Military Specification QQ-P-416F, Type 1, Class 2 (Cor-Ten) for buried application.
 - 2. Exposed: Mechanical galvanized ASTM B695, Class 40.
 - 3. Heads and dimensions per ANSI B1.1.
 - 4. Threaded per ANSI B1.1.
 - 5. Project ends 1/4 to 1/2 IN beyond nuts.

- D. Gaskets: See individual piping system requirements in Section 15060.

- E. If mechanical coupling system is used, utilize pipe thickness and grade in accordance with AWWA C606.

- F. Polyethylene Encasement required on all buried DIP: See AWWA C105.

- G. See Piping Schedules in Section 15060.

- H. Manufactured Units
 - 1. Couplings:
 - a. Flanged adaptors:
 - 1) Unit consisting of steel or carbon steel body sleeve, flange, followers, Grade 30 rubber gaskets.
 - 2) Provide units equal to those specified in Article 2.1.
 - 3) Supply flanges meeting standards of adjoining flanges.
 - 4) Rate entire assembly for test pressure specified on piping schedule for each respective application.
 - b. Compression sleeve coupling:
 - 1) Unit consisting of steel sleeve, followers, Grade 30 rubber gaskets.
 - 2) Provide units equal to those specified in Article 2.1.
 - 3) Supply flanges meeting standards of adjoining flanges.
 - 4) Entire assembly to be rated for test pressure specified on piping schedule for each respective application.
 - 5) Provide field coating for buried couplings per AWWA C203.
 - c. Mechanical couplings:

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- 1) Use of mechanical couplings and fittings in lieu of flanged joints is acceptable where specifically specified in Section 15060. Utilize units defined in Article 2.1.
- I. Fabrication
 1. Furnish and install without outside coatings of bituminous material any exposed pipe scheduled to be painted.
 2. Furnish cast parts with lacquer finish compatible with finish coat.
 - J. Linings and Coatings
 1. Provide cement mortar lining in accordance with AWWA C 205.
 2. Provide polyethylene encasement for buried pipe in accordance with AWWA C 105.
 3. Piping for water systems that do not come in contact with fish, provide linings to a minimum thickness of 40 mils.

2.15 PIPING APPURTENANCES

- A. Flanges, Threads and Unions
 1. Unless otherwise noted, all flanges on equipment and appurtenances provided under this section shall conform in dimensions and drilling to ANSI/ASME B16.1, class as required to meet the pressure rating of the connecting pipe. All pipe threads shall conform in dimension and limits of size to ANSI/ASME B1.20.1, Taper Pipe Thread.
 2. Flanges for steel pipe 3 inch and over shall be forged steel slip on flanges of the following manufacturers or equivalent
 - a. Grinnell
 - b. Crane Co.
 3. Unions for steel pipe 2-1/2 inch and smaller shall be threaded and of the following manufacturers or equivalent
 - a. Stockham
 - b. Grinnell
 4. Unions used for jointing copper to ferrous pipe shall have a brass sweat copper connection and a corrosion resistant steel threaded connection. Seats shall be ground and matched for smooth alignment. Dielectric insert shall be rated for the temperature and fluid handled.
 5. Unions for PVC pipe shall be rated for Schedule 80 PVC materials and fittings and comply with ASTM D 1784 for PVC Type 1, Grade 1. Threaded fittings shall conform to ASTM D 2464.
 6. Adapter Flange. Adapter flanges shall be ductile iron complying with ASTM A 536. The flange shall meet ANSI B16.1 with cast iron flanges

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(ANSI B16.1), forged steel flanges (ANSI B16.5), and steel plate flanges (C207). Class of flange shall be as required to meet the requirements of the connecting pipe.

- a. PVC: Uni-Flange Corp. Series 900, EBAA Iron Series 8500, or approved equal.
 - b. Ductile Iron: Uni-Flange Corp. Series 400, EBAA Iron Series 1000 "EZ", or approved equal.
 - c. Set screws shall comply with AISI 4140 steel tensile, 190,000 psi minimum heat treated and zinc plated.
7. Blind Flanges. All blind flanges shall be manufactured of ductile iron in compliance with AWWA C 110 (ANSI A21.10), drilled and faced in accordance with ANSI B16.1, class as required to meet the pressure rating of the connecting pipe.
- a. Handles for removal of blind flange shall be 5/8 inch diameter reinforcing bars (two in all) welded in place.
8. Flange Hardware
- a. Flange gaskets shall comply with ANSI A21.10 and AWWA requirements. The 1/8 inches thick gaskets shall be of SBR or neoprene rubber complying with ANSI requirements.
 - b. Flange bolts and nuts of high carbon, heat treated steel shall comply with ANSI B18.2.1 standard and be zinc chromate plated.
9. Compression Couplings. APAC, Dresser, Romac compression coupling or approved equal. The coupling shall be of the type necessary for connecting the type and diameters of pipe required.
10. PVC Fittings. Unless otherwise noted on drawings or in the specifications, fittings for PVC pipe excluding schedule pipe shall be PVC and manufactured by Head Manufacturing Co., Preston, ID, (208) 852-2000 or (800) 635-2790, or approved equal and certified for the pressure rating of the associated pipe. Elbow fittings shall be standard angles, a combination of standard angles, or angles fabricated to the nearest one degree for PIP, IPS, and sewer pipes.

B. Welded Branch Fittings

1. Fittings shall be machine made and ground for a uniform fitting onto piping sidewalls.

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2. Fittings shall be carbon steel to meet criteria of ANSI/ASME B16.11 and ASTM A105M.
3. Fittings shall be of the size to match Schedule 40 or Schedule 80 black or AWWA steel pipe. Strength shall be equal 2000 PSI minimum. Connections shall be butt-weld, threaded, or socket weld type.
4. Approved manufacturers:
 - a. Allied Branchlet Type 1
 - b. Bonney Forge Weld-O-Let
 - c. Wheeling Pipe-O-Let

C. Wall and Floor Sleeves

1. All pipe sleeves installed in the floors shall be Schedule 40 steel and hot-dipped galvanized. Sleeves shall extend 4 inch above finished floors, or as otherwise shown on the Drawings.
2. Pipe sleeves where a mechanical seal is called out or shown on the Drawings and a water-tight seal is necessary shall be provided and shall be one of the following:
 - a. Manufactured wall sleeves of ductile iron with an integral anti-seep ring 1-1/2 inch wide minimum continuous all around. Provide with a mechanical seal between the pipe and the sleeve.
 - b. Fabricated wall sleeves of steel with an integral anti-seep ring 1-1/2 inch wide minimum, continuous all around. Hot-dip galvanize after fabrication. Provide with a mechanical seal between the pipe and the sleeve.

D. Mechanical Seals

1. Seals shall be modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening.
2. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and nut. After the seal assembly is positioned in the sleeve, tightening of the bolts shall cause the rubber sealing elements to expand and provide an absolutely water-tight seal between the pipe and wall opening.
3. The seal shall be constructed so as to provide electrical insulation between the pipe and wall, thus reducing chances of cathodic reaction between these two members.

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4. Where mechanical seals are installed into concrete walls or floors, the seal manufacturer shall provide a sleeve designed for use with the seal to be cast into the concrete.
 5. Mechanical seal shall be manufactured by "Link Seal" from Thunderline Corp. or approved equivalent.
- E. Pressure Gauges for Water Service
1. Pressure Gauge
 - a. Gauges shall have 2 or 2-1/2 inch diameter minimum dials unless otherwise noted, stainless steel or aluminum case, 1/4 inch or 1/2 inch NPT bottom or back connection. All bourdon tube connections (socket, tube and tip assembly) shall be silver bronze tube and welded for steel tubes. Movements shall be bronze or stainless steel with bushed bearing. Gauge accuracy shall be 2 1/2% of full range or less. Gauges shall be provided with a full scale pressure range as indicated on the Drawings.
 - b. Provide a gauge cock for all connections to piping.
 - c. Approved manufacturers:
 - 1) Ashcroft
 - 2) U.S. Gauge
 2. Differential Pressure Gauges
 - a. Differential pressure gauges shall be magnetically coupled diaphragm type with stainless steel or aluminum cases and provided with zero adjustment screws.
 - b. Provide a gauge cock for piping connections.
 - c. Approved manufacturers:
 - 1) Ashcroft
 - 2) U.S. Gauge
 - 3) Dwyer

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F. Temperature Gauges

1. Direct reading temperature gauges shall utilize a thermowell and mount directly onto piping tanks or other components which they measure the internal working fluids.
2. Remote reading temperature gauges shall be installed at a remote location and sense temperature with a remote bulb and thermowell that is inserted into piping, tanks or other components.
3. Temperature gauges shall be provided with the temperature range as indicated on the Drawings.
4. The temperature gauge manufacturer shall provide all necessary mounting hardware, thermo-wells and cabling for proper installation as shown on the Drawings.
5. Temperature gauges shall be hermetically sealed by metal thermometers with all working parts sealed inside the case. Temperature gauge shall have a minimum dial size of 2 inches. Tank gauges shall have a full scale accuracy of plus or minus one percent and have stainless steel cases and acrylic windows.
6. Approved Temperature Gauge manufacturers
 - a. Ashcroft
 - b. US Gauge
7. For Electronic temperature indicators refer to Drawings.

G. Stainless Steel Flexible Connections:

1. Stainless steel flexible connections shall be made of corrugated stainless steel hose covered with braided stainless steel.
2. Flexible connection shall absorb vibration, relieve stress from mating equipment and allow some misalignment of mating equipment with vibrating machinery.
3. Minimum operating pressure shall be 200 psi at 70°F.
4. End fittings to be flanged or pipe threaded for connections as shown on the Drawings.
5. Approved manufacturers:
 - a. Piping Accessories Inc.
 - b. Stemmerich Inc.

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H. Flexible Couplings

1. The pipe couplings shall be of a gasketed, sleeve-type with diameter to properly fit the pipe.
2. Each coupling shall consist of one (1) steel middle ring, of thickness and length specified, two (2) steel followers, two (2) rubber-compounded wedge section gaskets and sufficient trackhead steel bolts to properly compress the gaskets.
3. Flexible couplings shall be rated or above the pressure rating of the pipe.
4. Flexible couplings to be straight type flexible couplings for joining plain end pipe of same size diameter or transition-type flexible couplings for joining plan end pipe of different outside diameter.
5. Approved manufacturers:
 - a. Keflex
 - b. Flexonics
 - c. Metraflex
 - d. Rockwell
 - e. Dresser

I. Quick Disconnects

1. Quick disconnect couplings shall provide positive leak proof connections for hoses and pipes that can be quickly and easily disconnected and reconnected without lugs, twisting or the use of tools.
2. Quick disconnect shall lock in place when coupled using a cam and groove system.
3. Quick disconnect coupling shall be constructed of stainless steel unless otherwise indicated and have Buna - N gaskets.

J. Rubber Hose or Flexible Connections

1. Hoses for pipe and tubing shall be rubber hose with a multi-fiber braid reinforcement.
2. Hose shall be rated for a minimum operating pressure of 225 psi, and have a minimum operating temperature range of -40 degrees F to 160 degrees F.
3. Hose shall be rated for air and water use.

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4. End fittings shall be pipe threads to match piping and quick disconnect connections couplings or connecting piping.
5. Approved manufacturers:
Weatherhead
Goodyear
Goodrich

K. Trench Drains

1. Trench Drains shall be made of precast polymer concrete with a top width of 6.1 inches, radiused bottoms, and nominal length of 39.2 inches. All channels shall interlock with tongue and groove connections with adjoining channels. Each channel shall have four horizontal anchoring ribs to mechanically lock the channel into the floor. Channels shall have a built-in slope of 0.6%. Channels shall be provided with galvanized steel locking grates, furnished by channel manufacturer. Locking mechanism shall be designed to provide obstruction free trench access.
2. Approved manufacturer:
 - a. Polydrain, Inc.

L. Manual Air Vents

1. A manual air vent shall be provided in all closed and open loop piping at high points of water system which are not vented by other means.
2. Air chamber shall extend vertically from piping.
3. Tap 1/4" Type L copper (or larger if indicated) from top of air chamber to discharge location.
4. Provide 1/4" tee handle brass cock in outlet piping at accessible location.

PART 3 EXECUTION

3.1 GENERAL

- A. All pipe shall be installed in strict accordance with manufacturer's recommendations, drawings and/or specifications and in the best commercial trade practice.
- B. Wherever a pipe passes from concrete to earth, a flanged connection, mechanical seal or a flexible joint shall be installed as shown or required. Particular care shall be taken to ensure a full support of the pipe in the earth between and beyond the

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joints. Pipe passing through concrete wall shall have integrally cast or welded on water stop ring cast into wall.

- C. Where pipes pass through walls and floors, extreme care shall be exercised to ensure joints are watertight. The pipe shall be free of all dirt and grease to secure a tight bond with the concrete.
- D. Welding shall be done by certified operators who have been qualified by tests as prescribed by the AWS in Standard Qualification Procedure to perform the type of work required. The quality of welding shall conform to AWS Code of Arc Welding in Building Construction, Section 4, Workmanship.
- E. The Contractor shall perform all work of cutting pipe and fittings or special castings necessary to the proper and accurate assembly, erection and completion of the work. All pipe shall be cut to fit accurately with smooth edges and faces.

3.2 INSTALLATION

A. Alignment

- 1. Alignment of pipe shall be maintained to lines and grades shown on the Drawings. Site installation shall be as staked in the field by the Contractor.

B. Exposed and Interior Pipe

- 1. Exposed and interior piping shall be run parallel and square with the lines of the structures unless otherwise indicated. Pipes shall be accurately cut to allow assembly without springing or forcing.
- 2. All exposed and interior piping, valves, and fittings shall be securely fastened to the structure with hangers, supports, guides, anchors or sway braces to maintain pipe alignment, prevent sagging and straining due to uncontrolled movement. All supports shall support the weight of pipe, fittings, valves and contents without exceeding the maximum recommended load for the pipe support.
- 3. Pipe supports shall be as detailed on drawings or as specified in SECTION 15050. Spacing of supports shall not exceed 10 feet for ferrous metal piping 2 inch and larger diameter and 5 feet for nonferrous piping and all piping less than 2 inch in diameter.
- 4. Pipe supports shall be installed to support pipes at all pump connections and changes in direction.

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5. Contractor shall provide additional supports which may be determined as necessary by the Engineer for the proper suspension, bracing, or support for the pipe.
6. Contractor shall provide special supports under the pipe where fixtures such as valves, etc., are to be supported by the pipe. No attempt is made to show all of these supports or hangers on the drawings, but the Contractor shall be required to include such supports and bracings and they shall be installed in a manner which would be considered as good practice in the trade and in compliance with the requirements of the Engineer.
7. All pipe supports, hangers, racks and anchors shall be hot-dip galvanized after fabrication. All hangers, racks, saddles and supports shall be of standard manufacture for that purpose. No straps or hangers of plumber's tape shall be acceptable.
8. Flanged joints shall be made up true and square so that there is no strain on pipe or valve. Bolts shall be tightened uniformly around the joint.
9. Threaded joints shall be neatly cut with sharp tools, and the jointing procedure shall conform with the best trade practice. Before jointing, all scale shall be removed from pipe by some suitable means such as standing on end and rapping sharply. After cutting, all pipe shall be reamed. All pipe shall be screwed together with an application of approved pipe compound applied to all threads, and once a joint has been screwed tight, it shall not be backed off unless the threads are re-cleaned and new compound applied. This application shall be neatly made and all compound and dirt shall be thoroughly wiped off the outside of every joint.
10. Unions shall be installed in all threaded joint piping to facilitate the removal of sections for maintenance and repair in accordance with the best trade practice. All such unions shall be included in the bid price whether shown on the drawings or not. Connections between pipes of dissimilar metals shall be made with insulating unions (dielectric). This shall include cast-iron valve connections to adapters for copper pipe, etc.
11. Special joints such as plastic fittings, copper tubing joints, etc., shall be made in accordance with the manufacturer's specifications. All low points in piping shall have valved drains.

C. Buried Pipe

1. Any special tools required for laying, jointing, cutting, etc., shall be supplied and properly used. All pipe shall be thoroughly cleaned before laying and shall be kept clean until accepted in the completed work and when laid, shall

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conform accurately to the lines and grades given. At all times during pipe laying operations, the trench shall be kept free of water.

2. All pipe and fittings shall be delivered in sound condition. Care shall be taken to protect pipe exterior coatings and linings during all phases of the work. Place no material of any kind inside of any piece of pipe or fitting during handling, storage or transit. Pipe and fittings shall be stored in a protected area. Use strap slings for lifting coated pipe.
3. Any section of pipe with a damaged end or barrel shall be repaired as directed if in the opinion of the Engineer a satisfactory repair can be made; otherwise, the damaged section shall be replaced with an undamaged section at the expense of the Contractor.
4. All piping systems shall be constructed from the materials shown and to the lines, grades and dimensions shown. Where not shown, the pipes shall be located to avoid interference with other features.
5. Bell-and-spigot pipe shall be laid with the bells upstream of the flow. All types of piping shall be laid and fitted together so that, when complete, the pipe will have a smooth and uniform invert. Lay pipe, fittings and accessories with proper equipment and in a manner to prevent damage. Each length of pipe laid shall be thoroughly swabbed to remove all foreign material before the next length is laid. Each pipe shall be inspected for defects before being lowered into the trench. Any defective pipe materials found during inspection, prior to placing within the trench, shall be replaced at the expense of the Contractor. When pipe laying is not in progress, seal the open ends of installed pipe to prevent entrance of water into the line. Whenever water is excluded from the interior of the pipe, place enough backfill on the pipe to prevent floating in the event of dewatering failure. Remove any pipe that has floated from the trench and restore the bedding. No pipe shall be laid when the trench conditions or the weather are unsuitable for proper installation as determined by the Engineer.
6. All piping for which no location dimensions are shown shall be installed in a neat and workmanlike manner in accordance with the best trade practice. It shall be the Contractor's responsibility to properly layout all piping to clear obstructions such as equipment, larger sized pipes, etc. Under no condition, shall the pipe be laid against the wall of a trench. The minimum distance for exterior of pipe to trench wall shall be 4 inches. The minimum distance between pipes in the same trench (either vertical or horizontal) shall be 6 inches. Hand tamping of backfill shall be required in areas with less than 12 inches of clearance between a pipe and another pipe, structures, or trench sidewall.

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7. When deflecting the pipe from a straight line, either in the vertical or horizontal plane or when long radius curves are shown, the amount of deflection allowed shall not exceed that recommended by the pipe manufacturer.
8. Buried pipelines shall be installed only in the presence of the Engineer. Trenching and backfill shall be as specified in SECTION 02221. All buried pipe shall be placed with bedding as detailed on the Drawings.
9. All laying operations to provide watertight pipe and pipe joints shall be the responsibility of the Contractor. If adjustment of the position of a length of pipe is required after it has been laid, it shall be removed and rejoined as for a new pipe.
10. Jointing materials of approved type shall be installed in strict accordance with their manufacturer's specifications. Clean the sealing surfaces of the pipe immediately before assembly, and assembly shall be made as recommended by the manufacturer. Check the completed piping to assure joints are intact. Prior to the placement of earthfill or other material around the pipe, observe pipe for leakage. Repair any leaks. Repeat the procedure until the pipe is watertight (The pipe joints shall show no leakage). Pipe joints shall not be deflected in an amount greater than recommended by the manufacturer.

D. Flexible Couplings

1. Flexible couplings for joining plain ends of buried and exposed pipe shall be installed as per manufacturer's instructions.
2. Middle and following rings and bolts shall receive a shop coat of rust inhibitive primer. All flexible couplings below ground shall be treated after installation with a heavy coating of single part coal-tar epoxy.

E. Pipe Identification

1. Pipe identification shall be as indicated in SECTION 15010.

F. Trench Drains

1. Trench Drains shall be installed in strict accordance with the manufacturer's details. A minimum of 4" concrete shall be placed below each channel. Catch basins shall be precast polymer concrete provided by the same manufacturer as trench drains.

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2. Any trench drain entering the catch basin shall interlock fully with tongue and groove connection. Joints between channels shall be sealed with adhesive in accordance with manufacturer's recommendations.

G. Vents

1. Vents shall be installed where air can collect at high points in the piping.
2. Where large quantities of air can collect provide an enlarged stand pipe.
3. Vent tubing from manual and automatic vents shall be vented to the nearest floor drain or to a slab that slopes to a floor drain.

3.3 TESTING

A. All pipes

1. Tests shall be conducted at any time during the course of construction as deemed necessary by the Engineer. The type of test conducted shall be at the Engineer's option. Whenever the rate of infiltration, exfiltration or deflection is found to exceed the allowable amounts, the Contractor shall stop construction. The Contractor may then be required to provide at his own expense, televised or photographic visual inspection of the interior of the pipe to help determine the reason for failing the testing. The Contractor shall make appropriate repairs by methods approved by the Engineer, and shall retest the pipeline until it is satisfactory. No compensation shall be paid to the Contractor for testing, televising, photographing, repairing, delays or reconstruction to comply with the allowable leakage amounts.
2. Work accomplished under this subsection will not be measured, nor will it be paid for directly. This work will be considered as incidental to the subject pipe installation and all costs in connection therewith shall be included in the unit price for the pipe.

B. Pressurized Water and Formalin Lines

1. The following pressurized water lines shall be hydrostatic tested: IR, GW, AGW, CW, HW, F, GP, LIFT, PB, SP, SW, SW/RO AND UW. Refer to SECTION 02660 for testing of buried PW piping. Refer to SECTION 15400 for testing of PW, PHW, PCW and V piping inside building.
2. Contractor shall notify the Engineer at least 48 hours prior to testing. The Engineer will be present at all tests.
3. The Contractor shall provide all test equipment including test pumps, gauges, pipe connections, instruments, other apparatus required, and

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personnel necessary to conduct the test. Pressure gauges used shall be graduated in increments not greater than 5 psi and shall have a range of approximately twice the test pressure. Only recently calibrated gauges and instruments may be utilized for testing procedures.

4. Systems may be tested in sections as work progresses; however, any previously tested portion shall become a part of any later test of composite system.
5. Prior to testing, remove from systems all equipment which would be damaged by test pressure. Provide and install plugs as required for testing. Replace removed equipment after testing.
6. Test time will be accrued only while full test pressure is on system. Prepare and brace the pipeline in accordance with equipment manufacturer's instructions.
7. Complete all testing and secure acceptance by the Engineer before backfilling or concealing lines. If it is necessary to partially backfill the line prior to testing to hold the line in place, the initial backfill shall cover only the body of the pipe with joints and connections left uncovered for inspection. When local conditions require that the trenches be backfilled immediately after the pipe has been laid, the testing may be carried out after backfilling has been completed, but before placement of permanent surface.
8. Fill each section of the pipe slowly with water and expel air by means of taps at high points. Apply the specified test pressure by means of pump connected to the pipe in an approved manner. The pressure shall be slowly built up to the maximum design working pressure. Pressurization should take a minimum of ten (10) minutes for pipes four (4) inches and smaller in a test section of 1,000 feet and proportionally longer for increased diameters and lengths. Maintain the test pressure by additional pumping if necessary for the specified time during which the system and exposed pipe, valves and fittings, shall be carefully examined for leakage. Repair or remove and replace all defective elements and repeat the test until all visible leakage has been stopped and no leakage is detected. Monitor pressure drops and inspect the pipeline in its entirety while the test pressure is maintained. Test shall be pressure as indicated in the Piping Schedule.
9. The duration of each leakage test shall be two hours, unless otherwise specified, and during the test the main shall be subjected to the quantity of water that must be supplied into the newly laid pipe, or any specified leakage test pressure after the pipe has been filled with water and the air in the pipeline has been expelled. No installation will be accepted if leakage in excess of that indicated in the Pipe Schedule is detected.

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10. Using methods reviewed and accepted by the Engineer, correct leaks by remaking joints with new material after the leaks have been corrected the system shall be retested using the same method.

C. Drain Lines

1. The following drain lines shall be tested using the method described below: CFD, FV, FR, OF, RO, PWV, SD AND WD. Refer to SECTIONS 02730 for testing of SS and V piping. Refer to SECTION 15400 for testing of SS and V piping inside buildings.
2. Perform a pressure/leakage test upon the completion of each section. Perform leakage tests, except where excessive amounts of ground water are encountered, in which case perform infiltration tests. Plug lower end of section to be tested with suitable test plug and provide blocking as needed. Slowly fill the section with water (being careful to expel all air) from high point. Minimum water head on any test section shall be as indicated in the Pipe Schedule. Extend or plug cleanouts as necessary. Let stand for six hours. Allowable leakage shall be as indicated in the Pipe Schedule. Where leakage in excess of that indicated in the Pipe Schedule is discovered, repair, and if necessary, re-lay the line.

D. Compressed Air and Oxygen Piping

1. Compressed air and instrument air piping shall be tested in accordance with SECTION 15480.
2. Oxygen piping shall be tested in accordance with SECTION 15481.

END OF SECTION

SECTION 15100

VALVES

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Work includes furnishing all labor, material and equipment required to provide and install valves for all piping except potable water (PW, PHW and PCW), compressed and instrument air (CA, CD and IA), low pressure air (LPA) and oxygen (O) system valves as specified herein and shown on the Drawings. Work also includes operating nuts, valve boxes, tee posts, and accessories as required.
- B. Refer to SECTIONS 02660, 11200 and 15400 for PW, PHW and PCW system valves.
- C. Refer to SECTION 15480 for CA, CD and IA system valves.
- D. Refer to SECTION 15481 for O system valves.

1.2 SUBMITTALS

- A. Provide submittals that include pressure ratings, materials of construction, dimensional drawings, CV ratings and manufacturers product literature for all valves specified herein in accordance with SECTION 01340.
- B. Submit Operations and Maintenance Literature for all valves in accordance with SECTION 01730.

PART 2 PRODUCTS

2.1 GENERAL

- A. All valves shall be manufacturer's standard design unless otherwise specified and shall be furnished with operating wheel, wrench nut or lever as noted on the Drawings. Unless otherwise indicated, the direction of rotation of the wheel, wrench nut or lever to open the valve shall be to the left (counter-clockwise). Each valve body or operator shall have cast thereon the word OPEN and an arrow indicating the direction to open. A union, flanged, grooved or shouldered type connection shall be provided within 2 feet of each threaded end valve unless the valve can be otherwise easily removed and such techniques of removal are reviewed and accepted by the Engineer.

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- B. All valves of the same type shall be from a single manufacturer.
- C. Unless otherwise specifically noted in these specifications or on the drawings, all valves in contact with water supply for hatchery operations (fish rearing, holding, incubation) shall have only iron, stainless steel, Buna N or plastic for bodies and trim. No bronze trim or other heavy metal material will be allowed.
- D. All valve materials shall be compatible with the connecting pipe material.

2.2 PROCESS SYSTEMS

- A. Process systems include all process water and glycol systems. Valves for compressed and instrument air (CA, CD and IA), potable water (PW, PHW and PCW), and oxygen (O) are included in other sections. Formalin valves (F) are included later in this specification.
- B. Unless otherwise indicated on the Drawings, Process System Butterfly Valves, Ball Valves, Plug Valves, Check Valves and Gate Valves shall be installed according to the following schedule. All other valves shall be as specified herein.

VALVE INSTALLATION	SIZE	MATERIAL
Buried	All	Iron or Steel
Located in Buried Vault	All	Iron or Steel
Indoors and Exposed	2 1/2" and smaller	Plastic
	3" and larger	Iron or Steel

C. Butterfly Valves

1. Butterfly Valves - Iron Body

- a. Valves shall be tight closing by means of a corrosion resistant metal disc against a resilient seat of Buna-N, Hycar or EPDM material.
- b. Valve shafts shall be stainless steel with self-lubricating bronze or brass bushing and permanently packed seals.
- c. Discs shall be ductile or cast iron secured to shafts in such a way as to transmit normally occurring operating torques.
- d. Valves shall be rated for 150 psi or greater and have a wafer style body or be provided with grooved connections for use with grooved piping.

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2. Butterfly Valves - Plastic Body
 - a. Plastic butterfly valves shall have polyvinyl chloride (Type 1, Grade 1) body with polypropylene (Type 1) disc. Seat shall be neoprene and provide bubble tight shut-off. Stems shall be stainless steel.
 - b. Valve shall be rated for 150 psi or greater.
3. Exposed Valves
 - a. Exposed butterfly valves 6 inches and under shall be position locking lever operated, except where noted otherwise. Full open to full closed position shall be one quarter turn of the lever.
 - b. Exposed 8-inch diameter and up butterfly valves or valves designated to have gear operators on the Drawings shall have rotary manual type operators with weatherproof construction. Valves shall have a position indicator window and handwheel or crank actuator input, except where specifically noted to provide another type of input. Provide hand wheel, nut or chain operators as indicated on the Drawings.
 - c. Gear type manual valve operators shall be either rack and pinion or traveling nut type designed to withstand 450 foot-pounds of input torque at full open or closed positions without damage to the valve or operator. Valves shall open with a counter-clockwise rotation. The maximum force needed to operate the valve shall be no more than 80 pounds.
 - d. Electrically actuated valves shall be provided with an electric actuator sized by the valve manufacturer and shall comply with the following criteria:
 - 1) General:
 - a) Self contained including motor, gearing, torque switch, limit switches and cast housing.
 - b) Electrical enclosure: NEMA 4 or NEMA 7 to comply with area rating classification shown on Drawings.
 - c) Factory assembled requiring only field connection of power and control wires.
 - d) Comply with Section 11005.
 - 2) Motors:
 - a) Produce 1.5 times the required torque.
 - b) Sized for two complete open-close cycles without overheating.
 - c) One fully closed to fully open cycle to occur within 60 SEC.

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- d) Class F insulation.
 - e) Operate at plus or minus 10 percent voltage.
 - f) 120 Volt, single phase, 60 Hz.
 - g) Provide thermal cutout switch and internal heater for actuator enclosure.
 - h) Control wiring as shown on Drawing control diagrams.
- e. Where shown on the Drawings, provide butterfly valves with an extended neck and shaft that places the gear actuator away from the valve body. The length of the neck and shaft extension shall be as shown on the Drawings or as required to place the actuator at a convenient location for the operation of the valve. The actuator shall have a hand crank, handwheel or chain operator as shown on the Drawings.
4. Buried Butterfly Valves
- a. All buried iron body valves shall be factory-coated per SECTION 09900.
 - b. All buried valves shall be furnished with mechanical gear operators. Valve operators shall be designed to hold disc in any intermediate position between full open and fully closed without creeping or fluttering. They shall be totally enclosed, lifetime lubricated, fully gasketed and designed to withstand submersion in water.
 - c. Valve operator shall be traveling nut type designed to withstand 450 foot-pounds of input torque at full open and closed positions without damage to the valve or operator. Valves shall open with a counter-clockwise rotation. The maximum force needed to operate the valve shall be no more than 80 pounds.
 - d. Where indicated on the Drawings, buried valves shall have buried actuators at the valve with extension shafts terminating at ground or floor level in a valve box with a 2 inch square AWWA nut. Extension shafts shall be 1-1/4" square and have a centering device for installation in a 5-1/4" valve box.
 - e. Where indicated on the Drawings, buried valves shall be furnished with an extended neck or operating stand and shaft placing the installed height of the actuator centerline at 3'-6" above finished grade. An integral position indicator shall be included in the top of the actuator.

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- f. Buried valves shall have flanged ends or grooved joint ends or as indicated on the Drawings. Discs shall be stainless steel or factory coated iron.
- 5. Approved manufacturers:
 - a. Iron Body:
DeZurik, Sartell, MN
Nibco, Elkhart, IN
Mark Controls Corp. (Centerline), Tulsa, OK
 - b. Plastic Body:
ASAMI/America, Medford, MA
Hayward
- D. Ball Valves
 - 1. Ball Valves - Plastic Body
 - a. Ball valves shall be lever handled true union rated at 150 psi, non-shock. Valves shall be thermoplastic PVC materials with self lubricating Teflon seats, EPDM O-rings, full-port design. Valves shall be "safe blocked" such that downstream end can be disassembled while upstream remains pressurized.
 - b. Termination ball valves may be single union.
 - c. Approved manufacturers:
Hayward
Chemtrol
ASAHI/American
 - 2. Ball Valves - Steel Body
 - a. Ball valves shall have cast steel or iron body, stainless steel ball and stem, teflon seats and be lever actuated unless indicated otherwise on the Drawings. Ball valves shall be rated for 285 psi or greater. End connectors shall be flanged.
 - b. Approved manufacturers:
Crane
KTM
Jenkins

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E. Gate Valves

1. Gate Valves - Iron Body

a. Gate valves shall be non-rising stem type, flanged joint, iron body, rubber encased iron wedge, resilient seat, corrosion-resistant interior coating, "O" ring stem seal, 175 psi pressure rating. Valves shall have 2-inch square wrench nut or handwheel operators turning counter-clockwise to open as indicated or shown on the Drawings. Valve shall be AWWA approved.

b. Approved manufacturers and model:

Mueller	A-2360 or 2361 series
Clow	RW
Kennedy	1579

2. Gate Valves - Plastic Body

a. Plastic body gate valves shall be constructed with PVC or polypropylene bodies and gates and EDPM "O" ring seals.

b. Valves shall be non-rising stem with a solid wedge disk and shall be rated for 150-psi at 73°F. Valves shall have handwheel actuators.

c. Approved manufacturers:

Harrington Industrial Plastics

3. Buried Gate Valves

a. All buried iron body valves shall be factory coated per SECTION 09900.

b. Where indicated on the Drawings, buried valves shall have buried actuators at the valve with extension shafts terminating at ground or floor level in a valve box with a 2 inch square AWWA nut. Extension shafts shall be 1-1/4" square and have a centering device for installation in a 5-1/4" valve box.

c. Buried valves shall have flanged ends as indicated on the Drawings. Discs shall be stainless steel or factory coated iron.

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F. Check Valves

1. Swing Check Valves - Plastic Body

- a. Check valves shall be swing type suitable for horizontal or vertical installation and shall be rated for 150 psi.
- b. Body and disc shall be PVC or polypropylene and shall have removable top for access to internals without removing from piping. Body and disc may also be stainless steel.
- c. Valve seat shall be EPDM and shall seal at as low as 5 psi back pressure.
- d. Approved manufacturers:
ASAHI/America
Stockham
Crane
American Valve

2. Swing Check Valves - Iron Body

- a. Swing check valves shall have a swing type flap gate, removable top and be constructed of cast iron, rated for W.O.G. service at 250 psi.
- b. Approved manufacturers:
Jenkins
Nibco
Worcester

3. Silent Check Valves

- a. Check valves shall be of the silent operating type that begin to close as the forward flow diminishes and are fully closed at zero velocity preventing flow reversal and resultant water hammer or shock.
- b. The valve design shall incorporate a center guided, spring loaded disc, guided at opposite ends and have a short linear stroke that generates a flow area equal to the pipe size. The operation of the valve shall not be affected by the position of installation. The valve shall be capable of operating in the horizontal or vertical positions with the flow up or down. Heavy duty springs for vertical flow down installations shall be provided when specified on 14 in. and larger valves.
- c. All component parts shall be field replaceable without the need of special tools. A replaceable guide bushing shall be provided and held in position by the spring. The spring shall be designed to withstand

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100,000 cycles without failure and provide a cracking pressure of 0.5 psi and to fully open at a flow velocity of 4 ft/sec.

- d. The valve disc shall be concave to the flow direction providing for disc stabilization, maximum strength, and a minimum flow velocity to open the valve.
- e. The valve disc and seat shall have a seating surface finish of 32 micro-inch or better to ensure positive seating at all pressures. The leakage rate shall not exceed one-half of the allowable rate for metal seated valves allowed by AWWA Standard C508 or 0.5 oz per hour per inch of valve diameter.
- f. The valve flow way shall be contoured and unrestricted to provide full flow areas at all locations within the valve. Cv flow coefficients shall be equal to or greater than specified below and verified by an independent testing laboratory.

Valve Size	Wafer Style Cv	Globe Style Cv
2 in	66	N/A
2.5 in	88	110
3 in	130	155
4 in	228	278
5 in	N/A	435
6 in	520	625
8 in	900	1115
10 in	1450	1770
12 in	N/A	2500

- g. The valve body shall be constructed of ASTM A126 Class B cast iron, ASTM A216 Grade WCB cast steel, or ASTM A536 Grade 65-45-12 ductile iron. The seat and disc shall be ASTM A351 Grade CF8M stainless steel. The compression spring shall be ASTM A313 Type 302 stainless steel with ground ends.
- h. Valves shall have a globe style configuration with flanged end connections.

4. Ball Check Valves

- a. Ball check valves shall be designed for non-clog operations and shall be capable of passing solids, grit, and stringy material.
- b. Ball check valves shall be constructed with a cast iron body, Nitrile coated rubber ball and Class 125 ANSI B16.1 flange connections. Valves shall be rated for up to 150 psi.

5. Duck Bill Check Valve or Backflow Preventer

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- a. Duck bill flow backflow preventers shall be constructed with neoprene material and designed with flanged connections to mount to end of pipe.
- b. Valves shall be Tideflex series valves provided by Red Valve Company, Inc. or approved equal.

G. Eccentric Plug Valves

1. Acceptable Manufacturer:
 - a. DeZurik.
 - b. Millikin.
 - c. ValMatic.
 - d. Victaulic.
 - e. Keystone.
2. Materials:
 - a. Body: Cast-iron ASTM A126, Class B.
 - b. Plug: One piece construction ductile iron, ASTM A536 65-45-12 or cast iron, ASTM A126 Class B.
 - c. Plug facing: Grease and/or petroleum-resistant resilient Neoprene or Buna-N compound, 70 Type A durometer hardness per ASTM D2240.
 - d. Shaft bearing bushings: Permanently lubricated TFE or Delrin sleeve type stainless steel.
 - e. Valve seats: Welded-in overlay of 90 percent nickel, minimum Brinell hardness of 200, (minimum 1/8 IN thick).
 - f. Stem seal: Nitrile butadiene packing or Buna-N dual U-cups per Sec. 3.7 AWWA C504.
3. Accessories
 - a. Refer to Drawings for type of actuator.
 - 1) Furnish actuator integral with valve.
4. Design Requirements
 - a. Port area:
 - 1) Valves 4 IN through 20 IN: Equal to or exceed 80 percent of full pipe area.
 - 2) Valves greater than 20 IN: 100 percent equivalent full pipe area.
 - b. Valve body: Fitted with bolted bonnet.
 - c. End connections: See Section 15100.
 - d. Stem seal: Adjustable and replaceable without disassembling valve or bonnet.
 - e. Designed for seating drip tight in any flow direction.
 - f. Rating:
 - 1) 1/2 through 12 IN, 175 psi working pressure.
 - 2) 14 through 36 IN, 150 psi working pressure.
 - 3) Three-way valves, 125 psi working pressure.
 - g. Actuator:
 - 1) Actuator gearing in enclosure suitable for running in oil with seals on shaft to prevent entry of dirt or water.
 - 2) Positive identification on actuator indicating valve position.

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3) Adjustable stop to set closing torque.

H. Buried Plug Valves

1. All buried iron body valves shall be factory coated per SECTION 09900.
2. Where indicated on the Drawings, buried valves shall have buried actuators at the valve with extension shafts terminating at ground or floor level in a valve box with a 2 inch square AWWA nut. Extension shafts shall be 1-1/4" square and have a centering device for installation in a 5-1/4" valve box.
3. Buried valves shall have flanged ends or as indicated on the Drawings.

I. Reduced Pressure Backflow Preventers

1. Reduced Pressure Backflow Preventers shall consist of isolation ball valves up and downstream of double check and relief valves.
2. The reduced pressure backflow preventer shall consist of two independently operating, spring loaded, "Y" pattern check valves and one hydraulically dependent differential relief valve. The assembly shall automatically reduce the pressure in the "zone" between the check valves to at least 5 psi lower than inlet pressure. Should the differential between the upstream and the zone of the unit drop to 2 psi, the differential relief valve shall open and maintain the proper differential.
3. Mainline valve body and caps including relief valve body and cover shall be bronze. Check valve moving member shall be center stem guided. All hydraulic sensing passages shall be internally located within the mainline and relief valve bodies and relief valve cover. Diaphragm to seat area ratio shall be 10:1 minimum. Relief valve shall have a removable seat ring. Check valve and relief valve components shall be constructed so they may be serviced without removing the valve body from the line. All seat discs shall be reversible. Shut-off valves and test cocks shall be full ported ball valves.
4. The assembly shall be rated to 175 psi water working pressure and water temperature range from 32 degF to 140 deg F.
5. The assembly shall meet the requirements of ASSE Standard 1013, AWWA Standard Code C511-89, and CSA Standard B64-4.
6. Acceptable Manufacturers:
 - a. FEBCO.
 - b. Watts.

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J. Pressure Sustaining Valve for Water Service

1. Automatic control valve(s) shall be a combination pressure sustaining and check valve, fluid actuated and shall have a single moving assembly. A flexible, non-wicking, FDA approved, nylon fabric reinforced synthetic elastomer diaphragm shall be free of drag or wear. The diaphragm shall not be used as a seating surface. This assembly shall have a stem which is fully guided by separate upper and lower bearings to preclude binding or deflection. When the valve is in the closed position sealing at the seat shall be accomplished by the contact between one edge of a securely retained elastomer ring and a smooth seat surface. The seat design shall be removable and not have edges that will induce seal cutting, or wear at low flows. Progressive throttling of flow shall be accomplished by a ring retainer washer. The valve body and cover shall be of cast iron. An FDA approved fused epoxy coating shall be applied to the internal and external exposed surfaces of these components after cleaning. All internal valve components shall be removable and repairable while the valve body remains in the line. Packing glands and/or stuffing boxes are not permitted and there shall be no pistons operating the valve or controls. Valves shall have an externally mounted wye strainer for protection of the control circuit, check valves to prevent return flow, and ball valves to isolate the pilot system from the main valve.
2. Provide valves as shown on the Drawings. Valves shall be suitable for installation on vertical pipe where shown on the Drawings.
3. Operation: The valve shall maintain a constant upstream pressure regardless of demand fluctuations and shall disallow reverse flow. The control shall be adjustable, spring loaded, normally closed, direct acting, diaphragm valve designed to permit flow when controlled pressure exceeds the spring setting. The control system shall have an adjustable closing speed needle valve.
4. Performance and sizes shall match connecting pipe size unless indicated otherwise on the Drawings.
5. Approved manufacturers:
 - a. ClaVal
 - b. Jordon Valve
 - c. Watts

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K. Air Release Valves

1. Air Release Valves for Fish Rearing Water Supply Systems

- a. Air release valves shall be of the simple lever type and shall be capable of automatically releasing accumulated air from a fluid system while that system is in operation and under pressure.
- b. To assure drip tight shut-off, a viton orifice button shall be used to seal the valve discharge orifice when the valve is in a closed position. Unless otherwise indicated on the Drawings, the orifice diameter shall be 1/16".
- c. The body and cover shall be of cast iron. With the exception of the viton orifice button, the leverage mechanism, float and all other internal trim shall be of stainless steel.
- d. The stainless steel float shall be designed to and capable of withstanding a pressure in excess of 1000 psi.

2. Combination Air Release/Vacuum Valves

- a. Combination air release/vacuum valves shall be a combination of small and large orifice valves. The large orifice valve shall allow large quantities of air to escape when systems are started and close tight when liquid enters the valve. It shall also permit large quantities of air to re-enter when the systems are stopped to prevent vacuum from forming in the piping. The small orifice valve shall vent air that accumulates while piping system is in operation.
- b. The only moving parts shall be the stainless balls which will remain in the throat area when discharging air.
- c. The large orifice valve shall operate at differential pressures of up to 5 psi without blowing shut or collapsing the valve.
- d. The large orifice seat shall be of composition material and replaceable. The body shall be cast iron.
- e. All valves exterior shall be painted with red oxide primer paint at the factory and coated at the site per SECTION 09900.
- f. Air vacuum valves shall be sized as indicated on the Drawings with a small orifice diameter of 1/16" unless indicated otherwise on the Drawings.

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- g. Approved manufacturers and model:
Golden Anderson, Inc. Fig. No. GH-7K

L. Knife Gate Valves

1. Standard Knife Gate Valves

- a. Knife gate valves shall be constructed with stainless steel bodies, gates, seats, and stems. Valves shall be wafer style drilled for ANSI 125/150 class flange connections, and rated for operating pressure up to 150 psi.
- b. Valves shall be provided with the type of actuator shown of the Drawings and all necessary mounting hardware for mounting where required extension stems and hardware shall be provided.
- c. Approved manufacturers:
Dezurik Series L

2. Pneumatically operated knife gate valves

- a. Refer to SECTION 15525 for pneumatically operated knife gate valves associated with the hydrocyclone system.

M. Pressure Relief Valve

- 1. Acceptable Manufacturers:
 - a. Consolidated 1990 Series.
 - b. Or approved equal.
- 2. Materials:
 - a. Bonnt: Cast steel.
 - b. Base: Stainless steel.
 - c. Spring: Steel.
 - d. Diaphragm: Neoprene.
 - e. Trim: 416 stainless steel.
- 3. Design Requirements:
 - a. Pipe relief to discharge at non-hazardous location.
 - b. Relief pressure: Size and setting as indicated on the Drawings.

N. Flow Control Valve

- 1. The Rate of Flow Control Valve shall limit flow to the preset maximum rate regardless of changing line pressure.
- 2. The valve shall be hydraulically operated, single diaphragm-actuated, globe or angle pattern. The valve shall consist of three major components: the

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body with seat installed, the cover with bearings installed, and the diaphragm assembly. The diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating operating pressure from line pressure. Packing glands and/or stuffing boxes are not permitted and there shall be no pistons operating the main valve or pilot controls.

3. The valve shall contain a resilient, synthetic rubber disc, having a rectangular cross-section contained on three and one-half sides by a disc retainer and forming a tight seal against a single removable seat insert. The disc guide shall be of the contoured type to permit smooth transition of flow and shall hold the disc firmly in place. The disc retainer shall be of a sturdy one-piece design capable of withstanding opening and closing shocks. It must have straight edge sides and a radius at the top edge to prevent excessive diaphragm wear as the diaphragm flexes across this surface.
4. The diaphragm assembly containing a non-magnetic 303 stainless steel stem of sufficient diameter to withstand high hydraulic pressures shall be fully guided at both ends by a bearing in the valve cover and an integral bearing in the valve seat. The seat shall be a solid, one-piece design. The stem shall be drilled and tapped in the cover end to receive and affix such accessories as may be deemed necessary. The diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating operating pressure from line pressure.
5. The diaphragm shall consist of nylon fabric bonded with synthetic rubber compatible with the operating fluid and shall be cycle tested 100,000 times to insure longevity.
6. The main valve seat and the stem bearing in the valve cover shall be removable. Cover bearing, disc retainer, and seat shall be made of the same material. All necessary repairs and/or modifications other than replacement of the main valve body shall be possible without removing the valve from the pipeline. Packing glands and/or stuffing boxes shall not be permitted and components including raw casting material shall be of North American manufacture.
7. The valve manufacturer shall warrant the valve to be free of defects in material and workmanship for a period of three years from date of shipment, provided the valve is installed and used in accordance with all applicable instructions.
8. Material Specification
 - a. Valve Size: As indicated on Drawings
 - b. Main Valve Body and Cover: Ductile Iron
 - c. Main Valve Trim: Stainless Steel

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- d. End Detail: Flanged
 - e. Pressure Rating: 250 psi
 - f. Temperature Range: 32 to 70 deg F
 - g. Rubber Material: Buna N
 - h. Coating: Epoxy
9. The pilot system shall be a direct acting diaphragm valve designed to close when the controlling differential exceeds the adjustable spring setting. The pilot control shall be normally held open by the force of the compression on the spring above the diaphragm and closes when the pressure acting on the underside of the diaphragm exceeds the spring setting. The pilot control system shall contain a fixed orifice. No variable orifices shall be permitted.
 10. An orifice plate flange assembly shall be included and mounted one to five pipe diameters downstream. The contractor shall connect the sensing line between the pilot system and the orifice plate.
 11. The valve shall be a Cla-Val Co. Model No. 40-01/640-01 Rate of Flow Control Valve as manufactured by Cla-Val Co., Newport Beach, CA 92659-0325.
 12. Material Specification for Pilot Control:
 - a. Pressure Rating: 250 psi
 - b. Trim: Stainless Steel
 - c. Rubber Material: Buna N
 - d. Tubing and Fittings: Stainless Steel
 - e. Adjustment Range: As required for set point indicated on Drawings
 - f. Operating Fluids: Water (from line pressure)
 - g. Flow Setting: See Drawings
- O. Combination Flow and pressure Regulating Valves
1. The rate of flow and pressure reducing valve shall reduce a higher inlet pressure to a steady lower outlet pressure as long as flow rate is below a preset maximum. When demand exceeds the flow setting, the valve shall limit flow to the preselected maximum rate.
 2. Valve shall conform to the specifications indicated in paragraph 2.2.N of this section, except valves shall be Cla-Val Model No. 49-01/649-01.
- P. Buried Valve Boxes and Wrenches
1. Valve boxes for buried valves shall be cast iron two piece adjustable units of standard 5 1/4" shaft diameter. Boxes shall be screw type for height adjustment. A cast iron cover shall be furnished with each box.

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2. All valve wrenches (T-handle valve key) shall fit 2 inch square operating nuts and be compatible with the valves and boxes furnished.
3. Approved manufacturers:
Clow Corp., Valve Div., Oskaloosa, IA
East Jordan Iron Works, East Jordan, MO

Q. Curb Stops

1. Curb stops shall be bronze body, Mueller Oriseal III or approved equivalent. Provide extension rods for all curb stops.
2. Valve boxes shall be cast iron, extension type with slide-type adjustment and with flared base. The minimum thickness of metal shall be 3/16 inch. The word "WATER" shall be cast in the cover. The boxes shall be of such length as will be adapted, without full extension, to the depth of cover required over the pipe at the valve location. Mueller Type H-10365 with a H-10361 Lid or equal shall be supplied for all valves.
3. Provide two valve wrenches for entire project to operate box covers and curb stops.

R. Yard Hydrants and Non Freeze Hose Hydrant Connections

1. Yard hydrants and non freeze hose connections shall be freeze proof post-type hydrants complete with operating key and equipped with a tapped drain port in valve housing.
2. Hydrants designated as yard hydrants on the Drawings shall be Zurn 1390 or approved equivalent, with a 2 inch inlet connect and 2 inch hose outlet connection.
3. Hydrants designated as hose hydrants or non freeze hose bibs on the Drawings shall have 1" inlet and 3/4" outlet and be Zurn 1385 or approved equal.

S. Hose Bibs

1. Hose bibs shall be globe or angle valve with body and bonnet conforming to ASTM B62, composition, 200 psi working pressure. Crane No. 1 (with male nipple), Walworth Fig. 59 (with male nipple), or equivalent.

2.3 FORMALIN SYSTEM

- A. Ball valves and full port ball valves. Ball valves shall be constructed with stainless steel bodies, balls and stems and shall be rated for 250 psi W.O.G. or

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greater or approved equal. Ball valves shall have threaded end connections, PTFE seats and EDPM O rings. All components of valves shall be compatible with formaldehyde, formic acid and methanol.

- B. Check valves. Check valves type shown on the Drawings and shall be constructed with stainless steel bodies and springs. Valves shall be provided with threaded end connections and rated for 250 psi W.O.G. or greater. All components of valves shall be compatible with formaldehyde, formic acid and methanol, and must not contain copper, zinc, bronze, lead or cadmium.
- C. Relief valves shall be sized as shown on the Drawings, rated for 250 psi or greater and provided with threaded end connections. Valves shall be constructed with stainless steel and EPDM or PTFE seals with an adjustment range and setting as stated on the Drawings. Valve shall be compatible with formaldehyde, methanol and formic acid.
- D. Electrically actuated ball valves and full port ball valves
 - 1. Valves shall be full port or standard port valves as indicated on the Drawings conforming to paragraph 2.3.A of this section.
 - 2. Electric actuators shall be explosion proof, conforming to UL listed Class 1, Div 1 requirements where noted on the Drawings. Actuators shall be designed for open and closing operations only (modulation of valve is not required). Valve actuators shall operate on 120 volt, single phase power and be rated medium or heavy duty.
- E. Reduced pressure backflow preventers: See paragraph 2.2.H of this section.

2.4 POTABLE WATER SYSTEM

- A. Valves for the Potable Water System shall conform to SECTIONS 02660, 11200, and 15400.

2.5 COMPRESSED AIR SYSTEM VALVES

- A. Refer to SECTION 15480 for compressed air system valves.

2.6 OXYGEN SYSTEM VALVES

- A. Refer to SECTION 15481 for compressed air system valves.

PART 3 EXECUTION

3.1 VALVE INSTALLATION

A. Valve Installation (Exposed)

1. Valves shall be installed at all points indicated on the Drawings.
2. Gate valves shall be installed with stems vertical wherever possible and shall not be installed with stems below horizontal under any condition.
3. Butterfly and plug valves shall be installed with the stem horizontal. Plug valves shall be installed with the plug seat on the inlet side and with the plug rotating up into the open position on horizontal lines.
4. Ball valves shall operate freely without binding or sticking in any position from fully open to fully closed. Any valves that do not operate freely shall have operations adjusted to the satisfaction of the Engineer.
5. Check valves shall be installed where shown on the Drawings, in either a true vertical or horizontal position.
6. Check valves shall be installed in regard to the direction of flow.

B. Valve Installation (Buried)

1. Valves and fittings shall have the interiors cleaned of all foreign matter. Valves shall be inspected by the Contractor in both open and closed position prior to installation. Installation of valves shall be as recommended by the manufacturer.
2. All buried valves shall be painted with coal tar epoxy prior to installation, in accordance with SECTION 09900 of these Specifications.
3. Buried valves shall be bedded and backfilled according to the requirements of the pipe that they are attached to and SECTION 02200. Concrete supports for operators where required shall be as shown on the Drawings.
4. Where indicated on the drawings, buried valves shall be provided with a cast-iron valve box. The valve boxes shall be set to position during backfilling operations so they will be in a vertical alignment to the valve operating gear shaft. The lower casting of the unit shall be installed first in such a manner as to be cushioned and to not bear directly upon the body of the valve or upon the water line. The upper casting of the unit shall then be

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placed in proper alignment of such as elevation that its top will be at final grade.

5. Where indicated on the Drawings, buried valves shall be provided with extension neck for mounting actuators 3'6" above finished grade. Valves shall be set so that extension neck is vertically plumb.

3.2 VALVE IDENTIFICATION

- A. All valves shall be tagged or have valve cover identification as indicated in SECTION 15010.

PART 4 WARRANTY

4.1 GENERAL

- A. All valves shall be warranted for both labor, equipment and all components for a 1 year period after final acceptance.

END OF SECTION

SECTION 15101

WATER CONTROL GATES

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. The work includes furnishing all labor, material and equipment required to provide and install all water control gates as shown on the Drawings and as specified herein.

1.2 SUBMITTALS

- A. Shop drawings shall be submitted in accordance with SECTION 01340.
- B. Shop drawings shall indicate all material types, sizes and dimensions required for a complete and functional installation. Fastener material, sizes and quantities shall be included with the submittal.
- C. Shop drawings shall indicate any preparation required before gate installation. This preparation shall include, but not be limited to, blockouts, embeds, predrilled holes, and mounting hardware attachment.
- D. Shop drawings shall indicate the finish on each item detailed.
- E. Submittal shall include manufacturer's certification that gate to be supplied has been factory tested, and conforms to AWWA standards for leakage.

1.3 RELATED REQUIREMENTS

- A. SECTION 01340 - SUBMITTALS
- B. SECTION 09900 - PAINTING

PART 2 PRODUCTS

2.1 GENERAL

- A. All water control gates shall be manufacturer's standard design unless otherwise specified and shall be furnished with operating wheel, 2" square wrench nut or hand crank as shown on the Drawings. Unless otherwise indicated, the direction of rotation of the wheel, wrench nut or lever to open the gate shall be to the left

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(counter-clockwise). Each gate body or operator shall have cast thereon the word OPEN and an arrow indicating the direction to open.

- B. All water control gates of the same type shall be from a single manufacturer.
- C. Unless otherwise specifically noted in these specifications or on the drawings, all gates in contact with water shall have only iron, aluminum, stainless steel, Buna N or plastic for bodies and trim. No bronze trim or seats will be allowed.
- D. All water control gates shall be complete, including all gates, guides, frames, bench studs, base plates, brackets, anchor bolts, stems, stem extensions, stem guides, manual operators, and all other necessary appurtenances.
- E. Maximum manual effort required to operate any gate, after the gate has unseated, shall not exceed 40 pounds.
- F. The use of a manufacturer's name and catalog number is for the purpose of establishing a standard of quality and general configuration desired only. Products of alternate manufacturers will be considered, subject to review in accordance with SECTION 01340 and the conditions specified herein.
- G. All necessary attaching bolts, anchor bolts, mounting and assembly hardware shall of Type 316 stainless steel, and shall be furnished by the gate manufacturer.

2.2 MATERIALS

A. Slide Gates

1. Guide Frames

- a. Guide frames shall be of extruded aluminum, Alloy 6061-T6, incorporating a dual slot design. The vertical guides shall be designed for maximum rigidity, and shall extend in one continuous piece from the gate. Guides shall weigh not less than 3 pounds per linear foot, and shall incorporate a replaceable extruded dense polyethylene bearing strip in an extruded retainer slot on the downstream side of the gate.
- b. The frame invert shall be extruded aluminum, Alloy 6061-T6. The invert extrusion shall weigh no less than 2 pounds per linear foot. Provide a neoprene insert that functions as a seating surface for the gate disc.
- c. Vertical guide frames and invert extrusions shall be joined with factory welded corners. The yoke supporting the operating device shall be formed by members welded or bolted at the top of the guides. Where

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guides extend above the operating floor, the guides and yoke shall be sufficiently strong so that no further reinforcing will be required.

- d. Guide slots shall be sized to provide a minimum disc engagement of 1 inch on each side.

2. Disc (Sliding Member)

- a. The disc plate shall be one-piece aluminum plate, Alloy 6061-T6, reinforced as required so that the disc will not deflect more than $1/360$ of the gate span, when the upstream liquid depth is as specified and the downstream liquid depth is less than $1/2$ inch. Gate disc shall be reinforced with one-piece aluminum angles or channel type extrusions welded to the disc plate. The pocket and yoke of the gate shall be sufficiently strong to withstand a load of 100 pounds applied at the operator. Bolted reinforcements will not be permitted.

3. Stems

- a. Lifting stems shall be one-piece Type 303, Type 304, or Type 316 stainless steel, with a minimum diameter of 1 inch, and of ample cross-section to prevent distortion.
- b. Stems shall be sized so that the ratio of the unsupported stem length (L) to the radius of gyration (r), both in similar units does not exceed 200.
- c. Stems shall be designed to withstand in compression, without damage, the thrust equal to at least $2-1/2$ times the rated output of the housing mechanism, with a 40 pound effort applied to the handwheel or crank.
- d. The stems shall be connected to the disc plate by means of an extruded aluminum yoke, bolted to the stem and welded to the disc.

4. Gate Operators

- a. All slide gates shall be provided with a non-rising stem lockable hand wheel or 2" nut operator unless shown or called out otherwise on the Drawings.
- b. The operator shall be of the sealed, ball-thrust, roller or needle bearing type and equipped with bronze lift nut, internally threaded with Acme threads. Mechanical seals shall be provided at all housing penetrations.

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5. Flush Bottom Seal

- a. Provide gates with a flush bottom seal. All gate parts shall be identical to those defined in other paragraphs of this specification section except that a solid neoprene seal shall be securely fastened to the bottom cross member of the frame.
- b. The neoprene seal shall be removable without disturbing the concrete in the invert of the opening.
- d. The top seal shall be flush with the invert of the frame.
- d. The gate slide shall make uniform contact with the top surface of the seal when it is closed and shall not damage the seal surface.

6. Gate Manufacturer

- a. Acceptable gate manufacturers:
 - 1) Waterman Industries
 - 2) Golden Harvest, Inc.
 - 3) Fresno Valve and Casting, Inc.
 - 4) Rodney Hunt

B. Shear Gates

1. Shear gates shall be sized as shown on the Drawings and constructed with cast iron bodies and gates and stainless steel trim.
2. Shear gates not defined on Sheet M58 for seating/unseating head requirements shall be designed for up to 7 feet of seating head and 7 feet of unseating head. All shear gates shall have replaceable stainless steel wedges for seating.
3. Shear gates shall be provided with 125 lb. ANSI standard flange connections.
4. Shear gates shall be Waterman Model C-16 or approved equal.

2.3 SHOP ASSEMBLIES AND TESTS

- A. Furnish all metalwork in prefabricated sections sized for convenient shipping. Match mark parts as required.
- B. Assemble each gate completely in the shop. While assembled, check each gate for dimensions, clearance, tolerances, and accuracy of alignment; correct any error or misalignment.

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- C. Fit seals accurately to each gate in accordance with the manufacturer's requirements.
- D. During fabrication of the gates, shop welding may be subject to tests and inspections by the Owner, Engineer, or their designated testing agency.
- E. Perform shop assembly prior to shipment to verify design, construction, and machining for proper alignment, fits, and clearances.
- F. Perform mechanical and functional shop tests on gate equipment to the extent possible.
- G. Tests: Manufacturer's standard production tests. Shop tests to demonstrate, insofar as practical, that the equipment and accessories are fully functional and meet the performance requirement specified in these Specifications.

2.4 RUBBER SEALS

- A. Furnish all rubber seals in unspliced continuous sections, except at corners. Splices shall be factory vulcanized by the seal manufacturer in their plant and shall have a tensile strength of not less than 50% of that of the unspliced material.
- B. Drilling of the seals shall be performed in the shop with a special rubber drilling tool that will produce smooth, clean-cut holes, free from ragged edges, that will fit snugly around the bolts. Use seal retaining and mounting bars as templates, where possible. Remove seals and retaining bars prior to painting. When assembled, the seals shall be straight and true of any warps or distortions.

2.5 TOLERANCES AND FITS

- A. Overall measurements of the gates: Corrected for expansion and contraction using a base temperature of 70 deg F. The purpose of this equipment requires that, when erected, the seals and seal plates be in continuous contact with a "preset" on the seals not to exceed 1/4".
- B. Structural Members: Completed to detail dimensions within a tolerance of $\pm 1/16$ " for sections up to 30 feet in length and $\pm 1/8$ " for sections over 30 feet in length.
- C. All structural shapes must be straight and square to the skin plate. All corners must be square.
- D. The outside surface of the skin plate shall be true plane. When erected, the skin plate must be a plane surface at points of contact between the seals and seal plates.

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- E. The seals shall be parallel to the skin plate. The distance from the skin plate to the outside edge of the seals shall have a tolerance of 0 to 1/16”.

PART 3 EXECUTION

3.1 FINISHES

- A. All aluminum surfaces in contact with the concrete shall be coated with two coats of unthinned bitumastic paint or be insulated with suitable protective neoprene gasket materials.
- B. All other surfaces shall be finished in accordance with SECTION 09900.

3.2 INSTALLATION

- A. Insofar as practical, the gate assemblies shall be completely factory assembled, shipped as a unit, disassembled on site and installed in strict conformance with the manufacturer's recommendations.
- B. All gates shall be installed level, true, and plum, at the locations indicated on the Drawings.
- C. All anchor bolts and necessary bolt setting plates shall be provided by the gate manufacturer. Two nuts shall be provided for each anchor bolt, and anchor bolts shall be cast-in-place during concrete placement. Threads shall be protected and shall be cleaned before the nuts are attached and tightened.

3.3 TESTING

- A. Gates and operators shall be adjusted and tested by operating through complete cycles of opening, closing, and opening. Gates shall operate freely without binding, vibrating, or sticking in any position from fully open to fully closed. Any gates that do not operate freely shall be adjusted to the satisfaction of the Engineer. Leakage around the gates shall be within the tolerance outlined in AWWA specifications for sealed gates.

PART 4 WARRANTY

4.1 GENERAL

- A. The slide gates shall be warranted for both labor, equipment and all components for a 1 year period after final acceptance.

END OF SECTION

SECTION 15120

PIPING SPECIALTIES

PART 1 GENERAL

1.1 WORK INCLUDES

A. Base Bid:

1. Contractor shall provide all items specified herein and shown on the drawings, including but not limited to:
 - a. Chilled Water Storage Tank
 - b. Glycol Fill Pumping System
 - c. Glycol
 - d. Piping System Specialties
 - e. Control Valves
 - f. Installation

B. Related work specified elsewhere:

1. 15050: Basic Mechanical Materials and Methods
2. 15060: Pipes and Fittings
3. 15100: Valves
4. 15140: Pumps
5. 15250: Pipe and Duct Insulation
6. 15750: Heat Transfer Equipment

1.2 CODES, FEES AND PERMITS

A. All work and installations of this Section shall comply with the recommended practices of the following:

1. SMACNA
2. ASHRAE
3. ASME Boiler & Pressure Vessel Code
4. National Fire Prevention Association
5. International Mechanical Code

B. All necessary fees and permits required for the work of this Section shall be obtained and paid for by this Contractor.

C. Should there be found a discrepancy between the Drawings and Specifications and/or any code, rule or regulation during the bidding period, it shall be brought to the attention of the Architect/Engineer to be resolved prior to bid opening.

D. Should there be found a discrepancy between the Drawings and Specifications and/or any code, rule or regulation during the construction period, it shall be

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brought to the attention of the Architect/Engineer to be resolved prior to proceeding with the work.

1.3 SUBMITTALS

- A. Submit in accordance with 01340.
- B. Shop Drawings:
 - 1. Contain equipment dimensions and show all required factory and external piping connections, accessories required and full equipment ratings and capacities and performance characteristics.
 - 2. Submit manufacturer's recommendations and installation instructions.
- C. Operation and Maintenance Manuals:
 - 1. Provide operation and maintenance manuals.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver and store products in factory wrapped packages which properly protect same against weather, damage and dirt.
- B. Handle all products and equipment to avoid crushing, bending or damage to components or finishes.
- C. Where possible, store inside or when necessary to store outside, store above grade and enclose in waterproof breathable wrapping.
- D. Do not install any damaged units. Replace and return damaged units to manufacturer.

PART 2 PRODUCTS

2.1 CHILLED WATER STORAGE TANK

- A. Chilled water storage tank shall be ASME Code constructed and stamped in accordance with Section VIII of the ASME Code. Tank shall be registered with the National Board of Boiler and Pressure Vessel Inspectors and a certificate of shop inspection shall be furnished.
- B. ASME working pressure shall be 125 psi.
- C. Material of construction shall be Carbon Steel. Vessels shall be provided with a 12" x 16" manhole.
- D. Tank shall be furnished with an air vent, a 1/2" flexible, elastomeric thermal insulation black in color, and internal baffle to divert water flow.
- E. Manufacturers: Cemline or approved equal.

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2.2 GLYCOL FILL PUMPING SYSTEM

- A. Provide, as indicated on the plans, a prefabricated, automatic and autonomous make-up package for the glycol system.
- B. The package shall be designed to occupy a minimum amount of floor space, to operate on a standard 120VAC, 60 Hz electrical circuit, and to maintain the design fill pressure in the glycol system. The pumping assembly shall be mounted in a sturdy steel frame with legs to keep it off of the floor.
- C. It shall include two 1.7 gpm at 10-70 psi pumps, 1/2 hp motors, magnetic starters, a pressure tank with pressure control, a priming valve, a pressure reducing valve, a shut-off valve and a pressure gauge. It shall be connected to the system with a flexible connection. It shall feature a control panel equipped with H-O-A switches for each pump starter, and a fail-safe alternator that allows one pump to operate if the other pump malfunctions. It shall feature a cut-off and alarm arrangement, which will stop the pump in case of excessive pressure, or a low solution level, and activate and audible (which can be silenced) and a visual alarm. A 120V dry contact shall also be available for a remote alarm.
- D. Storage tank volume shall be 100 gallons.
- E. It shall be manufactured by Wessels Company or equal.

2.3 GLYCOL

- A. Provide a sufficient quantity of glycol to fill the entire system including piping, pumps, storage tank, chiller and fluid cooler. When system is full, fill the glycol fill pumping of system storage tank 2/3 full, approximately 66 gallons.
- B. Glycol shall be inhibited propylene glycol-based heat transfer fluid as manufactured by Dow or an approved equal. Contractor provide a premixed solution of 50% propylene glycol by volume.

2.4 PIPING SYSTEM SPECIALTIES

- A. Manual Air Vents:
 - 1. Field construct an air chamber a minimum of 12" high full size of associated piping.
 - 2. Air chamber shall extend vertically from piping.
 - 3. Tap 1/4" Type L copper (or larger if indicated) from top of air chamber to discharge location.
 - 4. Provide 1/4" tee handle brass cock in outlet piping at accessible location.
 - 5. Provide manual air vent at all high points of water system which are not vented by other means.

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B. Relief Valves:

1. ASME rated direct spring-loaded type, lever operated, non-adjustable factory set discharge pressure.
2. Provide relief valve on expansion tank.
3. Select system relief valve capacity to relieve full expansion capacity.
4. Manufacturers:
 - a. ITT/Bell and Gossett
 - b. Thrush Products, Inc.
 - c. Watts Regulator Company

C. Balancing Valves:

1. Cast iron or bronze body with bronze or stainless steel calibrated disc or venturi with readout valves fitted with integral check valves.
2. Integral pointer indicating degree of valve opening.
3. Integral seals constructed for 125 psi working pressure.
4.

<u>Manufacturers</u>	<u>Models</u>
a. Armstrong Pumps, Inc.	Circuit Balancing Valve
b. ITT/Bell and Gossett	Circuit Setter
c. Illinois	Series 6000
d. Flow Design	ACCU Setter

D. Hose Drain Valves:

1. Bronze body, full port with stuffing box and combination IPS inlet and copper to hose outlet, removable handle with 1 handle for each 10 valves.
2. Provide at all undrained low points of water piping system.
3.

<u>Manufacturers</u>	<u>Models</u>
a. Hammond	700 Series
b. Approved equal	

E. Thermometers:

1. Thermometers shall be 9" red reading mercury thermometers. Inclined face type shall be provided whenever necessary for easy reading from the floor. Scale ranges shall be selected so that normal operating range is approximately mid range. Scale shall be in degrees F.
2. All thermometers shall have separable sockets with heat transfer medium between socket and temperature element.
3. Thermometers shall be removable without draining system.
4.

<u>Manufacturers</u>	<u>Models</u>
a. Weksler	AA5H-9
b. Palmer	356
c. Terrice	BX9140

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F. Pressure Gauges:

1. Gauges shall have 4-1/2" dials, stainless steel case, 1/4" or 1/2" NPT bottom or back connection. All bourdon tube connections (socket, tube and tip assembly) shall be silver brazed for bronze tube and welded for steel tubes. Movements shall be bronze or stainless steel with bushed bearings. Accuracy shall be 1% of dial range or better.
2. All gauges shall be removable from piping system with cocks placed in sensing line.
3. Scale ranges shall be selected so that normal operating range is approximately mid scale.
4. Gauges on pumps shall be combination gauges.
5.

<u>Manufacturers</u>	<u>Models</u>
a. Ashcroft	Series 1020 and 1320
b. Terrice	Series 600
c. U.S. Gauge Div. Ametek, Inc.	"A" Line 5800 Series
d. Ametek	P-500

G. Air Separator

1. The unit shall have an internal stainless steel air collector tube with 5/32" diameter perforations and 63% open area designed to direct accumulated air to the high capacity air vent via an NPT vent connection at top of unit.
2. The unit shall have a removable galvanized steel system strainer with 3/16" diameter perforations and a free area of not less than five times the cross-sectional area of the connecting pipe. A blowdown connection with valve and hose connection shall be provided to facilitate routine cleaning of the strainer.
3. Manufacturer to furnish data sheet specifying air collection efficiency and pressure drop at rated flow.
4. The air separator shall be designed, constructed and stamped for 125 psig at 350° F in accordance with Section VIII, Division 1 of the ASME Boiler and Pressure Vessel Code, and registered with the National Board of Boiler and Pressure Vessel Inspectors. The air separator(s) shall be painted with one shop coat of light gray air-dry enamel.
5. See equipment schedule on drawings for size, capacity and manufacturer.
6. Air separator shall be fully insulated with formed access to strainer for removal.

H. Air Release Valves

1. Shall be float actuated high capacity air vents designed to purge free air from the system and provide shutoff at pressures up to 150 psig at a maximum temperature of 250°F.
2. The design of these valves shall prevent air from entering the system if system pressure should drop below atmospheric pressure.
3. The valve shall be constructed of cast iron and fitted with components of stainless steel, brass and EPDM.

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I. Expansion Tank

1. Provide as shown on the drawings, a pre-charged vertical steel expansion tank with integral heavy duty Butyl rubber diaphragm. The tank shall have an NPT system connection, and a charging valve connection to facilitate the on-site charging of the tank to meet system requirements.
2. The tank shall be constructed in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code and stamped 125-psi working pressure.

J. Basket Strainers

1. Provide pipeline strainers with stainless steel screen, basket type with clamp cover.
 - a. Perforations:
 - 1) Water, liquids: 0.125 inch
 - b. Provide valve drain and hose connection off strainer bottoms.
 - c. Strainers used in potable water shall be epoxy coated and rated for such use.
 - d. Cast-iron body, flanged ends, clamp cover, 125 psig (steam), 175 psig (Water, Oil, Gas).
 - e. Manufacturers:
 - 1) Tate Andale: Model CS
 - 2) Metraflex Company: No. B-1-TC
 - 3) Mueller Steam Specialty Co.: No.
 - 4) Sarco Company: No.

2.5 CONTROL VALVES

A. Three-Way Control Valve

1. Automatic control valves shall have flanged fittings, 2-1/2 in. through 6 in. sizes, and shall be ANSI-rated to withstand the pressures and temperatures encountered.
2. Valves shall have metal-to-metal seats, stainless steel stems, and replaceable spring-loaded reinforced carbon-filled teflon packing.
3. Valves shall have a maximum leakage rate of 0.05% Cv at the control port.
4. Valves shall have a 50:1 rangeability or better.
5. All chilled water valves shall be provided with linear contoured throttling plugs.
6. Three-way valves shall be provided in mixing configuration.

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7. Ratings:
- a. Flanged 3-way Control Valve
 - b. Action: Mixing valve.
 - c. Controlled Media: 50% glycol solution.
 - d. Valve Body Temperature-Pressure Ratings: Water: ANSI Class 125.
 - e. Flow Capacity: $C_v = 100$.
 - f. Flow Characteristic: Linear port B-AB.
 - g. Rangeability: 50:1.
 - h. Close-Off Pressure (maximum): 58 psi
 - i. Leakage Rate (maximum):
 - 1) $<0.5\%$ of C_v , A-AB;
 - 2) $<1\%$ of C_v , B-AB.
 - j. Valve Body:
 - 1) End connections:
 - a) Face-to-face flange dimensions per ANSI/ISA 75.03.
 - b) Bolt holes conform to ANSI B16.1.
 - 2) Material: Cast iron, ASTM A126 Class B.
 - k. Trim:
 - 1) Seat: body integrated, Stainless steel.
 - 2) Plug: Stainless steel, skirt guided.
 - 3) Stem: Stainless steel.
 - 4) Packing: Spring loaded PTFE cone rings.

B. Three-Way Control Valve Actuator

- 1. Valve actuators shall mount directly to the bonnet of the valve, and connect to the valve stem without requiring adjustments, linkages, brackets or adapters.
- 2. Direct coupled valve actuators shall be 24 VAC power, available with floating or analog control signal inputs, and available for either direct (stem down to close) or reverse acting (stem up to close) stroke direction.
- 3. Actuators shall have a field selectable stroke position on signal failure.
- 4. Provide spring return with manual override capability under the cover, for emergency override during periods of no power.
- 5. Valve actuators shall be provided by valve manufacturer to provide a single source of responsibility for the valve/actuator assembly.
- 6. Actuators shall be UL and CSA listed, manufactured under ISO 9001 International Quality Control Standards.

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C. Two-Way Control Valve:

1. Butterfly valves shall be sized to match piping in which they are installed, 2-way configuration, with cast iron, lug-style bodies conforming to ANSI Class 125 and 150 flange standards.
2. Water valves shall have resilient seats capable of bi-directional, dead-end service, and bubble-tight shutoff to 200 psi.
3. Valves shall have EPDM seats, aluminum-bronze disks, and stainless steel stems.
4. Butterfly valve bodies shall have an integrally cast top plate for direct flush-mounting. This mounting shall not require brackets or adapters.
5. All valves shall seat fully in the closed position; angle seating is unacceptable.
6. Each individual valve assembly shall be fully tested prior to shipment. Valves shall be manufactured in compliance with ISO 9001.

D. Two-Way Control Valve Actuator

1. Provide permanently lubricated self-locking gear train, which will eliminate the need for motor brakes.
2. Provide manual override which does not require the use of levers or latches.
3. Provide mechanical travel stops adjustable to 15° in both directions for precise adjustment or valve travel.
4. Provide NEMA 4X or NEMA 7 enclosure with Factory Mutual, UL or CSA approvals.
5. Provide UL listed motor with thermal overload devices in motor windings to protect the motor should overheating occur.
6. Provide hard anodized, epoxy coated aluminum housing to permit service in an aggressive environment.
7. Provide visual mechanical position indicator for accurate visual reference of valve position.
8. Provide limit switch cams to allow for simple and convenient travel adjustment.

E. Control Valve and Actuator Manufacturers:

1. Honeywell or approved equal.

PART 3 EXECUTION

3.1 PIPING SYSTEM SPECIALTIES

A. Air Vents:

1. Where air quantities can collect, provide enlarged collection standpipes.
2. Provide vent and drain tubing to nearest drain.

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B. Relief Valves:

1. Pipe relief valve outlet full size to nearest floor drain and terminate 6" above drain.
2. Pipe relief valves separately to drain. Headering of discharge piping not acceptable.

C. Balancing Valves:

1. Flow monitoring and balancing devices shall be installed at each water coil in fan systems and at pumps to monitor and balance flows. Additional devices shall be installed in piping sections as shown on the Drawings.
2. Devices shall be located with minimum of three (3) pipe diameters up stream and one (1) pipe diameter downstream of device.

D. Flow Sensing Switches:

1. Install flow switches in chiller outlet to accomplish monitor and control functions indicated.
2. Paddles on flow switches shall be of size recommended by manufacturer for pipe size in which it is installed.

E. Thermometers:

1. Thermometers shall be provided where shown on Drawings and/or in the following locations:
 - a. Inlet and outlet of chiller.
2. Thermometers shall be installed directly within the flow of the fluid they are indicating.
3. Thermometers in water lines shall be installed in wells packed with heat conductive paste.
4. Where pipe sizes are 1-1/2" and below these sizes shall be increased 1 size where thermometers are inserted.
Thermometers shall be installed so their scales read easily from the floor.

F. Pressure Gauges:

1. Pressure gauges shall be installed in the following locations;
 - a. On the discharge and suction side of each pump.
 - b. Where detailed on chiller.
 - c. At system makeup connection.
2. All gauges shall be installed with pigtail loop and shut-off cock and shall have sufficient clearance to remove gauge without disturbing the piping.

3.2 EQUIPMENT INSTALLATION

- A. All equipment shall be installed as shown on Drawings and as recommended by equipment manufacturer.

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3.3 INSTALLATION - CONTROL VALVES

- A. Preliminary:
 - 1. Read and comply with all of manufacturer's instructions.
 - 2. Before installing the valve, raise and lower the valve stem to make sure that the valve stem operates freely. Impaired stem operation can indicate that the stem was bent by rough handling. This condition shall require replacing the valve.
 - 3. Protect the stem from damage due to bending or scratching.
- B. Location: Select a location where the valve and actuator are accessible. Allow sufficient space for servicing the valve and actuator.
- C. Mounting the Valve:
 - 1. Hoist valve by its body only. Do not lift by stem, bonnet, flanges, or flange holes.
 - 2. Install the valve so the common outlet flow is from the AB port indicated on the valve body.
 - 3. Install the valve so the actuator is above the valve body. The valve can be installed in any position between vertical and horizontal. Do not install the valve with the stem below horizontal or upside down.
 - 4. Use companion flanges with the same number of boltholes and dimensions as the valve to be installed. Use standard cast-iron flanges for the two end ports.
 - 5. Use a gasket material recommended for the medium to be handled.
 - 6. Use mounting bolts long enough so the nuts can use the full length of the nut threads.
 - 7. Use bolts 1/8 in. smaller than the diameter of the bolthole to allow clearance for installing.
- D. Mount the actuator. Connect all wiring in accordance with Division 16 requirements.
- E. Test the valve and actuator for proper operation.

3.4 INSTALLATION - AIR SEPARATOR

- A. Hang separator from structure.
- B. Provide air vent as scheduled on detail.
- C. Provide ball or butterfly valves.
- D. Provide drain valve and hose connection.
- E. On chilled water system insulate full body.
- F. After flushing, remove smaller mesh screen and install operation screen.

3.5 GLYCOL SYSTEM CLEANING AND FILL

- A. Cleaning sequence for chilled water (glycol) loop.
1. General:
 - a. Systems are to be cleaned before they are used for any purpose except conduct pressure test before cleaning. Add cleaner to closed systems at concentrations as recommended by the manufacturer.
 - b. Use neutralizer agents on recommendation of the system cleaner supplier and approval of the Architect/Engineer.
 - c. Flush open systems with clean water for one hour minimum. Drain completely and refill.
 - d. Remove, clean, and replace strainer screens.
 - e. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.
 2. Glycol Water Systems:
 - a. Add cleaner to the system water until the M alkalinity value is 250 above that of the initial fill water. Verify the M alkalinity level before and after the addition of the cleaner by means of chemical tests that are observed by the Owner's construction representative; include results of all tests in the Operating and Maintenance manuals. Apply heat while circulating, slowly raising temperature to 160°F and maintain for 12 hours minimum; vent all high points to assure 100% system circulation. Remove heat and circulate to 100°F or less; drain system as quickly as possible and refill with clean water. Circulate for 6 hours at design temperature, vent air at all high points, then drain. Refill with clean water and repeat until the system cleaner is removed and the M alkalinity level returns to normal. Remove and clean all strainers. Re-vent the system.
 - b. Remove all traces of chloride from the system; test to verify this removal and submit test results to the Engineer.
- B. Glycol Fill
1. The chilled water system is a glycol water system.
 2. Completely flush all traces of cleaning chemicals before adding the glycol water mixture to the system. Verify this by chemical test.
 3. Use a hand pump to fill system from barrels. Circulate fluid for several hours, vent all high points where air may collect, and test the system for proper concentration of glycol; include copy of test report in the Operating and Maintenance manuals.

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END OF SECTION

SECTION 15140

PUMPS

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Work includes furnishing all labor, material, and equipment required to supply, install, and test process water handling pumps, drive units, controls, and appurtenances to pumping equipment as shown on the Drawings, specified herein and required to make the units complete and fully operable.

1.2 SUBMITTALS

- A. Submit product data and shop drawings in accordance with SECTION 01340 and operating and maintenance instructions in accordance with SECTION 01730.
- B. Submit manufacturer's product data on pump and driver. Submittals shall include the following features:
 - 1. Manufacturer's specifications data and descriptive literature.
 - 2. Factory certified performance curves showing capacity in gpm, NPSH, head, efficiency and pump horsepower from 0 gpm to 110% of design capacity.
 - 3. Motor efficiency and power factor at all design operating points.
 - 4. Drawings showing general dimension, confirming the size of the pump, openings, connections, construction details of the equipment, wiring diagrams, piping drawings, and weights of major components.
 - 5. Procedures for proper installation.
 - 6. Manufacturer's guarantee.
 - 7. Information about the nature and location of parts, service crews, and repair facilities.

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1.3 OPERATION AND MAINTENANCE DATA

- A. Operating and adjustment instructions.
- B. Parts lists.
- C. Disassembly, repair, and assembly instruction including drawings.
- D. Maintenance procedures and recommended maintenance intervals.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver pumping equipment to the job site at the appropriate time for installation. Equipment items shall be created or affixed to pallets with protective wrappings. Equipment shall be shipped to the job site with all openings sealed to prevent entry of foreign materials, rodents, etc. Exercise care to prevent damage from handling. Store mechanical and electrical components off the ground in weathertight enclosures. Keep equipment dry at all times.

PART 2 PRODUCTS

2.1 CLARIFIER PUMPS – SUBMERSIBLE RAIL-MOUNTED NON-CLOG PUMPS

- A. General Requirements
 - 1. Each pump shall be supplied with guide rails, brackets, and appropriately sized discharge elbows for installation as shown on the Drawings.
 - 2. Furnish and install two submersible pumps. Each pump shall be equipped with a 3.0-HP, submersible electric motor connected for operation on 460 volts, three-phase, 60 hertz, 1780 RPM, seven wire service, with 50-feet of submersible cable (SUBCAB) suitable for submersible pump applications. The power cable shall be sized according to NEC and ICEA standards and have PMSHA approval. The pump shall be supplied with a mating cast iron 3-inch discharge connection and be capable of delivering 300-GPM at 17-TDH. An additional point on the same curve shall be 400-GPM at 5-feet total head. Shut off head shall be 33-feet (minimum). Each pump shall be fitted with one foot of stainless steel chain and 15-feet of stainless steel guide cable for pump retrieval using a Grip-eye system.
- B. Pump Design and Construction
 - 1. Pump shall be designed for pumping wastewater.

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2. The pumps shall be automatically and firmly connected to the discharge connection, guided by a guide bar system extending from the top of the station to the discharge connection. There shall be no need for personnel to enter the wet-well. Sealing of the pumping unit to the discharge connection shall be accomplished by a machined metal-to-metal watertight contact. No portion of the pump shall bear directly on the sump floor.
3. Pump Construction
 - a. Major pump components shall be of gray cast iron, ASTM A-48, Class 35B, with smooth surfaces devoid of blow holes or other irregularities. All exposed nuts or bolts shall be AISI type 304 stainless steel constructions. All metal surfaces coming into contact with the pumpage, other than stainless steel or brass, shall be protected by a factory applied spray coating of alkyd primer with an acrylic dispersion zinc phosphate primer with a polyester resin paint finish on the exterior of the pump.
 - b. Sealing design shall incorporate metal-to-metal contact between machined surfaces. Critical mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile or Viton rubber O-rings. Fittings will be the result of controlled compression of rubber O-rings in two planes and O-ring contact of four sides without the requirement of a specific torque limit.
 - c. Rectangular cross-sectioned gaskets requiring specific torque limits to achieve compression shall not be considered as adequate or equal. No secondary sealing compounds, elliptical O-rings, grease or other devices shall be used.
4. Cooling System
 - a. Motors are sufficiently cooled by the surrounding environment or pumped media. A water jacket is not required.
5. Cable Entry Seal
 - a. The cable entry seal design shall preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall consist of a single cylindrical elastomer grommet, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the body containing a strain relief function, separate from the function of sealing the cable. The assembly shall provide ease of changing the cable when necessary using the same entry seal. The cable entry junction chamber and motor shall be separated by a stator lead sealing gland or terminal board, which shall isolate the interior from foreign material gaining access through the pump top. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.

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6. Motor
 - a. The pump motor shall be a NEMA B design, induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber. The stator windings and stator leads shall be insulated with moisture resistant Class F or H insulation. The stator shall be insulated by the trickle impregnation method using monomer-free polyester resin resulting in a winding fill factor of at least 95%. The stator shall be heat-shrink fitted into the cast iron stator housing. The use of multiple step dip and bake-type stator insulation process is not acceptable. The use of bolts, pins or other fastening devices requiring penetration of the stator housing is not acceptable. The motor shall be designed for continuous duty handling pumped media of 40 C (104 F) and capable of up to 15 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of cast aluminum. Thermal switches set to open at 125 C (260 F) shall be embedded in the stator lead coils to monitor the temperature of each phase winding. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the control panel. The junction chamber containing the terminal board, shall be hermetically sealed from the motor by an elastomer compression seal. Connection between the cable conductors and stator leads shall be made with threaded compression type binding posts permanently affixed to a terminal board. Wire nuts or crimping type connection devices are not acceptable. The motor and pump shall be designed and assembled by the same manufacturer.
 - b. The combined service factor (combined effect of voltage, frequency and specific gravity) shall be a minimum of 1.15. The motor shall have a voltage tolerance of plus or minus 10%.
 - c. The power cable shall be sized according to the NEC and ICEA standards and shall be of sufficient length to reach the junction box without the need of any splices. The outer jacket of the cable shall be oil resistant chloroprene rubber. The motor and cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet. The motor horsepower shall be adequate so that the pump is non-overloading throughout the entire pump performance curve from shut-off through run-out.
7. Bearings
 - a. The pump shaft shall rotate on two bearings. Motor bearings shall be permanently grease lubricated. The upper bearing shall be a single deep groove ball bearing. The lower bearing shall be a two row angular contact bearing to compensate for axial thrust and radial forces. Single row lower bearings are not acceptable.
8. Mechanical Seal
 - a. Each pump shall be provided with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies. The lower, primary seal unit, located between the pump and the lubricant

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- chamber, shall be constructed of silicon carbide or approved equal. The upper, secondary seal unit, located between the lubricant chamber and the motor housing, shall be constructed of chromium steel/carbon or approved equal. The seals shall require neither maintenance nor adjustment nor depend on direction of rotation for sealing. The position of both mechanical seals shall depend on the shaft.
- b. Each pump shall be provided with a lubricant chamber for the shaft sealing system. The lubricant chamber shall be designed to prevent overfilling and to provide lubricant expansion capacity. The drain and inspection plug, with positive anti-leak seal shall be easily accessible from the outside. The seal system shall not rely upon the pumped media for lubrication. The motor shall be able to operate dry without damage while pumping under load. Seal lubricant shall be FDA Approved, nontoxic.
9. Pump Shaft
- a. Pump and motor shaft shall be the same unit. The pump shaft is an extension of the motor shaft. Couplings shall not be acceptable. The shaft shall be AISI type 431 stainless steel. If a shaft material of lower quality than 431 stainless steel is used, a shaft sleeve of 431 stainless steel is used to protect the shaft material. However, shaft sleeves only protect the shaft around the lower mechanical seal. No protection is provided in the oil housing and above. Therefore, the use of stainless steel sleeves will not be considered equal to stainless steel shafts.
10. Impeller
- a. The impeller(s) shall be of gray cast iron, Class 35B, dynamically balanced, semi-open, multi-vane, backswept, non-clog design. The impeller vane leading edges shall be mechanically self-cleaned upon each rotation as they pass across a spiral groove located on the volute suction, which shall keep them clear of debris, maintaining an unobstructed leading edge. The impeller(s) vanes shall have screw-shaped leading edges and shall be capable of handling solids, fibrous materials, heavy sludge and other matter found in waste water. The screw shape of the impeller inlet shall provide an inducing effect for the handling of sludge and rag-laden wastewater. Impellers shall be locked to the shaft and shall be coated with alkyd resin primer.
11. Volute
- a. The pump volute shall be of A48 Class 35B gray cast iron and shall have integral spiral shaped cast grooves at the suction of the volute. The internal volute bottom or insert ring shall provide effective sealing between the pump volute and the multi-vane, semi-open impeller. The sharp spiral grooves shall provide the shearing edges across which each impeller vane leading edge shall cross during its rotation in order to remain unobstructed. The clearance between the internal volute bottom and the impeller leading edges shall be adjustable.

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12. Protection
 - a. All stators shall incorporate thermal switches in series to monitor the temperature of each phase winding. At 125 C (260 F) the thermal switches shall open, stop the motor and activate an alarm. A leakage sensor shall be provided to detect water in the stator chamber. The Float Leakage Sensor (FLS) is a small float switch used to detect the presence of water in the stator chamber. When activated, the FLS will stop the motor and send an alarm both local and/or remote. **USE OF VOLTAGE SENSITIVE SOLID STATE SENSORS AND TRIP TEMPERATURE ABOVE 125 C (260 F) SHALL NOT BE ALLOWED.** The thermal switches and FLS shall be connected to a MiniCAS (Control and Status) monitoring unit. The Mini CAS shall be designed to be mounted in any control panel.
13. Pump Control Panel
 - a. Furnish a duplex automatic pump control center in a NEMA 4X, Hoffman stainless steel, fiberglass or painted steel, enclosure. Panel to be designed for two submersible pumps and shall be designed and manufactured for submersible pump applications and supplied by the pump manufacturer to insure compatibility and proper pump protection. The control center shall be provided with three phase 460 volts.
 - b. The panel will be UL 508 or UL 913.
 - c. Motor starters shall be open frame, across the line NEMA rated with overload protection. Motor starter contact and coil shall be replaceable from the front of the starter without removing from its mounted position. Overload heaters shall be block type, utilizing melting alloy spindles, and shall have visual trip indication. Overload shall be sized for the full load amperage draw of the pumps. Definite purpose contactors, fractional size starters and horsepower rated contactors or relays shall not be acceptable.
 - d. Circuit breakers shall be indicating type, providing “on-off-trip” positions of the operating handle. When the breaker is tripped automatically, the handle shall assume a middle position indicating “trip.”
 - e. A control power transformer shall provide 120 volts for the external level sensing circuits (if required) and other pilot circuitry. Fuse or circuit breaker shall protect the primary and secondary of the control power transformer.
 - f. The panel will incorporate a separate motor thermal protection circuit for each pump motor. The circuit shall be manually reset after a stator thermal overload but automatically reset after a power failure.
 - g. All control relay components shall be mounted on DIN rails. Terminals shall be provided for all incoming and outgoing circuits, except for motor load cables, which may be connected directly to the overload relay terminals. All wires in the control panel shall be color coded by voltage. Power supply wires shall be isolated from the

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control wires. Control wiring is to be run in wire channels and not simply tied together. A nameplate shall be permanently affixed to the inside of the control enclosure. The nameplate shall have a stamped or engraved serial number and shall also identify the motor horsepower and amperage of the pump(s).

- h. The control panel will include the following functions:
- 1) An electronic alternator providing automatic alternation of the pumps and prohibiting both pumps from operating simultaneously. Only one pump can operate at a time.
 - 2) Hand-Off-Auto (H-O-A) selector switches for each pump.
 - 3) Run lights. Lights to show that a pump is running, pump failure and high water in lift station shall be included in the station.
 - 4) A high water alarm will be provided.
 - 5) Auxiliary contacts on each starter for telemetry (telemetry by others).
 - 6) Mini-CAS (control and status) relay for moisture detection, one for each pump, with N.O. pole for remote alarm.
 - 7) Timers to exercise pumps.
 - 8) Elapsed time meters.
 - 9) Pump starts counters.
 - 10) Three (3) floats, (lead pump on, high water and pump off).
 - 11) Indicator light for high water condition.
 - 12) Battery back up for indicator light.
 - 13) Horn for high water condition.
 - 14) Inner door.
 - 15) Automatic meggering of each pump motor before starting.
 - 16) Wire diagrams.
 - 17) Convenience outlet (5 amps).
 - 18) Anti-condensation heaters.
 - 19) Control panel illumination lights.
 - 20) Control panel intrusion alarm.
 - 21) Padlock hasp and eye for outside door of panel.
 - 22) On-site start-up assistance (one day).
 - 23) Amp meters.

C. Approved Manufacturers:

1. ABS
2. ITT FLYGT

2.2 BASE MOUNTED PUMPS

- A. Furnish and install pumps with performance characteristics as shown on the Drawings. Pumps shall be base mounted, single stage, end suction design with a foot mounted volute to allow removal and service of the entire rotating assembly without disturbing the pump piping electrical motor connections or pump to motor alignment.

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- B. Pump volute shall be Class 30 cast iron with integrally-cast pedestal support feet. The impeller shall be cast iron enclosed type, balance to ANSI/HI 1.1-1.5-1994, section 1.4.6.1.3.1, figure 1.106, balance grade G6.3 and keyed to the shaft and secured by a locking capscrew.
- C. The liquid cavity shall be sealed off at the pump shaft by an internally-flushed mechanical seal with ceramic seal seat and carbon seal ring, suitable for continuous operation at 225 deg F. (107 deg C). A replaceable bronze shaft sleeve shall completely cover the wetted area under the seal.
- D. Pump shall be rated for minimum of 175 psi (12 bar) working pressure. Volute shall have gauge tappings at the suction and discharge nozzles and vent and drain tappings at the top and bottom.
- E. The pump's vibration limits shall conform to Hydraulic Institute ANSI/HI 1.1-1.5-1994, section 1.4.6.1.1 for recommended acceptable unfiltered field vibration limits (as measured per HI 1.4.6.5.2, Figure 1.108) for pumps with rolling contact bearings.
- F. Baseplate shall be of structural steel of fabricated steel channel with fully enclosed sides and ends, and securely welded cross members. Grouting area shall be fully open. The combined pump and motor baseplate shall be sufficiently stiff as to limit the susceptibility of vibration. The minimum baseplate stiffness shall conform to ANSI/HI 1.3.4-1997 for Horizontal Baseplate Design standards.
- G. The seismic capability of the pump shall allow it to withstand a horizontal load of 0.5g, excluding piping and/or fasteners used to anchor the pump to mounting pads or to the floor, without adversely affecting pump operation.
- H. A flexible type, center drop-out design coupler, capable of absorbing torsional vibration, shall be employed between the pump and motor. Pumps for variable speed application shall be provided with a suitable coupler sleeve. The coupling shall be shielded by a dual rated ANSI B15.1, Section 8 & OSHA 1910.219 compliant coupling guard and contain viewing windows for inspection of the coupling.
- I. Motor shall meet NEMA and EPACT '92 (where applicable) specifications and shall be of the size, voltage and enclosure called for on the plans. Pump and motor shall be factory aligned, and shall be realigned by the contractor per factory recommendations after installation.
- J. Pumps shall be provided with suction diffusers. Diffuser shall provide an angle pattern flow-straightening fitting that combines a diffuser-strainer orifice cylinder and full-length straightening vanes with pressure drop equal to or less than

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schedule. Cast iron body, steel straightening vanes and orifice cylinder and bronze start-up strainer. Suction diffuser shall be by pump manufacturer.

- K. The pump(s) selected shall conform to ANSI/HI 9.6.3.1 standards for Preferred Operating Region (POR) unless otherwise approved by the Engineer. The pump NPSH shall conform to the ANSI/HI 9.6.1-1997 standards for Centrifugal and Vertical Pumps for NPSH Margin.
- L. Each pump shall be factory hydrostatically tested for Hydraulic Institute standards. It shall then be thoroughly cleaned and painted with at least one coat of high grade paint prior to shipment.
- M. The pump(s) shall be manufactured, assembled and tested in an ISO 9001 approved facility.
- N. Pumps shall be Series 1510 as manufactured by ITT Bell & Gossett or equal.

2.3 SUBMERSIBLE VERTICAL TURBINE PUMPS

- A. Unless otherwise specified, submersible vertical turbine pumps shall be constructed in accordance with AWWA E101, driven by an electric motor, size as indicated on the Drawings. Pumps shall be designed for connection to piping as indicated. A strainer shall be provided at the pump suction. Pumps shall be operable for the entire range of flow denoted on the pump curve.
- B. Pump Head Assembly
 - 1. Pump head assembly shall consist of a pitless adapter from which the vertical discharge pipe is suspended and fittings as required for connecting to the piping system. Head assembly shall be provided with provisions for securing slings to facilitate setting and lifting.
- C. Pump Bowl Assembly
 - 1. Pump bowl assembly shall include the pump bowls, impellers, shaft, and bearings and may be of single stage or multistage configuration.
- D. Pump Bowls
 - 1. Pump bowls shall have integrally cast vanes with smooth, streamlined water passageways, and shall be constructed of close grained cast iron or bronze. Pump bowls shall be equipped with replaceable seal rings on the suction side for pumps with enclosed impellers.
- E. Impellers
 - 1. Impellers shall be carefully finished with smooth water passageways and shall not load the prime mover beyond the nameplate rating over the entire performance range of the pump. Impellers shall be of the enclosed or semi-open type and shall be constructed of stainless steel.
- F. Pump Shafts

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1. Pump shafts shall be stainless steel and the pump motor coupling shall be stainless steel capable of transmitting the required thrust in either direction.
- G. Bearings
1. Intermediate bowl bearings shall be water lubricated bronze or fluted rubber. Top bowl bearings and suction interconnecting bearings shall be grease packed bronze or water lubricated bronze or fluted rubber. Grease in grease packed bearings shall be nonwater soluble hydraulic type permanently sealed against loss. Grease packed bearings shall be provided with sand caps to prevent intrusion of abrasive particles. Thrust bearings shall be located in the pump motor.
- H. Strainer
1. A stainless steel strainer shall be furnished at the pump suction.
- I. Discharge Pipe
1. Discharge pipe shall be sized as shown. Discharge column retainers or spiders shall be utilized to maintain the discharge pipe centered in the well casing. A minimum of one retainer shall be provided for each 50 feet of discharge pipe. Provisions shall be made for fastening the retainer spiders to prevent them from sliding on the pipe and damaging the power cable when the pump is installed in the well.
- J. MOTORS
1. Submersible motors shall be designed and manufactured expressly for the intended use. Motors shall be rated for the voltage and phase as indicated on the Drawings, 60 Hz and such rating shall be stamped on the nameplate. Submersible motors may be the wet stator type, dry stator type, water, or oil filled stator type. Wet stator motors shall be filled at the factory with water treated to minimize corrosion, and shall be provided with a seal to keep interchange of cooling water and water being pumped to a minimum. Windings shall be insulated with a waterproof material. Dry stator motors shall have rotor bearings immersed in a coolant lubricant of water oil or water glycol mixture, or a water grease emulsion. When the coolant is water, it may be sealed in the motor or allowed to flow through the motor, depending upon design. Stator case shall be hermetically sealed and may be filled with a solid plastic material to help dissipate heat. Oil filled stator motors shall be completely filled with high dielectric constant oil. A mechanical seal shall be provided between the shaft and the motor housing and shall be designed to minimize the loss of oil. An oil reservoir shall be provided to replenish the oil loss for the life of the motor. Wet stator motors and oil filled stator motors shall employ a system to automatically balance the liquid pressure in the motor at any depth of submergence up to the maximum allowable. Motor bearings shall provide smooth operations under the conditions encountered for the life of the motor. Adequate thrust bearings shall be provided in the motor to carry the weight of all rotating

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parts plus the hydraulic thrust, and shall be capable of withstanding the upthrust imposed during pump starting. Motors shall be suitable for variable frequency drive operations.

K. POWER CABLES

1. Submersible power cables shall be specifically designed for use with submersible pumps, and shall be as recommended by the manufacturer of the motors with which the cables are used. Each cable shall be not less than No. 12 AWG stranded copper and shall have an ampacity of not less than 125 percent of the motor full load current. Each conductor shall be insulated with a heat resistant, moisture resistant synthetic rubber or thermosetting plastic jacket. A separate stranded, green insulated, grounding conductor shall be provided for each circuit. Single and multiple conductor cables shall be jacketed with a watertight synthetic rubber, plastic, or metal jacket impervious to oil or water. Metal jackets shall have a polychloroprene covering. Submersible cables shall be suitable for continuous immersion in water at the maximum depth encountered. Multiple conductor cables may be used for ampacities up to and including 200 amperes; for greater ampacities single conductor cables or two multiple conductor cables shall be used. Cables shall be securely supported from the pump column at intervals not to exceed 15 feet by corrosion resistant bands or clamps designed to prevent damage to the cable jacket. Single conductor cables shall be laced, cabled together, or clamped at intervals to prevent spreading apart. Except where cables are connected to the motor terminal wiring, cables shall contain no splices in the length from the junction box or motor starter to the motor. Cables shall be terminated at the junction box or motor starter with a watertight cable connector. Splices in cables will be allowed only at the connection to the motor, and may be made at that point only if there is sufficient room in the well casing without interfering with proper pump setting and operation. A waterproof plug and connector or other type of fitting may be provided for connection of the cable at the motor. Such connection shall be suitable for continuous immersion at the maximum water depth encountered. Splices shall use pressure connectors and shall be cast in an epoxy resin, providing a homogeneous waterproof bond to the outer jacket of the cables. Splices shall be factory fabricated and tested and shall be waterproof and suitable for continuous immersion at the maximum depth encountered. For each 50 feet of setting depth, 1 foot of extra cable length shall be provided to compensate for possible twist or sag of the cable during installation. Where cables pass the pump bowl assembly, cables shall be flat or protected against damage by a corrosion resistant shield forming a smooth rounded surface. Sharp bends in the cables at the shield or at the connection to the motor will not be allowed.
2. Note that depth sensor and low water electrodes will also be suspended in each well.

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2.4 UTILITY WATER PUMP

- A. The utility water pump shall be a packaged booster pump system consisting of a pump, hydropneumatic tank and controls to automatically start and stop the pump.
- B. The system shall be designed to supply 75 gpm at a pressure 50 psi.
- C. System operation: Upon water demand, water will flow from the pressure tank to the system. This will cause the pressure to drop as sensed by a pressure switch. Upon drop in pressure, the pump will start and run continuously until the water in the volute of the pump heats up (indicating a dead head condition) and trips a temperature switch.
- D. System components shall include: an 8.6 gallon pressure tank, pressure and temperature switch, suction check valve, pressure and temperature relief valve, completely wired motor control and a steel base.
- E. Pump shall be a bronze fitted, close coupled end suction centrifugal pump, with mechanical seals and a 3500 RPM, 5 HP ODP, 460 V, 3 phase motor. Pump volute shall be constructed of cast iron and shall be fitted with bronze wear rings.
- F. Pump shall be Paco model 848A or approved equal.

2.5 HYDROCYCLONE SUPPLY PUMPS

- A. Refer to SECTION 15525 for specification of these pumps.

2.6 END SUCTION CENTRIFUGAL PUMPS

- A. Pumps shall be a close coupled, or motor mount end suction centrifugal pumps with a semi-open impeller capable of passing 1 inch diameter solids or greater.
- B. Pump impellers, casing and suction heads shall be of cast iron construction.
- C. Casting of pumps shall be designed such that it can be rotated to accommodate different discharge patterns. Pump shall have a 125 lb. ASA flange connection.
- D. Suction heads shall be easily removable permitting inspection and servicing without disturbing discharge piping or pump alignment.

2.7 FORMALIN SYSTEM PUMPS

- A. Formalin supply pumps shall be corrosion resistant, self-priming magnetic drive, seal-less centrifugal pumps capable of pumping 7 GPM at 20 feet of TDH (using water as the pumping fluid).

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- B. Pumps shall be have EDPM o-rings, a priming chamber with basket strainer, high purity carbon bushings, explosion proof motors, all stainless steel external hardware and an O-ring sealed drain plug.
- C. The pumps shall be capable of self-priming from fluid elevations up to 20 feet below the pump suction.
- D. The manufacturer shall verify that all wetted materials inside the pumps are compatible with formalin and ethanol.
- E. The pumps shall be designed to run dry without damage.
- F. The pumps shall be provided with a 120 v, single phase, 3,450 RPM, ½ HP explosion proof motor. Pumps shall be Sethco Model PMSP-510-1/2 EI or approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

- A. All equipment shall be installed in accordance with the manufacturer's recommendations, drawings, and/or specifications. Alignment and adjusting shall be verified after installation.
- B. Before connecting pump to piping, all piping shall be thoroughly flushed and cleaned.
- C. Flexible connections shall be installed on pump suction and discharge where shown or where necessary to ensure stress free piping connections. A butterfly valve or other throttling and shut-off valve shall be installed at the discharge of the pump.
- D. The pumps shall have an electrical disconnect complying with the NEC.

3.2 TESTING

- A. In addition to testing that may be required by codes, the Contractor shall perform all tests specified in this section and shall furnish and pay for all material and labor required for tests. Prior to start-up, the pump shall be tested in place. These tests shall duplicate all normal operating modes. Should tests indicate unsatisfactory operation, conditions shall be corrected and the test repeated at the Contractor's expense.

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PART 4 WARRANTY

4.1 GENERAL

- A. The pumps shall be warranted for labor, equipment and all components for a one (1) year period after final acceptance.

END OF SECTION

SECTION 15170

MOTORS

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. The work includes all labor, materials, and equipment required to furnish, install and test AC induction motors as shown on the Drawings and as specified herein.

1.2 QUALITY ASSURANCE

- A. All motors shall be designed and constructed in accordance with the latest edition of NEMA Standard MG1 and applicable portions of the NEC. Motors for use in hazardous locations, as defined in NEC Article 500 shall be approved by a recognized testing laboratory. For this specification section, the term "recognized" shall mean having been listed as acceptable for at least 1 year by the authority having jurisdiction, as defined in the NEC.

1.3 SUBMITTALS

- A. Provide submittals in accordance with instructions given in SECTION 01340.
- B. Submittal of motor data shall be in conjunction with the piece of mechanical equipment served. See individual sections for submittals required.

1.4 PRODUCT DELIVERY AND STORAGE

- A. All motors shall be shipped to the jobsite with all openings plugged, taped or otherwise sealed to prevent entry of foreign materials, rodents, etc.
- B. Motors stored at the jobsite shall be in a dry location protected from sun and rain, unless otherwise authorized by the Engineer.

PART 2 PRODUCTS

2.1 SERVICE CONDITIONS

- A. All equipment shall be designed and built for industrial service and be capable of delivering rated horsepower under the following applicable conditions:

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1. 40°C maximum ambient temperature.
2. Voltage variations to +10% of nameplate rating.
3. Frequency variations to +5% of nameplate rating.
4. Combined voltage and frequency variations to +10% total, as long as frequency does not exceed +5%.

2.2 VOLTAGE

- A. Motors rated one-third horsepower and smaller shall be designed and connected for operation at either 120 volts single phase or 208 volts, three phase or as indicated on the Drawings. Motors one-half horsepower and larger shall be rated for 240 or 460 volt, 3 phase; 120 volt, 240 or 208 single phase; or as indicated on the Drawings.

2.3 ENCLOSURE TYPES

- A. Enclosures will be identified as follows:
1. ODP: Open drip-proof.
 2. TEFC: totally enclosed, fan cooled.
 3. Motors for submersible pumps shall be as specified in SECTION 15140
- B. Motors located indoors shall be open drip-proof type. Motors located outdoors shall be TEFC with corrosion-resistant finish.
- C. Drip-proof motors shall be designed such that particles of solid or liquid material falling at any angle from 0 to 15 degrees downward from the vertical shall not enter the ventilating openings or interfere with successful operation, as defined by NEMA standards.
- D. TEFC motors shall conform to the appropriate NEMA standards and shall be provided with drilled and tapped holes to drain all cavities within the motor. Motors with frames 286T or smaller shall have corrosion-resistant plugs in the drain holes. Motors with frame 324T or larger shall be provided with automatic breather-drain devices.

2.4 ELECTRICAL REQUIREMENTS FOR MOTORS

- A. Service factor for single-phase motors shall be 1.0 or greater unless indicated otherwise on the Drawings or component specifications.
- B. Service factor for all 3 phase motors shall be 1.15 unless indicated otherwise on Drawings or in component specifications.

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- C. Time rating. All motors covered by this section shall have continuous time ratings.
- D. Currents. Locked rotor currents shall not exceed the maximum values for NEMA Design B.
- E. Protection. Current density and heating characteristics shall be such that the motors will not burn out if subjected to a maximum of a 20-second stall at 6 times full-load current.
- F. Rating: Motors shall not be required to operate at greater than their nameplate horsepower. Use of the service factor will not be allowed under conditions of rated voltage and frequency.
- G. Insulation. All motors shall have insulation systems conforming to the requirements for NEMA Class B or higher.
- H. Minimum motor efficiency is 80% unless otherwise approved.

2.5 NAMEPLATES

- A. Motor nameplates shall be of a non-corrosive metal that is not discolored by hydrogen sulfide. Nameplates shall be engraved or stamped and shall be fastened to the motor frame with screws or drive pins of the same material.
- B. Nameplates shall indicate clearly all the items of information enumerated in NEMA Standard MG1-0.37, MG1-10.38, or MG1-20.60, as applicable.
- C. The Contractor shall coordinate the motor nameplate location so it is readily visible for inspection in the completed machine, and it shall not be painted.

2.6 MECHANICAL REQUIREMENTS FOR MOTORS

- A. Frame sizes. Frames shall conform to latest NEMA Standard MG1-11.31 for "T" frames, and all dimensions shall meet NEMA Standards insofar as they apply.
- B. Shafts shall be in accordance with NEMA "T" or "TS" dimensions. Long shafts shall be suitable for belt, chain or gear drive, within limits established by good industrial practice and documented by NEMA Standards MG1-14.42 and MG1-14.07. Short shafts shall be used for direct connection.
- C. Connection diagrams shall be permanently attached to the motor, either inside the conduit box or on the motor frame, in a location readable from the conduit box side.
- D. External finish: Shall be corrosion resistant for outdoor operation.

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- E. Hardware: All bolts, screws, and other external hardware shall be treated for resistance to corrosion by painting with a rust inhibitive primer immediately after installation and two final coats when final equipment painting is performed.

PART 3 EXECUTION

3.1 TESTS

- A. Insulation check. The Engineer may test the insulation resistance of the motor at any time after delivery of the motor to the jobsite or at any time during the warranty period. Tests for acceptability will be made using a 1,000-volt megohm meter (megger). Interpretations of test results for minimum acceptable values of insulation resistance will be made in accordance with IEEE No. 43. All deficiencies identified by any testing shall be corrected by the Contractor at no additional cost to the Owner.
- B. Load testing. The Engineer may test a motor at any time after delivery of the motor to the jobsite or at any time during the warranty period to determine its ability to operate at nameplate current or less, under all normal operating conditions. In the event that a motor does not meet the load test requirements, the Contractor shall replace the motor at no additional cost to the Owner.

3.2 PREPARATION FOR SHIPMENT

- A. Protective coating. Before shipment, the shaft extension and any other external bare exposed metal parts of each motor shall be coated with an easily removable rust preventive.
- B. Packaging. All motors shall be packed in styrofoam or securely fastened to a hardwood skid or pallet for fork-truck handling and shall be covered for protection against dirt and moisture during transit and for short-time outdoor storage.

PART 4 WARRANTY

4.1 GENERAL

- A. The motors shall be warranted for both labor, equipment and all components for a 1 year period after final acceptance.

END OF SECTION

SECTION 15175

FUEL STORAGE AND DISTRIBUTION

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Work includes furnishing all labor, materials and equipment for the installation of complete fuel storage and distribution systems including storage tanks, fuel pumps and enclosures, piping, valves, fittings and filters and concrete tank pads as specified herein and as shown on the Drawings.

1.2 REFERENCES

- A. Uniform Fire Code (UFC)
- B. NFPA
- C. Uniform Mechanical Code (UMC)

1.3 QUALITY ASSURANCE

- A. Diesel fuel work shall be done in accordance with NFPA-30- Flammable and Combustible Liquids Code and article 79 of the UFC.
- B. Propane work shall be done in accordance with NFPA54 National Fuel Gas Code and NFPA 58 LPG Gas Code and Article 82 of the UFC.
- C. Electrical connections shall be done in accordance with NFPA 70 National Electrical Code (NEC).

1.4 SUBMITTALS

- A. Submit the following information in accordance with SECTION 01340.
 - 1. Shop drawings and product data on fuel tank and accessories and on pump enclosure and accessories.
 - 2. Manufacturer's standard warranty.

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PART 2 PRODUCTS

2.1 ABOVEGROUND TANK

- A. The aboveground vaulted tank shall consist of a U/L listed doublewall saddle mounted steel above ground. Capacity shall be as scheduled on the Drawings.

- B Internal Steel Tank
 - 1. The internal steel tank shall be designed for aboveground storage of flammable liquids at atmospheric pressure. The tank shall comply with requirements for stationary installation in accordance with NFPA No. 30 and 31.
 - 2. Steel tank to be constructed in accordance with UL 142 specifications.
 - 3. Steel tank to be circular in shape with continuous welds on all seams and end heads inside and out.
 - 4. Steel tank shell to have a wall thickness of 12 gauge or greater and the heads to have a wall thickness of 12 gauge or greater. The secondary tank shall have a shell thickness of 12 gauge or greater and heads shall have a thickness of 10 gauge or greater.
 - 5. Steel tank shall be designed to handle and store No. 2 diesel fuel.
 - 6. Exterior coating shall be white polyurethane enamel (5.7 mils thick) protective coating.
 - 7. The tank shall be designed for a seismic zone 4 loading.

- C. Certification
 - 1. The aboveground vaulted tank shall be provided with the following documentation of approval.
 - a. U.L. 2085 Protected Aboveground Tanks For Flammable Liquids UFC 79-7 For Protected Tanks.
 - b. U.L. 142 Steel Aboveground Tanks For Flammable and Combustible Liquids. (Inner tank only).
 - 2. Tank shall be warranted against default in material or workmanship for thirty (30) years.

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D. Accessories Required

1. 2" pipe for leak monitoring in the tank interstitial space with connection ready for mechanical action leak detector.
2. Interstitial space direct mechanical action leak detector.
3. 7 gallon minimum external above ground storage tank spill container overflow box with lid, drain, fill adapter and cap coupled with AST overflow prevention valve sized as recommended by tank manufacturer for remote tank fill system.
4. Emergency vent caps for tank and interstitial space, size as recommended by tank manufacturer.
5. Screened open vent cap 1 1/2" size minimum.
6. Opening and 4" connection suitable for inner tank level sensor. Level sensor specified in DIVISION 16.
7. Fuel supply and return fuel line connections with a drop tube for generator fuel supply line with a fusible valve.
8. Frost proof water drain valve for tank.
9. Tank labels and warning decals as required by codes.

E. Manufacturers

1. Ace Tank and Equipment Co.
2. Hallmark Industries
3. Reliable Steel, Inc.

2.2 PROPANE (LPG) TANKS

- A. The propane tanks, first stage pressure regulators, connection hoses and fittings shall be supplied and installed by the designated propane supply vendor and coordinated by the Engineer. The contractor shall be responsible to install the mounting pad for a maximum of 5,000 gallons of propane storage at location shown on the Drawings. Contractor shall coordinate with local suppliers for size of pad. Slab design shall be as accepted by the Engineer.

2.3 VALVES

- A. Ball valves shall be steel and AGA certified.

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PART 3 INSTALLATION

3.1 GENERAL

- A. The fuel tank(s) shall be installed in the generator buildings as shown on the Drawings.

- B. The tanks and all accessories (vents, product fill, etc.) shall be installed to meet the respective manufacturer's requirements local and national codes and installed to the designated ports/locations as established in the Drawings.

END OF SECTION

SECTION 15176

ULTRAVIOLET DISINFECTION

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. This section includes providing all materials, labor, equipment, and appurtenances required for the enclosed vessel, pressured flow, amalgam lamp based, ultraviolet (UV) system illustrated and scheduled on the Drawings and as specified herein. The UV systems are to be completed and operational with all control equipment and accessories as shown and specified. Included are the following topics:
- B. Related Work
 - 1. 15010: General Requirements for Mechanical Work
 - 2. 15060: Pipes and Fittings
 - 3. 15100: Valves

1.2 QUALITY ASSURANCE

- A. Prequalification Requirements:
 - 1. To be acceptable, the manufacturer must be able to demonstrate to the satisfaction of the Engineer successful performance with amalgam lamp UV systems in similar applications. The manufacturer must be able to demonstrate at least three (3) permanent installations of this equipment type in applications with similar design flow rates and UV dose requirements.

1.3 SUBMITTALS

- A. The Contractor shall submit shop drawings and product literature including all pertinent information for the proposed equipment such as dimensions, manufacturer, capacity, type, curves, certifications, accessories, physical and performance data, finishes, materials, location, layouts and wiring diagrams, etc.
- B. The Contractor shall submit Operation and Maintenance Manuals. These manuals shall contain complete wiring diagrams and schematics, parts lists, system operational data, dosage tables (based upon the range of field conditions, i.e. % transmissions and water flow rates), and drawings for the UV disinfection equipment supplied. The shop drawings and product literature may satisfy some of the requirements for the manuals, but it is the Contractor's responsibility to provide complete manuals.

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1.4 WARRANTY

- A. The Contractor shall provide a Manufacturer's written warranty that provides:
 - 1. For full replacement of all defective lamps within the first 1000 hours of operation.
 - 2. For full replacement of equipment with defects in materials or workmanship for a period of 18-months after shipment or 12-months after start-up. Replacement of defective equipment shall include installation, calibration, and adjustment of new equipment.
 - 3. Response time for required on site warranty work shall not exceed 48 hours. Repairs or problems that can be resolved by telephone or shipment of minor replacement parts will not require a manufacturer's representative to report to the Hatchery, provided hatchery personnel can perform the direct repairs under the manufacturer's direction.
- B. The Contractor's warranty period is one (1) year from Substantial Completion. Any manufacturer's warranty that expires before that time does not relieve the Contractor of the Contractor's warranty.

PART 2 MATERIALS

2.1 GENERAL REQUIREMENTS

- A. Provide UV systems complete with UV reactor(s), control panel(s), UV intensity monitoring system(s), and all accessories herein specified and indicated on the drawings.
- B. To be acceptable, the UV system must operate in enclosed vessels and use amalgam UV lamps. The UV system must be designed to fit within the piping configuration shown on the Drawings, without compromise of clearances or hydraulic performance criteria.
- C. Flow through the system shall not be disrupted while changing of UV lamps is being carried out.
- D. Each system shall have an automatic electric motor driven lamp wiping system.

2.2 DESIGN, CONSTRUCTION AND MATERIALS

- A. General:
 - 1. All metal components in contact with the process water shall be Type 316L stainless steel which has been passivated, mechanically polished and electro-polished.
 - 2. All material exposed to UV light shall be Type 316L stainless steel, Type 214/219 quartz or a suitably UV resistant material. Each system shall have an automatic electric motor drive lamp wiping system.
 - 3. The system shall be designed for complete immersion of the UV lamps including electrode with the full length of the lamp in the water. All lamp

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electrical connections shall be at one end of the UV lamp. The major axis of the UV lamps shall be parallel to the direction of flow in the reactor.

B. UV Reactor:

1. Each UV reactor shall be manufactured from seamless stainless steel tubing.
2. Each UV reactor shall have a drain port fixed to its outer wall. Provide one sample port for use in obtaining a UV treated water sample.
3. Each UV reactor shall accept its respective UV lamps and quartz sleeves through only one end of the vessel. This end of the UV reactor shall allow for complete reactor entry so internal inspection and/or service can be accomplished.
4. The service side of the UV reactor and the UV lamp sleeve seals shall be made using suitable O-ring materials.
5. UV reactors shall be able to operate safely at a maximum inlet pressure of 150 psi, and be factory hydrostatically pressure tested to 225 psi.

C. UV Lamps:

1. The filament shall be significantly rugged to withstand shock and vibration.
2. Lamp bases shall be resistant to UV and ozone.
3. All electrical connections to the UV lamp shall be terminated at one end.
4. UV lamps shall have a lamp base design that prevents arcing between electrical pins.
5. UV lamps shall have a monochromatic spectral output, with the emissions peaking at 254 nanometers.
6. The type of quartz used for lamp manufacturer shall be compatible with wavelength emission.
7. The mercury contained in the lamps shall be mixed with a base metal and fixed to the inside wall of the UV lamp quartz.

D. Lamp End Seal and Lamp Holder:

1. The open end of the UV lamp sleeves shall be sealed to the sleeve guide by a suitable compression o-ring.
2. O-ring compression shall be made by a sleeve nut, which shall require no special tools for installation or removal.
3. Each UV lamp electrical connection shall incorporate a sealing boot which is held firmly in place by the sleeve nut to prevent emission of ultraviolet rays.

E. UV Lamp Sleeves:

1. Clear fused quartz tubing, closed at one end shall be used. Type 219 quartz shall be used for disinfection and ozone destruction applications.

F. Electronic Power Supplies

1. Each pair of UV lamps shall be powered by one electronic power supply.
2. The electronic power supply shall not be frequency dependant.

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3. Each lamp within the pair shall operate on its own circuit within the power supply so as to prevent consecutive lamp failures should one lamp fail.
4. UV lamps are to be operated by an electronic power supply which automatically adjusts lamp output as a function of lamp age.
5. Electronic power supplies shall possess the ability to vary the outputted electrical power to the lamps; thereby providing UV output variability with respects to lamp age and/or water quality conditions.

G. Electrical

1. Each UV reactor shall be powered from a remote mountable System Control Center by means of a waterproof cable interfacing with a watertight strain relief.
2. The System Control Center shall be of 304 stainless steel construction.
3. System Control Center electrical rating shall be a minimum of NEMA 12.
4. The System Control Center shall be provided with 277 volt, 60 Hz single phase power.

H. Control and Instrumentation

1. System control shall be microprocessor based. Operator interface is to be configurable microprocessor based and be located indoors.
2. Alarm Conditions:
 - a. Lamp Failure: Failed lamps shall be indicated by digital readout of the lamp position on the System Control Center panel. Lamp position in the reactor shall be indicated via lamp numbers fixed to the lamp wiring at the service end of the UV reactor.
 - b. Low UV Intensity: Germicidal UV intensity shall be continuously monitored by a silicon carbide diode installed in each reactor with UV intensity displayed in mW/cm^2 at the System Control Center panel for each reactor.
 - 1) A low UV alarm shall occur in the event that UV intensity at the sensor drops below 102% of the minimum UV intensity required to maintain the minimum specified UV dose at the maximum flow rate and minimum UV transmittance. The system shall open a "low UV alarm" relay and automatically increase output of the electronic power supplies to full output. The system shall remain in the full output mode until manually reset by the operator.
 - 2) A critical UV alarm shall occur in the event that UV intensity at the sensor drops below 100% of the minimum UV intensity required to maintain the minimum specified UV dose at the maximum flow rate and minimum UV transmittance. The system shall deenergize a "critical/major UV alarm" single throw relay upon alarm condition or upon power failure.

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- c. Lamp life status – at the end of UV lamp life (8500 hours) the elapsed time meter will flash continually for the next 240 hours to alert the operator that all lamps in the reactor require change out.
- d. Remote ON/OFF capabilities are to be provided.
- e. Acceptable Manufacturer: Trojan Technologies, Inc. (519) 457-3400.

2.3 SPARE PARTS

- A. The following spare parts and safety equipment shall be supplied:
 - 1. One full set of replacement lamps, sleeves and sleeve holders for each UV system.
 - 2. Two Spare Ballasts.
 - 3. Two (2) face shield(s), able to block UV light wavelengths between 200 and 400 nm.
 - 4. All required components to provide for complete lamp, quartz sleeve and wiper mechanism replacement at the end of service life (8,750 hours +/-).

PART 3 EXECUTION

3.1 GENERAL

- A. Contractor shall install the UV Systems per the Equipment Manufacturer's directions and the project Drawings. The Contractor will provide all required supports and anchoring required to install the UV units. The plumbing and electrical connections shall be provided as detailed on the Drawings and specifications. The Equipment Manufacturer will provide adequate crating and protection of the UV Systems for shipment to the project site. Installation instructions will be provided that specifically outline installation of the UV system. Lifting instructions will be provided to assist the Contractor in placing the units in the mechanical room.

3.2 START-UP

- A. Prior to start-up, the Contractor shall have attained complete Operation and Maintenance Manuals from the supplier and submitted at least one copy to the Engineer's corporate home office. Another copy shall be kept at the site and made accessible to the Engineer. Other copies shall be per Division 1.
- B. After the Contractor confirms that scheduled flowing water will be available to pass through the UV units, the Contractor shall arrange to have a factory-authorized field technician to the project site for the purpose of verification of installation of the equipment, training of the Contractor, and initial equipment start-up and trouble-shooting. This shall be prior to the formal Component Start-up.

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3.3 TRAINING

- A. The Contractor shall have a factory authorized field technician again review the installation, operate the UV systems on hatchery process water and train Owner how to operate and maintain the UV system. Training shall include actual replacement of a lamp. This shall be done after the formal Component Start-up and before the System Test. The Contractor shall coordinate the scheduling of this visit with the hatchery manager and the UV system manufacturer. This shall not be during the same week as start-up.
- B. The Contractor shall make a factory-authorized field technician make site visits at three (3) months and nine (9) months after final acceptance for a period of eight (8) working hours each trip for the purpose of inspection of the equipment and training the facility personnel on proper operation and maintenance procedures.

END OF SECTION

SECTION 15250

PIPE AND DUCT INSULATION

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. The work includes furnishing all labor, material and equipment required to provide and install all pipe, insulation and accessories as shown on the Drawings and as specified herein.

1.2 SUBMITTALS

- A. Submit product information for all products in accordance with SECTION 01340.

1.3 REFERENCES

- A. International Mechanical Code (IMC) with Oregon Amendments
- B. International Building Code (IBC) with Oregon Amendments, Chapter 20
- C. Sheet Metal and Air Conditioning Contractors National Association (SMACNA)

PART 2 PRODUCTS

2.1 GENERAL

- A. Insulations and their accessories shall not provide any nutritional or bodily uses to rats, mice, insects or other vermin, fungi or bacteria.
- B. Insulations and their accessories shall have U.L. Listed composite surface burning characteristics no greater than the following, unless noted otherwise in this Specification.
 - 1. Flame Spread 25
 - 2. Smoke Developed 50
 - 3. Fuel Contributed50
- C. Insulations and their accessories shall not react corrosively with the equipment, and piping they cover.
- D. Insulations shall be form fitted or cut to fit the piping so as to leave no more than a 1/4 inch airspace between the pipe and the insulation of more than 1/4 inch.

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- E. Insulation shall be labeled or stamped with the brand name of the manufacturer.

2.2 PIPE INSULATION

A. General:

- 1. Insulate all Cold Water (CW), Hot Water (HW) and Hot Water Return (HWR) piping above grade. Do not insulate Waste (W) or Vent (V) Piping.

B. For piping with operating temperature of 140° and lower:

- 1. Piping insulation shall be tubular. Insulation for valves, fittings, expansion joints, flanges and other connections shall be segmented sections 1" thick, molded or blanket type coverings of pipe insulation.
- 2. Pipe insulation shall be closed cell elastomeric foam type conforming to ASTM E96 – 90 Procedure B.
- 3. Insulated pipe, fittings and valves shall have PVC jackets constructed with white PVC film, gloss finish one side, semi-gloss other side. FS LP-535D, Composition A, Type II, Grade GU Ultraviolet inhibited indoor/outdoor grade to be used where exposed to high humidity, ultraviolet radiation, or installed outdoors. Jacket thickness to be minimum .02" indoors/.03" outdoors for piping 12" and smaller, .03" indoors/.04" outdoors for piping 15" and larger. Jackets for piping system scheduled to be painted shall be surface prepped according to SECTION 09900. Pre-colored jackets may be used in lieu of painting as directed by the Engineer.

C. For piping with operating temperature of 141° F and above:

- 1. Pipe insulation shall be molded, heavy density, one-piece insulation made from inorganic glass fibers bonded with a therosetting resin. The jacket is a whitekraft paper bonded to aluminum foil and reinforced with glass fibers. The longitudinal lap shall have a self-sealing adhesive.
- 2. Fittings, valves, and hangers shall be insulated with heavy density material of the same thickness and covered with "proto 25/50 rated PVC fitting covers".

2.3 DUCT INSULATION

A. General:

- 1. Insulate all Supply, Outside and Return Air ductwork. Do not insulate Exhaust Air ductwork.

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- B. Supply, Outside and Return Air Ductwork Insulation:
1. For round flexible ducts the duct insulation shall have a minimum R-value of 4.2 SF° F/BTUH with an integral polyethylene vapor barrier outer shell cover.
 2. Rectangular and round rigid duct insulation shall be fiberglass duct wrap insulation that has a minimum installed R-value of 4.2 SF°/BTUH with a vinyl vapor barrier outer facing.

PART 3 EXECUTION

3.1 INSTALLATION

- A. GENERAL: All installation shall be installed per manufacturers instructions for the specific product used.
1. Insulation and jackets shall be protected from crushing, denting, and similar damage during construction. Vapor barriers shall not be penetrated or otherwise damaged. Insulation, jacket, and vapor barriers damaged during construction shall be removed and new material shall be installed.
 2. Thermal pipe hanger shields shall be provided by the Contractor and installed during pipe support installation. Where thermal pipe hanger shields are used, the Contractor shall apply 3-inch wide vapor barrier tape or band over the butt joints.
 3. Where heat trace is called for on the Drawings, the heat trace shall be installed under the pipe insulation. Contractor shall verify that the heat trace used will operate at temperatures compatible with the insulation and pipe material used.
 4. Insulation shall be applied over clean, dry surfaces.
 5. Pipe insulation shall have ends sealed with end joint strips and held in place by waterproof adhesive.
 6. Covers on fittings and valves shall be mechanically secured by corrosion-resistant tacks pushed into the overlapping throat joint.
 7. All duct insulation seams shall be sealed by manufacturer recommended vapor barrier seam tape to form a continuous seamless vapor barrier.

END OF SECTION

SECTION 15270

FLOWMETERS

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. The work includes furnishing all labor, materials and equipment necessary for complete installation of all water meters as shown on the Drawings and as specified herein.

1.2 QUALITY ASSURANCE

- A. Dimensions, tolerances and materials shall be as indicated on submitted shop drawings. Manufacturer shall conduct factory standard tests prior to shipment.

1.3 SUBMITTALS

- A. Submittals shall be made in accordance with SECTION 01340.
- B. Submit manufacturer's product data on meters including dimensions, tolerances and materials, and remote instrumentation.
- C. The meter and instrumentation submittals shall provide sufficient details to indicate that the equipment will provide the full flow metering, remote instrumentation and alarm capabilities intended for this system.
- D. Submit certificates of factory test record for each flow meter provided prior to contract final acceptance.
- E. Submit operation and maintenance information in accordance with SECTION 01730.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. The meters shall be handled in a manner which will prevent damage. The meters shall be shipped with end covers over ends of tubes. These covers shall be left in place (except for inspection) until installation in piping systems. The meters shall be stored in a protected and clean environment, until installed.

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PART 2 PRODUCTS

2.1 PROPELLER-TYPE WATER METERS

- A. Provide flowmeters as shown on the Drawings. They shall have full-bore tubes and flanged ends. The flanges shall be ANSI 150-pound drilling. The tubes shall be steel with factory installed protective internal and external coating.
- B. The meter tube shall be furnished with four straightening vanes directly upstream of the meter head assembly, and shall be protected internally and externally by factory applied protective coating.
- C. The meter head shall be cast iron and connected to the tube by means of a connection designed for easy removal from the tube for inspection or repair.
- D. The meter tube shall have uniform inside diameter not less than nominal size of the meter required.
- E. The meter shall be furnished with conical-shaped 3-blade polypropylene propeller, mounted transversely in the center of the meter tube.
- F. The meter shall be designed to handle thrust at the front of the propeller support assembly to reduce wear and improve performance.
- G. The meter head shall be equipped with a high-speed pickup register. This register shall be completely sealed. The wire terminals and exposed wires will be potted with silicone grease per manufacturer's instructions.
- H. The meter shall register within two percent of the rated flow through flow range. Pressure loss through the meter at maximum flow shall not exceed 3 inches of water. Meters shall be capable of measuring maximum flows under continuous service.
- I. Flow Transmitter - For each propeller flowmeter equipped with a flow transmitter, provide the following:
 - 1. Isolated DC 4 to 20 mA (500 ohm max. loop impedance) current output proportional to flow rate for connection to the PLC.
 - 2. Digital Flow Indicator; Rate of Flow in GPM.
 - 3. Coordinate installation of instrumentation for water flow with SECTION 16910.

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J. Propeller Flowmeters shall be the following or approved equal:

1. Sensus Technologies
Uniontown, PA 15407
(412) 439-7700
Model 102, Propeller Meter
2. Water Specialties
Phone: 1-800-800-3544
Model ML - 04 Propeller meter with TR-16 Transmitter.

2.2 ULTRASONIC FLOWMETERS

- A. Ultrasonic flowmeters shall be of the transit-time design (not Doppler). They shall clamp onto the exterior of the pipe.
- B. The meter spool shall be furnished with four straightening vanes 5 diameters upstream of the spool.
- C. The acoustic sensors shall be capable of operating under submerged conditions.
- D. The meter shall consist of acoustic sensors, interconnecting cable, and electronic transmitter, and shall have an accuracy of +/- 2% above 1-fps.
- E. The flowmeter electronic transmitter shall transmit an isolated DC 4 to 20 mA current output proportional to the flow rate. This will be connected to a PLC. If the selected flowmeter has an RS485 communication option, this can be substituted for a mA signal to the PLC.
- F. The electronic transmitter shall display rate of flow in GPM.
- G. Coordinate installation of instrumentation with SECTION 16910.
- H. Ultrasonic flowmeters shall be the following or approved equal:
 1. General Electric - Panametrics AquaTrans AT868 clamp on ultrasonic flow transmitter.
 2. Controlotron - model 1020 clamp-on ultrasonic flowmeter.
 3. Sparling
 4. Badger Meter Series 4500 Compu-Sonic with optional sensor holder, extra cable length (specify exact length) and optional software for a laptop computer interface.

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2.3 INSERTION PADDLE WHEEL FLOW METERS

- A. Provide Paddle Wheel Insertion Flow Meters as illustrated on the Drawings and specified herein.
- B. Sensor body and paddle wheel shall be polypropylene or polyethylene. Wheel shaft shall be stainless steel or titanium. Body shall be mounted in and removable from a section of pipe, tee or saddle.
- C. A microprocessor shall convert paddle wheel movement into calibrated digital flow rate indication in gallons per minute.
- D. Battery powered meters meter shall be powered by a replaceable battery with a two year life.
- E. Per the Drawings, some battery powered meters shall have remote rate indicators wall mounted with watertight interconnecting wiring. Per the Drawings, other flow rate indicators shall be integral to the sensor and pipe mounted or may be wall mounted provided with watertight interconnecting wiring.
- F. All mounting hardware shall be stainless steel.
- G. Meters shall be waterproof and accurate to not less than 2% of full scale and repeatable to 1% of full scale in water with 1% or less suspended solids.
- H. Powered meters shall have 24 volt powered rate indicators with 4-20 mA output.
- I. Manufacturers:
 - 1. George Fischer/Signet
 - 2. Data Industrial
 - 3. Ecosol
 - 4. Blue-White
 - 5. Midwest Instruments and Controls Corp.

2.4 MAGNETIC FLOW METERS

- A. Design and fabrication:
 - 1. Utilize characterized field principle of electromagnetic induction to produce signal directly proportional to flow rate.
 - 2. High input impedance pre-amplifiers.
 - 3. Minimum impedance: 1010 ohms.
 - 4. Provide flanged end connections per ASME B16.5 rated for piping system operating and test conditions.

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5. If installed in underground vault: Splash and dripproof and capable of temporary submersion for a period of 24 HRS under 15 FT of water.
6. Operating pressure: 50 psi.
7. Operating temperature: 107 Deg F.
8. Grounding requirements:
9. Nonmetallic or lined pipe:
10. Inlet and outlet grounding rings of same material as electrode.
11. Conductive piping:
12. Conductive path between the meter and the piping flanges.
13. Provide cable between magnetic flow meter and transmitter.
14. Pulsed DC magnetic field excitation.
15. Automatic zero.
16. Adjustable low flow cutoff.
17. Minimum signal lock (empty tube zero) to prevent false measurement when tube is empty.
18. Inaccuracy:
19. Above 10 percent of range: Accuracy shall be +1.0 percent of rate.
20. Below 10 percent of range: Accuracy shall be +0.1 percent of range setting.
21. Add +0.1 percent of range to above inaccuracies for analog outputs.
22. 4-20 mA DC isolated output into maximum 800 ohms.
23. Power supply: 117 V +10 percent, 60 Hz.
24. Indication of flow rate and totalized flow at transmitter.
25. Meter operable as specified in liquids with 5.0 micro mho/cm or more conductivity.
26. Transmitter electronics shall use microprocessor based architecture and be configured using parameters.

B. MANUFACTURERS

1. Bailey-Fischer Porter
2. McCrometer (Water Specialities) Ultra-Mag
3. Johnson Yokogawa
4. Roesmount

PART 3 EXECUTION

3.1 INSTALLATION OF METERS

A. Propeller-type Water Meters

1. Flow meters shall be installed with register in an easily readable position.
2. All meters shall be installed a minimum of ten (10) pipe diameters upstream and five (5) pipe diameters downstream of flow disturbance such as fittings, valves, etc unless otherwise approved by the flowmeter manufacturer.

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3. Specific installation instructions of the meter manufacturer shall be followed.
4. Bolting of meter to piping flanges shall be done with Type 304 stainless steel bolts as specified in SECTION 05990.

B. Insertion Paddle Wheel Flowmeters.

1. Install flowmeter register in an easily readable position.
2. Follow specific instructions of the meter manufacturer for installation.
3. Install at a minimum of 10 pipe diameters upstream and 5 pipe diameters downstream of any fittings or valves unless otherwise approved by flowmeter manufacturer.

C. Ultrasonic Flowmeters

1. Flowmeters shall be installed with sensors in an accessible position capable of being removed without removing the piping.
2. All meters shall be installed with a minimum number of straight pipe diameters downstream and upstream of any flow disturbance such as fittings, valves, etc. as recommended by the flow meter manufacturer.
3. Specific installation instructions of the meter manufacturer shall be followed.

3.2 INSTALLATION OF INSTRUMENTATION

- A. Flow transmitters shall transmit a 4-20 mA signal proportional to the flow. This signal shall be sent over a cable (Belden #8760 or equal) inside conduit to the monitoring and control station as shown on the drawings. Coordinate installation of electronic instrumentation with SECTION 16910.

3.3 TESTING

- A. The meters shall be pressure tested with the system in which they are installed.
- B. At completion of the installation, the meters shall be operated and adjusted per manufacturer's recommendations. All remote instrumentation shall be installed and calibrated per the manufacturer's recommendations. Units must agree with indicated flow rate not exceeding manufacturer's accuracy and calibration for the system components or be replaced at not additional cost.

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3.4 PAINTING

- A. Painting shall be in accordance with SECTION 09900. Do not paint meter face.

PART 4 WARRANTY

4.1 GENERAL

- A. All flowmeters shall be warranted for both labor, equipment and all components for a 1 year period after final acceptance.

END OF SECTION

SECTION 15400

PLUMBING

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Work includes furnishing all labor, material, and equipment required to supply all plumbing systems for potable water (hot and cold) and sanitary sewer piping inside and below building slabs as specified herein and shown on the Drawings.

1.2 REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

- B. American National Standards Institute (ANSI) Publications:

70-2-91	Quality Control Standard for Control Valve Seat Leakage
A13.1-81	Scheme for the Identification of Piping Systems (R 1993)
AI 17.1-92	American National Standard for Buildings and Facilities Providing Accessibility and Usability for Physically Handicapped People
B 1.20.1-83	Pipe Threads, General Purpose (Inch)
B 16.3-92	Malleable Iron Threaded Fittings
B 16.5-88	Pipe Flanges and Flanged Fittings
B 16.34-88	Valves - Flanged, Threaded, and Welding End

- C. American Society for Testing and Materials (ASTM) Publications:

A53-96	Pipe, Steel, Black and Hot-Dipped Zinc-Coated, Welded and Seamless
A74-94	Cast Iron Soil Pipe and Fittings
B88-96	Seamless Copper Water Tube
D 1 784-95	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
D1785-93	Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
D2467-94	Socket-Type Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
D3222 Rev A-91	Unmodified Poly (Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials

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D. American Water Works Association (AWWA) Publications:

C 110/ A21.10-93	Ductile-Iron and Gray-Iron Fittings, 3 in. Through 48 in for Water and Other Liquids
C153/ A21.53-94	Ductile-Iron Compact Fittings, 3 in. Through 16 in., and 54 in. Through 64 in., for Water and Other Liquids
C200-91	Steel Water Pipe - 6 in. and Larger, Second Edition
C207-94	Steel Pipe Flanges for Waterworks Service - Sizes 4 in. through 144 in.
C208-83	Dimensions for Fabricated Steel Water Pipe Fittings: Addendum C208A (R-1989)
C210-92	Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines
C219-91	Bolted, Sleeve-Type Couplings for Plain-End Pipe First Edition
C508-93	Swing-Check Valves for Waterworks Service, 2 in. (50 mm) Through 24 in. (600 mm)
C511-92	Reduced-Pressure Principle Back flow Prevention Assembly First Edition
C900-89	Polyvinyl Chloride (PVC) Pressure Pipe, 4 in. Through 12 in. for Water Distribution, Addendum C90A - 1992
C905-88	Polyvinyl Chloride (PVC) Water Transmission Pipe, Nominal Diameters 14 in. Through 36 in.
M11-89	Steel Pipe - A Guide for Design and Installation Third Edition

E. International Association of Plumbing and Mechanical Officials (IAPMO) Publications:

1994 Edition Uniform Plumbing Code (UPC)

F. Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS) Publications:

SP-58-93	Pipe Hangers and Supports - Materials, Design and Manufacture
SP-69-91	Pipe Hangers and Supports - Selection and Application
SP-80-87	Bronze Gate, Globe, Angle and Check Valves

G. National Electrical Manufacturers Association (NENFA) Publications:

ICS 6-93 Industrial Control and Systems Enclosures

H. Plumbing and Drainage Institute (PDI) Publications:

302-83 Guide for Code Authorities and Others for Selected Plumbing and Drainage Products

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- I. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA) Publications:
 - 1991 Edition Seismic Restraint Manual Guidelines for Mechanical Systems First Edition
- J. National Energy Conservation Act (NAEGA)
- K. American Society of Heating, Refrigerating and air conditioning Engineers (ASHRAE)
- L. American Gas Association (AGA)

1.3 SUBMITTALS

- A. Furnish submittals in accordance with SECTION 01340 for items listed below:
- B. Test Reports and Certificates:
 - 1. Pressure and leakage tests for all plumbing systems.
 - 2. Bacteriological analysis for potable water systems. Refer to SECTION 02660 for specific requirements.
 - 3. 10-year warranty certificate on water heaters.
- C. Maintenance Data and Operating Instructions (per SECTION 01730).
- D. Manufacturer's Product Data.
- E. Catalog cuts and shop drawings of all items listed herein on plumbing fixtures.
- F. Restraining joints with rods and anchorage components and systems for counteracting pipe thrust forces.

1.4 JOB CONDITIONS

- A. Obtain exact location and mounting heights of fixtures from details on the plans. Do not order any fixtures until casework shop drawings (if applicable) have been reviewed and accepted by the CSR. Coordinate all fixture locations with casework manufacturer.
- B. Where trim and rough is not specified, furnish all installed equipment and materials necessary for the completion of the job and of the same quality as specified elsewhere.

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- C. Trim chrome plated: no exposed PVC, galvanized, or black pipe.
- D. Escutcheon plates for all lines through cabinets and walls.
- E. All countertop sinks set on bead of clear silicone sealant.
- F. Install trim as specified and connect to all equipment where required.

PART 2 PRODUCTS

2.1 PIPING SCHEDULE

- A. Potable water, sanitary sewer piping, and vent piping associated with the sanitary sewer system inside buildings shall be as indicated on the Drawings and specified below. Refer to SECTIONS 02660 and 02730 for potable water and sanitary sewer piping elsewhere.
- B. Copper Pipe:
 - 1. Aboveground: ASTM B88, Hard Drawn, Type “L” with solder joint fillings conforming to ANSI B-16.22 or ANSI B16.18.
 - 2. Buried: ASTM B88, Hard Drawn, Type “K” with solder joint fittings conforming to ANSI B-16.22 or ANSI B-16.18.
 - 3. General:
 - a. Pipe passing through building grade beams or foundation walls below grade shall be provided with sleeves of Schedule 40 galvanized steel pipe. The annular space between pipe and sleeve shall be closed by tight packed oakum rope. Pipe shall be centered in a sleeve sized with 4 inches of open space between outside of pipe and inside of sleeve.
 - b. Pipe passing through building floors and walls above grade shall be provided with sleeves of Schedule 40 galvanized steel pipe. Floor sleeves shall extend 4 inches above finished floor and wall sleeves shall be flush with wall. On interior walls and floors the annular space between the pipe and sleeve shall be closed by tightly packed oakum rope. Exposed interior and exterior sleeves shall be provided with escutcheons. Floor sleeves shall be provided with high type escutcheons.

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C. Cast Iron and Soil Pipe:

1. Cast iron soil pipe shall be standard weight and provided with hub and spigot or hubless end connections.
2. Hub and spigot pipe and fittings shall conform to ASTM A-74. Gaskets for hub and spigot piping shall conform to ASTM C-564.
3. Hubless pipe and fittings shall conform to CISP 301 and CISPI 310.
4. Vent stacks through the roof shall be of the sizes indicated on the plans and extend above the roof a minimum of 12 inches.
5. Vent piping shall be installed to meet the requirements of the current Uniform Plumbing Code.
6. Vent or revent connections into waste or vent stacks shall be made at a point not less than 5'-0" above the highest served.
7. Wherever soil or vent pipes pass through the roof, an absolutely watertight joint shall be made. The flashing shall extend at least 12" on all sides of the pipe and shall extend up, over, and down inside the pipe. The exact method of joining the flashing to various types of roofs and roofing materials shall be submitted for approval and coordinated with building manufacturer.

2.2 VALVES

A. Supply Stop Valves:

1. Copper: NIBCO No. 725 or approved equal.
2. Threaded: NIBCO No. 75 or approved equal.

B. Fixture Shutoff Valves: Chromium-plated by Brass Craft, American Standard, or approved equal. Valves may be angled or straight.

C. Sillcock: Frostproof, NIBCO No. 52 or approved equal.

D. Isolation Valves: Gate, butterfly, or ball valves as specified below.

1. Gate Valves: 125-200 lb. (WOG), all bronze construction screw-in bonnet, non-rising stem, solid wedge disc, threaded or soldered ends.
3. Butterfly Valves: 125-200 lb. (WOG), all bronze construction, Viton seats, lever handle, threaded ends.
4. Ball Valves: 125-200 lb. (WOG), all bronze construction, Teflon, Buna-N seats, level handle, threaded or soldered ends.

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- E. Check Valves: “Silent” type consisting of a spring closed bronze disc. Valves shall be globe style, threaded, or 125 lb. steel or iron body, bronze trim, and stainless steel spring.

- F. Hose Bibbs (HB):
 - 1. Materials: Installed on interior of buildings shall be constructed of cast iron or bronze or brass, protected against backflow and provided with a ¾" hose thread outlet.
 - 2. Acceptable Manufacturers: Woodford, Series 26 or approved equal.

- G. Wall Hydrants (WH):
 - 1. Materials: Bronze head and tail piece assembly with renewable nylon seal. Provide with ¾-inch female inlet or ¾-inch union elbow assembly as required by job conditions. Hydrant shall be non-freeze, protected against backflow and shall drain automatically. Outlets shall have ¾" hose bibb connection with handle or tee handle operator.
 - 2. Acceptable Manufacturers:
 - a. Base: Woodford, Series 65.
 - b. Optional: Merrill.

- H. Pressure and Temperature Relief Valves:
 - 1. Materials:
 - a. AGA and ASME-approved, tight shutoff, self-closing, bronze-bodied with a spring loaded bronze seated stop.
 - b. Threaded inlet and outlet.
 - c. Test lever.
 - d. Capacity: Same power as water heater.
 - e. Relief Setting: 210°F, 150 psig, unless otherwise required by code.
 - 2. Acceptable Manufacturers:
 - a. Base: Watts.
 - b. Optional: A.W. Cash or Wilkins.

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2.3 PLUMBING APPURTENANCES

- A. Insulating Bushings: Install EPCO or approved equal dielectric type insulation bushings where piping connects to dissimilar metals.
- B. Joints: Apply an approved Teflon sealing tape on all threaded joints.
- C. Escutcheons: Provide hinged or normal solid type for all penetrations.

2.4 FLOOR DRAINS (FD):

- A. Materials: Sized as shown in the drawings; cast iron body with flange and seepage openings.
- B. Acceptable Manufacturers:
 - 1. Base: Smith, Series 2110
 - 2. Optional: Wade and Zurn.

2.5 CLEANOUTS

- A. Wall Cleanouts (WCO):
 - 1. Materials: Recessed wall type, cast iron body with threaded brass plug, flush mounted stainless steel access cover with countersunk center screw, and vandalproof secured.
 - 2. Acceptable Manufacturers:
 - a. Base: Smith, Series 4402
 - b. Optional: Wade and Zurn.
- B. Floor Cleanouts (FCO):
 - 1. Materials: Cast iron body with adjustable housing, flanged ferrule, heavy duty top and bronze taper plug. Provide flange with flashing clamp. Outlets shall be with rubber seal and same diameter as piped served.
 - 2. Acceptable Manufacturers:
 - a. Base: Smith, Series 4106
 - b. Optional: Wade.

2.6 P-TRAPS

- A. Exposed P-traps, drain lines, wall flanges, and accessories for fixture connections shall be chromium-plated, heavy-duty type, of an approved manufacturer. Furnish P-traps with cast brass nuts and cleanout plugs.

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2.7 TRAP PRIMERS

- A. Materials: Provided trap primers for all floor drains. Trap primers shall be activated by a pressure drop on the supply piping system. Delivery volume shall be adjustable.
- B. Acceptable Manufacturers: Precision Plumbing Products, Model No. PR-500 or approved equal.

2.8 PIPE INSULATION

- A. Potable water piping shall be insulated. Exposed potable hot water piping shall also be insulated.
- B. Insulation shall be split sectional or snap-on type constructed of molded fiberglass fibers bonded with phenolic resin. Insulation shall comply with Federal Specifications HH-1-558D Form D and ASTM 547 Class 2. Thermal conductivity of the insulation shall be no greater than 0.24 Btu. -In/Hr.-Sq. Ft.-Deg. F at a mean temperature of 200°F. Density shall be a minimum of 4 pounds per cubic foot. Insulation shall be covered with a foil and draft vapor barrier or with a weatherproof jacket.

2.9 POTABLE WATER HEATERS

- A. Hatchery Building Water Heater (DWH-1):
 - 1. Electric storage water heater, factory-assembled, packaged commercial storage tank with heating elements, controls, and other components as indicated. Designed for potable water service, UL-listed and NSF-approved. Water heater shall have an input of 9 kW and a recovery rate of 36.9 gph at a 100°F temperature rise.
 - 2. Factory assemble so that installation involves only setting, leveling, anchoring, and connection of piping and electrical services. Water heater shall be anchored or strapped to resist horizontal displacement due to earthquake motion. Strapping shall be at points upper 1/3 and lower 1/3 of its vertical dimensions. Maintain a minimum distance of 4 inches between straps and controls.
 - 3. Scheduled Information:
 - a. Entering water temperature.
 - b. Leaving water temperature.
 - c. Recovery capacity.
 - d. Electrical requirements.
 - e. Storage tank capacity.

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4. Storage Tank:
 - a. 52 gallon capacity.
 - b. Minimum working pressure rating of 150 psi.
 - c. Vertical, floor-mounted.
 - d. Minimum pressure rating: 150 psi working pressure; 300 psi test pressure.
 - e. Tank handhole cleanout.
 - f. Brass drain valve.
 - g. Insulation: R-16 complying with ASHRAE 90.1.
 - h. Steel outer jacket with manufacturer's standard enamel finish.
 - i. Glass lined steel tank with anode rods.
 5. Heating Elements:
 - a. Heavy duty and resistant to oxidation and scaling.
 - b. Easily replaceable.
 - c. Fused in accordance with NEC and UL.
 6. Controls:
 - a. Fused, 120V control circuit.
 - b. Adjustable leaving water temperature range: Off and 95-140°F. Provide one pre-wired, factory-tested, UL-listed, surface-mounted thermostat per heating element.
 - c. High temperature limit with adjustable setpoint.
 - d. Low water cut-off.
 - e. Immersion thermostat
 - f. Magnetic contactors
 7. Other Components:
 - a. Temperature/pressure relief valve that complies with all applicable local and national codes.
 - b. Pressure gauge.
 - c. Temperature gauge.
 8. Acceptable Manufacturers:
 - a. Base: A.O. Smith, Model DRE-52.
 - b. Optional: Rheem, Ruud, State.
- B. Tankless Water Heater (DWH-2):
1. Tankless, electric, instant-flow, 98% energy efficient, with in-line OMNI flow control.
 2. Acceptable Manufacturers:
 - a. Base: Chronomite, Model SR-40.
 - b. Optional: Stiebel Eltron, Hot Aqua.

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2.10 EXPANSION TANK (DET-1)

- A. Materials: Commercial, diaphragm for potable water.
- B. Acceptable Manufacturers:
 - 1. Base: BG, Model PT-5.
 - 2. Optional: WATTS.

2.11 POTABLE WATER PUMPS (DHWP-1)

- A. Materials: Circulating, in-line centrifugal pump; pump casing and impeller shall be bronze, designed for domestic water circulating. Seal-less, fractional, horsepower pump.
- B. Acceptable Manufacturers:
 - 1. Base: Grundfos, Series UP.
 - 2. Optional: Bell & Gossett, ITT.

PART 3 EXECUTION

3.1 POTABLE WATER PIPING AND PLUMBING

- A. Unless otherwise specified, install plumbing systems and test in accordance with the Uniform Plumbing Code.
- B. Soldered joints for copper tubing shall be made with suitable fittings. Clean surfaces to be soldered bright by approved mechanical means such as fine sandpaper, steel wool, or special steel brushes. Properly flux joints with a non-corrosive acidless flux. Copper tubing is to be installed only by experienced workmen.
- C. Install piping without undue strains and stresses and make provisions for expansion, contraction, and structural settlement. Hangers, supports, and anchors shall be adequate in design and spaced at sufficiently close intervals to keep the pipe in alignment and to carry the load of the pipe and contents. Floor cleanout covers shall be level with the finished floor.
- D. Provide ground joint unions at plumbing fixtures where union supply fittings are not part of the fixture trim at equipment connections.
- E. Pitch all piping to drain at low points with hose end drain valves.
- F. Threaded joints in chromium-plated pipe shall be made up neatly so that no threads are exposed. Make joints and connections in accordance with Chapter 8 of the Uniform Plumbing Code.

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- G. Ensure pipe and fittings are kept clean during the work. Should any pipe become partially or wholly clogged before final acceptance, clean it out in a satisfactory manner or replace. Correct leakage or other defects in the work which may be disclosed at any time prior to acceptance.
- H. Conceal supply, drain, and vent piping plumbing systems from view where feasible. Where exposed pipes pass through walls, floors, or finished ceilings, fit pipes with appropriate plates and escutcheons.
- I. Insulate water service and distribution piping and traps installed in locations subject to freezing.
- J. Work to be concealed or covered shall be tested and accepted before being concealed or covered.
- K. Connections between copper tubing and steel pipe shall be made with dielectric insulating fittings. Dielectric unions shall be installed in the cold and hot-water pipelines near water heaters.

3.2 SANITARY SEWER PIPING INSTALLATION

- A. Pipe shall be fitted and matched so that when laid they will form a smooth, uniform invert.
- B. Pipe passing through building grade beams or foundation walls below grade shall be provided with sleeves of Schedule 40 galvanized steel pipe. The annular space between pipe and sleeve shall be closed by tightly packed oakum rope. Pipe shall be centered in a sleeve sized with 4 inches of open space between outside of pipe and inside of sleeve.
- C. Pipe passing through building floors and walls above grade shall be provided with sleeves of Schedule 40 galvanized steel pipe. The floor sleeve shall extend a minimum of 4 inches above finished floor and the wall sleeve shall be flush with wall. On interior walls and floors the annular space between the pipe and sleeve shall be closed by tightly packed oakum rope. Exposed interior and exterior sleeves shall be provided with escutcheons.
- D. Pipe laying shall be started at the outlet end with the spigot ends pointing in the direction of flow.
- E. Exposed connections at fixtures shall be chrome plated brass.
- F. Minimum Slope:
 - 3" and under = 1/4" per foot.
 - 4" and above = 1/8" per foot or as shown on drawings

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- G. Change in direction of sanitary sewer piping shall be made with 45 degree wyes, 1/8 bends, long sweep 1/4 bends, combination wye and 1/8 bend. No sanitary tees or double hubs shall be used in horizontal sewers.
- H. Vent stacks through the roof shall be of the sizes indicated on the plans and extend above the roof a minimum of 12 inches.
- I. Vent piping shall be installed to meet the requirements of the current Uniform Plumbing Code.
- J. Vent or revent connections into waste or vent stacks shall be made at a point not less than 5' -0" above the highest served.
- K. Wherever vent pipes pass through the roof, an absolutely watertight joint shall be made by means of flashing and counter flashing. The flashing shall extend at least 12" on all sides of the pipe and shall extend up, over and down inside the pipe. The exact method of joining the flashing to various types of roofs and roofing materials shall be submitted for approval and coordinated with building manufacturer.

3.3 PIPE INSULATION

- A. All fiberglass insulation for piping and ducting shall be applied with tightly butted joints and all voids, chipped corners or other openings shall be filled with the proper material which is compatible with the insulating material used.
- B. All fittings and valves shall be insulated with fiberglass wool wrapped and packed to fill the entire fitting space, even with the level of the adjoining insulation.

3.4 DRAIN AND CLEANOUTS INSTALLATION

- A. Floor Drains:
 - 1. Floor drains shall be installed with top 1 inch below finished floor elevation.
 - 2. Floor drains located in floors on grade shall be made absolutely watertight. Floor drain located in floors other than those on grade shall be made watertight by means of flashing and counter-flashing with 2-1/2 pound sheet lead. The flashing shall extend at least 18 inches on all sides of the drain and shall extend into and be clamped to the drain body with a bolted flashing clamp.
 - 3. Floor drains with extended rims shall be installed with top rim flush with 1 inch depressed floor.

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4. Floor drains shall be provided with P-traps and trap primer connection.
- B. Cleanouts:
1. Floor cleanout shall be installed flush with finished floor.
 2. Cleanouts for underground sewers shall be located where shown on Drawings.
 3. Fittings shall be long sweep ells or combination wye and 1/8 bends for extension to floor.
 4. Threaded plugs in cleanouts shall be lubricated with graphite grease at installation.

3.5 PLUMBING SPECIALTIES INSTALLATION

- A. Plumbing specialties valves and appurtenances shall be installed as shown on the Drawings and in accordance with manufacturer's recommendation.
- B. Wall hydrants shall be secured to the face of the wall or in the wall by grouting in place per drawings.
- C. Wall hydrants shall be designed for the thickness of the wall of which the hydrant is being installed per the Drawings.

3.6 POTABLE WATER HEATER INSTALLATION

- A. Potable water heaters shall be installed in accordance with manufacturer's recommendations.

3.7 TESTS IN GENERAL

- A. All piping and connections shall be tested prior to installation of nonconducting covering or concealment within building construction. Each test shall be performed as hereinafter specified and shall be continued or repeated until lines under test are proven tight to the satisfaction of the CSR.
- B. Sections of system may be tested separately, but when so tested it shall be distinctly understood that any defect which may develop in a section already tested and accepted shall be corrected and that section retested.

3.8 TESTING OF POTABLE WATER SYSTEM

- A. The potable water system inside the building shall be subject to hydrostatic test of not less than 100 psi. This pressure shall be maintained not less than four hours;

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no drop in pressure will be allowed after expiration of which, if lines prove tight, pressure may be reduced to normal pressure for the building.

3.9 TESTING OF SANITARY SEWER AND VENT PIPING

- A. The sanitary sewer system inside of building, including all soil, waste, drain, and vent piping for the sanitary sewer, shall be tested with water. Water tests shall have been completed prior to final connections of any fixture to sewer system. Soil, waste, drain, and vent piping above ground or floor level shall have openings plugged where necessary and be filled with water to level of the top of vent pipes, roof drain, or 10'-0" above the floor, whichever is greater. Water shall be allowed to stand no less than 12 hours; after expiration of which lines prove tight, i.e., if water level has remained constant, they shall be drained and fixtures connected.

3.10 CHLORINATION

A. General:

1. Flush and sterilize the completed waterline with chlorine before acceptance for domestic service in the presence of the CSR.
2. Chlorinate the finished pipeline prior to hydrostatic testing.

B. Health and Procedure Standards:

1. Flushing and sterilization of line shall be accomplished in accordance with the requirements of AWWA C 601 for the chlorinating agent and the method of application.

C. Equipment, Materials, and Procedure:

1. Furnish all equipment, material, and water for sterilization and flushing of waterline. Use qualified personnel for the procedure.
2. Liquid chlorine or hypochlorite (HTH) may be used, and shall conform to Federal Specifications O-C-114, Type II, Grade B.
3. If chlorine tablets are used for disinfection, one tablet shall be attached to the inside top of each section of pipe with Loctite Permatex No. 1 just prior to installing the pipes in their final location.
4. The number of 5-g tablets required for each pipe shall be 0.0012d2L rounded to the next higher integer.
5. After the pipe is filled with water and chlorine, hold the water in contact with the pipe for 24 hours. After 24 hours the water in the pipeline shall be

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tested by a representative designated by Owner to ensure a residual chlorine content of not less than 25 mg/l. Thoroughly flush pipeline to remove chlorinated water.

6. Care shall be taken in flushing the pipeline to prevent property damage and danger to the public.
7. Samples of water may be collected for bacteriological examination and residual chlorine content prior to service.

END OF SECTION

SECTION 15450

PLUMBING FIXTURES

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Work includes furnishing all plumbing fixtures and trim and the labor and materials required for the installation of these fixtures as specified herein and as shown on the Drawings.

1.2 SYSTEM DESCRIPTION

- A. New plumbing fixtures and trim as shown on the plumbing drawings. Plumbing fixtures and trim consist of:

1. Water closets
2. Urinals
3. Lavatories
4. Sinks
5. Drinking fountain
6. Wall box
7. Safety eyewash

- B. Products furnished but not installed under this Section include:

1. Plumbing fittings (including faucets) and piping indicated for fixtures, appliances, appurtenances and equipment provided by Owner.
2. Plumbing fittings (including faucets) and piping indicated for fixtures, appliances, appurtenances and equipment specified in other sections.

- C. Products installed but not furnished under this Section include:

1. Owner-supplied fixtures, as indicated.
2. Accessories, appliances, appurtenances, and equipment specified in other sections requiring plumbing services or fixture-related devices, as indicated.

1.3 QUALITY ASSURANCE

- A. ADA Requirements: Comply with requirements of Americans with Disability Act. Provide fixtures complying with ADA accessibility requirements.

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- B. Regulatory Requirements: Comply with requirements of ANSI Standard A117.1 “Buildings and Facilities -- Providing Accessibility and Usability for Physically Handicapped People” and Public Law 90-480 “Architectural Barriers Act, 1968” with respect to plumbing fixtures for the physically handicapped.
- C. Regulatory Requirements: Comply with requirements of ATBCB (Architectural and Transportation Barriers Compliance Board) “Uniform Federal Accessibility Standards (UFAS) - 1985-494-187” with respect to plumbing fixtures for the physically handicapped.
- D. Listing and Labeling: Provide electrically-operated fixtures specified in this Section that are listed and labeled.
 - 1. The terms “listed” and “labeled” shall be as defined in the National Electrical Code, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A “Nationally Recognized Testing Laboratory” (NRTL) as defined in OSHA Regulation 1910.7.
- E. Design Concept: The drawings indicate types of plumbing fixtures and are based on the specific descriptions, manufacturers, models, and numbers indicated. Plumbing fixtures having equal performance characteristics by other manufacturers may be considered provided deviations in dimensions, operation, color, or finish or other characteristics are minor and do not change the design concept or intended performance as judged by the Architect.

1.4 REFERENCES

- A. See SECTION 15050.

1.5 SUBMITTALS

- A. Furnish Dimensional Drawings and Product Data submittals in accordance with SECTION 01340 for items listed below.
 - 1. Product data for each type of plumbing fixture specified, including fixture and trim, fittings, accessories, appliances, appurtenances, equipment, supports, construction details, dimensions of components, and finishes
 - 2. Wiring diagrams for field-installed wiring of electrically-operated units.
- B. Submit complete maintenance data and operating instructions in accordance with SECTION 01730 for all plumbing fixtures and trim specified within this section.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver plumbing fixtures in manufacturer’s protective packing, crating, and covering.

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- B. Store plumbing fixtures on elevated platforms in a dry location.

PART 2 PRODUCTS

2.1 WATER CLOSETS (WC-1)

A. Fixtures (Flushometer-type)

1. Materials: Floor mounted flush valve type water closet, white vitreous china, siphon jet action, elongated bowl, and 1-1/2 inch top inlet spud; ADA approved.
2. Acceptable Manufacturers:
 - a. Base: American Standard, Model Madera 3043.102.
 - b. Optional: Kohler.

B. Flush Valves:

1. Materials: Exposed type, chrome plated, 1 inch supply inlet, screw driver back-check angle stop, vacuum breaker, lever activating handle, solid ring pipe support, and 1-1/2 inch top outlet spud, with wall and spud flanges.
2. Acceptable Manufacturers:
 - a. Base: Royal, Model 111.
 - b. Optional: Zurn.

C. Seats:

1. Materials: White, elongated type, open front, concealed check stainless steel hinges, and rubber bumpers.
2. Acceptable Manufacturers: Beneke, Church Seat Co., Olsonite.

2.2 URINALS (UR-1)

A. Fixtures:

1. ADA, vitreous china, flushing rim, blowout flush action, wall-mounted.
2. Acceptable Manufacturers:
 - a. Base: American Standard, Lynbrook Model 6601.012.
 - b. Optional: Kohler.

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B. Flush Valve:

1. Exposed, flushometer, diaphragm type; chrome-plated with dual filtered bypass, stop seat and vacuum breaker. Urinal shall have ADA-compliant metal oscillating non-hold-open handled, angle stop, and adjustable tailpiece. Spud coupling and flange for 1-1/4-inch top spud. Sweat solder adapter with cover tube and cast set screw wall flange.
2. Acceptable Manufacturers:
 - a. Base: Royal, Model 180.
 - b. Optional: Zurn.

2.3 LAVATORIES (LV-1)

A. Fixtures:

1. Materials: Vitreous china, wall mounted, ADA compliant, lavatory or approved equivalent.
2. Acceptable Manufacturers:
 - a. Base: American Standard, Lucerne Model 0356.015.
 - b. Optional: Kohler.

B. Faucets:

1. Materials: Cast-brass with polished chrome-plated finish. Rigid gooseneck with two wrist handles.
2. Acceptable Manufacturers:
 - a. Base: Chicago Faucet, Model 1100-GN2AE3-317.
 - b. Optional: Kohler, Delta.

C. Supplies and Stops: Supplied through the wall, chrome plated cast brass stop, 1/2 inch female standard pipe thread inlet by 3/8 inch O.D. compression type outlet angle stop, wheel or four armed handle, chrome plated copper flexible riser, and wall flange.

D. Strainer and Tailpiece: Chrome plated cast brass drain, 1-1/4-inch, with flat strainer.

E. P-Trap: 17-gauge chrome plated brass, 1-1/4 inch, integral cleanout, and wall escutcheon. Provide "True-Bro" cover.

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2.4 SINK (S-1)

A. Bowl:

1. Materials: Single-compartment, countertop-mounted, constructed of 20-gauge stainless steel with 21" x 22" x 7" deep basin. Sink strainer shall be supplied for sink drains.
2. Acceptable Manufacturers:
 - a. Base: Just, Model SL-2122-B-GR.
 - b. Optional: Elkay.

B. Faucet:

1. Materials: Swing gooseneck with wrist blade handles. Plastic components not permitted.
2. Acceptable Manufacturers:
 - a. Base: Chicago 1100-GN2AE3-317.
 - b. Optional: Kohler, Delta.

C. Food Waste Disposer:

1. Materials: Stainless steel grinding components, dishwasher drain connection, 3/4 hp heavy duty, 120V, 1 phase 60 Hz.
2. Acceptable Manufacturers: IN-SINK-ERATOR, Model 444.

2.5 SINK (S-2)

A. Bowl:

1. Materials: Double-compartment, countertop-mounted, constructed of 20-gauge stainless steel with two 14" x 16" x 7" deep basin. Sink strainer shall be supplied for sink drains.
2. Acceptable Manufacturers:
 - a. Base: Just, Model CDL-2133-B-GR.
 - b. Optional: Elkay.

B. Faucet:

1. Materials: Swing gooseneck with wrist blade handles. Plastic components not permitted.
2. Acceptable Manufacturers:

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- a. Base: Chicago 1100-GN2AE3-317.
- b. Optional: Kohler, Delta.

2.6 SINK (S-3)

A. Bowl:

- 1. Materials: Double-compartment, double drainboard, countertop-mounted, constructed of 18-gauge stainless steel with two 19" x 16" x 12" deep basin and no holes for faucet.
- 2. Acceptable Manufacturers:
 - a. Base: Just, Model SI-4067-A-GR Modified, Standard 7-1/2-inch bowls to be substituted with 12-inch-deep bowls.
 - b. Optional: Elkay.

B. Faucet and Appurtenances: Supplied by others.

2.7 SINK (S-4)

A. Bowl:

- 1. Materials: Single-compartment, floor-mounted, free-standing, constructed of fiberglass with 23" x 22" basin with accessory kit, drain plug, and hardware.
- 2. Acceptable Manufacturers: Florestone Model FM or approved equal.

B. Faucet:

- 1. Materials: Combination service sink faucet, wall-mounted.
- 2. Manufacturer: Chicago 897.

C. Supplies and Stops: Supplied through wall; chrome-plated cast brass stop, 1/2-inch female standard pipe thread inlet by 1/2-inch O.D. compression type outlet angle stop, wheel, or four armed handle, chrome plated flexible riser and wall flange.

D. Strainer and Tail Piece: 1-1/2-inch chrome-plated brass tail piece; 1-1/2-inch chrome-plated waste and drain connection.

2.8 DRINKING FOUNTAIN (DF-1)

- A. Materials: "Hi-Lo," wall-mounted; constructed of 18-gauge, type 304 stainless steel with satin finish. Two, 1-piece fountains with rounded bowls, push button

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valves, polished chrome-plated brass bubbler heads, waste strainers, and matching stainless steel back panels.

- B. Acceptable Manufacturers:
1. Base: Haws, Model 1119.
 2. Optional: Elkay, Halsey-Taylor.

2.9 WALL BOX (WB-1)

- A. Materials: 2-inch drain and ½-inch hot and cold supplies with shut-off valves.
- B. Acceptable Manufacturer: Guy Gray, Model BB-200TS.

2.10 SAFETY EYEWASH (EW-1)

- A. Materials: Swing-down eye/face wash wall-mounted over sink. Provided with an MV-1 thermostatic mixing valve (Powers Model ES-150) with positive dual internal cold water bypass with recessed cabinet.
- B. Acceptable Manufacturers:
1. Base: Bradley, Model 270JW.
 2. Optional: Haws, Guardian.

2.11 SAFETY EYEWASH (EW-2)

- A. Materials: Portable air-pressure-operated eyewash with body spray; 37-gallon capacity stainless steel tank, certified to meet ASME requirements. Provided with the following components:
1. Eyewash head.
 2. Eyewash flow control.
 3. Dust cover.
 4. Eyewash valve.
 5. Hose.
 6. Relief valve.
 7. Pressure gauge.
 8. "Test This Week" tag.
 9. Bacteriostatic additive.
 10. Cart.
- B. Acceptable Manufacturers:
1. Base: Haws, Model 7601.37.
 2. Optional: Bradley, Guardian.

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PART 3 EXECUTION

3.1 PLUMBING FIXTURES AND TRIM

- A. Plumbing fixtures shall be roughed-in to conform with fixture locations as shown on the Architectural Drawings.
- B. Piping, valves, fittings, and trim shall be polished chromium plated when exposed in finished areas.
- C. Fixtures, trim, exposed piping surfaces, and accessories shall be adjusted, tested, cleaned, and polished to the satisfaction of the CSR prior to final acceptance.
- D. Pipe penetrating floors, walls, or ceilings shall be provided with solid polished chromium-plated escutcheon plates.
- E. Rough-ins shall be accurately laid out before setting fixtures. Fixtures shall be set plumb and uniformly, making connections at right angle to walls.
- F. Fixtures shall be caulked around floors and walls with white silicone caulking after final setting.

3.2 PLUMBING FIXTURE CARRIERS

- A. Plumbing fixture carriers shall be roughed-in to conform with fixture locations as shown on the Architectural Drawings.
- B. Plumbing fixture carriers exposed trim surfaces shall be adjusted, cleaned, and polished to the satisfaction of the CSR prior to final acceptance.
- C. Rough-ins shall be accurately laid out before setting plumbing fixture carriers. Plumbing fixture carriers shall be set plumb and uniformly at right angle to walls.
- D. Plumbing fixture carriers shall be coordinated with all other trades before the construction of the walls in which the plumbing fixture carriers are to be located.

END OF SECTION

SECTION 15480

COMPRESSED AIR SYSTEMS

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. The work includes furnishing all labor, materials, and equipment necessary for the installation of the compressed air and instrument air systems including compressors, filters, driers, receivers, safety features, valves, piping and other related features as specified herein and as shown on the drawings.
- B. Related Sections
 - 1. Painting, SECTION 09900
 - 2. Packaged Cyclone Separator System, SECTION 15525
 - 3. Basic Electrical Materials and Methods, SECTION 16050
 - 4. Process Instrumentation and Alarm, SECTION 16910

1.2 REFERENCE

- A. This section references the latest edition of the following documents. They are part of this section as specified and modified. In the case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

<u>Reference</u>	<u>Title</u>
ASTM B88	Seamless Copper Water Tube
ANSI B16.22	Wrought Copper and Cooper Alloy Solder Joint Pressure Fittings
ANSI B16.18	Cast Bronze Cast Copper Alloy Solder Joint Pressure Fittings
AWWA C203	Coal Tar Protective Coatings and Linings for Steel Water Pipe – Enamel and Tape – Hot Applied
AWWA C206	Standard for Field Welding of Steel Water Pipe

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AWWA C209	Cold Applied Tape Coatings for Exterior of Special Sections, Connections and Fittings for Steel Water Pipe
ANSI/ASME B1.20.1	Pipe Threads, General Purpose
ANSI/ASME B16.1	Cast Iron Pipe Flanges and Flanged Fittings
ANSI/ASME B16.11	Forged Steel Fittings, Socket Welding and Threaded
ANSI/ASME B16.5	Pipe Flanges and Flanged Fittings
ANSI/ASME B18.2.2	Square and Hex Nuts
ANSI/AWWA M11	Steel Pipe - A Guide for Design and Installation
ASME Boiler and Pressure Vessel Code	Section VIII - Rules for Construction of Pressure Vessels, 1995
ASTM A53	Specification for Pipe, Steel, Black and Hot Dipped, Zinc Coated Welded and Seamless
ASTM A105	Specifications for Forgings, Carbon Steel, for Piping Components
ASTM A307	Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
ASTM A312	Seamless and Welded Austenitic Stainless Steel Pipe
ASTM A376	Seamless Austenitic Steel Pipe for High-Temperature Central-Station Service
CAGI	Compressed Air and Gas Association
NEMA	National Electrical Manufacturers Association
UL	Underwriters Laboratories

1.3 SUBMITTALS

- A. Provide submittals in accordance with SECTION 01340 for items listed below.
1. Dimensional drawings on air compressors, air driers, air filters and air receivers.
 2. Performance data on air compressors indicating pressure and ACFM ratings for site conditions.

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3. Performance data for filters including flow ratings, particulate filtration ratings, aerosol and vapor removal ratings and pressure drops through the units.
 4. Performance data for desiccant drier including flow, dew point, total air treatment volume capacity and filtration capabilities.
 5. Information on system controls for all mechanical and electrical equipment.
 6. Pipe specifications, materials, and fabrication drawings.
 7. Back pressure, pressure regulating and safety relief valve capacity tables and pressure rating.
 8. Pressure and CV rating for full port and standard port ball valves.
 9. Dimensional drawings and materials of construction for all valves.
 10. Information on engine driven drive systems and start/stop controls.
 11. General informational data on component design and operation for all components.
 12. Maximum operating pressure ratings for all equipment.
 13. Motors, operating voltage, rpm, and service factor.
 14. Wiring diagrams for all packaged control equipment.
 15. Shop drawings showing anchorage provisions for the air compressors, air receivers and equipment enclosures, as specified herein.
- B. Provide installation instructions with field installed equipment.
- C. Provide operation and maintenance instructions per SECTION 01730.

1.4 QUALITY ASSURANCE

- A. The intent of the Drawings and this specification is to provide for the installation of the compressed air systems complete in every respect. Minor details, special conditions and additional details as well as materials and equipment usually furnished with the systems specified shall be included in the Work as if specified herein, whether mentioned or not. Certain items of equipment may be specified in singular; however, the Contractor shall provide the numbers of such items as are indicated on the Drawings or as required for a complete and operational

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system. If conflicts occur between designations or callouts in the Project Specifications and/or on the Drawings, the most stringent requirement shall govern. All equipment furnished shall carry a warranty on component design materials and workmanship for one year from the date of project acceptance. All defective parts and components identified during the contract period or in the warranty period shall be replaced at no additional cost.

1.5 PRODUCT DELIVERY AND STORAGE

- A. Ship equipment from factory with all openings sealed.
- B. Store all equipment at the job site in a dry location indoors and protected from wind and rain. The storage location shall be approved in advance by the Engineer.
- C. Contractor shall be responsible for all damage or vandalism to equipment and components while stored at the job site.
- D. Coordinate with air compressor manufacturer concerning site storage conditions and follow manufacturer's recommendations.

PART 2 PRODUCTS

2.1 AIR COMPRESSORS

- A. Electrically driven air compressor 5 HP and larger
 - 1. Air compressors shall be provided where shown on the Drawings. The compressors shall be packaged systems sized as indicated on the Drawings.
 - 2. Electrically driven packaged compressor systems 5 HP and larger shall include the following:
 - a. Air cooled, two-stage reciprocating air compressors rated for the ACFM and pressure stated on the Drawings. Compressor shall be provided with inlet filters.
 - b. Intercooler.
 - c. Aftercooler with belt guard rated for a 15°F cooling temperature difference.
 - d. ODP drive motor operating on 460 volt, 3 phase, 60 Hz power. Horsepower as indicated on the Drawings.

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- e. 120 gallon, horizontal or vertical mount ASME, 200 psi receiver with automatic condensate drain. Size and configuration as indicated on the Drawings. Compressor and other packaged equipment shall be tank mounted.
 - f. Control panel.
 - g. Pressure switches for loading and unloading.
 - h. Safety relief valves.
3. The compressor control panel shall be provided with:
- a. Lead/lag control.
 - b. Full voltage motor starters.
 - c. Fused disconnects.
 - d. Automatic start/stop capacity control.
 - e. Constant speed capacity control.
 - f. Low oil level shut down.
4. Air compressor shall be constructed with a cast iron frame, overhung crankshaft supported by two heavy duty ball bearings, solid one piece connecting rods, two low pressure cylinders and one high pressure cylinder constructed of cast iron, precision balanced aluminum low pressure pistons and a cast iron high pressure piston, cast iron flow type flywheel, finned copper tube intercooler and splash lubrication.
5. Compressors shall be driven by 460v, 3 phase, ODP motors.
6. Air compressors shall be Gardner Denver HR Series or approved equal.
- B. Engine Driven Air Compressors
1. Engine driven air compressors shall be provided where shown on the Drawings. The compressors shall be packaged systems sized as indicated on the Drawings.
 2. Engine driven packaged compressor systems 5 HP and larger shall include the following:

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- a. Air cooled, two-stage reciprocating air compressors rated for the ACFM and pressure stated on the Drawings. Compressor shall be provided with inlet filters.
 - b. Intercooler.
 - c. Aftercooler with belt guard rated for a 15°F cooling temperature difference.
 - d. 120 gallon, horizontal or vertical mount ASME, 200 psi receiver with automatic condensate drain. Size and configuration as indicated on the Drawings. Compressor and other packaged equipment shall be tank mounted.
 - e. Control panel.
 - f. Pressure switches for loading and unloading.
 - g. Safety relief valves.
3. The compressor control panel shall be provided with:
- a. Lead/lag control.
 - b. Automatic start/stop capacity control.
 - c. Constant speed capacity control.
 - d. Low oil level shut down.
4. Air compressor shall be constructed with a cast iron frame, overhung crankshaft supported by two heavy duty ball bearings, solid one piece connecting rods, two low pressure cylinders and one high pressure cylinder constructed of cast iron, precision balanced aluminum low pressure pistons and a cast iron high pressure piston, cast iron flow type flywheel, finned copper tube intercooler and splash lubrication.
5. Engine driven air compressors shall be powered by a propane engine. Engine may be provided by the compressor manufacturer or utilize a standard gas engine which is modified to operate with propane gas.
6. The compressor engine shall be automatically started with a battery operated electric start upon drop in pressure, as indicated by a pressure switch, and unloaded and stopped (the engine killed) when pressure has reached the maximum operating pressure as sensed by the pressure switch. Set points

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for starting and stopping of compressor shall be as indicated on the Drawings.

7. Air compressors shall be Gardner Denver HGR Series or approved equal, modified as required for operation with propane fuel.
 8. Provided with battery charger.
- C. Electrically driven air compressors smaller than 5 HP.
1. Electrically driven air compressors smaller than 5 HP shall be as shown on the Drawings and as specified in other sections. Air compressors associated with the cyclone separator system shall be as specified in SECTION 15525.

2.2 RECEIVERS

- A. Receivers for the compressed air system shall be sized as indicated on the Drawings and shall be vertically or horizontally mounted with angle legs as shown on the Drawings, approved and stamped in accordance with Section VIII of the ASME Boiler and pressure Vessel Code for Unfired Pressure Vessels and rated for 200 psig minimum.
- B. Receivers shall be constructed with a mounting height to allow drain connections as shown on the Drawings.
- C. The receivers shall meet all applicable Federal, State and local codes.
- D. The receivers shall be painted per SECTION 09900. Color to be selected by the Engineer.

2.3 AUTOMATIC DRAINS

- A. Automatic drains shall be provided where indicated on the Drawings. Automatic drains shall be designed to automatically discharge accumulated condensate utilizing a float activated valve. The drain body shall be constructed of cast iron or aluminum, the float shall be stainless steel and the valve and seat shall be stainless steel. The automatic drain shall be rated to operate with a compressed air supply up to 175 psi and discharge to atmosphere with a condensate specific gravity of 1.0. Components of the automatic drain shall be compatible with all common compressor lubricants. Automatic drains shall be designed to operate without pilot or vent lines.

2.4 FILTERS

- A. Coalescing Filters

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1. Coalescing Filters shall be sized as shown on the Drawings and designed with a die cast metal housing with powder coat finish, silicone free construction, snap in elements and shall be compatible with commonly used mineral and synthetic compressor lubricants.
2. Coalescing Filters shall be rated for removal of liquid aerosols and particulates to 0.01 ppm by weight and particulate matter to 0.01 micron at the capacity indicated on the Drawings with a pressure of 100 psig at site conditions. The filters shall be provided with a rotary differential pressure indicator and float type automatic drain. The filter pressure drop shall not exceed 3 psig at the rated conditions. The filters shall be rated for operating pressures up to 250 psig.

2.5 LOW PRESSURE AIR BLOWERS

- A. Low pressure Air Blowers Shall be two stage regenerative air blowers designed to provide air flow an pressure as indicated on the drawings. Blowers shall provide oil free air. Blower housing and rotor shall be constructed of aluminum and shall be close coupled to a 5 horsepower, 3 phase motor with thermal overload protection. At Innaha, the motor voltage shall be 230 volts and at Lostine the motor voltage shall be 460 volts. Blower rotors shall be dynamically balanced. Blowers shall be provided with integrated silencers, intake filters and shock absorbing mounting plates. Blowers shall be Siemens ELMO-G 2BH7 series, performance curve 67G.

2.6 CARTRIDGE DESICCANT DRIER

- A. The desiccant drier shall remove moisture, hydrocarbons and particulates from the instrument air system using mechanical filtration, coalescing and desiccant filtration.
- B. The desiccant portion of the unit shall be designed with a cleanable and reusable coalescer scrubber, and constructed with polyethylene, Delrin components and a Delrin bowl. The unit shall be provided with an automatic drain.
- C. The desiccant drier shall be rated for operating pressures up to 250 psi at 180°F, 0.3 micron particulate filtration, and a 0°F dew point.
- D. The drier portion of the unit shall utilize a silica gel desiccant element designed to change color when filter needs to be changed.
- E. The desiccant drier shall be rated to deliver 40 SCFM at 100 psig with a 2.8 psi pressure loss and clean 3,300,000 standard cubic feet of air. The filter drier shall be BEACH Model F-T40D or approved equal.

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2.7 PIPING

- A. Pipe System Material Designation. The types of material for the pipes associated with the compressed air systems shown on the Drawings are designated within the Pipe Schedule on the Drawings.
- B. Steel Pipe
 - 1. Steel pipe shall be in accordance with ASTM A53. Minimum wall thickness shall be Schedule 40. Pipe shall be Type S, seamless pipe. Fittings and joints shall be welded and conform AWWA C206.
 - 2. All pipes shall be unlined.
 - 3. Piping shall be coated as follows:
 - a. Exposed steel pipe shall be coated as indicated in SECTION 09900. Color to be selected by the Engineer.
 - b. Buried steel pipe shall receive a hot applied coal tar enamel coating with Kraft paper wrap, in accordance with AWWA C203. Field repair of coating shall use cold applied primer and tape in accordance with AWWA C209.
- C. Stainless Steel Pipe
 - 1. Stainless steel pipe shall be Schedule 40 wall thickness available for the size noted on the Drawings. Pipe shall be type 304 stainless steel and conform to ASTM A312 or ASTM A376.
- D. Copper Pipe
 - 1. Copper piping shall be hard copper. Hard copper piping shall be constructed with Hard Drawn Copper unless otherwise indicated on the Drawings.
 - 2. Where soft copper piping loops are required for connections as shown on the Drawings, piping shall be constructed with Soft Annealed Copper.
 - 3. Pipe size indicated on the Drawings and in the pipe schedule refer to the inside diameter of the pipe.
 - 4. Buried copper piping shall conform to ASTM B88, Type "K"
 - 5. Above grade copper piping shall conform to ASTM B88, Type "L"

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6. All piping shall be rated for minimum working pressure of 250 psi or greater.
7. Fittings for copper pipe shall be solder joint fittings conforming to ANSI B16.22 or ANSI B16.18.

2.8 FLANGES, THREADS AND UNIONS

- A. Unless otherwise noted, all flanges on equipment and appurtenances provided under this section shall conform in dimensions and drilling to ANSI/ASME B16.1, Class 150. All pipe threads shall conform in dimension and limits of size to ANSI/ASME B1.20.1, Taper Pipe Thread.
- B. Unions for pipe 2 1/2 inch and smaller shall be threaded or solder joint and of the following manufacturers or equivalent: Stockham; Grinnell.
- C. Unions used for jointing copper to ferrous pipe shall have a brass sweat copper connection and a corrosion resistant steel threaded connection. Seats shall be ground and matched for smooth alignment. Dielectric insert shall be rated for the temperature and fluid handled.

2.9 WELDED BRANCH FITTINGS

- A. Fittings shall be machine made and ground for a uniform fitting onto steel piping sidewalls.
- B. Fittings shall be carbon steel to meet criteria of ANSI/ASME B16.11 and ASTM A105.
- C. Fittings shall be of the size to match Schedule 40 or Schedule 80 black steel pipe. Strength shall be equal 2000 PSI minimum. Connections shall be butt-weld, threaded, or socket weld type.
- D. Manufacturers and models or equivalent:

Allied	Branchlet Type 1
Bonney Forge	Weld-O-Let
Wheeling	Pipe-O-Let

2.10 PRESSURE GAUGES

- A. Gauges shall have 2 or 2 1/2 inch dials unless otherwise noted, stainless steel or bronze cases, 1/4 inch or 1/2 inch NPT bottom or back connection. All bourdon tube connections (socket, tube and tip assembly) shall be silver bronze tube and welded for steel tubes. Movements shall be bronze or stainless steel with bushed bearing. Gauges shall be liquid filled and provided with pulsation dampeners.

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All pressure gauges shall be provided with gauge cocks. Gauges shall be provided with a full scale pressure range as shown on the Drawings.

B. Manufacturers and models or equivalent:

1. Ashcroft 1009
2. US Gauge 550L

2.11 STAINLESS STEEL FLEXIBLE CONNECTIONS

- A. Stainless steel flexible connections shall be made of corrugated 316 stainless steel covered with braided stainless steel.
- B. Stainless steel flexible connections shall absorb vibration, relieve stress from mating equipment and allow some misalignment of mating equipment with vibrating machinery.
- C. Minimum operating pressure shall be 200 psi at 70°F. Operating temperature range shall be -30°F to 180°F.
- D. Unless otherwise shown on the Drawings, one end of the flexible connection shall be fitted with a union connection to facilitate installation and removal. The other end shall be flanged, swivel type, or pipe thread connections as required for attachment to equipment and piping.
- E. Stainless steel flexible connections shall be manufactured by the following manufacturers or approved equivalent:
 1. Omega Flex
 2. Piping Accessories Inc.
 3. Stemmerich Inc.

2.12 COMPRESSED AIR AND INSTRUMENT AIR SYSTEM VALVES

- A. Pneumatically Actuated Butterfly Valves
 1. VALVES: Butterfly valves shall be rated for air service and bubble tight shutoff at 175-psi line pressure and 100 degree F Temperature. Valves may be provided in a wafer or lug style configuration to fit class 150lb ASNI flange drilling, constructed with ductile iron bodies, carbon or stainless steel disks, stainless steel shafts and EDPM seats. The same manufacturer shall provide all butterfly valves unless approved otherwise. Valves shall be quarter turn, lever actuated.
 2. ACTUATORS: Pneumatic actuators shall be industrial duty vane type actuators with spring return units and configures with a fail-closed configuration. Actuators shall be designed to fully open and fully close

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valves with no intermediate positioning needed. Actuators shall be designed die cast zinc casings, stainless steel or zinc plated iron output shafts, Delrin bushes, Polyurethane seals, have a working pressure up to 100 psig and a working temperature range from -20 degrees C to 100 degrees C. The actuator shall be rated for 4,000,000 cycles and sized to operate with a 60 psi filtered dry air source. Pneumatic actuators shall be provided with a unit mounted solenoid valves as specified below that are designed to quickly open the valve (2 seconds or less).

3. SOLENOID VALVES: Unit mounted solenoid valves shall be provided with a manual override that allows actuation of the valves without solenoid operation. Solenoid valves shall be provided with Viton seals or approved equivalent for operation with a clean, dry non-lubricated compressed air at a pressure of up to 120 psi and a temperature of up to 200°F. Solenoid valves shall operate on 120 volt, single-phase power. When energized, the solenoid valve shall allow pressurized air to enter the actuator, opening the butterfly valve. When de-energized, the solenoid valve shall allow the pressurized air to escape the actuator, causing the spring return to close the butterfly valve. Solenoid valve accessories, including but not limited to dust excluders and inlet and exhaust port metering valves, shall be provided by the solenoid valve manufacturer and designed for compatibility with the solenoid valve used.

B. Ball Valves

1. Ball valves shall have a brass or bronze body with stainless steel ball and stems, and a Buna-N, PTFE or RPTFE seat. End connection shall be threaded. Valves shall be a non lubricated type.
2. Ball valves to be quarter-turn, lever or handwheel activated. Actuating lever position to be adjustable if used.
3. Ball valves shall be rated for a minimum of 250 psi W.O.G. for temperatures ranging from -20°F to 400°F.
4. Ball valves shall be provided with lockable valve operators to prevent unauthorized use of the valves.
5. All valves shall open with a counter clockwise rotation of the operator. Each valve operator or valve body shall have cast thereon the word "OPEN" and an arrow indicating the direction to open.
6. All ball valves shall be provided by the same manufacturer unless otherwise approved.
7. Ball valves shall be manufactured by the following manufacturers or approved equivalent:

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- a. Jenkins
- b. Worcester
- c. Velan

C. Swing Check Valves.

1. Swing check valves shall have a swing type flap gate and be constructed of brass or bronze, rated for W.O.G. service at 250 psi minimum rated for exterior submergence of up to 10 feet for a period of one continuous week per year and provided with threaded end connections.
2. Swing check valves shall be manufactured by the following manufacturers or approved equivalent:
 - a. Jenkins
 - b. Nibco
 - c. Worcester

D. Safety Relief Valves

1. Safety relief valves shall be designed for air service and sized as shown on the Drawings. Valves shall be rated for a maximum inlet pressure of 300 psi at 300°F.
2. Valves shall be ASME stamped and certified.
3. Valves shall be constructed with bronze body and stainless steel valve trim and shall be provided with threaded connections.
4. Valves shall be Keckly Type 40 or approved equal.

E. Pressure Regulating Valves

1. Pressure regulating valves shall be designed for air service and sized and set as shown on the Drawings. They shall be designed to maintain a constant downstream pressure under varying flow and upstream pressures.
2. Pressure regulating valves shall be self-contained, direct acting and have a globe configuration. Valves shall be constructed with cast iron bodies, replaceable stainless steel main valve seats, bronze or stainless steel trim, steel or stainless steel springs, a ductile iron spring housing and threaded end connections.

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3. Pressure regulating valves shall be rated for operation with air and a maximum operating pressure of 500 psi or greater, with an adjustment range from 40 to 170 psi.
4. Pressure regulating valves shall be Jordan Valve Mark 60 or approved equal.

F. Back Pressure Valves

1. Back pressure valves shall be designed to maintain a constant pressure upstream of the valve under varying flow and downstream pressures. The valves shall be designed for air service and be sized and set as indicated on the Drawings.
2. The valves shall be self-contained, direct acting and have a globe configuration, brass or bronze, bronze or stainless steel trim, stainless steel seats, steel or stainless steel springs, ductile iron spring housing and threaded end connections. Valves shall be provided with an adjustment spring that allows adjustment from 40 to 165 psi and be rated for operating pressures up to 500 psi.
3. Back pressure valves shall be Jordan Valve Mark 50 or approved equal.

G. Filter/Regulator

1. The filter regulator shall be designed with an integral configuration that includes the filter, pressure regulator and a pressure gage sensing outlet pressure all as part of a single unit.
2. The filter shall be rated for 5 micron particulate removal. The capacity, pressure adjustment and set point of the unit shall be as indicated on the Drawings.
3. The filter regulator shall be constructed with a zinc alloy body, and provided with a metal bowl with sight gage, and an automatic mechanical drain. The unit shall be rated for a maximum operating pressure of up to 250 psi at 175°F.

2.13 AIR HOSE

- A. Hoses for air service shall be rubber hose with a multi-fiber braid reinforcement.
- B. Hose shall be rated for a minimum operating pressure of 225 psi, and have a minimum operating temperature range of -40°F to 160°F.

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- C. Hose shall be rated for air and water use and compatible with all common compressed air lubricants.
- D. Hose ends and hose disconnects shall be Joint Industry Council (J.I.C.) flare type fittings. Hose ends and disconnects shall enable hose to be removed from tubing, piping, pneumatic actuator or air motor with a threaded connection.

2.14 SPARE PARTS

- A. Provide two (2) extra air inlet filters and crankcase oil filters for each air compressors.
- B. Provide two (2) extra filter cartridges for each of the filters and the filter drier.
- C. Provide one (1) gallon of lubricating oil for lubricators.
- D. Provide five (5) gallons of lubricant for air compression.

2.15 VAULTS

- A. Blowoff / Drain Vaults
 - 1. The blowoff / drain vaults shall be a reinforced concrete utility box with a reinforced concrete lid, rated for H-20. Adjust box size as required for housing of selected equipment as shown on the Drawings.

2.16 PRESSURE SWITCH

- A. Pressure switch shall be weatherproof, have a UL label, provided with an adjustment dial, capable of withstanding 200psi and provided with at least one N.O. contact.
- B. Pressure switch shall be United Electric H400-S164B or Allen-Bradley 836T-T261J or equivalent. Set as indicated on the Drawings.

2.17 AIR BACKWASH CONTROL PANEL

- A. Refer to the electrical drawings and specifications.
- B. Panel shall be fabricated by a UL certified 508A panel shop.
- C. Submittals shall include schematic, component layout, and component cut sheets.

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2.18 DIFFERENTIAL LEVEL SENSOR

- A. The differential level measurement panel shall utilize twin bubblers that discharge to dip tubes located ahead and behind the screen. The system shall compare the difference in pressure between the two-bubbler tubes and send a signal to the air backwash control panel when the set point differential has been exceeded.
- B. The system shall include the following:
1. A door mounted NEMA 4x panel with clear view access cover.
 2. A filter regulator with pressure gauge. The unit shall have a 5-micron filter, be rated for 150-psi maximum pressure, and have a 0-50 psi adjustment range.
 3. A Rosemount 3051CD differential pressure transmitter, 0.075% Accuracy and a calibrated span of -10 – 0 – +10 inches of Water.
 4. (2) Purge rate flow controllers to maintain a near constant purge flow to each dip tube.
 5. (2) Stainless steel & glass rotameters with a 0.5 to 2.5 SCFH range
 6. An LED indicator. Indicator to have a 4 digit 0.56 inch display indicating -10 – 0 – +10 inches. Unit to have (2) 5 Amp Form A Relay Outputs, Programmable set points and adjustable hysteresis, 24 VDC excitation for transmitter and powered with 115 VAC, 60HZ.
 7. Unit to be pre-plumbed with copper tubing and 1/4 inch NPT bulkhead connections for input and output connecting tubes.
 8. The system shall be equipped with automatic blow down of the bubbler tubing at the push of a button. Upon push of blow down button the system shall automatically momentarily suspend actuation of the backwash operation, isolate sensitive internal components to prevent damage and blow down each of the bubble tubes downstream of the panel. After the blow down operation is complete, and after a time delay (adjustable by the operator) the system shall reactivate the backwash system operation as described above.
- C. Unit shall be a Righton Instrument Company model 39RX12H-AB Head Loss Bubbler System or approved equal, available from Righton Instrument Company (732) 295-3207

PART 3 EXECUTION

3.1 AIR COMPRESSOR AND RECEIVERS

- A. Install all compressed air and instrument air equipment per manufacturer's recommendations.

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- B. Perform installation in accordance with all applicable Federal, State and local codes.
- C. Provide necessary electrical control and connections per details on the Drawings and as specified in DIVISION 16.

3.2 PIPING

- A. General. Install all pipe in strict accordance with manufacturer's recommendations, Drawings and/or specifications and in the best commercial trade practice.
 - 1. Where pipes pass through walls and floors, exercise extreme care to ensure joints are watertight. The pipe shall be free of all dirt and grease to secure a tight bond with the concrete.
 - 2. Welding shall be performed by certified operators who have been qualified by tests as prescribed by the AWS in Standard Qualification Procedure to perform the type of work required. The quality of welding shall conform to AWS Code of Arc Welding in Building Construction, Section 4, Workmanship.
 - 3. Perform all pipe cutting and provide fittings or special castings necessary to the proper and accurate assembly, erection and completion of the work. Cut pipe to fit accurately with smooth edges and faces.
- B. Exposed Pipe. Run exposed piping parallel and square with the lines of the structures unless otherwise indicated. Cut pipes accurately to allow assembly without springing or forcing.
 - 1. Securely fasten all exposed piping, valves, and fittings shall be securely fastened to the structure with hangers, supports, guides, anchors or sway braces to maintain pipe alignment, prevent sagging and straining due to uncontrolled movement. All supports shall support the weight of pipe, fittings, valves and contents without exceeding the maximum recommended load for the pipe support.
 - 2. Pipe supports and spacing of supports shall be as detailed on the Drawings.
 - 3. Install pipe supports to support pipes at all changes in direction.
 - 4. Provide additional supports which may be determined as necessary by the Engineer for the proper suspension, bracing, or support for the pipe.
 - 5. Provide special supports under the pipe where fixtures such as valves, etc., are to be supported by the pipe. No attempt is made to show all of these

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supports or hangers on the Drawings. Include such supports and bracings and install in a manner which would be considered as good practice in the trade and in compliance with the requirements of the Engineer.

6. All pipe supports, hangers, racks and anchors shall be hot-dip galvanized after fabrication. All hangers, racks, saddles and supports shall be of standard manufacture for that purpose. No straps or hangers of plumber's tape shall be acceptable.
 7. Make up flanged joints true and square so that there is no strain on pipe or valve. Tighten bolts uniformly around the joint.
 8. Cut threaded joints neatly with sharp tools. The jointing procedure shall conform with the best trade practice. Before jointing, remove all scale from pipe by some suitable means such as standing on end and rapping sharply. After cutting, ream all pipes. All pipe shall be screwed together with an application of approved pipe compound applied to all threads, and once a joint has been screwed tight, it shall not be backed off unless the threads are re-cleaned and new compound applied. This application shall be neatly made and all compound and dirt shall be thoroughly wiped off the outside of every joint.
 9. Install unions on all threaded joint piping to facilitate the removal of sections for maintenance and repair in accordance with the best trade practice. Include all such unions in the bid price whether shown on the Drawings or not. Use insulating unions (dielectric) connections between pipes of dissimilar metals, including cast-iron valve connections to adapters for copper pipe, etc.
 10. Check the orientation and diameter of all holes in the air distribution manifolds. If holes have been galvanized closed or the galvanized coating has reduced the diameter of the holes, drill coating to match what is indicated on the Drawings. If the holes are in the wrong orientation, welded shut, re-drilled in the right configuration and touched up with "Galv-Weld" or approved equal.
- C. Buried Pipe. Any special tools required for laying, jointing, cutting, etc., shall be supplied and properly used. Thoroughly clean all pipes before laying and keep clean until accepted in the completed work. Lay pipe accurately to the lines and grades given. At all times during pipe laying operations, keep trenches free of water.
1. All pipe and fittings shall be delivered in sound condition. Care shall be taken to protect exterior coatings and linings during all phases of the work. Place no material of any kind inside of any piece of pipe or fitting during

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handling, storage or transit. Store pipe and fittings in a protected area. Use strap slings for lifting coated pipe.

2. Repair any section of pipe with a damaged end or barrel as directed. If, in the opinion of the Engineer, a satisfactory repair cannot be made, replace the damaged section with an undamaged section.
3. Construct all piping systems from the materials shown and to the lines, grades and dimensions shown. Where not shown, locate the pipes to avoid interference with other features.
4. Lay piping and fit together so that, when complete, the pipe will have a smooth and uniform invert. Thoroughly swab each length of pipe laid to remove all foreign material before the next length is laid. Inspect each pipe for defects before being lowered into the trench.
5. Install all piping for which no location dimensions are shown in a neat and workmanlike manner in accordance with the best trade practice. It shall be the Contractor's responsibility to properly layout all piping to clear obstructions such as equipment, larger sized pipes, etc. Under no condition, shall the pipe be laid against the wall of a trench. The minimum distance for exterior of pipe to trench wall shall be 4 inches. The minimum distance between pipes in the same trench (either vertical or horizontal) shall be 6 inches. Hand tamping of backfill shall be required in areas with less than 12 inches of clearance between a pipe and another pipe, structures, or trench sidewall.
6. When deflecting the pipe from a straight line, either in the vertical or horizontal plane or when long radius curves are shown, the amount of deflection allowed shall not exceed that recommended by the pipe manufacturer.
7. All laying operations to provide watertight pipe and pipe joints shall be the responsibility of the Contractor. If adjustment of the position of a length of pipe is required after it has been laid, it shall be removed and re-jointed as for a new pipe.

3.3 FLANGES AND UNION INSTALLATION

1. Provide flanges and unions at all final connections. Arrange piping and piping connections so that area being served maybe serviced or totally removed without disturbing piping beyond final connections and associated shut-off valves.

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2. All flanged connections shall be in accordance with ANSI B16.5 for steel flanges.
3. Bolts and nuts shall be in accordance with ASTM A307 Grade B with bolts and nuts in accordance with ANSI/ASME B18.2.2.
4. Flanges and unions shall be made of same compatible material as piping systems in which they are installed.

3.4 PRESSURE GAUGES INSTALLATION AND APPLICATION

- A. Install pressure gauges where shown in the Drawings.
- B. Install all gauges with shut-off cock with sufficient clearance to remove gauge without disturbing the piping.

3.5 VALVE INSTALLATION

- A. Install valves at all points indicated on the Drawings.
- B. Install all valves with stems at true vertical or true horizontal as shown on the Drawings. Valves shall not be installed with stems below horizontal under any condition.
- C. Ball valves shall operate freely without binding or sticking in any position from fully open to fully closed. Any valves that do not operate freely shall have operations adjusted to the satisfaction of the Engineer.
- D. Install check valves where shown on the Drawings, in either a true vertical or horizontal position, and per manufacturer's recommendations.
- E. Install check valves in regard to the direction of flow.

3.6 MISCELLANEOUS EQUIPMENT

- A. Install all other equipment, including but not limited to the alarm pressure switch, filters, and the filter drier, in strict accordance with the manufacturer's recommendations.

3.7 TESTING

- A. Air System Piping Pressure Test
 1. The compressed air and instrument air piping pressure test shall include all compressed air (CA) piping, instrument air (IA) piping, filters, regulators, valves and other appurtenances with pressure ratings above the test pressure.

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The test shall not include equipment with design pressure ratings less than the stated test pressure. The test shall also exclude the air distribution manifolds. Equipment not to be tested shall be bypassed or isolated for the piping test.

2. Provide all equipment required including but not limited to compressors, piping, gages, valves, and safety relief valves for cleaning, flushing, safety and testing.
3. Prior to testing, all piping, compressed air and instrument air components shall be blown out to remove dirt and construction debris from the piping. All filter and desiccant cartridges shall be removed and backpressure and regulating valves isolated for blowout operations.
4. Test buried piping prior to burial. Perform repairs and retesting as necessary prior to burial.
5. After all air piping has been blown out, the air system shall be pressure and leak tested as a complete system. Tests shall include any previously tested piping that has been buried. All air supply and exhaust piping and flexible connections shall be tested. The systems shall be pressurized with air and isolated from the source for a period of 2 hours. Inspect for leaks by applying soapy water to all fittings and connections and by monitoring the system pressure.
6. Maintain the full test pressure for the duration of the test. If pressure falls below the test pressure or any leakage is detected by the soapy water solution, it shall be repaired and retested to the acceptance of the Engineer.
7. The test pressure for each piping system shall be as in the pipe schedule on the Drawings. Components that are not designed for the specified test pressure or do not require a pressure test shall also be isolated during the test.
 - a. After the above testing is complete, the items isolated during testing shall be reinstated and the system leak tested once more at a pressure corresponding to the rated design pressure of the components.

B. Compressed Air and Instrumentation System Operational Test

1. After pressure testing, each system shall be operationally tested to ensure valves, controls and equipment operate as intended. Any needed adjustments shall be made and malfunctioning components shall be repaired or replaced to the acceptance of the Engineer.

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- C. After all testing and training operations are complete, the Contractor shall change the cartridge elements in all filters, filter / regulators and dryers, and charge the lubricators with lubricant. The elements and lubricants used for this shall not be taken from the spare parts provided under paragraph 2.13.
- D. Provide testing of safety relief valves and compressed air equipment as required to comply with federal, state, and local codes.

3.8 CLEANUP AND REPAIR

- A. Store spare parts at a location designated by the Engineer.
- B. The Contractor shall maintain his operations in a neat and orderly manner causing as little inconvenience as possible. Repair all items identified as needing repair to the Engineer's satisfaction. Thoroughly clean the work area after completion of the work.

3.9 ACCEPTANCE

- A. Final acceptance of the project shall not be made until the Contractor has completed the total project and all testing, facility startup and commissioning per SECTION 01410, restoration, and cleanup has been performed to the satisfaction of the Engineer.

PART 4 WARRANTY

4.1 GENERAL

- A. Compressed air equipment shall be warranted for labor, equipment and all components for a 1 year period after final acceptance.

END OF SECTION

SECTION 15481
OXYGEN SYSTEMS

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. The work includes furnishing all labor, materials and equipment to complete the work of designing, fabricating and installing the oxygen systems as specified herein and as shown on the Drawings.
- B. The work shall include, but is not limited to, furnishing and installing an oxygen distribution and application system, including all piping, valving, Low Head Oxygenators (LHO) and other features and components shown on the drawings, specified herein or as required to make the system complete and fully operational.

1.2 SUBMITTALS

- A. Submit the following in accordance with SECTION 01340:
 - 1. Product Literature
 - a. Piping and appurtenances.
 - b. Gas pressure regulator showing capacity and pressure ranges.
 - c. Valves.

1.3 PROJECT CONDITIONS

- A. Items Furnished and Installed by Contractor:
 - 1. Oxygen Flowmeters
 - 2. Valves
 - 3. Gas Pressure Regulators
 - 4. Piping and Associated Fittings, Connectors, etc.
 - 5. Low Head Oxygenators
- B. Items furnished by others will be arranged by the Owner:
 - 1. The Owner will lease bulk liquid oxygen storage and evaporating equipment for supplying oxygen to the facility.

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2. The following items shall be included in the lease equipment.
 - a. Bulk liquid oxygen storage tank.
 - b. Vaporizer.
 - c. Gas pressure switch.

1.4 QUALITY ASSURANCE

- A. Codes: All work relating to the oxygen delivery system shall be in accordance with the Uniform Plumbing Code, the Uniform Fire Code, NFPA 53M - Fire Hazards in Oxygen-Enriched Atmospheres, all applicable Occupation Safety and Health Administration codes and all applicable State and Local Codes unless the Contract Documents are more stringent.
- B. Ratings and Performance Tests: Shall comply with ASME, NFPA and ASHRAE standards as specified.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Ship from factory with all openings sealed. All valves, pipe, fittings and other components shall be cleaned for oxygen service and protected during storage.
- B. All equipment under this section shall be stored at the job site in a dry location indoors and protected from wind and rain. The storage location and delivery schedule shall be approved in advance by the Engineer.
- C. Contractor shall be responsible for any damage or vandalism to the equipment while stored at the job site.

PART 2 PRODUCTS

2.1 GENERAL

- A. The oxygen supply system will consist of bulk storage tank and vaporizer equipment interconnecting piping, valves, and distribution piping. Foundation and location for bulk storage tank and vaporizer shall be provided as shown on the drawings. Minimum bulk storage capacity and vaporizer capacity shall be arranged for by the Owner as indicated on the Drawings. The bulk storage system will be provided with a gas pressure switch.
- B. Valves
 1. All valves shall be cleaned and packaged for oxygen service at the factory.

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2. Valves shall be ball valves with bronze body end threaded or solder ends. Valves shall be rated for minimum 175-psi oxygen gas service. Valves are available from:

Red-White Valve
Lake Forest, CA
or
Jenkins
Bridgeport, Conn.

C. Gas Pressure Regulators

1. Gas pressure regulators shall be single stage, medium duty cylinder regulators manufactured from brass barstock bodies with zinc die cast caps. Other features shall include nylon-reinforced rubber diaphragm, detached stem valves, positive valve closure, porous metal filter, 2-inch gauges and non-breakable Lexan gauge crystals.
2. The gas pressure regulators shall be as follows:

<i>Gas</i>	<i>Maximum Delivery Pressure</i>	<i>Inlet Pressure</i>	<i>Outlet Set Pressure</i>
Oxygen	60 psi @ 90 SCFH	200 psi	50 psi

D. Piping

1. All oxygen service piping on the drawings shall be hard copper unless noted otherwise.
2. All exposed copper piping shall be Type L, all buried copper piping shall be Type K.
 - a. Piping shall meet the requirements of ASTM B88.
 - b. Solder fittings and unions shall meet the requirements of ANSI B16.22 and where required 95-5 tin-silver or thin antimony solder shall be used.
 - c. Unions shall be used wherever necessary to allow removal of all components on an individual basis.
3. Flexible hose, downstream of oxygen flowmeters, shall be transparent reinforced polyvinyl tubing rated for temperature ranges of -40°F to 200°F and pressures up to 50 psi. Attach hose to shank fittings with stainless steel clamps.

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PART 3 EXECUTION

3.1 GENERAL

- A. The distribution and interconnection oxygen piping is covered in this section as well as the system testing of the oxygen system.
- B. Valves and Regulator Installation
 - 1. Install regulators according to manufacturer's recommendations and industry standard practice.
 - 2. Install pressure switches with an isolation gate valve.
 - 3. Install all lines with a gradual slope in order that moisture is drainable and provide a drain valve at low point whether shown on the drawings or not.
- C. Piping Installation
 - 1. Piping shall be installed in strict accordance with manufacturer's recommendations, the Contract Documents, in accordance with the best commercial trade practice and in conformance with all appropriate codes.
 - 2. Where pipes pass through the walls and floors, extreme care shall be exercised to ensure joints are watertight and the pipe is protected from abrasion.
 - 3. Installation and assembly shall be done by qualified trade's people well versed in working with oxygen systems.
 - a. Copper piping ends and fittings shall be cleaned with an abrasive cloth to ensure proper joining when soldered.
 - b. No burrs, copper dust, oil, thread-joint compound or other contaminants shall be introduced into the piping at any time during the installation process.
 - 4. The Contractor shall perform all the work necessary for a proper and accurate assembly, erection and completion of the work. All pipe shall be cut to fit accurately with smooth edges and faces.
 - 5. Exposed piping shall be run parallel and square with the lines of the structures unless otherwise indicated. Pipes shall be accurately cut to allow assembly without springing or forcing.
 - 6. All exposed piping, valves, fittings shall be securely fastened to the structure with hangers, supports, guides, anchors or sway braces expressly made for

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this purpose, to maintain pipe alignment and prevent sagging and straining due to uncontrolled movement. All supports shall support the weight of the pipe, fittings, valves and contents without exceeding the maximum recommended load for the pipe support.

- a. Pipe supports shall be provided at a spacing not to exceed 5 feet.
- b. Pipe supports shall be installed to support pipes at all connections and changes in direction.
- c. Contractor shall provide additional supports which may be determined as necessary by the Engineer for the proper suspension, bracing, or support for the pipe.
- d. Contractor shall provide special supports under the pipe where fixtures such as valves, etc., are to be supported by the pipe. No attempt is made to show all of these supports or hangers on the drawings but the Contractor shall be required to include such supports and bracings and they shall be installed in a manner which would be considered as good practice in the trade and is acceptable to the Engineer.
- e. All non-submerged pipe supports, hangers, racks and anchors shall be plastic or copper. Submerged supports, hangers, racks, and anchors shall be fabricated from stainless steel. All hangers, rack, saddles and supports shall be of standard manufacture for that purpose. No straps or hangers of plumber's tape shall be acceptable.
- f. Special joints such as plastic fittings, copper tubing joints, etc., shall be made in accordance with the manufacturer's specifications. All low joints in piping shall be capable of being drained by gravity with valved drains if necessary.
- g. Buried pipe: Any special tools required for laying, jointing, cutting, etc., shall be supplied and properly used. All pipe shall be thoroughly cleaned before laying and shall be kept clean until accepted in the completed work. At all times during pipe laying operations, the trench shall be kept free of water.
- h. All pipe and fittings shall be delivered in sound conditions. Care shall be taken to protect any coatings or linings during all phases of the work. Place no material of any kind inside of any piece of pipe or fittings during handling, storage or transit. Pipe and fittings shall be stored in a protected area.
- i. Any section of pipe with damage shall be repaired as directed by the Engineer.

D. Cleaning and Testing of Oxygen Piping

1. Testing

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- a. After the piping system has been completely installed but prior to the installation of flowmeters and flexible tubing, the entire system shall be tested as indicated in the pipe schedule on the Drawings for two hours. No pressure drop or evidence of leakage is allowed.
- b. The Contractor shall furnish all labor, tools and equipment for testing, including compressors, piping, valves, temporary caps and supports. The Contractor shall install adequate blocking or other means of resisting test pressure. It shall be the Contractor's responsibility to adequately block or otherwise support all factory-attached caps. Any damage resulting from or caused by these tests shall be repaired at the Contractor's expense.
- c. Testing of pipelines shall be done as nearly as possible in completed runs, or to a convenient cut off, to enable all outlets of the run to be plugged or capped. Selection of test runs shall be reviewed by the Engineer to assure that the desired test coverage can be obtained.
- d. All leaks shall be repaired or defective material replaced and the test repeated, as directed by the Engineer.

2. Cleaning

- a. After the pressure testing is completed and accepted by the Engineer, all oxygen lines shall be cleaned.
- b. As a first cleaning step, flush all lines thoroughly with water to remove all dust, dirt and foreign particles.
- c. Next, flush all lines again with a hot solution of sodium carbonate or trisodium phosphate to remove all oil, grease and other oxidizable materials.
- d. Flush thoroughly with clear water.
- e. Drain all water and blow clear with dry, oil-free compressed air or nitrogen.

E. System Test

1. Contractor shall demonstrate the complete operation and functioning of the oxygen system from the bulk oxygen tank and evaporator through the distribution system. System shall be operated at various flow regimes from maximum flow to partial flow. Pressure switch settings shall be adjusted for proper operation of the equipment using the pressure settings listed as a guide.

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- F. Contractor Interconnection to Bulk Oxygen Supply Tanks and Evaporator:
 - 1. Connect oxygen supply lines to leased bulk oxygen storage system and evaporator.

PART 4 WARRANTY

4.1 GENERAL

- A. All oxygen related equipment shall be warranted for both labor, equipment and all components for a 1 year period after final acceptance.

END OF SECTION

SECTION 15525

HYDROCYCLONE SYSTEM

PART 1 GENERAL

1.1 WORK INCLUDED

A. Base Bid:

1. Contractor Provide:

- a. All labor, material, and equipment required to supply, install, and test all pumps, hydrocyclone units, controls, and appurtenances as shown on the drawings, specified and required to make the units complete and fully operable.
- b. Products included:
 - 1) General
 - 2) Equipment Responsibility
 - 3) System Description
 - 4) Hydrocyclone Separator
 - 5) Plant Start-Up And Operator Training

1.2 RELATED WORK

A. Specified Elsewhere:

1. 15050: Basic Mechanical Materials and Methods
2. 15060: Pipes and Fittings
3. 15100: Valves
4. Division 16: Electrical

1.3 SERVICE ENGINEER

- A. The system manufacturer shall provide for, and pay the cost of, an authorized service engineer from the manufacturer to be on hand for field assembly of equipment, starting the unit, making adjustments and training the Owner's operators. See additional requirements later in this Section.
- B. Approximately six months after final acceptance, the Contractor shall have a factory authorized service engineer or technician to visit the jobsite for the purpose of additional operator training, adjustments and checks of the system.

1.4 SUBMITTALS

- A. Submit Product Data, and Operation and Maintenance Instructions on all pumps, hydrocyclones, air compressor, pipe, and valves.

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- B. Shop Drawings: Submit shop drawings of all pumps and drivers for approval. Shop drawings shall include the following features:
 - 1. Manufacturer's specifications data and descriptive literature on pumps and motors. Provide electrical data showing MCA (minimum circuit amps) and MOCP (maximum overcurrent protection).
 - 2. Performance curves showing capacity in gpm, NPSH, head, efficiency and pump horsepower from 0 gpm to 110% of design capacity.
 - 3. Motor efficiencies and power factors at all design operating points.
 - 4. Drawings showing general dimension, confirming the size of the pump, openings, connections, construction details of the equipment, piping drawings, and weights of major components.
 - 5. Complete electrical drawings showing the wiring diagrams for the entire assembly. Clearly indicate field wiring requirements.
- C. Shop Drawings: Submit shop drawings for hydrocyclone system including dimensions, connections, skid arrangement and pipe/ equipment supports.
- D. Provide Operation & Maintenance Manuals:
 - 1. Prior to startup the Contractor shall have received complete Operation and Maintenance Manuals from the supplier and submitted at least one copy to the Engineer. Another copy shall be kept at the site and made accessible to the Engineer. Other copies shall be per Division 1.

1.5 PRODUCT DELIVERY AND STORAGE

- A. Equipment shall be shipped to the jobsite with all openings plugged, taped or otherwise sealed to prevent entry of foreign materials, rodents, etc.
- B. All equipment stored at the jobsite shall be in a dry location protected from sun and rain.

1.6 QUALITY ASSURANCE

- A. Equipment Manufacturer
 - 1. In order to establish a standard of quality the hydrocyclone system shall be supplied by Process Engineers and Equipment Company, Spokane, WA 509-468-8201.

1.7 JOB CONDITIONS

- A. Existing Conditions
 - 1. If existing conditions prohibit proper installation or as shown on the Drawings or specifications herein, the Contractor shall notify the Engineer in writing requesting instruction.

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2. The Contractor is responsible for the verification of new and existing dimensions, locations, elevations, and materials on site before that particular phase of installation begins.

PART 2 PRODUCTS

2.1 GENERAL

- A. The system shall be a packaged, skid mounted, hydrocyclone system configured specifically for the removal of sediment from a river water supply. The mechanical components shall include four (4) base mounted centrifugal pumps feeding four (4) hydrocyclones, suction and discharge headers, branch piping, valves and controls all mounted on a common steel base. The entire system shall be prefabricated, pre-wired and skid mounted on a painted, structural steel base.

2.2 EQUIPMENT RESPONSIBILITY

- A. The system and all associated components including: controls, pumps, motors, valves, and base shall be furnished by one equipment supplier. The equipment supplier shall have responsibility for the complete and proper operation of the new pumping equipment, hydrocyclones, and control equipment, as specified. Start-up services shall be included, and shall include operating instruction to the operators. The system shall be manufactured and integrated by Process Engineers and Equipment Corp., Spokane, WA.

2.3 SYSTEM DESCRIPTION

- A. The hydrocyclones, pumps and motors, piping, valves, and controls shall be mounted on a common steel base. The Control Panel shall be installed and factory and wired to pump motors and accessories. The overall system shall be as shown in the plans.
- B. Each pump/ hydrocyclone unit shall be designed to deliver 2,000 GPM. The pressure drop across the unit shall not exceed 22 psi.
- C. The pump system will be designed for 50HP, 3-phase, 460-volt electrical service.

2.4 HYDROCYCLONE SEPARATOR SYSTEM

- A. Valves
 1. Isolation Valves
 - a. The pumps shall be provided with pneumatic actuated knife gate valves on the discharge side of each pump in order to isolate the pump when not operational. The valves shall have a 125 lb rating and stainless steel blade. See additional requirements in Section 15100.

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2. Check Valves

- a. A check valve shall be provided for each hydrocyclone discharge, as shown on the plans. The valve shall utilize a spring assist to insure a quick closure of the disc during zero flow conditions to prevent surges and water hammer. The valve body shall be constructed of cast iron. The seat and disc shall be constructed of stainless steel. The valve shall have a 125 lb rating. See additional requirements in Section 15100.

B. Piping

1. The system shall be configured with a suction header and a discharge header, as well as discharge branch piping for each pump. The discharge branch pipes shall be connected to the hydrocyclone respectively with sizes as shown on the drawing. Provide reducers where necessary. The pump branch piping, and headers shall be constructed of steel pipe.
2. All piping shall be painted per Section 09900.
3. All bolts, nuts, and washers shall be stainless steel.

C. Flexible Connectors

1. Flange Rubber Spool Expansion Joints:
 - a. Expansion joints shall be flanged rubber spool type at least 125-psi rated with galvanized or stainless flanges or retaining rings and fasteners. Size per Drawings.
 - b. Manufacturers:
 - 1) Holz Rubber Company, Inc. 800-285-1600
 - 2) Mercer Rubber
 - 3) Metraflex
 - 4) Robbins Myers

D. Pipe Supports

1. Pipe supports by minimum sizing for:
 - a. 8" and smaller piping shall be a minimum of 2" x 3" x 3/16" wall rectangular tubing
 - b. 10" and larger piping shall be a minimum of 3" x 4" x 1/4" wall rectangular tubing
 - c. 6" and larger piping shall be provided with "kick" bracing projecting fully from the underside of the pipe to the floor at an angle of no less than 15 from vertical out at a right angle to the run of the pipe being supported. These "kick" braces shall be in addition to the vertical pipe supports called out above.
2. Pipe supports shall be fully welded at both end points to the pipe and steel floor where required. Simple pipe stands made of pipe welded only at the floor and upholding a bracket with or without a threaded jack bolt or a U-bolt are not acceptable, as no lateral or transverse support is provided.

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E. Pressure Testing

1. The pressure piping within the system, including valves, fittings, connections as make up the entire system shall be hydrostatically tested at a pressure of 100 PSI or a pressure equal to the lowest test pressure rating of the equipment within the tested system, whichever is greater pressure. The test pressure shall be applied for a minimum of 20 minutes, during which time all joints, connections and seams shall be checked for leaking. Any deficiencies found shall be repaired and the system shall be retested. The results of this testing shall be transmitted in writing to the Engineer prior to shipment of the station and shall note test pressure, time at full pressure and be signed by the Quality Control Manager or test technician.

F. Centrifugal Pumps

1. The pumps shall be base-mounted centrifugal pumps, model APT 31-6 (8x6 – 11) as manufactured by Ahlstar. The pump shall be constructed with a cast iron housing assembly, 416 stainless steel shaft, bronze bushings, and stainless steel fasteners. The pump shall be of the non-overloading type. The impeller shall be dynamically balanced. The motor shall be in accordance with the latest NEMA Standards, and shall have the following characteristics:

a.	Enclosure	TEFC
b.	Number of Phases	Three(3)
c.	Cycle	60 Hz.
d.	Voltage	460 Volt
e.	Speed	1760 RPM
f.	Efficiency	High

2. Each motor shall have a sufficient horsepower rating to operate the pump at any point on the pump's head-capacity curve without overloading the nameplate horsepower rating of the motor, regardless of service factor. The motor shall have a service factor of at least 1.15. The service factor is reserved for variations in voltage and frequency.
3. Performance curves shall rise constantly towards shut-off head. Pumps having "flat" head curves will not be acceptable.

a.	Number of Units	4
b.	Type of Drive	Fixed Speed
c.	Discharge Size	6 in, minimum
d.	Suction Size	8 in, minimum
e.	Design Capacity	2,000 GPM
f.	Design Head	65 ft (28 psi)
g.	Rotative Speed	1760 RPM, maximum
h.	Shut-off Head	92 ft, minimum
i.	Drive Horsepower	50 bhp, minimum

G. Hydrocyclones

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1. The hydrocyclones shall be Krebs Model DS20L – gMAX units with sectional cast and fabricated steel housings, sectionalized gum rubber liners throughout, a 6.5” vortex finder, a 35.5 square inch inlet liner, and a 0.75 inch gum rubber apex insert.
2. Performance of the units shall be as follows:
 - a. 2,000 gpm per pump line separator units.
 - b. 22 psi pressure drop.
 - c. D50 pf 38 microns.
 - d. D98 of 80 microns.
 - e. Approximately 25 – 40 gpm underflow water discharge.

H. Steel Base

1. All of the mechanical and control components shall be factory installed and wired on a common structural steel base. The base shall be constructed of structural channel and tubing. The entire base shall be covered by a steel plate floor and the entire base all pipe, valves, and supports shall be coated with Tnemec 114 epoxy paint (primer plus two finish coats). The control equipment shall be mounted on a panel stand constructed of the structural tubing.

I. Control Panels

1. Each pump shall have a control panel for pump and discharge valve operation. Each panel shall be mounted near its respective pump and be easily accessible by the operator. NEC clearance requirements shall be maintained.
2. Each control system shall be housed in a NEMA-12 enclosure. Gauges shall be Grade-A, and shall indicate individual pump pressure.
3. Panel features:
 - a. Primary voltage, 460 volt.
 - b. Manual-off-automatic, selector.
 - c. Fused disconnect.
 - d. Motor starter.
 - e. Control transformer.
 - f. Motor actuated solenoid valve for pneumatic valve.
 - g. Double lugs on the load side of the overload relay for field connection of power factor correction capacitors.
 - h. Run indicator light.
 - i. Power indicator light.

H. Instrumentation

1. Pressure gauges shall be provided to indicate pressure at the discharge of each pump.
2. Provide a 0 – 60-psi gauges with 3-1/2” dial and shut off valve.

I. Pump Discharge Control Valves

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1. The discharge of each pump shall have a pneumatic actuated knife gate valve for pump isolation when not in use. A solenoid valve in each pump control panel shall energize on pump start to open the valve by admitting air pressure. Knife gate valve shall spring closed when pump stops.

J. Compressed Air Supply

1. Compressed air for valve actuation shall be provided by a two-stage, 3 HP air compressor mounted on a ASME 80 gallon vertical receiver. Provide pressure switch for control from 90 to 110 psi. Provide pressure gauge, discharge isolation valve and auto tank drain extended to floor drain. Mount on 4" high concrete pad and bolt compressor to pad.

K. Pneumatic Connections

1. Pneumatic connections to the various devices required to complete the system shall have the size tubing and fittings required for the task.
2. Polyethylene tubing shall be Poly-Flo polyethylene tubing as manufactured by Imperial-Eastman. It shall be colored blue. Catalog #66-P (blue) shall be used wherever 3/8" O.D. tubing is called for or recommended by the system manufacturer. Catalog #44-P (blue) shall be used wherever 1/4" O.D. tubing is specified or recommended by the system manufacturer.
3. Terminations at the panel and at the device shall be made with Poly-Flo tube fittings (brass) as manufactured by Imperial-Eastman Co. Either straight connectors or angle connectors shall be used depending upon the actual tubing situation to make the neatest appearing connection.
4. Tubing splices will not be allowed. Only continuous runs of tubing will be permitted.
5. All tubing shall be supported in PVC conduit or neatly strapped to piping.

L. Operator's Manual

1. Plant operating manuals designed and assembled by the single manufacturer specifically for this project and covering all equipment and process items furnished by the single manufacturer shall be furnished with the system.

2.5 PLANT START-UP AND OPERATOR TRAINING

- A. After the Contractor has pumped flowing water and pumped backwash available to the filters, the Contractor shall have a factory authorized person check the filter installation and start it up and program it. The Owner shall be trained at this time and the Contractor shall learn how to operate the filter at this time. At least one O & M manual shall be submitted to Engineer and one made available at site. This shall be prior to formal Component Startup.
- B. The Contractor shall have factory engineer return one time during the year following start-up to review plant operation and provide further operator training

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as required. Subsequent to the return visit, the factory engineer shall make a report in writing to the Engineer and the Owner concerning the status of the plant.

PART 3 EXECUTION

3.1 INSTALLATION

- A. All equipment shall be installed in accordance with the manufacturer's recommendations, drawings, and/or specifications. Alignment and adjusting shall be verified after installation.
- B. Before connecting pumps to piping, all piping shall be thoroughly flushed and cleaned. All piping connected to pumps shall be supported from adjacent structures without placing any load on the pumps.
- C. Provide pressure gauges on the discharge of all pumps. Pressure gauges shall be installed with shut-off cock and shall have sufficient clearance to remove gauge without disturbing the piping.
- D. All pumps shall have a local electrical disconnect complying with the NEC.
- E. Panel covers shall be identified as to device and use via an engraved laminated nameplate with black 1/4 inch letters on a white background affixed to the device by screws or rivets.
- F. Motor nameplates shall be checked for full load current rating and allowable temperature rise to determine correct overload thermal units for each motor.

3.2 TESTING OF PUMPS

- A. In addition to testing that may be required by codes, the Contractor shall perform all tests specified in this section and shall furnish and pay for all material and labor required for tests. Prior to the plant start-up, each pump shall be tested in place with its own motor and drive unit. The tests shall duplicate all normal operating modes and all failure modes. The Contractor shall notify the Engineer or Owner a minimum of 15 days in advance of running any tests unless otherwise specified and no tests shall be accepted unless the Engineer or representative of the Owner is present. Should test indicate unsatisfactory operation or leaks occurring, conditions shall be corrected and test repeated at Contractor's expense.

During the testing of each pump the Contractor shall check and record the following:

- 1. Service Factor of each motor.
- 2. Discharge and suction (if applicable) pressure at normal operating head and at shut-off head.
- 3. Motor current (each phase) at normal operating head and at shut-off head.
- 4. Line voltage (each phase) at each pump.

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5. Pump/ motor alightment.

3.3 START-UP SERVICE FOR PUMPS

- A. After the Contractor has established that the scheduled flow of water is available for pumping and has a place to be pumped to, the Contractor shall furnish the services of a qualified factory trained field service engineer at the site to inspect the installation and instruct the User's personnel on the operation and maintenance of the pumping units. After the pumps have been completely installed and wired, the Contractor shall have the manufacturer do the following:
1. Megger stator and power cables.
 2. Check seal lubrication.
 3. Check for proper rotation.
 4. Check power supply voltage.
 5. Measure motor operating and no-load current.
 6. Check level control operation and sequence.
- B. The Contractor shall coordinate the services of a qualified electrician and the manufacturer's representative of the variable frequency drives.
- C. The Contractor shall provide written record of the site visit of the manufacturer's representative including representative's contract information and the names of the User's who attended training.

END OF SECTION

SECTION 15600

HVAC EQUIPMENT

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. The work covered by this section consists of furnishing all labor, materials, and equipment necessary for the installation and design of the building heating and cooling equipment as shown on the Drawings and as specified herein.

1.2 SUBMITTALS

- A. Shop Drawings
 - 1. Submit dimensional layout drawings, product literature and performance data for all heating equipment scheduled and required associated equipment specified herein. Submittals shall conform to SECTION 01340.
- B. Operation and Maintenance Data
 - 1. Provide instructions for operation maintenance of all equipment specified in this section in accordance with SECTION 01730.

1.3 QUALITY ASSURANCE

- A. Reference Standards
 - 1. Except as modified by governing codes and by the Contract, comply with the applicable provisions and recommendations of the following:
 - a. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE).
 - b. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA).
 - c. National Fire Protection Association (NFPA).

1.4 GUARANTEE

- A. The heating and ventilating equipment shall be guaranteed for a minimum of one year from date of Certificate of Substantial Completion.

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1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, and handle the equipment to prevent damage and disfigurement.
- B. Protect all items from damage during transit and installation.

PART 2 PRODUCTS

2.1 HEAT PUMP (HP)

A. Outdoor Unit

1. General

- a. Units shall be assembled on heavy gauge steel mounting/lifting rails and shall be weather proofed. Unit shall include a hermetic reciprocating compressor(s), plate fin condenser coil, fans and motors, controls and holding charge of R-22. Operating Range shall be between 115°F and 35°F in cooling as standard from factory. Units shall be UL 1995 listed CSA CAN/CSA-C22.2 No. 236-M90, certified and rated in accordance with ARI Standard 210/240, 340 and 270.

2. Casing

- a. Unit casing shall be constructed of 18-gauge zinc coated heavy gauge, galvanized steel. Exterior surfaces shall be cleaned, phosphatized and finished with a weather-resistant baked enamel finish. Units surface shall be tested 500 hours in salt spray test. Units shall have removable end panels which allow access to all major components and controls

3. Refrigeration System

- a. The unit shall have direct drive scroll compressor(s) with centrifugal oil pump and provide positive lubrication to all moving parts. Motor shall be suction gas-cooled and shall have a voltage utilization range of plus or minus 10 percent of nameplate voltage. Crankcase heater, internal temperature and current sensitive motor overloads shall be included for maximum protection. Shall have internal spring isolation and sound muffling to minimize vibration transmission and noise. External high and low pressure cutout devices shall be provided. Evaporator defrost control provided in indoor blower coil shall prevent compressor slugging by temporarily interrupting compressor operation when low evaporator coil temperatures are encountered.
- c. Condenser Coil: Coils shall be internally finned or smooth bore 3/8" copper tubes mechanically bonded to configured aluminum plate fin as

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standard. Coil shall be factory pressure and leak tested to 425 psig air pressure. Metal grilles with PVC coating for coil protection is optional.

- d. Condenser Fan and Motor(s): Direct-drive, statically and dynamically balanced propeller fan(s) with aluminum blades and electro-coated steel hubs shall be used in draw-through vertical discharge position. Permanently lubricated totally enclosed motors shall be provided and shall have built-in current and thermal overload protection. Motor(s) shall have ball bearing type.
- e. Controls: Heat pump units shall be completely factory wired with necessary controls and contactor pressure lugs or terminal block for power wiring. Control wiring shall be 24-volt control circuit which includes fusing and control transformer. The unit shall have a mounted fused disconnect device.
- f. Defrost Controls: Electronic timed initiated, temperature terminated defrost system with choice of 50, 70, or 90 minute cycle. Timed override limits defrost cycle to 10 minutes.
- g. Low Ambient Operation: Standard units shall start and operate to approximately 15°F when matched with Trane air handlers and coils. Optional head pressure control accessory permits operation to 0°F.
- h. Low Ambient Head Pressure Control: Shall modulate the RPM of unit outdoor fan motor in response to outdoor ambient temperatures and unit head pressure. Accessory provides unit cooling operation to outdoor temperatures of 0°F.
- i. Vibration Isolation Packages: Shall reduce transmission of noise and vibration to building structures, equipment and adjacent spaces. Packages shall be available in either neoprene-in-shear or spring-flex types.
- j. Time Delay Relay : Shall prevent compressors in dual compressor unit from coming online simultaneously. Timer shall be 24-volt, 60 cycle, with four minute timing period.
- k. Anti-Short-Cycle Timer: Shall prevent rapid on-off compressor cycling in light load conditions by not allowing compressor to operate for 5-7 minutes upon shutdown. Shall consist of a solid state timing device, 24-volt, 60 cycle with either 5 or 7 minute fixed-off timing period.
- l. Condenser Coil Guard: Metal Grille with PVC coating shall be provided to alleviate coil damage.

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B. Indoor Unit (FCU)

1. General

- a. Air handler units shall be completely factory assembled including coil, condensate drain pan, fan motor(s), filters and controls in an insulated casing set up for vertical configuration. Units shall be rated and tested in accordance with ARI standard 210. Units shall be UL listed and labeled in accordance with UL 1995 for indoor blower coil units.

2. Casing

- a. Unit casing shall be constructed of zinc coated, heavy gauge, galvanized steel. Exterior surfaces shall be cleaned, phosphatized and finished with a weather-resistant baked enamel finish. Casing shall be completely insulated with cleanable, foil faced, fire-retardant, permanent, odorless glass fiber material. All insulation edges shall be either captured or sealed. Knockouts shall be provided for unit electrical power and refrigerant piping connections. Captive screws shall be standard on all access panels.

3. Refrigeration System

- a. Each refrigeration circuit is controlled by a factory installed thermal expansion valve.

4. Evaporator Coil

- a. Configured aluminum fin surface shall be mechanically bonded to 3/8" internally enhanced copper tubing and factory pressure and leak tested at 375 psig. Coil is arranged for draw-through airflow and shall provide a double sloped condensate drain pan constructed of PVC plastic. The drain pan shall be removable for cleaning. The condensate drain pan shall be installed in a position to operate as a horizontal flow configuration with external connections on either side on the unit.

5. Evaporator Fan

- a. Single inlet, single width, forward curved, centrifugal-type fan(s) with adjustable belt drive shall be standard. Thermal overload protection shall be standard on motor. Fan and motor bearings shall be permanently lubricated. Oversize motors shall be available as an option for high static application.

6. Controls

- a. Magnetic evaporator fan contactor, low voltage terminal strip, check valve(s), and single point power entry shall be included. All necessary controls shall be factory-installed and wired. Evaporator defrost

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control shall be included to prevent compressor operation when low evaporator coil temperatures are encountered.

7. Filters
 - a. Filters shall be accessible from the side coil access panel. Two inch, throw-away filters shall be included with unit.
8. Electric Heaters
 - a. UL approved electric heat modules shall be installed directly on fan discharge. Electric Heaters shall have two stage control, single-point electric power connection. Electric heater elements shall be constructed of heavy-duty nickel chromium elements internally wye connected on 480 volt, three phase. Each 480 volt heater shall have automatic line break high limit controls.
9. Mounting Subbase
 - a. Shall be provided and installed. Subbase shall be constructed of heavy gauge, zinc coated galvanized steel with baked enamel finish to match air handler unit.
10. Vibration Isolators
 - a. Shall be provided and installed to reduce transmission of noise and vibration to building structures, equipment and adjacent spaces, and shall be neoprene-in shear types for floor mounting.
11. VVT Zone & Bypass Dampers: Each damper shall include
 - a. A motorized damper assembly constructed of minimum 24 gage galvanized iron with blade of 20 gage.
 - b. Blade operation to provide full modulation from open to close.
 - c. The ability to operate the zone dampers in master / slave arrangement, where the master damper is controlled by the zone controller.
 - d. Dampers to have fully sealed edges.
 - e. A duct temperature sensor shall be integral to the damper assembly.
12. Packaged VVT Control system shall be provided to include a monitoring thermostat, bypass controller and zone controllers. The electronic monitoring thermostat shall have the following features:
 - a. Heat/cooling controls
 - b. Day/night temperature settings and quick change provision
 - c. Automatic heat/cool changeover
 - d. Remote indoor and outdoor temperature and occupancy sensors
 - e. Programmable weekly cycle

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13. Economizer Section shall be a three-damper; air handler accessory package. This unit shall be supplied with it's own control system which is designed to fully integrate with the heat pump's control system. The economizer controls shall modulate the outside air intake damper, the relief air damper and the return air damper between minimum and full 100% outside air to make the maximum utilization of outside air in the control of the building's environment. The submittal shall include, but not be limited to, a full description of operation and heat pump compliant controls integration.
14. Approved manufacturers:
 - a. Heat pump
 - Carrier
 - Lenox
 - Trane
 - b. VVT Controls
 - Carrier
 - Titus
 - Trane

2.2 ELECTRIC RADIANT HEATERS (ERH)

- A. Radiant heaters shall be electric with a purpose 90-degree asymmetric heating pattern.
- B. The heater shall be designed with heavy duty metal sheathed elements resistant to impact and vibration. Heaters shall have corrosion resistant 0.040 gold anodized aluminum reflector housing.
- C. Radiant heaters shall be factory wired with high temperature silicone wire. Controls shall be wired to contactor which energizes the heater in response to a thermostat.
- D. Approved manufacturers:
 - Fostoria
 - Markel
 - Q Mark

2.3 ELECTRIC UNIT HEATERS (UH)

- A. Electric unit heaters shall be sized as shown on the Drawings. Heaters shall be provided with an industrial rated, totally enclosed, permanently lubricated motor, with thermal overload, a high mass, all steel spiral finned tubular heating element, an automatic reset thermal cut-out that disconnects elements and motor in the event normal operating temperatures are exceeded. Where unit mounted

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thermostats are indicated on the Drawings, heaters shall be provided with a heavy duty thermostat that is built-in with a range of 35 degrees to 85 degrees F, removable knob for tamperproof operation, and a heavy gage die formed steel casing with a corrosion resistant coating. Heaters shall be UL listed. Heaters shall be sized as shown on the Drawings.

B. Approved manufacturers:

Markel
Berko
Q Mark

2.4 WALL MOUNTED THERMOSTATS FOR HEATING ONLY APPLICATION

A. Provide low voltage thermostat. Thermostats shall be UL Listed, have SPDT switches, metal housing, setpoint adjustment, knockouts for rigid conduit, built in thermometer and have engraved legend plate indicating the heaters controlled. Control transformer and fuses shall be provided in a unit heater

B. Approved manufacturers:

Honeywell
Fostoria
Markel
Q-Mark
Berko

PART 3 EXECUTION

3.1 HEAT PUMP INSTALLATION

- A. Heat pump installation shall be in strict accordance with the manufacturer's requirements. Units shall be vibration isolated using either a spring damper system or neoprene vibration isolators. Units shall be installed and be supported and braced as required or as detailed to be level and aligned. All components shall be mounted on equipment pads (inside and outdoor units).
- B. Accessories such as valves, disconnects, unions, etc., shall be installed so as to be accessible for operation and servicing.
- C. Condensate drain lines shall be 3/4 inch minimum and horizontal piping shall be pitched towards its drain point at 1/8 inch per foot. Condensate drain piping shall be trapped at the unit except as noted on the Drawings, with a deep seal trap of at least 4 inches from the drain pan invert to the trap invert. Extend all condensate drain lines to floor drains or other drain lines designated on the Drawings.
- D. Provide electrical disconnects as required by the NEC.

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3.2 TESTING

- A. Subsequent to installation, the Contractor shall perform functional tests and start-up for a minimum period of 3 days with various thermostat settings to assure proper operation over the full design range.
- B. The testing and start-up shall be done by authorized manufacturer's representative or direct employee. Written reports of this testing and start-up shall be supplied to the Engineer.
- C. The Contractor shall supply and furnish all equipment, materials, and labor to perform test.
- D. Should adjustment, testing, repair or replacement of the heat pump be required to satisfy the requirements of these Specifications, the Contractor shall provide such work and materials necessary to ensure compliance with the Contract Documents and manufacturer's performance standards, at no additional cost to Owner

3.3 ADJUST AND CLEAN

- A. Adjust and lubricate moving parts for smooth, quiet operation. As work progresses, remove the crating and packing materials from the premises.

PART 4 WARRANTIES

4.1 GENERAL

- A. The HVAC equipment shall be warranted for labor, equipment and all components for a 1-year period after final acceptance.

END OF SECTION

SECTION 15750

HEAT TRANSFER EQUIPMENT

PART 1 GENERAL

1.1 WORK INCLUDES

A. Base Bid:

1. Contractor shall provide all items specified herein and shown on the drawings, including but not limited to:
 - a. Air Cooled Chiller
 - b. Fluid Cooler
 - c. Plate & Frame Heat Exchanger
 - d. Installation

B. Related work specified elsewhere:

1. 15050: Basic Mechanical Materials and Methods
2. 15060: Pipes and Fittings
3. 15100: Valves
4. 15120: Piping Specialties
5. 15140: Pumps
6. 15250: Pipe and Duct Insulation

1.2 CODES, FEES AND PERMITS

A. All work and installations of this Section shall comply with the recommended practices of the following:

1. SMACNA
2. ASHRAE
3. ASME Boiler & Pressure Vessel Code
4. National Fire Prevention Association
5. International Mechanical Code

B. All necessary fees and permits required for the work of this Section shall be obtained and paid for by this Contractor.

C. Should there be found a discrepancy between the Drawings and Specifications and/or any code, rule or regulation during the bidding period, it shall be brought to the attention of the Architect/Engineer to be resolved prior to bid opening.

D. Should there be found a discrepancy between the Drawings and Specifications and/or any code, rule or regulation during the construction period, it shall be brought to the attention of the Architect/Engineer to be resolved prior to proceeding with the work.

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- E. Fan coils and blower coils shall be tested in accordance with ARI 430 and ARI 260. The units shall comply with NFPA 90A and be UL listed.

1.3 SUBMITTALS

- A. Submit in accordance with DIVISION 1.
- B. Shop Drawings:
 - 1. Contain equipment dimensions and show all required factory and external piping connections, accessories required and full equipment ratings and capacities and performance characteristics.
 - 2. Submit manufacturer's recommendations and installation instructions.
- C. Operation and Maintenance Manuals:
 - 1. Provide operation and maintenance manuals.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver and store products in factory wrapped packages which properly protect same against weather, damage and dirt.
- B. Handle all products and equipment to avoid crushing, bending or damage to components or finishes.
- C. Where possible, store inside or when necessary to store outside, store above grade and enclose in waterproof breathable wrapping.
- D. Do not install any damaged units. Replace and return damaged units to manufacturer.

1.5 QUALITY ASSURANCE

- A. Chiller:
 - 1. Unit shall be rated in accordance with ARI Standard 550/590-98 (U.S.A.).
 - 2. Unit construction shall be designed to conform to ASHRAE 15 latest revision safety standard, NEC (U.S.A.), and ASME (U.S.A.) applicable codes.
 - 3. Unit shall have UL (U.S.A.) or CSA (Canada) approvals (60 Hz).
 - 4. Unit shall be manufactured in a facility registered to ISO 9001:2000 (International Standards Organization) manufacturing quality standard.
 - 5. Unit operation shall be fully tested at the factory.

PART 2 PRODUCTS

2.1 AIR COOLED CHILLER

- A. General: Factory assembled, single-piece or factory-matched duplex chassis, air-cooled liquid chiller. Contained within the unit cabinet shall be all factory wiring, piping, controls, refrigerant charge (R-410A), and special features required prior to field start-up.

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B. Unit Cabinet:

1. Frame shall be of heavy-gage, painted galvanized steel.
2. Cabinet shall be galvanized steel casing with a baked enamel powder or pre-painted finish.
3. Cabinet shall be capable of withstanding 500-hour salt spray test in accordance with the ASTM (U.S.A.) B-117 standard.

C. Fans:

1. Condenser fans shall be direct-driven, airfoil cross-section, shrouded-axial type, and shall be statically and dynamically balanced with inherent corrosion resistance.
2. Air shall be discharged vertically upward.
3. Fans shall be protected by coated steel wire safety guards.

D. Compressor/Compressor Assembly:

1. Fully hermetic scroll type compressors.
2. Direct drive, 3500 rpm (60 Hz), protected by motor temperature sensors, suction gas cooled motor.
3. External vibration isolation rubber-in-shear.
4. Each compressor shall be equipped with crankcase heaters to minimize oil dilution.

E. Cooler:

1. Shell-and-tube type, direct expansion.
2. Tubes shall be internally enhanced seamless-copper type rolled into tube sheets.
3. Shell shall be insulated with 3/4-in. foam (closed-cell) with a maximum K factor of 0.28.
4. Design shall incorporate a minimum of 2 independent direct-expansion refrigerant circuits.
5. Cooler shall be tested and stamped in accordance with ASME Code for a refrigerant working side pressure of 445 psig. Cooler shall have a maximum fluid-side pressure of 300 psig.

F. Condenser:

1. Coil shall be air-cooled with integral subcooler, and shall be constructed of aluminum fins mechanically bonded to seamless copper tubes.
2. Tubes shall be cleaned, dehydrated, and sealed.
3. Assembled condenser coils shall be leak tested and pressure tested at 656 psig.

G. Refrigeration Components: Refrigerant circuit components shall include replaceable-core filter drier, moisture indicating sight glass, electronic expansion device, discharge service valve and liquid line service valves, and complete operating charge of both refrigerant R-410A and compressor oil.

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H. Controls, Safeties, and Diagnostics:

1. Unit controls shall include the following minimum components:
 - a. Microprocessor with non-volatile memory. Battery backup system shall not be accepted.
 - b. Separate terminal block for power and controls.
 - c. Control transformer to serve all controllers, relays, and control components.
 - d. ON/OFF control switch.
 - e. Replaceable solid-state controllers.
 - f. Pressure sensors installed to measure suction and discharge pressure. Thermistors installed to measure cooler entering and leaving fluid temperatures.
2. Unit controls shall include the following functions.
 - a. Automatic circuit lead/lag.
 - b. Capacity control based on leaving chilled fluid temperature and compensated by rate of change of return-fluid temperature with temperature set point accuracy to 0.1° F.
 - c. Limiting the chilled fluid temperature pull-down rate at start-up to an adjustable range of 0.2° F to 2° F per minute to prevent excessive demand spikes at start-up.
 - d. Seven-day time schedule.
 - e. Leaving chilled fluid temperature reset from return fluid.
 - f. Chilled water pump start/stop control and primary/standby sequencing to ensure equal pump run time.
 - g. Timed maintenance scheduling to signal maintenance activities for pumps, strainer maintenance and user-defined maintenance activities.
 - h. Low ambient protection to energize cooler and hydronic system heaters.
3. Diagnostics:
 - a. The control panel shall include, as standard, a Scrolling Marquee display capable of indicating the safety lockout condition by displaying a code for which an explanation may be scrolled at the display.
 - b. Information included for display shall be:
 - 1) Compressor lockout.
 - 2) Loss of charge.
 - 3) Low fluid flow.
 - 4) Cooler freeze protection.
 - 5) Thermistor or transducer malfunction.
 - 6) Entering and leaving-fluid temperature.
 - 7) Evaporator and condenser pressure.

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- 8) Time of day:
 - a) Display module, in conjunction with the microprocessor, must also be capable of displaying the output (results) of a service test. Service test shall verify operation of every switch, thermistor, fan, and compressor before chiller is started.
 - b) Diagnostics shall include the ability to review a list of the 30 most recent alarms with clear language descriptions of the alarm event. Display of alarm codes without the ability for clear language descriptions shall be prohibited.
 - c) An alarm history buffer shall allow the user to store no less than 30 alarm events with clear language descriptions, time and date stamp event entry.
 - d) The chiller controller shall include the ability to access all chiller control functions from any point on the chiller.
 - e) The control system shall allow software upgrade without the need for new hardware modules.
 - f) The control system shall provide Modbus Communications.

- 9) Crankcase heater failure.

4. Safeties:

- a. Unit shall be equipped with thermistors and all necessary components in conjunction with the control system to provide the unit with the following protections:
 - 1) Loss of refrigerant charge.
 - 2) Reverse rotation.
 - 3) Low chilled fluid temperature.
 - 4) Thermal overload.
 - 5) High pressure.
 - 6) Electrical overload.
 - 7) Loss of phase.
- b. Condenser fan motor shall have external overcurrent protection.

I. Operating Characteristics:

1. Unit shall be capable of starting and running at outdoor ambient temperatures from -20°F to 125°F with factory installed head pressure and/or fan cycling controllers, as required.
2. Unit shall be capable of starting up with 95°F entering fluid temperature to the cooler.

- J. Motors: Condenser-fan motors shall be totally enclosed single speed, 3-phase type with permanently lubricated bearings and Class F insulation.

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K. Electrical Requirements:

1. Unit/module primary electrical power supply shall enter the unit at a single location.
2. Primary electrical power supply shall be rated to operate up to 125°F ambient temperature.
3. Unit shall operate on 3-phase power at the voltage shown in the equipment schedule.
4. Control points shall be accessed through terminal block.
5. Unit shall be shipped with factory control and power wiring installed.

L. Special Features:

1. Unit-Mounted Non-Fused Disconnect: Unit shall be supplied with factory-installed, non-fused electrical disconnect for main power supply.
2. Medium Temperature Brine: Unit shall be factory modified to start and operate at leaving chilled fluid temperatures between 15°F and 39°F.
3. Minimum Load Control: Unit shall be equipped with factory installed, microprocessor-controlled, minimum-load control that shall permit unit operation down to a minimum of 15% capacity.
4. Coil Covers and Security Grilles: Unit shall be supplied with field-installed coil covers and PVC-coated grilles to protect the condenser coil and internal chiller components from physical damage.
5. Removable Core Filter Drier: Unit shall be equipped with a removable core filter drier.
6. Compressor Suction Service Valve: Standard refrigerant discharge isolation and liquid valves enable service personnel to store the refrigerant charge in the cooler or condenser during servicing. This factory-installed option allows for further isolation of the compressor from the cooler vessel.
7. Suction Line Insulation: Insulation is tubular closed-cell insulation.
8. Freeze Protection Cooler Heaters: Cooler heaters shall provide protection from cooler freeze-up to -20°F.
9. Factory-installed convenience outlet including GFI (Ground Fault Interrupt) receptacle with independent fuse protection.
10. Power factor correction capacitors.

M. Acceptable Manufacturers:

1. Carrier
2. Trane
3. McQuay

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2.2 FLUID COOLER

- A. Fluid cooler shall be as scheduled on the drawings and be equal to Exact Exchangers, Inc. (800-443-9228) Model HL/FLD-1213 containing twelve 1.5hp fans, 460 volt, 3 phase. The unit shall have copper tubes with aluminum fins.
- B. The fluid cooler shall be equipped with a unit mounted control panel that will automatically cycle fans to maintain a constant discharge temperature.
- C. ON-OFF control by a field connected control relay.

2.3 DOUBLE WALL PLATE AND FRAME HEAT EXCHANGERS

- A. Design:
 - 1. Units shall be single pass.
 - 2. All connections shall be located on the fixed head, frame plate, allowing the movable head, pressure plate, to slide back permitting plates to be added, removed, or replaced from the plate pack without disturbing the connections or associated piping.
 - 3. The design shall permit the removal of interior plates without requiring the removal of preceding or subsequent plates.
 - 4. The unit shall be ASME Code stamped.
 - 5. Both heat exchangers specified for this project, shall have the identical frames, plates and gaskets, such that they are interchangeable. The differences shall be in the number of plates and the length of the rods.
 - 6. The fluid on the process sides of these heat exchangers consists of a mixture of well water and reuse water from the incubation racks. Appropriate fouling factors shall be used for this mixture when determining the required number of plates for each unit.
- B. Frame:
 - 1. The frame plate and pressure plate shall be carbon steel SA 516 grade 70.
 - 2. The frame and pressure plate shall be of sufficient thickness to meet the ASME design pressure. Stiffeners or support brackets are not permissible.
 - 3. Carbon steel frame components shall be painted with gray epoxy paint.
 - 4. Units shall have carbon steel female tapped NPT connections.
 - 5. The carry bar (top bar) and guide bar (bottom bar) plate contact surfaces shall be stainless steel.
 - 6. The design shall allow the plates to be supported by the guide bar and the carry bar shall help properly align the plates. Carry and guide bars shall be steel with a zinc chromate coating.
- C. Tightening Bolts:
 - 1. Tightening bolts shall be zinc plated carbon steel SA 193 B7.

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2. The tightening bolt assemblies shall include captive working nuts at the pressure plate, rear head, such that the unit can be opened and closed with one wrench from the front of the unit.

D. Plates:

1. Double wall heat exchanger plates shall provide a vented air space for positive indication of potential cross-contamination.
2. Plates shall be pressed in a one step stamping process.
3. Plates shall use an integral rolled edge hanging system to provide a rigid hanger device between the plate and carry bar and guide bar. Welded on hanging brackets or stiffeners are not permissible.
4. The plate pack shall use a positive plate to plate alignment system to ensure proper plate to gasket seals throughout the plate pack. The positive alignment system shall either be a gasket lug which fits within a plate recess on the preceding plate (tongue in groove) to align successive plates or an extended rolled edge hanger which nests successive plates through direct contact around the entire plate hanger. Plate designs, which only offer alignment through contact with the carry and guide bar are not permissible.
5. Plates shall be permanently marked to indicate plate material and thickness.

E. Gaskets:

1. All gaskets except the gasket on the first plate shall be identical.
2. The gaskets shall be a one-piece construction with a double gasket barrier at the port region. The area isolated by the double gasket shall be vented to the atmosphere, so that a gasket failure can be detected by leakage to the exterior prior to any possible cross contamination.
3. When available, glue-free gaskets shall be provided. If not available, provide glued-on gaskets. Gasket attachment methods, which break during gasket removal or plate maintenance, thus destroying the gasket are not acceptable.

F. Materials of Construction:

1. Plate material shall be 0.0138" thick, double wall, AISI 316 stainless steel.
2. Gasket material shall be Nitrile.

G. Manufacturers:

1. ITT Bell & Gossett
2. Sondex
3. Mueller
4. Alfa Laval.

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PART 3 EXECUTION

3.1 EQUIPMENT INSTALLATION

- A. All equipment shall be installed as shown on Drawings and as recommended by equipment manufacturer.

3.2 INSTALLATION - AIR COOLED CHILLER

A. General

1. Installation shall be in accordance with manufacturer's installation instructions.
2. Inspect chiller for damage prior to installation. Replace any units that are damaged.
3. Check the unit nameplate and verify that unit voltage matches that specified.
4. Installation is to be performed by qualified personnel who are familiar with local codes and regulations, especially concerning refrigerant release to the atmosphere.
5. Be careful to avoid rough handling of the unit. Do not push or pull the unit from anything other than the base. Block the pushing vehicle away from the unit to prevent damage to the sheet-metal cabinet and end frame.
6. To lift the unit, lifting slots are provided in the base of the unit. Arrange spreader bars and cables to prevent damage to the condenser coils or cabinet.
7. Construct equipment base as noted on the drawings. Equipment base shall be level to within 1/2" over its length and width.
8. Verify the unit's refrigerant charge is in place.

B. Location

1. Coordinate unit location such that all areas are accessible for maintenance.
2. Provide at least 36" clear in front of all electrical cabinets on unit.
3. Allow manufacturer's recommended clearances, as a minimum, from obstructions. Clearances are required for both airflow and maintenance, including component removal.

C. Sound transmission

1. Provide flexible pipe connections between chiller and wall penetrations to minimize transmission of noise into wall.
2. Use flexible electrical conduit to isolate sound to unit.

D. Water Piping Connection

1. Connect chilled water piping to unit as shown on drawings.
2. Install piping with minimum bends and changes in elevation to minimize pressure drop. Provide air vent valves at the high points of the system and drain valves at the low points of the system.

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3. Install strainer in water inlet piping. Size strainer in accordance with manufacturer's instructions.
 4. Install thermometers and pressure gauges where shown on the drawings.
 5. Following piping installation, perform a preliminary leak check of piping, prior to insulating it. After obtaining a satisfactory leak check, insulate piping as specified.
- E. Insulation of piping shall include that water piping within the chiller that is not factory insulated.
1. Support water piping independent of the chiller.
 2. Mount water flow switch in the leaving water line to shut down the unit when water flow is interrupted. Follow installation instructions provided with the flow switch. Calibrate the switch to open at one-half of its nominal flow rate.
- F. Electrical Power
1. Provide electrical power connection to unit.
 2. Wiring shall comply with all applicable codes and ordinances and specifications.
 3. Provide time-delay fuses, sized in accordance with manufacturer's instructions.
- G. Pre-Start Up
1. Flush and clean the chilled water system.
 2. Open all electrical disconnects and check all electric connections for tightness.
 3. Inspect all water piping for flow direction and correct connections at the evaporator.
 4. Verify thermostat water temperature sensor is installed in the leaving water line.
 5. Check compressor oil level.
 6. Check voltage of the unit power supply. Check for proper phasing.
 7. Energize crankcase heaters for the manufacturer recommended length of time prior to unit startup.
 8. Open all water flow valves and start the chilled water pump. Check all piping for leaks and vent the air from the evaporator and the system piping. Flush the evaporator and system piping.
- H. Startup
1. Set temperature controller to the desired chilled water temperature. Set the chilled water delta-T.
 2. Start chilled water pump.
 3. Set the controller to call for cooling. The unit should begin its startup sequence.
 4. After running the unit for a short time, check the oil level in the compressor, rotation of fans and flashing in the refrigerant sight glass.

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3.3 ON-SITE TRAINING

- A. Provide one (1) four hour training session for owner's representatives on chiller. Training shall include normal operation, maintenance and troubleshooting of the chiller, including controls operation.
- B. Provide 72 hour notice to owner's representative of training session.

END OF SECTION

SECTION 15870

BUILDING AIR HANDLING AND VENTILATION

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Work includes furnishing all labor, materials and equipment required to complete the work of the noted Sections of this Division specified herein and as shown on the drawings.

1.2 WORK INCLUDED

- A. The work shall include, but is not necessarily limited to, the furnishing, installing and connection of exhaust fans, heat recovery fans, ductwork, fresh air intake louvers, and fresh air intake dampers for mounting at the locations shown on the drawings.

1.3 SUBMITTALS

- A. Submit shop drawings and the manufacturer's descriptive literature on all equipment listed in this specification in accordance with SECTION 01340 prior to the product installations and associated fabrications. Descriptive literature shall include capacity curves, fan drive information (direct or belt), materials of construction, motor voltage, phase, service factor, dimensional drawings and required appurtenances for installation. Shop drawings shall include all dimensional data required for installation.
- B. Submit maintenance and operating instructions in accordance with SECTION 01730.

1.4 QUALITY ASSURANCE

- A. Reference Standards: Except as modified by governing codes and by the Contract, comply with the applicable provisions and recommendations of the following:
 - 1. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE).
 - 2. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA).

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3. National Fire Protection Association (NFPA).
4. International Mechanical Code (IMC).
5. Underwriters Laboratories (UL)
6. Air Movement and Control Association (AMCA)

PART 2 PRODUCTS

2.1 WALL-MOUNTED PROPELLER-TYPE EXHAUST FANS:

- A. AMCA certified.
- B. Industrial quality.
- C. Materials:
 1. Propeller: Cast aluminum or aluminum.
 2. Venturi: Spun aluminum.
 3. Panel and supports: Aluminum or stainless steel.
 4. Drive shaft: Solid stainless steel.
 5. Sheaves: Cast iron.
- D. Propellers:
 1. Statically and dynamically balanced.
 2. Airfoil design.
 3. Minimum four blades.
- E. Sealed pillow block bearings.
- F. Welded reinforced motor base plate.
- G. Adjustable motor base.
- H. Motor: See SECTION 16050.
 1. Driver and driven sheaves:

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- a. Keyed hub type.
 2. Drive sheaves: Fixed pitch diameter.
 3. Driver:
 - a. Shipped with variable pitch diameter sheave.
 - b. Fixed pitch diameter size based on approved test and balance reports.
 4. V-belt drives sized for 150 percent motor horsepower.
- I. Accessories:
1. Inlet guard.
 2. Outlet guard.
 3. Heavy-duty automatic shutter.
 4. Mounting adapter.
 5. Bird screen.
- J. Size and capacity as scheduled on Drawings.
- K. Approved Manufacturers
1. Greenheck
 2. Loren Cook
 3. Penn

2.2 HEAT RECOVERY FANS - PROPELLER TYPE

- A. Fans shall be of anodized aluminum or steel construction and epoxy coating. Fan blades shall be bolted into place onto the motor housing. All parts shall be covered by an epoxy finish.
- B. Motors shall be of a capacitor type with a cold drawn 7/8-inch diameter shaft and permanently sealed chrome steel ball bearings.
- C. The fan motor shall have an integral, automatic reset thermal protector and variable speed control capabilities. The fan motor shall be contained within a split casing.

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- D. All components shall be enclosed.
- E. The fan, motor, and control assembly shall be listed by Underwriters Laboratories.
- F. Provide variable speed controller from the same manufacturer as the fan.
- G. Provide fans of sizes and numbers as shown on the Drawings.
- H. Manufacturers and models:

Dayton
Leading Edge, Inc. Leading Edge Series
Vent Products 1770

2.3 CENTRIFUGAL FANS:

- A. Non-overloading horsepower capability.
- B. Single-inlet, single-width, or double-inlet, double-width.
- C. Materials:
 - 1. Wheel and blades: Aluminum or stainless steel.
 - 2. Housing and inlet bell: Aluminum or stainless steel.
 - 3. Drive shaft: Solid stainless steel.
 - 4. Wheel hub: Cast iron.
- D. Backwardly curved, single-thickness airfoil section blades.
- E. Wheels:
 - 1. Statically and dynamically balanced.
 - 2. Wheel hub riveted to backplate.
 - 3. Blades welded to wheel hub and riveted or welded to backplate.
 - 4. Attached to shaft with keys and set screws
- F. Die-formed inlet bell.

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- G. Continuously welded housing.
- H. Bearings:
 - 1. Self-aligning, grease-lubricated heavy pillow block-type.
 - 2. Located outside of airstream.
 - 3. 150,000 HR average life.
- I. Motor: See SECTION 16050.
- J. Driver and driven sheaves:
 - 1. Keyed hub type.
 - 2. Drive sheaves: Fixed pitch diameter.
- K. Driver:
 - 1. Shipped with variable pitch diameter sheave.
 - 2. Fixed pitch diameter size based on approved test and balance reports.
 - 3. V-belt drives sized for 150 percent motor horsepower.
- L. Flanged inlet and outlet.
- M. Structural steel subbase.
- N. Accessories:
 - 1. Access doors - as standard with manufacturer.
 - 2. Vibration isolators - as standard with manufacturer.
- O. Size and capacity as scheduled on Drawings.
- P. Approved Manufacturers
 - 1. Greenheck
 - 2. Loren Cook
 - 3. Penn

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2.4 UNIT HEATER - ELECTRIC:

- A. Type: Vertical.
- B. UL listed for non-rated areas.
- C. Material:
 - 1. Cabinet: 18 GA steel.
 - 2. Heating elements: Copper-clad steel.
- D. Fan motors:
 - 1. See SECTION 16050.
 - 2. Built-in automatic reset overload protection.
- E. Dynamically balanced fan.
- F. Built-in automatic reset cutout protection.
- G. Accessories:
 - 1. Mounting bracket.
 - 2. 40 to 90 DegF, 5 DegF differential internal thermostat.
- H. Electrical, fan motor, and airflow data as scheduled on Drawings.
- I. Approved Manufacturers
 - 1. Markel
 - 2. Q-Mark
 - 3. Trane

2.5 GALVANIZED SHEET METAL DUCTWORK

- A. Unless shown otherwise on the Drawings, all sheet metal ducts shall be designed, constructed of galvanized steel, and installed in accordance with the recommendations of the Sheet Metal and Air Conditioning Contractor's National Association (SMACNA) publication's latest edition to be vibration and noise free.

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- B. Rectangular and Round Rigid Ductwork:
1. All ductwork shall be constructed and erected in a workmanlike manner. Ducts shall be straight and smooth on the inside with neatly finished joints, air tight, and shall be free from vibration under all conditions in direction of airflow. Ducts shall be securely attached to building construction in an approved manner. Change in dimensions and shape of ducts shall be gradual. All duct sizes fall within limiting dimensions indicated on drawings, unless otherwise approved.

- C. The following gauges of iron shall be used for low pressure galvanized ducts, risers, and vents, except as otherwise specified.

<u>Round Ducts</u>	<u>Gauge</u>	<u>Rectangular Ducts</u>	<u>Gauge</u>
6 to 12 inch dia.	No. 26	Up to 12 inches wide	No. 26
13 to 23 inch dia.	No. 24	13 to 30 inches wide	No. 24
24 to 36 inch dia.	No. 22	31 to 54 inches wide	No 22

- D. Provide all necessary supports and hangers according to standard trade practice.
- E. All 90° rectangular elbows up to 18" wide and all 45° elbows shall consist of an inside radius of not less than one-half the width of the duct, or shall be furnished with single blade duct vanes with 2-1/4" blade spacing. 90° elbows larger than 18" shall be equipped with air foil type duct vanes having an inside radius of 4-1/2", and an outside radius of 2-1/4", and shall be Tuttle & Bailey Type D, Elgen Manufacturing Corp., Vane Runners, or approved equal.
- F. Curved elbows in round ducts shall have a minimum center line radius equal to 1-1/2 times the duct width. Square elbows shall have turning vanes similar to Tuttle-Bailey Ducturn. Job fabricated turning vanes will not be accepted without prior approval.
- G. Furnish and install sound isolating flexible connections on the inlet and outlet of each fan and unit to which duct connectors are made. Flexible connections shall be made from Ventglas, neoprene coated glass fabric. At least 1" slack shall be allowed in these connections to insure that no vibration is transmitted from fan to ductwork. Fabric shall either be folded in with the metal or attached with metal collar frames at each end to prevent air leakage.
- H. Joints and openings in ducts and around equipment with excessive leakage shall be sealed airtight.
- I. All exposed ducts with a maximum width and/or depth of 24" shall have flat seams.

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- J. Wherever exposed ducts pass through walls, floors, or ceilings, a 2" sheet metal collar fitting close around ducts shall be slipped along duct until flange is tight against finished surface covering edges of openings and presenting a neat appearance. Lock collar to duct.
- K. Opposed blade type volume dampers shall be installed where called for on drawings or otherwise necessary for proper balancing. Dampers to have felt or neoprene edges, and shall be gasketed around inside of frame for tight fit.
- L. Dampers with a shaft length of 12" or less shall be equipped with Ventlok No. 635 or approved equal 3/8" dial regulators and No. 607 end bearings.
- M. Larger dampers shall be controlled with Ventlok or approved equal self-locking regulators No. 640 or No. 641 in 3/8" or 1/2" size, and shall be installed with No. 607 end bearings.
- N. Duct hardware for Concealed Manual Dampers: Concealed ceiling dampers shall be operated by means of Ventlok No. 666 concealed damper regulators or No. 677 concealed damper regulators. Where ceiling regulators must be flush mounted, Ventlok No. 688 exposed damper regulators shall be used.
- O. At all places where inside of duct will be visible through return air grille louvers, etc., paint normally visible inside portion of duct with flat black paint.
- P. Install hinged doors on ductwork and housing to provide access to all parts of every automatic damper, fire damper and all other items requiring maintenance or inspection. Access doors shall be 13" x 12" if permitted by duct size, and if not, shall be as large as possible. All access panels shall be at least two gauges heavier than the surface in which placed and shall have sponge rubber gaskets cemented in place.
- Q. Where insulation is expressly indicated, insulation shall be installed per SECTION 15250.
- R. Approved manufacturers:
 - Gensco
 - Jones & Laughlin
 - United McGill
 - U.S. Steel
 - Wheeling-Pittsburg

2.6 ROUND FLEXIBLE DUCTWORK (INSULATED, LOW PRESSURE)

- A. Approved manufacturers: Genflex other approved manufacturers are Clevaflex, Flex-Master, Hercules, Therma-Flex, Wiremold, or approved equal.

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- B. Insulated, low-pressure, flexible duct system shall be a factory-fabricated assembly consisting of a zinc-coated spring steel helix. Flex duct and insulation shall be sheathed in a vapor barrier jacket (Refer to SECTION 15250 for specific duct insulation requirements). Inner liner shall be of continuous, non-perforated aluminum copolymer forming a positive inner air seal, such that if the outer vapor barrier is punctured, no air will be lost. The composite assembly, including insulation and vapor barrier, shall meet the Class 1 requirement of NFPA Bulletin No. 9A, and be labeled by Underwriters' Laboratories, Inc., with a flame-spread rating of 25 or less, and a smoke developed rating of 50 or under.
- C. Duct system shall include a Model CB coupling as an integral part of one end, factory installed for quick connection to an air outlet device. Opposite end shall have a "spin in" fitting, Model SM-1C, 1-1/2 to 1 bell mouth fitting where non-removable ceilings occur, and SM-1D, 1-1/2 to 1 bell mouth fitting with damper where "lift-out" ceilings occur.
- D. Flexible ducts shall be installed in a fully extended condition, free of sags and kinks, using only the minimum length required to make the connection. Maximum length to be 10'-0" and no bends greater than 45 degrees are allowed.
- E. Where horizontal support is required, flexible duct shall be suspended on 36-inch centers with a minimum 3/4-inch wide flat banding material. All joints and connections shall be made with 1/2-inch wide, positive-locking, steel straps.
- F. Insulated, low-pressure, flexible duct system Genflex Type SLF-181 or approved equal.
- G. Where "lift-out" ceilings occur, flex duct shall be installed with volume damper in flex duct at connection to main duct, and a distributing grid at the diffuser (omit volume damper at the diffuser).
- H. Where permanent ceilings occur, omit damper in flex duct and provide an opposed blade volume damper at the diffuser.

2.7 FIXED LOUVERS

- A. Refer to SECTION 10200.

2.8 MOTORIZED DAMPERS

- A. Refer to SECTION 10200.

2.9 DAMPER MOTORS (2-POSITION-ELECTRIC)

- A. Refer to SECTION 10200.

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2.10 FIRE DAMPERS

A. Materials:

1. Frame, blades, enclosure: Galvanized steel.

B. Fabrication:

1. Frame: 20 GA, G60.
2. Blades: Curtain type. 24 GA, G60.
3. Enclosure: 20 GA, G60.
4. Fusible link: 212 DegF, UL listed.
5. Fire rating: 1-1/2 HR per UL 555.
6. Mounting: Vertical or horizontal.
7. Design with blade package out of air stream.

C. Basis of Design:

1. Ruskin CFD and FD 35

D. Approved Manufacturers

1. Ruskin
2. Air Balance
3. American Warming

2.11 DIFFUSERS, REGISTERS AND GRILLES

A. See schedules for face size, connection size, material, type, frame type, finish and basis of design..

B. Approved Manufacturers

- a. Titus
- b. Price
- c. Anemostat

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2.12 SILICONE SEALANTS

- A. All locations designated on the Drawings or herein relating to sealant or caulking on ventilation equipment both interior and exterior shall be high-grade silicone sealant.
- B. Sealants shall be one component silicone sealant conforming to federal specification TT-S-0015434-71 (Com-NBS). Passing requirements for 50% plus/minus joint movement.
- C. Manufacturers:

Dow corning	790
Sika	231
3M Corporation	101

PART 3 INSTALLATION

3.1 HEAT RECOVERY FAN (PROPELLER TYPE) INSTALLATION

- A. Fans should be as sized and located on the Drawings.
- B. Fans should be mounted a minimum of 8 inches from ceiling structure with a minimum clearance of 3'-0" on all sides. All fans mounted within 7'-0" of the floor shall have a wire fan-guard installed.
- C. Fans shall be supported from the building ceiling structure or provide additional framing as required to mount where shown on the Drawings. Contractor shall submit for approval his proposed mounting method and details.
- D. Fans shall be wired in accordance with the electrical specifications.
- E. All heat recovery fans shall have individual variable speed controllers. Mount controllers where indicated on the Drawings.
- F. Fans shall be tested at their full range of speeds. All visible imbalances shall be eliminated.

3.2 ALL OTHER BUILDING VENTILATION COMPONENTS

- A. All other components shall be installed in strict accordance with the manufacturer's recommendations or in compliance with the referenced standards.

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PART 4 WARRANTY

4.1 GENERAL

- A. The building air handling and ventilation equipment shall be warranted for labor, equipment and all components for a 1-year period after final acceptance.

END OF SECTION

SECTION 15970

INSTRUMENTATION AND CONTROL FOR HVAC SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Instrumentation and control for HVAC systems.
 - 2. Temperature control.
 - 3. Ventilation control.
 - 4. Control wiring.
 - 5. Panels and accessories.
 - 6. Miscellaneous.
- B. Related Sections include but are not necessarily limited to:
 - 1. Division 1 - General Requirements.
 - 2. Section 15600 - HVAC Equipment.
 - 3. Section 15870 – Building Air Handling.
 - 4. Division 16 - Electrical.

1.2 QUALITY ASSURANCE

- A. See Section 01400.
- B. Referenced Standards:
 - 1. ASTM International (ASTM):
 - a. D1693, Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics.
 - 2. The Instrumentation, Systems, and Automation Society (ISA):
 - a. S5.1, Instrumentation Symbols and Identification.
 - b. S5.4, Standard Instrument Loop Diagrams.
 - 3. Scientific Apparatus Makers Association (SAMA):
 - a. PM C20.1, Process Measurement and Control Terminology.
- C. Miscellaneous:
 - 1. Controls to be in compliance with Section 16010 for NEMA and NEC enclosure class requirements unless noted or specified otherwise.
 - 2. Unless specifically noted otherwise, components of systems shall be industrial duty suitable for moist, corrosive environments.
 - 3. Express control device performance requirements in terminology in accordance with SAMA PM C20.1. Process measurement and control terminology.

1.3 SYSTEM DESCRIPTION

- A. Work shall be provided as an integrated operating system.

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- B. Provide a complete system of automatic temperature control, thermostats, relays, valves, damper operators and other associated controls and appurtenances required to maintain minimum conditions described in detail herein and on Drawings, together with thermometers, gages and other accessory equipment.
 - 1. Assemble control system with complete system of wiring to fulfill requirements of the Contract Documents.
- C. Install system using competent mechanics under direct supervision of control manufacturer.
- D. Controls, as set out in "Sequences of Operation," are designed to illustrate operating functions only.
 - 1. Control sequence shall be considered supplementary to sequence of operation.
 - 2. These minimum specified items, and any additional controls, not indicated but required to meet performance as outlined in the Contract Documents, shall be furnished and installed at no additional cost to Owner to make a complete system.
- E. Sequences of Operation - General:
 - 1. EF-1:
 - a. When space temperature exceeds 75°F (Adjustable) or when relative humidity exceeds 60% (Adjustable) associated intake damper to open. When damper is 100% open, end switches to signal fan to energize. Provide 10 minute delay for shut-down upon reaching temperature and or humidity set points. Upon shutdown, de-energize fan and close damper. Provide manual override to open damper & energize fan and to close damper and de-energize fan.
 - 2. EF-2, 3, 4, & 6
 - a. When space temperature exceeds 75°F (Adjustable) associated shut-off damper to open. When damper is 100% open, end switches to signal fan to energize. Provide 10 minute delay for shut-down upon reaching temperature set point. Upon shutdown, de-energize fan and close damper. Provide manual override to open damper & energize fan and to close damper and de-energize fan.
 - b. Hatchery Garage (Room 120) intake damper be open whenever EF-2 or 4 is energized.
 - 3. EF-5, 8, 9 & 10:
 - a. Provide 10 – 120 minute timer to activate restroom fans.
 - 4. EF-7:
 - a. Provide wall switch to activate fan.
 - b. Normal mode of Fan operation is continuous.
 - c. When the wall switch signals "On", the associated EF-7 shut-off damper to open. When damper is 100% open, end switches to signal fan to energize. Provide 10 minute delay for shut-down upon reaching temperature set point. Upon the wall switch signaling, "Off," de-energize the fan and close the damper.
 - 5. EF-11:
 - a. Electrical Room Fan to energize when space temperature exceeds 75°F (Adjustable).
 - 6. EF-21, 22, 23, 31 & 32:

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- a. When space temperature exceeds 75°F (Adjustable) associated shut-off damper to open. When damper is 100% open, end switches to signal fan to energize. Provide 10 minute delay for shut-down upon reaching temperature set point. Upon shutdown, de-energize fan and close damper. Provide manual override to open damper & energize fan and to close damper and de-energize fan.
7. ERH-1 & 2:
 - a. Independent local control of packaged electric radiant heater by manufacturer. Default temperature settings to be 45°F for heating (adjustable).
8. FCU-1 & CU-1:
 - a. Independent local control of packaged duct-less split system by vendor. Default temperature settings to be 68°F for heating (adjustable) and 72°F for cooling (adjustable).
 - b. Provide packaged VVT control system to operate zone and bypass dampers. Provide manufacturer's zone, bypass and monitor controllers.
9. HRF-1 to 8:
 - a. Provide manufacturer's wall-mounted motor speed controller. Control all fans from one controller.
10. UH-1 to 16 & UH-21 to 25 & UH-31 to 34:
 - a. Provide Independent local control of packaged electric unit heater by integral thermostat. Default temperature settings to be 68°F for heating (adjustable).
11. Generator Dampers Operation (serves Generator / Compressor Room):
 - a. Generator exhaust duct bypass dampers (DMP-1 & 2) default to full open. Upon energizing generator, southwest dormer intake damper (DMP-4) to full open. Generator controls to signal bypass dampers (DMP-1 & 2) to close upon generator reaching design coolant temperature. Upon generator de-energizing, southwest dormer intake damper (DMP-4) to close and generator bypass dampers (DMP-1 & 2) to full open.

1.4 SUBMITTALS

- A. See Section 01340.
- B. Shop Drawings:
 1. Wiring and control diagrams showing point to point termination with auxiliary interlocks for each item in each control loop.
 2. Information on equipment proposed for use including corrosion protection.
- C. Quality Control Submittals:
 1. Secure from equipment manufacturers, detailed and complete control and power wiring diagrams, word descriptions of controls provided as part of the HVAC equipment or equipment interfaced or interlocked thereto, and submit with equipment manufacturer's submittals.
 - a. Provide the above information to control manufacturer.
- D. Operation and Maintenance Manuals:
 1. See Section 01340.

1.5 PROJECT CONDITIONS

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- A. Unless stated otherwise, the environment and air streams will include varying concentrations of the following chemical components:
1. Condensation.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Manufacturer's catalog numbers hereinafter are for reference to type, style, dimension, related items and to establish a standard of quality. Reference to a manufacturer's number hereinafter does not imply full compliance to these Specifications.
 2. Instrumentation and control systems:
 - a. Honeywell
 - b. Johnson Control Co.
 - c. Greenheck for Greenheck HVAC equipment
 - d. Carrier Corporation for Carrier HVAC equipment
 - e. Trane Corporation for Trane HVAC equipment
 - f. Lenox Corporation for Lenox HVAC equipment
 - g. Titus for Titus HVAC equipment
- B. Submit requests for substitution in accordance with Specification Section 01640.

2.2 EQUIPMENT

- A. Dampers:
1. Refer to Section 10200.
- B. Damper Operators:
1. Provide operators of proper size and number to secure true throttling or two-position action as required.
 2. Furnish damper operators for installation inside ductwork and attached to frame of damper, or installed outside ductwork and connected to extended shaft as required.
 3. Provide operators for outside air, spring-loaded with sufficient power to assure tight closing of dampers on fan shutdown or in the fail safe position indicated by "Sequence of Controls."
 4. Provide electric operators with fully immersed in oil gear train, in closed cast aluminum housing.
 - a. Provide damper operators with integral spring return motor springs to make controls fail safe in closed position.
 - b. Provide fully modulating operators from proportional electric controllers.
 - c. Provide end switches or proportioning controllers permitting simultaneous operation or interlocking with other equipment.
 - d. Provide separate electrical circuits for damper operators with no more than four operators on a circuit.

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5. Use of electric operators shall be limited to small dampers in those applications where it is impractical to provide pneumatic operators and are to be approved by the Engineer.
6. Ensure coordination to provide for the installation of tight closing dampers low leakage type (6 cfm per square foot at 4 IN WC pressure across damper) with compatible dampers, damper operators and related controls.

C. Electric Control Instruments:

1. Provide stainless steel sensing elements type thermostats with liquid filled, compensated thermal systems so that equally spaced dial graduations are possible over entire range.
 - a. Make thermal systems field detachable with averaging or plain bulbs as installation conditions dictate.
 - b. Provide sensing elements minimum of 60 IN in length and suitable for operation from -30 to 300 DegF.
 - c. Provide reverse acting on-off type thermostats for controlling ventilating fans.
 - d. Provide multiple stage thermostats where designated in sequence of operation.
2. Provide transformers for supplying current to control equipment operating at less than 120 V and where required by manufacturer's automatic control system design capable of supplying 125 percent of energy requirements of equipment connected for not less than 1 HR.
 - a. Enclose transformers in UL listed cabinets with conduit connections.
 - b. Provide fused disconnect switches on both primary and secondary sides.
 - c. Provide in full compliance with Division 16 Specifications.
3. Provide low limit electric thermostats of two-position type with 20 FT bulb and manual reset. It shall be capable of opening thermostat circuit if any 1 FT section of bulb is subjected to a temperature below thermostat setting.
 - a. For corrosive environments provide thermostats with stainless steel sensing elements. Ensure element is installed to sense coldest point should stratification occur.
4. Provide each thermostat with an accurate red-reading thermometer sensing temperature outside of enclosure.
5. Room humidistats and humidity transmitters shall have elements of plastic membrane or CBA type, as conditions dictate.
 - a. Equip with adjustable sensitivity from 1/4 LB percent to 10 LB/percent.
 - b. Calibrate dials over a 20-percent range.

D. Local Control Panels:

1. Provide local control panels for EF-1, 2, 3, 4 & 6, and EF-21, 22, 23, 31 & 32.
2. Panel shall be wall mounted NEMA 4X sized to accommodate electrical switches and devices to enable the controlled fan to perform it's sequence of operation.
3. Mount all relays and switches on rear inside of enclosure.
 - a. Tag each instrument corresponding to symbols used on control diagrams.
4. Temperatures, pressures, equipment operation, and related items shall be continuously indicated on panels.
5. Provide ON / OFF / AUTO override switch.

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6. Points to be monitored are scheduled under another paragraph of these Specifications.

2.3 FABRICATION

- A. Protect metal parts of controls, instrumentation and related items from corrosive atmosphere by either protective coatings or select materials.
 1. Aluminum and stainless steel require no further protection.
- B. Provide NEMA 4X fiberglass control enclosures with tempered glass windows and vapor tight gaskets, illustrated in Hoffman Bulletin A-50 or approved equal, for protection of controls from corrosive environment.
 1. Install control instruments inside enclosure and extend remote stainless steel sensing elements through enclosure wall.
 2. Provide vaportight seals for penetrations of enclosure.
- C. Provide in each enclosure industrial corrosion inhibitors, Hoffman Corrosion Inhibitors, as illustrated in Hoffman's technical Bulletin HCI or approved equal.
- D. Protect metal accessory items such as mounting brackets and fasteners not stainless steel, fiberglass or aluminum by epoxy or phenolic coatings.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Comply with requirements of Section 16050 and Section 16195.
- B. Identification: See Section 10400.
- C. Connect control devices to perform functions indicated and perform in required sequence.
- D. Use remote element temperature transmitters for points of temperature transmitters for points of temperature measurement occurring in air ducts or shafts, or in mechanical piping system.
- E. Where continuous indication of space temperature is on local control panels, install a thermostat and a temperature transmitter side by side.
 1. Pipe continuous indication signal to a receiver on panel.
 2. A resistance element or thermocouple signal may be used with continuous indicating meter, calibrated in degrees Fahrenheit.
- F. In general, locate thermostats for room control immediately inside door, above light switch, unless shown otherwise.
 1. Where light switch is in an entryway to room, locate thermostat on wall within room so it is capable of sensing true space conditions.
 2. Prior to installation, coordinate thermostat location with Engineer.
 3. Mount thermostats at 48 inches above finished floor.
- G. Mount local control panels adjacent to equipment served.

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- H. Provide appropriate type continuous reading indicator for each controller, transmitter and transducer.
 - 1. Mount in-line or tapped on controller.
 - 2. Mount at local control panel.
- I. Locate panels so visual observation and adjustment can be accomplished from floor level.

END OF SECTION