THE CITY OF MARYSVILLE
MARYSVILLE, CA

<u>ADDENDUM NO. 2</u>

CITY OF MARYSVILLE
17TH STREET PUMP REPAIR PROJECT –
2025 IRWM
CONTRACT NO. 25-01

The purpose of this Addendum No. 2 is to notify Bidders of clarifications to the Project Plans for the above project. This Addendum shall be attached to and become a part of said Contract Documents. **<u>THIS ADDENDUM SHALL BE SIGNED BY THE BIDDER, DATED AND SUBMITTED WITH THE PROPOSAL FOR THE PROJECT.</u>**

<u>Bidder Questions / Clarifications:</u>

1) ***Question:*** *Can you revise Section 35 45 01 with the correct information for the duty points?*

   Response: *Attached is revised section the duty points to use. This is not a sole source bid for a Cascade pump bowl or Flygt Submersible Pump. The bowl can be Cascade or equal and the new pump can be a Flygt Pump or equal.*

2) ***Question:*** *Can you provide more information on the existing Flygt Pump motor?*

   Response: This existing Flygt Motor is 12 HP. The replacement pump will likely need to be 15 HP to meet the required duty points but a 12 HP is preferred if all the duty points can be meet.

Attachments: Revised Specification Section *35 45 01*

BIDDER:

____
NAME

____
ADDRESS
____

____
SIGNATURE

DATE: ____________________

PREPARED BY:

John Mallen
____
CITY OF MARYSVILLE

DATED: May 19, 2025

Bid opening date and time was changed by

Addendum No. 1 to **Thursday, May 15, 2025**

at 2 P.M.

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SECTION 35 45 01

VERTICAL PUMPS, AXIAL-FLOW AND MIXED-FLOW IMPELLER-TYPE
02/16

PART 1 GENERAL

1.1 PRICES

1.1.1 Vertical Pumps, Axial-Flow and Mixed-Flow Impeller-Type

1.1.1.1 Payment

Payment will be made for costs associated with furnishing and installing the vertical pumps, axial-flow and mixed-flow impeller-type, as specified.

1.1.1.2 Unit of Measure

Unit of measure: lump sum.

1.2 REFERENCES

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

AMERICAN PETROLEUM INSTITUTE (API)

API RP 686	(2009) Recommended Practice for Machinery Installation and Installation Design

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C200	(2012) Steel Water Pipe - 6 In. (150 mm) and Larger
AWWA C203	(2008) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C207	(2018) Standard for Steel Pipe Flanges for Waterworks Service, Sizes 4 in. through 144 in. (100 mm through 3600 mm)
AWWA C208	(2017) Dimensions for Fabricated Steel Water Pipe Fittings
AWWA M11	(2016) Steel Pipe: A Guide for Design and Installation

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020) Structural Welding Code - Steel

ASME INTERNATIONAL (ASME)

ASME B16.5	(2017) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B17.1	(1967; R 2017) Keys and Keyseats

ASME B31.1	(2018) Power Piping
ASME B36.10M	(2015; Errata 2016) Welded and Seamless Wrought Steel Pipe
ASME B46.1	(2009) Surface Texture, Surface Roughness, Waviness and Lay
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications

ASTM INTERNATIONAL (ASTM)

ASTM A27/A27M	(2020) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A48/A48M	(2003; R 2016) Standard Specification for Gray Iron Castings
ASTM A108	(2013) Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
ASTM A217/A217M	(2020) Standard Specification for Steel Castings, Martensitic Stainless and Alloy, for Pressure-Containing Parts, Suitable for High-Temperature Service
ASTM A242/A242M	(2013; R 2018) Standard Specification for High-Strength Low-Alloy Structural Steel
ASTM A276/A276M	(2017) Standard Specification for Stainless Steel Bars and Shapes
ASTM A285/A285M	(2017) Standard Specification for Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength
ASTM A312/A312M	(2019) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A351/A351M	(2018) Standard Specification for Castings, Austenitic, for Pressure-Containing Parts
ASTM A352/A352M	(2018a) Standard Specification for Steel Castings, Ferritic and Martensitic, for Pressure-Containing Parts, Suitable for Low-Temperature Service
ASTM A516/A516M	(2017) Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A576	(2017) Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality

ASTM A609/A609M	(2012; R 2018) Standard Practice for Castings, Carbon, Low-Alloy, and Martensitic Stainless Steel, Ultrasonic Examination Thereof
ASTM A668/A668M	(2020a) Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use
ASTM A743/A743M	(2019) Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application
ASTM B148	(2014) Standard Specification for Aluminum-Bronze Sand Castings
ASTM B584	(2014) Standard Specification for Copper Alloy Sand Castings for General Applications
ASTM D2000	(2018) Standard Classification System for Rubber Products in Automotive Applications
ASTM E165/E165M	(2018) Standard Practice for Liquid Penetrant Examination for General Industry
ASTM E709	(2015) Standard Guide for Magnetic Particle Examination
ASTM F1476	(2007; R 2019) Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications

HYDRAULIC INSTITUTE (HI)

HI 9.1-9.5	(2000) Pumps - General Guidelines for Types, Applications, Definitions, Sound Measurements and Documentation
HI 9.6.4	(2009) Rotodynamic Pumps for Vibration Analysis and Allowable Values
HI ANSI/HI 14.6	(2011) Rotodynamic Pumps for Hydraulic Performance Acceptance Tests - A136

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 1940-1	(2003; R 2008) Mechanical Vibration - Balance Quality Requirements for Rotors in a Constant (Rigid) State - Part 1: Specification and Verification of Balance Tolerances

INTERNATIONAL SOCIETY OF AUTOMATION (ISA)

ISA RP2.1	(1978) Manometer Tables

1.3 SUBMITTALS

City approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the City. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G

Pump Base Plate And The Anchoring Bolts; G

SD-03 Product Data Humidity-

Controlled Storage

Materials; G

Spare Parts

Total Head; G

Shipping Bills

Pump Curves; G

Preliminary Pump Curves; G Installation and

Erection Instructions Manual

Field Tests

Impeller Weight

SD-04 Samples

Materials; G

SD-05 Design Data

Dynamic Analysis; G Stress-

Relieving Procedure; G

Piping; G

Baseplates and the Anchoring Bolts

SD-06 Test Reports

Witness Test.

Factory Test

Balancing Procedure; G

Results Of Impeller Balancing

SD-07 Certificates

Qualified Welders

Examination Procedure And Qualification Of The Examiner; G

SD-10 Operation and Maintenance Data

Operation and Maintenance Instructions Manual; G

1.4 QUALITY ASSURANCE

Furnish one or more competent erecting engineers who is knowledgeable about the installation of vertical pumps and associated drive machinery. Erecting engineers provided by this section include those from the Contractor's suppliers. When so requested, erecting engineers must provide and be responsible for providing complete and correct direction during initial starting and subsequent operation of equipment until field tests are completed. The erecting engineer must initiate instructions for actions necessary for proper receipt, inspection, handling, uncrating, assembly, and testing of equipment. The Erecting Engineer(s) must also keep a record of measurements taken during erection, and furnish one copy to the City on request or on completion of installation of the assembly or part. The erecting engineer must instruct the City in operation and maintenance features of work.

1.4.1 Detail Drawings

Submit drawings of sufficient size to be easily read, within 90 days of notice of award of contract. Submit information in the English language. Provide with English (IP) dimensions. Drawings must consist of complete designs of the pump, pump installation instructions, performance charts, brochures, and other information required to illustrate that the entire pumping system (including the pump, engine motor and speed reducer has been coordinated and will function as a unit.

a. Outline drawings of the pump showing pertinent dimensions and weight of each component of the pump. Prepare drawings to scale.

b. Drawing showing details and dimensions of pump mounting design or layout including any embedded items.

c. Cross-sectional drawings of the pump showing each component. Show major or complicated sections of the pump in detail. Indicate on each drawing an itemized list of components showing type, grade, and class of material used and make and model number of standard component used.

d. Detail and assembly drawings required for manufacturing showing dimensions, tolerances, and clearances of shafts, sleeve journals, bearings, including dimensions of grooving, couplings, and packing gland, and diameter and tip clearance of propeller.

e. Drawings covering erection and installation, that are intended to be furnished to the erecting engineer.

f. Drawings of the pump; base plate showing its dimensions. Include calculations used in the design of the thickness of the pump base plate and the anchoring bolts to ensure that the proper forces (shear, torsion, etc.) have been considered.

1.4.2 Welding

Weld structural members in accordance with Section 05 05 23 STRUCTURAL WELDING. For all other welding, procedures and welders must be qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by a previously qualified employer may be accepted as permitted by ASME B31.1. Perform welder qualification tests for each welder whose qualifications are not in compliance with the referenced standards. Notify the City 24 hours in advance of qualification tests. Perform the qualification tests at the work site if practical. The welder or welding operator must apply their assigned symbol near each weld made as a permanent record.

The names of all qualified welders, their identifying symbols, and the qualifying procedures for each welder including support data such as test procedures used, and standards tested to.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 General

Furnish major pump components with lifting lugs or eye bolts to facilitate handling. Design and arrange lugs or bolts to allow safe handling of pump components singly or collectively as required during shipping, installation, and maintenance. Submit copies of certified shipping bills to the City or memorandums of all shipments of finished pieces or members to designated site, giving designation mark and weight of each piece, number of pieces, total weight, and if shipped by rail in carload lots, car initial and number.

1.5.2 Processing for Storage

Prepare pumps (and spare parts) for storage indoors. Indoor storage consists of a permanent building that has a leak-proof roof, full walls to contain stored equipment, and a concrete floor or temporary trailers. A temporary structure may also be built at the job site for equipment storage that will contain features of the permanent building above except that provision for ventilation will be provided and floor may be crushed rock. A vapor barrier will be provided below the crushed rock. Crushed rock will be of sufficient thickness so that settlement of equipment will not occur. Equipment stored on crushed rock will have cribbing under each support location so that equipment does not come in contact with crushed rock. A plastic barrier will be placed between equipment and wood cribbing. Submit a list of equipment and materials requiring humidity-controlled storage to the City no later than 30 days prior to shipment of pumping units. Store long term (greater than 6 months) in accordance with pump manufacturer's recommendations.

1.6 PROJECT/SITE CONDITIONS

1.6.1 Datum

Elevations shown or referred to in specifications, are above or below minus North American Vertical Datum of 1988 (NAVD 88).

1.6.2 Static Head

Static head is the difference, in feet, between water surface elevation in the sump and water surface elevation of river. Total head includes static head, friction losses outside of equipment being furnished, plus velocity head loss.

1.7 MAINTENANCE

1.7.1 Special Tools

Furnish one set of all "special tools" required to completely assemble, disassemble, or maintain the pumps. "Special tools" refer to oversized or specially dimensioned tools, special attachments or fixtures, or any similar items. If required, provide a device for temporarily supporting the pump shaft and impeller during assembly, disassembly, and reassembly of the motor when the thrust bearing is not in place. Furnish lifting devices required for use in conjunction with a truck crane. Provide a portable steel cabinet large enough to accommodate all "special tools" furnished under this paragraph and as required by Section(s) 26 29 01 ELECTRIC MOTORS, 3-PHASE VERTICAL INDUCTION TYPE. Mount the cabinet on four rubber-tired casters. Provide drawers to accommodate tools. Fit front of cabinet with doors hinged to swing horizontally. Furnish doors with necessary stops, catches, and hasps for completely securing the cabinet with a padlock. Furnish the padlock complete with three keys. Pack "special tools" in wooden boxes if the size and weight do not permit storage in the tool cabinet. Provide slings if the box and tools are heavier than 75 pounds.

1.8 Warranty The manufacturer of the axial-flow impeller-type vertical pumps must provide a warranty all equipment furnished under this section against defective workmanship, materials, design, and performance for a period of five (5) years from the date the equipment is accepted. If the equipment or any part thereof does not conform to these warranties, and the City so notifies the manufacturer within a reasonable time after its discovery, the manufacturer must thereupon promptly correct such nonconformity by repair or replacement. Coordinate the down time for the equipment with the City, and be kept to a minimum duration that is mutually agreed to by the manufacturer and the City. The manufacturer is liable during the warranty period for the direct cost of removal of the equipment from the installed location, transportation to the manufacturer's factory or service shop for repair and return, and reinstallation on site. The manufacturer will be given the opportunity to perform the removal and reinstallation and to select the means of transportation. The expense of removing adjacent apparatus, installing spare equipment, costs of supplying temporary service, is not included in this warranty provision.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Design, furnish, and install three (3) identical large capacity vertical axial-flow or mixed-flow, single stage impeller-type pumps, as indicated.

Design, furnish, and install two (2) identical low flow capacity vertical axial-flow or mixed-flow, single stage impeller-type pumps, as indicated. The pumping systems include pumps, electric motor pump drives, and reduction gears. The pump manufacturer is responsible for the equipment of the entire pumping systems. Therefore, the electric motor, and reduction gears should be selected by the pump manufacturer. The low flow capacity pumps shall have variable speed drives.

2.1.1 Design Requirements

a. Pumps are for the purpose of pumping storm water from the 17th Street Pump Station. Water pumped will not exceed 100 degrees F, will be relatively turbid, and may contain sand, silt, and vegetative trash capable of passing through the trash rack. Trash racks will have four (4) inch clear openings. Design pumps to operate in the dry.
b. Drive the pumps with the vertical motors described in Section 26 29 01 ELECTRIC MOTORS, 3-PHASE VERTICAL INDUCTION TYPE as indicated.

c. Design pumps so that no major modifications, alterations, or additions will be required to the pumping station or suction bays to accommodate them. However, requests for changes in setting of pump, supports, and accessories that would involve only minor modifications, will be considered. Design pump so that pump parts will fit within the limiting horizontal and vertical dimensions shown and that installation and maintenance can be accomplished by the truck crane. Pumps, or pump parts assembled at pumping station must be capable of being lowered through floor openings shown with a minimum of 1 inch clearance around each side.

d. Each pump must discharge into discharge system shown. System loss curve, which includes friction losses from pump discharge elbow to end of discharge line, beginning of down riverward leg of discharge line, including bend losses, exit loss, and velocity head, is included as Figure 1 at end of this section to permit determination of total head. Determine losses within the pump.

e. Accomplish priming of siphon without assistance of vacuum equipment.

f. Design the pump and column to be installed and removed using the thirty (30) ton overhead crane indicated. Design the pump and column section lengths with the indicated crane lift as a limiting factor.

g. The design (drawings, computations, etc.) must be signed and sealed by a professional engineer.

2.1.2 Capacities

The large capacity pumps (total of 3) must:

a. Discharge not less than 10,000 ~~25,000~~ gal/min against total head corresponding to a dynamic head of 46 ~~35.0~~ feet with water surface in the sump at Elevation 48.0 ~~8.0~~ feet.

b. Discharge not less than 12,000 ~~28,000~~ gal/min against total head corresponding to a dynamic head of 42 ~~30~~ feet with water surface in the sump at Elevation 48.0 ~~9.0~~ feet.

c. Discharge not less than 13,000 ~~30,000~~ gal/min against total head corresponding to a dynamic head of 38 ~~25~~ feet with water surface in the sump at Elevation 48.0 ~~10.0~~ feet.

d. Discharge not less than 15,000 ~~32,000~~ gal/min against total head corresponding to a dynamic head of 30 ~~20~~ feet with water surface in the sump at Elevation 48.0 ~~11.0~~ feet.

e. Discharge not less than 16,500 ~~35,000~~ gal/min against total head corresponding to a dynamic head of 22 ~~15~~ feet with water surface in the sump at Elevation 48.0 ~~12.0~~ feet.

f. Discharge not less than 18,000 ~~36,000~~ gal/min against total head corresponding to a dynamic head of 14 ~~10~~ feet with water surface in the sump at Elevation ~~48.0~~ ~~13.0~~ feet.

g. Be capable of constant-speed operation from a total head corresponding to a dynamic head of 46 ~~35~~ feet down to total head corresponding to a dynamic head of 14 ~~8.0~~ feet with water surface in the sump at Elevation 48.0 ~~8.0~~.

The low flow capacity pumps (total of 1) must:

a. Discharge not less than 500 ~~7,000~~ gal/min against total head corresponding to a dynamic head of 45 ~~34.0~~ feet with water surface in the sump at Elevation 44.0 ~~8.0~~ feet.

b. Discharge not less than 700 ~~8,000~~ gal/min against total head corresponding to a dynamic head of 38 ~~30~~ feet with water surface in the sump at Elevation 44.0 ~~8.0~~ ~~feet.~~

c. Discharge not less than 900 ~~8,250~~ gal/min against total head corresponding to a dynamic head of 32 ~~25~~ feet with water surface in the sump at Elevation 44.0 ~~8.5~~ feet.

d. Discharge not less than 1,100 ~~8,500~~ gal/min against total head corresponding to a dynamic head of 25 ~~20~~ feet with water surface in the sump at Elevation 44.0 ~~9.0~~ feet.

e. Discharge not less than 1,300 ~~8,750~~ gal/min against total head corresponding to a dynamic head of 20 ~~15~~ feet with water surface in the sump at Elevation 44.0 ~~9.0~~ feet.

f. Discharge not less than 1,700 ~~9,000~~ gal/min against total head corresponding to a dynamic head of 10 feet with water surface in the sump at Elevation 44.0 ~~10.0~~ feet.

g. Be capable of constant-speed operation from a total head corresponding to a dynamic head of 45 ~~40~~ feet down to total head corresponding to a dynamic head of 8.0 feet with water surface in the sump at Elevation 44.0 ~~8.0~~.

Operation of pump at condition "a" may be at the rotative speed, which is the same as or different from that required to meet condition(s) "b", "c", "d", "e", "f", and "g".

2.1.2.1 Start-Up Condition

Upon startup, each pump must discharge sufficient water for the pumps to become primed and siphon recovery to begin. Since the head conditions will be higher prior to the pump discharge pipe becoming filled, the pump may be operated at a higher speed for a short period of time. The pump flow must be sufficient to result in a flow velocity in the discharge pipe of no less than 7 feet per second. The pump speeds may be changed during the pump priming period, but after priming is accomplished, the pumps will operate as constant-speed pumps. Siphon breaker and Air Relief valves will be used to help prime the pumps.

2.1.3 Pump Curves

Indicate on the pump curves for the submitted pumps that the pumps are capable of operating over the entire total head corresponding to the Dynamic head range and sump elevation range. Also provide pump curves for the startup condition for pumps that are operated at a different speed during startup.

Submit preliminary pump curves with the initial pump submittal. Indicate the pump's expected total head, static heads, brake horsepower, and efficiency, as ordinates. Plot against the pump discharge as the abscissa. The curves must indicate that the pump meets all specified conditions of capacity, head, brake horsepower, and efficiency.

2.2 MATERIALS

Material selection not specified is guided by HI 9.1-9.5 for corrosion, erosion, and abrasion resistance. Submit copies of purchase orders, deviations from the specified materials, mill orders, shop orders for materials, and work orders, including orders placed or extended by each supplier. Furnish a list designating materials to be used for each item at time of submittal of drawings. Furnish, within 60 days of notice of award, names of manufacturers of machinery and other equipment contemplated to be incorporated in the work, together with performance capacities and other relevant information pertaining to the equipment. Submit samples of materials as directed. Equipment, materials, and articles installed or used without the approval of the City are at risk of subsequent rejection.

a. Identify each pump by means of a separate nameplate permanently affixed in a conspicuous location. The plate must bear the manufacturer's name, model designation, serial number if applicable, and other pertinent information such as horsepower, speed, capacity, type, direction of rotation, etc. Make the plate of corrosion-resisting metal with raised or depressed lettering and a contrasting background.

b. Equip each pump with suitably located instruction plates, including any warnings and cautions, describing any special and important procedures to be followed in starting, operating, and servicing the equipment. Make the plates of corrosion-resisting metal with raised or depressed lettering and contrasting background.

c. Provide safety guards and/or covers wherever necessary to protect the operators from accidental contact with moving parts. Make guards and covers of sheet steel, expanded metal, or another acceptable material and removable for disassembly of the pump.

2.3 METALWORK FABRICATION

2.3.1 Designated Materials

Designated materials must conform to the following specifications, grades, and classifications.

MATERIALS	SPECIFICATION	GRADE, CLASS
Aluminum-Bronze	ASTM B148	Alloy No. C95500 Castings
Cast Iron	ASTM A48/A48M	Class Nos. 150A 150B, and 150C; 30A, 30B, and 30C
Cast Steel	ASTM A27/A27M	Grade 65-35, annealed
Cast Stainless Steel	ASTM A743/A743M	CF8
Coal Tar Protective Coatings	AWWA C203	
Cold-Rolled Steel Bars	ASTM A108	min, Wt. Strm 65,000 psi
Copper Alloy Castings	ASTM B584	Alloy No. C93700
Corrosion-Resistant Alloy Casting	ASTM A217/A217M	Grade CA15
	ASTM A352/A352M	CA6NM
	ASTM A351/A351M	CF8M
Dimensions for Steel Water Piping Fittings	AWWA C208	
Hot-Rolled Stainless	ASTM A576	Graded G10200 and G11410
Ring Flanges	AWWA C207	Class B

Rubber Products in Automotive Applications	ASTM D2000	
MATERIALS	SPECIFICATION	GRADE, CLASS
Seamless and Welded Austenitic Stainless Steel Pipe	ASTM A312/A312M	
Stainless Bars and Shapes	ASTM A276/A276M	Grades S30400 and S41000
Steel Forging	ASTM A668/A668M	Class F
Cast Stainless Steel	ASTM A743/A743M	CF8
Steel Pipe 6 inch and Larger	AWWA C200	
Steel Plates, Pressure Vessel	ASTM A516/A516M	Grade 55
Steel Plates, Pressure Vessel	ASTM A242/A242M	
Steel Plate, Structural Quality	ASTM A285/A285M	Grade B
Structural Steel	ASTM A36/A36M	
Surface Texture (Surface Roughness, Waviness, and Lay)	ASME B46.1	

2.3.2 Bolted Connections

2.3.2.1 Bolts, Nuts, and Washers

Bolts, nuts, and washers must conform to requirements of paragraph MATERIALS AND METALWORK FABRICATION, subparagraph DESIGNATED MATERIALS, and paragraph VERTICAL PUMPS, subparagraph PUMP COLUMN AND DISCHARGE ELBOW, subparagraph NUTS AND BOLTS for types required. Use beveled washers where bearing faces have a slope of more than 1:20 with respect to a plane normal to bolt axis.

2.3.2.2 Materials Not Specifically Described

Materials not specifically described must conform to latest ASTM specification or to other listed commercial specifications covering class or kinds of materials to be used.

2.3.3 Metalwork

2.3.3.1 Flame Cutting of Material

Flame cutting of material other than steel is subject to approval of the City. Shear accurately, and neatly finish all portions of work. Steel may be cut by mechanically guided or hand-guided torches, provided an accurate profile with a smooth surface free from cracks and notches is secured. Prepare surfaces and edges to be welded in accordance with

AWS D1.1/D1.1M. Chipping and/or grinding will not be required except where specified and as necessary to remove slag and sharp edges of mechanically guided or hand-guided cuts not exposed to view. Visible or exposed hand-guided cuts must be chipped, ground, or machined to metal free of voids, discontinuities, and foreign materials.

2.3.3.2 Alignment of Wetted Surfaces

Exercise care to assure that correct alignment of wetted surfaces being joined by a flanged joint is being obtained. Where plates of the water passage change thickness, transition on the outer surface, leaving inner surface properly aligned. When welding has been completed and welds have been cleaned, but prior to stress relieving, carefully check joining of plates in the presence of the City inspector for misalignment of adjoining parts. Localized misalignment between inside or wetted surfaces of an adjoining flange-connected section of pump or formed suction intake cannot exceed the amount shown in Column 4 of Table 1 for the respective radius or normal distance from the theoretical flow centerline. Correct misalignments greater than the allowable amount by grinding away offending metal, providing the maximum depth to which metal is to be removed does not exceed amount shown in Column 5 of Table 1. Do not remove metal until assuring the City that no excessive stresses will occur in the remaining material and that excessive local vibration will not result from removal of the material. Where required correction is greater than the amount in Column 5 of Table 1, reject pipe for use. Proposed procedure for all corrective work, other than minor grinding, must be approved by the City prior to start of corrective work. Finish corrective work by grinding corrected surface to a smooth taper. Length of the taper along each flow line element must be 10 times the depth of the offset error at the flow line. Wetted surface irregularities that might have existed in an approved model cannot be reason for accepting comparable surface irregularities in the prototype pump.

TABLE 1

(1)	(2)	(3)	(4)	(5)
Pipe Diameter (inches)	Pipe Radius or Distance (inches)	Pipe Thickness (inches)	Maximum Offset (inches)	Grind-Not More Than (inches)
24	12	3/8	1/16	3/32
30	15	3/8	1/16	3/32

36	18	3/8	3/32	3/32
42	21	1/2	3/32	1/8
48	24	1/2	1/8	1/8
54	27	1/2	1/8	1/8
60	30	3/4	5/32	5/32
TABLE 1				
(1)	(2)	(3)	(4)	(5)
Pipe Diameter (inches)	Pipe Radius or Distance (inches)	Pipe Thickness (inches)	Maximum Offset (inches)	Grind-Not More Than (inches)
72	36	1	5/32	5/32
84	42	1-1/8	3/16	1/4

2.3.3.3 Stress-Relieving Procedure

After all fabrication welding is completed, and prior to any machining, stress-relieve the bell and the impeller (if it is fabricated) by heat treatment. Submit proposed stress-relieving procedure.

2.3.4 Examination of Castings

Clean and carefully examine all castings for surface defects. Further examine all defects by nondestructive means. Examination personnel must be qualified/certified in accordance with applicable ASTM requirements. Submit the examination procedure and qualification of the examiner. Conduct examination tests in the presence of the City. Choose the examination procedure best suited for the application.

2.3.4.1 Examination Procedures

2.3.4.1.1 Ultrasonic

Conform inspection to the applicable provisions of ASTM A609/A609M.

2.3.4.1.2 Magnetic Particle

Conform inspection to the applicable provisions of ASTM E709.

2.3.4.1.3 Liquid Penetrant

Conform inspection to the applicable provisions of ASTM E165/E165M.

2.3.4.2 Acceptance and Repair Criteria

Acceptance and repair criteria must be in accordance with Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS.

2.4 VERTICAL PUMPS

2.4.1 Speed

Rotative speed of pump must be no greater than 600 rpm for the large capacity pumps. Rotative speed of pump must be no greater than 1,200 rpm for the low flow capacity pumps. Verify that rotative speed of pump at which the NPSH is produced is no less than required, as determined by cavitation tests specified in paragraph FACTORY TESTS (Alternate 2).

2.4.2 Reverse Flow

Each pump must withstand, with no damage, full rotative speed caused by subjecting the pump to reverse flow. The head used to determine this reverse rotative speed is calculated from specified highest discharge side water elevation and lowest pump intake side water elevation. Each pump and its connected electric motor must be capable of full reverse rotative speed when acting as a turbine by reverse water flow. Use the highest head specified in paragraph BOWL HEAD to determine the reverse speed.

2.4.3 Efficiency

Pump efficiency, as defined in HI ANSI/HI 14.6, must include losses from the suction bell to the discharge elbow outlet and must not be less than eighty (80) percent at the head-capacity condition(s) specified in paragraph CAPACITIES.

2.4.4 Suction Bell

Make each suction bell of either cast iron, cast steel, or welded steel plate. Provide a flanged connection for mating with the impeller bowl with a rabbet fit or four equally spaced dowels installed in the vertical position for initial alignment purposes and to maintain concentric alignment of the pump. Steel plate, if used, must have thickness of not less than 1/2 inch. Each suction bell must be made in one piece. Support each suction bell entirely by the pump casing. Supports from sump floor will not be acceptable. Support umbrellas, if used, by the suction bowl. Construct the umbrella in two pieces if a single piece umbrella could not be removed using the pump opening in the operating floor. Provide bolted flanges on each half of the umbrella and provide for and easily removable bolted connection to the suction bowl. Provide sufficient lifting lugs on the umbrella to aid in handling.

2.4.5 Impeller Bowl

Make each impeller bowl of either cast iron, cast steel, welded steel plate or a combination of cast steel and steel plate. Steel plate, if used, must have thickness of not less than 1/2 inch after machining is completed. Heat-treat and stress-relieve welds before final machining. Provide flanges for mating with the suction bell and the impeller bowl or two-piece construction of the impeller. Provide flanged connections with the suction bell and the diffuser or split construction with a rabbet fit or four equally spaced dowels installed in the vertical position for initial alignment purposes and to maintain concentric alignment of the pump. Machine finish the impeller-swept area in the impeller bowl to at least 125 microinch rms and concentric with the impeller axis. For mixed-flow impellers, the angle in the impeller bowl must equal the outside angle of the impeller blade tips. Tolerance for concentricity of the impeller with the impeller axis is not greater than 20 percent of the operating clearance between the impeller and the impeller bowl.

2.4.6 Diffuser Bowl

Make each diffuser bowl of cast iron, cast steel, welded steel plate, or a combination of cast steel and steel plate. Steel plate, if used, must have a thickness of not less than 1/2 inch after machining is completed. The diffuser must contain support for the upper impeller shaft bearing and have vanes to guide the pumped flow. Equip the diffuser bowl with a bypass drain, if required, to outside of the pump from the diffuser cavity located between the enclosing tube connection and the impeller. Furnish throttle bushing located in the cavity immediately above the impeller. Design bypass drain and throttle bushing to reduce water pressure on the lower seal. Impeller back-wear rings can also be used to reduce water pressure on the lower seal.

2.4.7 Pump Column and Discharge Elbow

2.4.7.1 Column and Discharge Elbow

Make each column and discharge elbow of either cast iron, cast steel, or welded steel plate. Steel plate, if used, must have a thickness of not less than 1/2 inch after machining is completed. Provide elbow of long radius type. If turning vanes made of welded steel plate are used, provide an access door in the discharge elbow to allow personnel to inspect turning vanes and remove trash if necessary. Design column and discharge elbow to withstand internal pressures and external loadings associated with various conditions of pump operation. Provide flanges for mating individual segments together and for mating the pump column to the diffuser bowl. Flanges must have rabbeted fits or four equally spaced dowels installed in flanges for initial alignment purposes and to maintain concentric alignment. Terminate the elbow in a plain-end circular section. Diameter tolerance of plain end is 1/2 inch. Provide diameter of discharge end of elbow as indicated and allow standard diameter flexible couplings to be used. Use adjustable thrust rods and thrust lugs to transfer the load by bridging the coupling between the pump discharge elbow and discharge piping. Determine the size and number of thrust rods needed for the expected loading. Use a minimum of four thrust rods. Maintain complete access to the discharge piping until the discharge pipe installation is complete, inspected, and approved.

2.4.7.2 Column and Discharge Elbow Support

Design pump column and discharge elbow for suspension from a baseplate assembly specified in paragraph BASE-PLATE AND SUPPORTS and located at operating floor level.

2.4.7.3 Pumps Discharge Diameter

Pumps having a discharge diameter greater than 60 inches must contain a manhole. Provide a structural steel bracket with a platform of raised-pattern floor plate similar to the one(s) indicated as a support for maintenance personnel for access to the pump through a manhole. Provide a manhole 24 by 30 inches, or largest practicable size with a gasketed cover, in the column above the diffuser bowl. Provide jack bolts in the cover together with eye bolts to facilitate removal.

2.4.7.4 Flanges

Machine flanges and drill bolt holes concentric with pump shaft vertical centerline, having a tolerance of plus or minus one fourth of the clearance between the bolt and bolt hole. When fabricated from steel plate, flanges must not be less than 1-1/2 inch thick after machining. Flange thickness after machining cannot vary more than 10 percent of greatest flange thickness. Provide external stiffeners, if needed. Construct fabricated flanges, as a minimum, to the dimensions of AWWA C207, Class B. Design flanges on major components of pump casing (suction bell, impeller bowl, diffuser bowl, and column and elbow piping) such that blind holes necessitating use of cap screws or stud bolts are not used. Design flanges for connection to column pipe by at least two continuous fillet welds. Connect the inside diameter of the flange to pump column with one weld, and connect the outside diameter of the pump column to the flange with the other weld. Final design of welds rests with the manufacturer, and specified welds are the minimum requirement. Parallel machine, when provided on each end of the same component, and mount parallel to a plane that is normal to pump shaft centerline. Flanges on each end of the same component must have parallel tolerance of 0.002 inch. Finish machine mating surface on flange to 125 microinch finish or better. Provide flanges with a minimum of three jacking bolts to aid in disassembly of the pump.

2.4.7.5 Flanged Joints

Design flanged joints to be air-and water-tight, without the use of preformed gaskets, against positive and negative operating pressures that will be experienced, except that permanent gasketing compound will be permitted. Provide mating flanges, unless of the male-female rabbet type, with not less than four tapered dowels equally spaced around each flange. If rabbeted fit is not used, then provide the method used to determine concentricity of connected pieces.

2.4.7.6 Nuts and Bolts

Use 300 series stainless steel for bolts used in assembling the pump and its supporting members, including anchor bolts and dowels. Use only bronze nuts and hexagonal bolts and nuts. Also use 300 series stainless steel washers.

2.4.7.7 Galvanic Protection

When dissimilar metals are used, use zinc anodes. Provide machined mounting pads and install anodes on carbon steel or cast iron parts. Fasten anodes to bare material on the pump so that continuity is obtained between the anode and the pump. Verify continuity by checking the joint with an ohmmeter. Locate anodes on the exterior of the pump below normal sump level. Total weight of anodes used per pump must be 80 pounds. Electrically bond pump joints at the joints.

2.4.7.8 Harnessed Coupling

Provide a flexible mechanical coupling or split-sleeve type coupling that either conforms to ASTM F1476, Type II, Class 3, stainless steel (as manufactured by Teekay or Straub Couplings), ASTM F1476, Type 1 (as manufactured by Victaulic), or Dresser Couplings style 38 or approved equal, to connect the pump discharge elbow to the discharge piping. Install a minimum of four harness bolts (sized by the pump manufacturer) at each coupling.

2.4.7.9 Discharge Piping

Install the discharge piping as indicated. Match the plain end of each discharge pipe with the pump discharge elbow in thickness and diameter and be able to allow a flexible mechanical coupling to connect it to the pump discharge elbow. Terminate the discharge piping in an open end. Provide the discharge pipe with pipe supports or cradles as recommended by the pump manufacturer. Locate the supports between the flexible coupling and the wall, as indicated. Provide suitably-sized thrust restraints at each flexible coupling as indicated. The supports must provide support for the weight of the pipe, the water that will pass through the pipe, and any dynamic forces that may develop due to water flowing through the pipe. Furnish a minimum 1/2 inch flanged vent nozzle equipped with an ASME B16.5 standard 125 pound flange and locate where indicated. The discharge pipe must be non-galvanized piping of welded or seamless pipe or welded steel plate. Use steel pipe conforming to AWWA C200 with dimensional requirements as given in ASME B36.10M. Provide fittings in compliance with AWWA C208.

2.4.8 Impeller

Make the impeller of cast steel or fabricated of welded steel plate.

2.4.8.1 Removal and Prior To Finishing

After removal from mold, and prior to finishing of surface imperfections, the City will inspect castings. Fill and grind minor surface imperfections as necessary to preserve correct contour and outline of impeller and to restore surface imperfections to the same degree of finish as surrounding surfaces. Correct surface pits, depressions, projections, or overlaps showing greater than 1/16 inch variation from the general contour for that section. Method and procedure for accomplishing repair must be as required in Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS.

Castings that exhibit surface imperfections (as defined above) covering an area of more than 10 percent of blade surface will be rejected.

2.4.8.2 Balance

Balance each impeller by the two-plane balancing technique. Balance each impeller at maximum operating speed. Check the balance at 110 percent of balance speed, and make needed corrections. Amount of allowable unbalance is in accordance with grade G6.3 of ISO 1940-1. Securely fasten weights needed to obtain the required level of balance to the inside cavity of the impeller hub. In no case can portions of the impeller be removed or weights be added to the outside of the hub, vanes, or water passages. Submit balancing procedure at least four weeks prior to the date of balancing. Weigh each finished impeller and weight stamped on the bottom of the hub with weight accurate to 0.5 percent of the total weight of the impeller. Weighing and balancing will be witnessed by the City. Submit all impeller weights and the results of impeller balancing.

2.4.9 Shafting

2.4.9.1 Shaft

Each impeller shaft must be stainless steel and intermediate shaft(s) must be same material as the impeller shaft. Design shafting so that shaft sections do not exceed ten (10) feet in length and that any necessary vertical adjustment of the impeller can be made without interfering with shaft alignment. Also provide for removal of the impeller from below without disassembly of the pump above the impeller bowl. If the pump is multi-staged, design to permit the lower bowls and impeller to be easily removed for in-place inspections of upper propeller and bowl. Design shafts for two different design cases. The first uses a factor of safety of 5 based on ultimate tensile strength of the shaft material and rated horsepower of the motor . The second uses 75 percent of the yield strength of the shaft material and maximum horsepower of the engine.

2.4.9.2 Couplings

Couple the pump and motor shafts and pump shaft sections together using rigid flanged coupling capable of transmitting the forces and torques involved. Bolt coupling halves together and maintain concentric with each other, by means of a rabbet fit to within 0.002 inch. Retain a shaft coupling nut, if used, by fitted bolts, and comply with all tolerances specified for the coupling. Finish machine the flange and bore in one setup to ensure that the flange of the coupling is true to the bore. Each flange must be perpendicular to the bore, and parallel to the opposite end and mating flanges to within 0.002 inch. Each flange must be concentric to the centerline of the shaft to within 0.002 inch. Construct couplings, including keys and fasteners, of stainless steel materials. All keys and keyseats (keyways) must meet the requirements of ASME B17.1. The finished shaft assembly must be concentric about the shaft centerline to within 0.004 inch. Shop assemble couplings and the pump shaft, and inspect for compliance with contract requirements. After inspection, matchmark parts, including fitted bolts, to their mating pieces.

2.4.9.3 Journals

Finish the shaft journal at all guide bearing and packing gland locations to at least 32 rms and finish the shaft at seal journal locations to 16 rms. The option exists to install replaceable stainless steel one-piece sleeves at each bearing, packing gland, and seal locations with the finishes stated above. Securely fasten sleeves to the shaft to prevent movement. Make keys and fasteners, if used, from corrosion resisting steel; fastening by adhesive or welding is not acceptable. All keys and keyseats (keyways) must meet the requirements of ASME B17.1. The surface hardness at the seal locations must be as recommended by the seal manufacturer.

2.4.9.4 Circumferential Line

Inscribe or etch a circumferential line on the shaft above the stuffing box and mount an adjustable pointer opposite this line in order to indicate a change in vertical position of shaft and to permit realignment after motor removal.

2.4.10 Shaft Enclosure

Provide a shaft enclosure to cover the intermediate shaft and coupling. It must be placed in tension or must be rigid enough to be self-supporting. Do not use external supports or bracing located in the pump water passage for support of the enclosing tube unless necessary to support intermediate bearings or indicated to be necessary or advantageous by the dynamic analysis required in paragraph DYNAMIC ANALYSIS. Consider the effect of external supports, including rubber inserts, in the dynamic analysis required in paragraph TEST, INSPECTIONS, AND VERIFICATIONS, subparagraph DYNAMIC ANALYSIS. Design each enclosure for easy assembly and disassembly in the field. Construct enclosing tubes, constructed with screw type joints and using tension in the tube to hold alignment, to prohibit the tension tube from unscrewing when the packing gland adjustments are made. Provide a shaft enclosure for grease-lubricated pumps with a drain having a shut-off valve located outside of the pump to permit draining the enclosure between operation periods. Locate the drain at the bottom of the shaft enclosure.

2.4.11 Guide Bearings and Seals

2.4.11.1 Guide Bearings

Provide each pump with sleeve-type bearings designed for oil lubrication. Each bearing must have a bronze lining in contact with shaft journal and must be replaceable type. Arrange the bearing liner for maximum distribution of oil for lubrication of journal surface. Bearings must have a surface finish of 32 microinches rms or better to match the journal finish. Since pumped water may contain some fine sand and silt in suspension, give special attention to the design and selection of bearing parts, especially seal rings, to preclude entrance of foreign material between the bearing and journal due to differential water pressure.

2.4.11.2 Oil Lubrication Shaft Seals

Pumps designed for oil lubrication must have a shaft seal system located below the upper pump shaft bearing. The seal system consists of a seal containing two lip elements. The element facing the bearing must have a stainless steel garter spring back-up and be constructed of TFE (Teflon). The secondary element faces the impeller and is constructed of TFE. Use a bullet-shaped assembly tool or other special tool over the end of the shaft or grooves in the shaft to preclude damage to the lip element during assembly. Assembly tools used are considered a special tool and must be furnished to the City as part of special tools specified in paragraph SPECIAL TOOLS. Pumps having two stages must have seals to protect the extra bearings required by two stages of construction.

2.4.12 Bearing Heat Sensors

Fit the impeller shaft bearings with temperature-sensing elements, inserted in the bearings to within 1/8 inch of shaft. Provide these temperature-sensing elements with temperature readouts mounted on the motor instrument board . Provide a visual and audible alarm system to warn of bearing overheating. Provide temperature indicator with dual outputs that have setpoints that are separately adjustable. Support leads and protect them from water and mechanical damage. Terminate the leads outside of the pump casing in a waterproof connection head, Minco CH 339 or equal, and cap until final connections are made in the field. The connection head must be rated watertight to 25 psi. Lead protection consists of pipes fastened to the pump with brackets using bolts and nuts to permit their removal, and constructed with enough unions to be completely disassembled. Leads passing through the pump water passage in the pump must either be contained in a guide vane or be protected by Schedule 120 pipe. Make protection pipe removable if connected to the shaft-enclosing tube. Install bearing heat sensors as indicated. Run leads and wiring to a junction box located on the baseplate. Provide a terminal strip in the junction box for connection of wiring to temperature readouts.

2.4.13 Thrust Bearing

Provide a thrust bearing in the motor to carry total thrust loads required.

2.4.14 Packing Gland

Provide grease- lubricated packing gland split longitudinally to facilitate removal or renewal. Arrange it to permit inspection, repair, removal, or replacement of packing without entering pump from below operating room floor. Provide eye bolts and tapped holes in each half of the split gland if halves weigh over 30 pounds each.

2.5 LUBRICATION SYSTEM

Oil lubrication of shaft bearings consists of introducing oil at the top line shaft bearing and allowing oil to run down the shaft for the lubrication of the lower bearings. Oil lubrication consists of an oil reservoir mounted on the pump baseplate or pump driver at such height to permit gravity flow of oil to the highest lubrication point of the pump shaft. Construct the reservoir of transparent material to permit observation of the quantity of oil in the reservoir. The oil reservoir must have a minimum capacity of 1 quart. The reservoir must have a solenoid valve to permit oil flow whenever the pump driver is in operation. The flow rate from the oil reservoir must be adjustable from five drips per minute to constant flow. The reservoir valve must permit manual flow of oil when the pump driver is not operating for prelubrication of the shaft bearing. Construct the oil line from the oil reservoir to the pump line shaft of stainless steel tubing and support at sufficient locations to preclude vibration of tubing when the pump is operating. If the pump has a bearing located below the impeller, this bearing must be grease-lubricated. Provide a grease line with a grease fitting from this bearing to a location on top of the baseplate. Provide a grease reservoir with this bearing configuration for containing extra grease. Lubricate shaft packing by grease. Run the grease lines to a location outside of the driver pedestal and provide with a fitting for manual lubrication.

2.5.1 Lubrication System Accessories

2.5.1.1 Grease Gun

Provide a hand operated, heavy duty lever grease gun for charging lubrication lines and for emergency lubrication. Provide grease as recommended by the vertical pump manufacturer.

2.5.1.2 Service Facilities

Provide a service facility consisting of a portable hand operated transfer pump, a hand-towed dolly, and a 120 pound drum of lubricant, all assembled and ready for operation. The pump must be self-contained and designed for mounting on the grease drum to protect the contents from the entrance of foreign matter. The pump must deliver not less than one pound in not more than eight strokes of the pump handle under normal temperature conditions. Furnish the necessary hose and quick disconnect coupling for a complete system. The hand-towed dolly must have a rigid platform with four anti-friction bearing mounted wheels, a towing handle, and a provision for securing the lubricant barrel. Use the type of lubricant recommended by the vertical pump manufacturer.

2.6 PAINTING

Perform painting in accordance with Section 09 97 02 PAINTING: HYDRAULIC STRUCTURES.

2.7 TESTS, INSPECTIONS, AND VERIFICATIONS

2.7.1 Dynamic Analysis

The assembled pumping unit, consisting of the motor, engine, speed reducer and pump must be free from critical speeds or harmful torsional vibrations at all speeds encountered within the operating range.

2.7.2 Lubricating System Tests

Test the complete lubricating system for each pumping unit, as deemed necessary by the City, to determine that the system meets the operational requirements specified. Test at least one valve of each size furnished with the lubrication line removed from its bearing and fitted with a pressure relief valve and pressure gage. Adjust the pressure relief valve to discharge it at the operating pressure specified and operate the system through one or more cycles as required to obtain an accurate measurement of the quantity of lubricant delivered. This must be within plus or minus 20 percent of the theoretical delivery of the respective valve. Replace, reinstall, and retest any component parts that are damaged as the result of these tests or that fail to meet the requirements of the specification.

2.7.3 Factory Test

2.7.3.1 General

Performance of each size pump to be furnished will be accepted on the basis of the factory test. Conduct this test using either a scale model of pump or first pump produced for this contract. Perform cavitation testing in accordance with HI ANSI/HI 14.6 if no published NPSHR curves are available.

2.7.3.2 Test Setup

The model pump must be homologous to the proposed prototype pump, and mounted with the shaft in the vertical position. Equip the sump where the pump suction occurs with windows strategically located for viewing those areas where separation is likely to occur. Windows may be rings of transparent material approximately 4 to 5 inches wide securely anchored between flanges. The impeller inlet diameter and the datum for this test specification must be as indicated on Figure 3 at the end of this section. The inlet diameter must be not less than 11 inches. The FSI used in the model test must be geometrically the same as that used for the proposed pump.

2.7.3.3 Instrumentation and Procedures

Describe each instrument in detail, giving all data applicable, such as manufacturer's name, type, model number, certified accuracy, coefficient, ratios, specific gravity of manometer fluid to be used, and smallest scale division. Provide calibration data on each of the instruments used. When necessary for clarity, include a sketch of the instrument or instrument arrangement. Include fully detailed narrative description of each proposed method of instrumentation, procedures to be used, and a sample set of computations. State the lowest equivalent static head that is obtainable with the testing when operating along the head-capacity curve of the proposed pump. Perform test procedures, except as specified, in accordance with applicable provisions of HI ANSI/HI 14.6.

2.7.3.3.1 Head Measurements

Make head measurements using either a direct reading water column, mercury-air, mercury-water, a Meriam fluid manometer, or a pressure transducer. Measure vacuums with either a mercury-air manometer, a mercury-water manometer, or a pressure transducer. Dampen fluctuations sufficiently to permit column gages or a differential pressure transducer to be read to either closest 0.01 foot of water or Meriam fluid or 0.1 inch of mercury. Use manometers as indicated by ISA RP2.1. When pressure transducers are used, check their accuracy with a manometer.

2.7.3.3.2 Capacity

Determine capacity by a calibrated venturi flowmeter or long-radius ASME flow nozzle. Do not use orifice plates. Connect the venturi or nozzle taps to the column gages equipped with dampening devices that permits differential head to be determined to either the closest 0.01 foot of water or Meriam fluid or 0.1 inch of mercury. Magnetic flowmeters and flowmeters utilizing ultrasonic flow measurements will be acceptable if calibration of flowmeter has been completed within the last 6 months.

2.7.3.3.3 Rotational Speed of Pump

Measure the rotational speed of the pump in accordance with "Method of Rotary Speed Movement" in HI ANSI/HI 14.6, except that revolution counters cannot be used. Non-contacting hand-held electronic tachometers are acceptable. The device used must permit the speed to be determined to 1 rpm.

2.7.3.3.4 Power Input

Measure power input to the pump in accordance with "Power Measurements" in HI ANSI/HI 14.6. Use a method to permit pump brake horsepower to be determined to the closest 0.5 horsepower.

2.7.3.3.5 Cavitation Tests

Use instruments suited for cavitation testing. However, do not use instruments that yield results less accurate than those obtained with the performance test.

2.7.3.4 Pump Test

Demonstrate that the proposed pump complies with the specified performance. The pump must be capable of operation without instability over the entire range of heads specified in paragraph CAPACITIES. Tolerances must be in accordance with HI requirements. Instability is defined, for this specification, as when one or more of the following conditions occur:

a. the pump has two or more flow rates at the same total head;

b. The head-capacity curve has a dip (region on curve where change in flow rate produces an abnormally low head);

c. When any point in the usable range of head-capacity curve cannot be repeated within 3 percent.

Rerun the test if this occurs. Compliance with specifications will be determined from curves required by paragraph TEST RESULTS. Test procedures, except as specified, must be in accordance with applicable provisions of HI ANSI/HI 14.6. The acceptance grade is 1U as described in HI ANSI/HI 14.6. Use water at approximately the same temperature for all tests run and record the temperature during test runs.

2.7.3.5 Test Procedure

2.7.3.5.1 Performance of The Pump

Determine the performance of the pump by a series of test points sufficient in number to develop a constant-speed curve over the range of total heads corresponding to the bowl heads in paragraph CAPACITIES. The performance/test range must include additional testing at total heads 2 feet higher than the total head determined in paragraph CAPACITIES. The lowest total head for testing must be, as a minimum, the total head determined from paragraph "CAPACITIES". If the test setup permits testing at lower total heads, extend the range of total heads 2 feet lower. Testing must be inclusive for the speed(s) involved with the sump at elevations. Conduct tests using prototype total heads. Head differentials between adjacent test points cannot exceed 3 feet, but in no case may fewer than 10 points be plotted in the pumping range. If the plot of the data indicates a possibility of instability or dip in the head-versus-capacity curve, a sufficient number of additional points on either side of instability must be made to clearly define the head-capacity characteristics. When a scale model of the pump is tested, consider the efficiency of the prototype pump to be the efficiency of the model. No other computation or adjustment of model efficiency to prototype conditions will be permitted.

2.7.3.5.2 Sump Elevations

Conduct tests at two different sump elevations (approximately a 5 foot differential) to determine the effect of test sump geometry on the performance of the pump. Should the test results indicate that the performance is not the same in all respects for both sump conditions, take whatever corrective action is necessary to produce congruent results. Use the sump elevations specified in paragraph CAPACITIES. The test results with this sump elevation must meet all specified conditions of capacity, head, and brake horsepower. Submit curves indicating test results.

2.7.3.5.3 Tests Results

Plot results of tests to show total head, bowl heads, brake horsepower and efficiency as ordinates; all plotted against pump discharge as the abscissa. Plot curves showing prototype performance to a scale that will permit reading head directly to 0.2 foot, capacity to 100 gpm, 5 cfs, efficiency to 1 percent, and power input to 5 horsepower.

2.7.3.5.4 Demonstration

Demonstrate to the City witness that the blade templates fit the tested pump. Perform the demonstration immediately after testing is completed.

Retain all templates for the tested pump, and furnish them to the City upon request of the City, to permit the City to verify geometric similarity with the manufacturer's pump. In addition to providing templates, furnish dimensioned drawings of the impeller that contain all dimensions needed to manufacture it. Stamp the tested impeller with identification marks. Provide necessary facilities and instruments needed to permit the City to verify that pumps in complete geometric similarity with the tested pump.

2.7.3.6 Cavitation Tests

2.7.3.6.1 Model Test

The model test must include the determination of net positive suction head required (NPSHR) at five or more points on the constant speed curve. Determine NPSHR, as a minimum, for five or more capacities corresponding to prototype capacities over the total range of specified operating conditions. If the pump has a capacity greater than that specified for the lowest and/or highest operating condition, then use these over-capacity conditions. Equally space the other test capacity points between the highest and lowest capacities.

2.7.3.6.2 NPSHR

Determine NPSHR on a constant-capacity, constant-speed basis, using arrangement Figure F.3 or F.4 as described under paragraph "Net Positive Suction Head Required Test" in HI ANSI/HI 14.6. Vary suction conditions to produce cavitation. NPSHR must be the maximum value at which any one or all of the plotted curves, head, horsepower, and efficiency depart from the constant values (point of tangency). Obtain a sufficient number of points to accurately locate the departure point.

2.7.3.6.3 Value of NPSHR

The value of NPSHR must be 2 feet less than the corresponding available net positive suction head available (NPSHA). Determine NPSHA using the temperature of the water in the model at the time the tests are run and the datum shown on Figure 3 at the end of this section. Use the water elevations specified in paragraph CAPACITIES to determine the NPSHA for the pumps.

2.7.3.6.4 Plotting Test Results

Plot the test results to the scales determined by the City at the time of the test. Draw curves showing total head, brake horsepower, and efficiency as ordinates and NPSH as the abscissa. In addition, draw curves showing NPSHR versus capacity with NPSH as the ordinate and capacity as the abscissa. Show NPSHA points on the curves.

2.7.3.6.5 Curves

Should it be considered necessary by the Contractor to take into account measurement inaccuracies when drawing the curve needed to determine NPSHR in accordance with paragraph NPSHR, use the following method. No other method is acceptable. Determine the inaccuracy for each parameter, and furnish the calculations to the City for approval. Using the calculated inaccuracy as the radius and the test point as the center, draw a circle for each test point. Draw two curves, one a maximum and the other a minimum, and pass through or touch each circle. The maximum curve must touch the top and the minimum curve must touch the bottom of as many circles as is practicable while maintaining smooth curves. Should the plot indicate that a test point is obviously erroneous, it may be ignored by mutual consent or the test may be rerun. Halfway between the maximum and minimum curves, draw another curve (the mean). The point at which the mean curve departs from the constant values (point of tangency) is considered to be the NPSHR of the pump for the capacity at which the test was run.

2.7.3.7 Witness Test

When the Contractor is satisfied that the tested pump performs in accordance with the requirements of the specifications and the guaranteed values, notify the City that the witness tests are ready to be run and furnish copies of the curves required in paragraph PUMP TEST AND CAVITATION TESTS along with a set of sample calculations with constants and conversion factors. Also, provide instrument calibration data in this report. Two weeks will be required to review this data before the City will be available to visit the Contractor's laboratory for witnessing the test. Should the results of the witness test reveal that the tested pump does not perform in accordance with the requirements of the specification and the guaranteed values, make such changes as are required to make it acceptable before again notifying the City that the witness tests are ready to be run. Immediately upon completion of each witness test, submit copies of all data taken during the test to the City witnessing the test. Furnish computations of test results and plotted preliminary curves to the witness.

2.7.3.8 Test Report

Submit, within 30 days of receipt of approval of the witness test, to City 3 hard bound copies of a report covering completely the test setup and performance and cavitation tests. Include, as a minimum, there following in each test report:

a. Provide a statement of the purpose of the test, the name of the project, contract number, and design conditions. Also provide where guaranteed values differ from specified values.

b. A resume of preliminary studies, if such studies were made.

c. A description of the test pump and motor, including serial numbers, if available. Information required under "b" may be included here.

d. A description of the test procedure used, including dates, test personnel, any retest events, and witness test data.

e. A list of all test instruments with model numbers and serial numbers.

f. Sample computations (complete).

g. A discussion of test results.

h. Conclusions.

i. Photographic evidence in the form of either multiple color photographs of test equipment, test setup, and representative test segments, and a digital recording on optical disc, at least 30 minutes in length, covering the same information as photographs. Label all photographic evidence with the Contract number, location, date/time, and test activity. Voice annotate the digital recording with the same information.

j. Copies of instrument calibration.

k. Copies of all recorded test data.

l. Curves required by paragraph TESTS RESULTS.

m. Curves showing the performance of the test pump.

n. Drawings of the test setup showing all pertinent dimensions and elevations and a detailed dimensioned cross section of the pump.

o. The name and credentials of the Erecting Engineer(s) who was(were) responsible for the pump testing.

2.8 BASEPLATE AND SUPPORTS

Proportion the baseplate to support the entire pump assembly, the motor and the loads (including the results of the dynamic analysis) to which it may be subjected during operation. Support and anchor is as indicated. Furnish lifting lugs or eye bolts, special slings, strongbacks, or other devices necessary to handle the pump during loading, unloading, erection, installation, and subsequent disassembly and assembly. Provide a sole plate as indicated under the baseplate. Install, level and grout the sole plate in accordance with API RP 686, Chapter 5 - Mounting Plate Grouting. Provide leveling nuts for leveling the baseplate assembly. Provide an anchor bolt layout to aid in placement of anchor bolts. Back off all leveling jacking bolts after grouting so that they do not support any of the load. The pedestal supporting the motor must contain a 1-inch lip to contain water leakage from the shaft packing. Provide a threaded drain to the sump. Provide the calculations used in the design of the baseplates and the anchoring bolts to ensure that the proper forces (shear, torsion, etc.) have been considered. The baseplates must be structural steel plate of adequate thickness to support the weight of the pump and right angle hear or motor (as applicable) plus the maximum hydraulic thrust of the pump. Provide plates of the length and width indicated, and the thickness as determined by the pump manufacturer.

2.9 PUMP DRAINAGE

Provide drain holes for all parts of the pump to eliminate trapped water. These drain provisions must be self-draining without any requirement to enter the sump.

2.10 FACTORY ASSEMBLY

The pump must be assembled at the manufacturer's plant in a vertical position to assure proper fitting and alignment of all parts. Tolerances cannot exceed those specified or shown on the manufacturing drawings. Check rotating elements for binding. The suction bell, impeller housing, diffuser, and the discharge elbow must be properly match marked and have their centerlines clearly marked on the outside of all flanges to facilitate erection and alignment in the field. Notify the City sufficiently in advance to permit a representative of the City to inspect and witness the pump assembly. Matchmark all parts disassembled for shipment.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Equipment

a. Install the equipment furnished under this section and related drive machinery furnished under other sections of this specification in accordance with the approved Installation and Erection Instructions Manual; no later than time of pump delivery, submit a typed or printed, and bound, digital manual describing procedures to be followed by the erecting engineer in erecting, assembling, installing, and dry-and wet-testing the pump. To the extent necessary or desirable, coordinate and consolidate description of the pump with similar descriptions specified for the gear reducer and diesel engine.

   (1) The description must be a complete, orderly, step-by-step explanation of operations required, and also include such things as alignment procedures, bolt torque values, permissible blade/bowl clearances; permissible bowl out-of-roundness; permissible shaft misalignment; recommended instrument setups; recommended gages and instruments; bearing clearances; and similar details.

   (2) Complement and supplement the description with drawings, sketches, photos, and similar materials to whatever extent necessary or desirable, resulting in a description that may be comprehended by an engineer or mechanic without extensive experience in erecting or installing pumps of this type.

b. The erection engineer(s), familiar with the equipment to be installed, must supervise the handling, installation, start-up and testing of the equipment as required by paragraph QUALITY ASSURANCE.

c. Submit digital copies of Operation and Maintenance Instructions Manual containing complete information on operation, lubrication, adjustment, routine and special maintenance, disassembly, repair, reassembly, and trouble diagnostics for the pump and auxiliary units. Provide the operation and maintenance manual and both parts lists on optical disc, formatted to print on ANSI size A 8-1/2 by 11-inch paper. Drawings incorporated in manual or parts lists, may be reduced to page size provided they are clear and legible, or may be folded into the manual to page size. Photographs or catalog cuts of components may be included for identification. Submit operation and maintenance data in accordance with section 01 78 23 Operation and Maintenance Data.

3.1.2 Pipes and Joints

Install pipes and joints in accordance with AWWA M11.

3.2 FIELD TESTS

Prior to proceeding with construction of the test setup but not later than 90 days after date of notice to proceed, submit a description of the test setup and test procedure proposed. Include dimensioned drawings and cross-sectional views of the setup and pump, respectively, with location of instruments and points of their connection shown.

3.2.1 Dry Tests

Test each pumping unit, consisting of a pump and motor in the dry to determine whether it has been properly erected and connected. After each pumping unit has been completely assembled, including all rotating elements and the lubrication system, operate at the full rated speed for a period of fout (4) hours, to assure proper alignment and satisfactory operation.

b. Take vibration measurements in accordance with HI 9.6.4. Vibration limits cannot exceed those recommended by HI Figure 9.6.4.2.5.16. If it is not possible to operate the pump at its best efficiency point, vibration limits may be adjusted in accordance with the requirements of the stated standard.

d. Repeat the dry test run if it is necessary to interrupt the test before all bearing temperatures have become stable. The temperature rate of rise for any bearing has not stabilized, terminate the test until the cause of overheating is determined and corrections are made. Then repeat the dry test run. Should tests reveal that there is a design deficiency or a manufacturing error in the pumping unit components, promptly correct the problem.

3.2.2 Wet Tests

Test each pump unit under load, at or near normal operating conditions, for at least twelve (12) hours or as directed by the City; the test will be witnessed by the City. Provide all supplies and equipment required to conduct the test. During the test Observe, measure and record the operation of the pumps during the test for sound, vibration and bearing temperatures. Without additional costs to the City, make all changes and correct any errors. The City may waive or postpone the test if sufficient water is not available.

-- End of Section --