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PART 1 - INTRODUCTION

1.1 This section applies to the hydronic pumps for HVAC, plumbing, and utility systems.

PART 2 - GENERAL DESIGN REQUIREMENTS

2.1 Pump Selection Considerations

A. The pump motor shall be selected as non-overloading over the entire pump curve shown by the manufacturer. Pump performance and motor characteristics shall be such that motor will not be loaded beyond its service factor.

B. The head/capacity characteristic-curve should continuously rise as flow is reduced to shutoff (or zero flow).

C. The pump should be selected with provisions for increased capacity.
   1. Pump TDH should be greater than system design head. Plan for 10 percent growth.
   2. Pump casing shall be selected with provisions for replacing impellor for both greater flow and head.
   3. Pump connection shall match system service Class. For example, systems with Class 300 valves shall have a pump with Class rating.

D. The pump should not be operated below the manufacturer's minimum continuous flowrate.

E. Pumps shall be selected for 1750 rpm, when available. Designer shall provide documentation justify selecting pumps at RPM's greater than 1750.

F. Mechanical seals, bearings, and pump material shall be rated for fluid type, and maximum system temperature and pressure.

G. Pump seals for most systems shall be mechanical type. When packing seals and or stuffing boxes are required, review the application with facility engineering.

H. Consultant shall design each application for optimal operating efficiency, reliability, and flexibility with the lowest life cycle cost.

I. Design for efficient and stable system operation: Professional shall determine the anticipated minimum and maximum loads for each pumping system and evaluate most appropriate number, combination and arrangement of pumps for optimal efficiency and stable operation of pumps and distribution over entire operating range.

J. Minimum Flow Considerations
   1. Overall pumping system shall be capable of operating effectively in extreme part load without deadheading or shutting off pumps entirely.
   2. Do not use automatic bypass valve installed in mains (directly across the pump) to ensure minimum flow. Provide means for maintaining minimum flow, and stable fluid temperature.
   3. If otherwise unavoidable to assure stable operation at very low flows (avoiding deadheading) and/or to maintain temperatures in the loop, small bypass control valves may be located out at the end(s) of the distribution piping system. The sizing of these valves shall be based on the absolute MINIMUM flow requirements of the pump operating at its minimum speed (as described above), not just an arbitrary "rule of thumb" percentage of the full design flow. In these cases, the bypass shall be normally closed and open only when pump/VFD is at minimum speed and DP set point is exceeded for a specified minimum period of time (5 minutes (adj.)).

K. All rotating parts shall be statically and dynamically balanced.

L. The inlet suction size shall be the same size as pipe connection, or larger.

2.2 System requirements

A. Provide (N + 1) pumps for the following applications.
   1. Perimeter heating systems
   2. RH and PH heating systems
   3. Critical systems.

B. Isolation valves shall be pipe size.

C. Pumps shall not have triple duty type valves

D. Pumps shall have separate isolation, balancing, and check valves.

E. Pumps shall include a suction diffuser, or suction pipe shall be designed in accordance with

applicable ANSI pump standards.

F. Pump inlet and outlet connections shall have suitable and system rated flexible connections. Flexible connectors shall have restraints where required.

G. Pumps shall be set on a minimum 4 inch high concrete pad or as appropriate.

H. Pump shall have suitable vibration isolation, including pipe connections.

I. Pumps shall be placed on inertia pads where applicable.
   1. Specify appropriate type spring type pipe hangers to account for pump movement.

J. Vibration dampening shall be consistent with the ASHRAE publication HVAC Noise and Vibration Control.

K. The inlet and outlet of each pump shall include a suitable thrust restraint.

L. Pumps shall be independently secured, and not rely on inlet and outlet piping connections and associated pipe hangers. Certain in-line pumps may be omitted from this criteria.

M. In-line pumps shall be secured with hanging rod and or suitable and rated seismic compliant system.

2.3 OPERATIONS and MAINTENANCE

A. Specify fully assembled units with flanged pipe connections. Installation shall permit complete serviceability without the necessity of breaking piping or motor connections.

B. There shall be a common liquid filled gauge shared between the suction and discharge of each pump (Duplex Units). There shall be isolation valves arranged to measure pressure separately for both the inlet and outlet side of the pump, and additionally to measure the delta P between the inlet and outlet of the pump. Pressure gauges shall have a rated ball valve to isolate and replace the pressure gauge.

C. Parallel pump set shall include isolation valves for each pump, and non-slamming backflow devices.

D. Each pump casing shall include a low-point drain, and high point vent connection.

E. Pumps shall include a removable OSHA approved coupling guard.

F. Pump casings shall be insulated. The insulation shall be removable and reusable. See Insulation Standard for other requirements.

G. Install pumps and associated appurtenances in strict accordance with the manufacturer's requirements for maintaining satisfactory hydraulic performance.

H. Equipment Layout: Maintain minimum recommended service clearances around pumps of 36 inches, and or manufacturer requirements. The greater of the two criteria shall apply.

I. Critical pumping systems shall undergo baseline vibration testing prior to turn-over to facility operations. Baseline vibration shall be conducted by a third party, and the report shall be turned over to Yale. Any deficiencies identified in the report shall be corrected by the installing contractor.

PART 3 - MINIMUM PRODUCT REQUIREMENTS

3.1 General Requirements

A. Pump types for specific services shall conform to the specification Sections listed in the following schedule:

Pump Service Schedule		
Service	Pump Type	Spec. Ref. Sec. and Article
Heating hot water	Base mounted, end suction	
Domestic hot water (NSF 61 no-lead approved)	In-line circulator or base mounted, end suction	
Utility Chilled water	Base mounted, split case	
Building chilled water	In-line circulator or base mounted, end suction	
DI/RO water	In-line or Base mounted, end suction	
Sewage lift pumps (ejectors)	Sewage ejectors	
Well water lift pumps	Vertical turbine pump	
Fire pumps	Base mounted split case	
Sump pump (water service)	Sump pump	
Submersible sewage pump	Submersible sewage pump	

3.2 Pump Types and Materials of Construction

A. General: For all types of pumps listed below, bearing frame and pump internals shall be

serviceable without disturbing motor or connected piping.

3.3 BASE-MOUNTED END SUCTION PUMPS

A. Pumps: Centrifugal, single stage, integrally mounted with motor upon a fully enclosed cast-iron or reinforced steel base. A flexible type coupler with guard shall connect the motor to the pump.

B. Casing: Minimally rated at 175 psi working pressure, furnished with gauge, vent, and drain ports. Class 30 cast-iron volute with integral pedestal support. Fully enclosed impeller, keyed to shaft and cap screw secured. Impeller material is specific to the service fed.

C. Mechanical Seal: Suitable for continuous operation at 225ºF, provided with a ceramic seal seat, carbon seal ring and replaceable bronze shaft seal. For high temperature service (380ºF) provide high temperature Durametallic seals and fittings for connection of a cold water source for seal cooling.

D. Bearings: Regreaseable, heavy duty ball bearings, replaceable without disturbing piping connections.

E. Stainless Steel Pumps: Design pumps to meet the requirements of ANSI B73.1. Construct wetted metallic parts using passivated 316 stainless. Provide Viton elastomers, John Crane mechanical seals, and wetted seal components of 316 stainless steel, ceramic, or glass-filled Teflon®. Provide 400 grit internal finish.

3.4 BASE-MOUNTED SPLIT CASE PUMPS

A. Pumps: Centrifugal, horizontal split case, single stage, integrally mounted with motor upon a fully enclosed structural steel base. A flexible type coupler with guard, shall connect the motor to the pump.

B. Casing: Cast-iron, dowelled, single volute, axially split, with flat face suction and discharge flanges cast into the lower half, and integral pedestal support. Flanges rated at 150 psi or 1.25 times actual working pressure, whichever is greater. The two halves shall be bolted together and designed for removal of shaft assembly without disturbing piping or motor mounting. Provide tappings for sealing fluid at stuffing box area, drain holes, air release or volute priming, suction and discharge gauges. Provide split glands with swing bolts as a packing retainer in the stuffing boxes. Boxes shall accept a single mechanical seal.

C. Impeller: Fully enclosed, statically and dynamically balanced, keyed to shaft. Provide annular type cast-iron wearing rings, locked against rotation, for the casing. Cast impeller wear ring integrally with the impeller. Impeller material is specific to the service fed.

D. Steel Shaft: Fully machined, keyed at the coupling end, provided with renewable bronze or stainless steel shaft sleeves which shall be firmly butted against the impeller hub with threaded sleeve nuts. Ring type packing shall be provided along with a split water seal cage. Provide lubricated deep grooved ball bearings on the shaft inboard and outboard

radial areas. For high temperature hot water service (380ºF/or greater) provide high temperature Durametallic seals and fittings for connection of a cold water source for seal cooling.

E. Stainless Steel Pumps: Design pumps to meet the requirements of ANSI B73.1. Construct wetted metallic parts using passivated 316 stainless. Provide Viton elastomers, John Crane mechanical seals, and wetted seal components of 316 stainless steel, ceramic, or glass-filled Teflon®. Provide 400 grit internal finish.

F. Fire Pumps: Shall meet all requirements of NFPA 20 and Owner's insurance underwriter.

3.5 VERTICAL TURBINE PUMPS

A. Pumps: Water lubricated turbine type, provided with bowl assembly, strainer, column and enclosed line shaft, discharge head and motor.

B. Bowls: Close grained cast-iron, accurately machined. Support stainless steel impeller shaft with neoprene bearings located on each side of the impeller.

C. Impeller: Accurately fitted and balanced, secured to shaft with tapered lock bushing or stainless steel thrust washer, key and snap rings. Impeller material is specific to the service fed. Adjustable through a top shaft adjusting nut.

D. Discharge Column Pipe: Furnished with interchangeable sections connected with threaded, sleeve type couplings. Provide butted joints to assure proper column alignment and line shafts coupled with threaded steel couplings machined from solid bar steel. Fit shaft with replaceable stainless steel sleeves. Column assembly guides shall be bronze. Each guide shall contain a water lubricated rubber bearing designed for the service intended.

E. Discharge Head: Cast-iron or fabricated steel consisting of a motor mounting ring, discharge elbow, and pump mounting base.

3.6 IN-LINE CIRCULATORS

A. Circulators: Centrifugal, single stage, flexibly close coupled, in-line, serviceable without removing from piping.

B. Casing: Cast-iron, rated for 125 psi working pressure. Impellers shall be cast-iron or cadmium plated steel with a heat treated carbon steel shaft.

C. Mechanical Seal: Carbon against a ceramic seat.

D. Bearings: Bronze, sleeve type, oil lubricated.

3.7 DOMESTIC HOT WATER CIRCULATORS

A. Circulators: Centrifugal, single stage, flexibly close coupled, in-line, serviceable without removing from piping.

B. Construction: All bronze, including casing, impeller, pump bearings, etc., especially designed for domestic water service.

C. Mechanical Seal: Carbon against a ceramic seat.

D. Bearings: Bronze, sleeve type, oil lubricated.

3.8 SEWAGE EJECTORS

A. Type: Heavy-duty, duplex, screenless, with nonclog 2-blade dynamically balanced impeller.

B. Pumps: Provide with stainless steel shaft, cast-iron suspension pipe, intermediate bearings, pressure grease fittings and pipes, stuffing box, ball thrust bearing, flexible coupling, motor support, and discharge pipe.

C. Motors: Pedestal mounted, drip proof.

D. Float Switch: Enclosed drip-proof automatic, pedestal mounted, for each pump. Accessories shall include a heavy copper float, guided float rod, and float cage.

E. Wall-mounted Duplex Control Panel: Prewired, provided to operate in conjunction with float switches. Panel shall contain fused disconnects with handles through cover, magnetic starters with overload reset through cover, separately fused automatic alternators, running lights, and terminal strip ready for field interconnections required for motors, float switches, and power.

F. High Water Alarm: Installed in the basin cover, provided with a transformer and alarm bell each of which shall be located in the control panel with appropriate prewiring to terminal strip, ready for field wiring to alarm proper.

G. Pump Basin: Cast-iron, sized as indicated on Contract Drawings. Basin depth shall be at least 3' deeper than lowest inlet.

H. Cast-Iron Basin Cover: Provide with appropriate openings for pumps, float rods, alarm, manhole, and vent. All parts shall be machined to fit gas-tight. Set cover flush with finished floor when a concrete basin is used.

I. Check Valve: Provide check valve(s) in each pump discharge line and connect together into a single main. Vent basin through opening in cover. Extend vent to a suitable location outdoors or as indicated on plans.

3.9 SUMP PUMPS

A. Pumps shall be fully submersible, furnished with cast-iron housing, integral diaphragm switch, oil filled continuous-duty double ball bearing motor with built-in overload protection, corrosion protected steel shaft, nonclog bronze impeller, motor cord, and cap.

B. Provide a check valve in the pump discharge line.

3.10 SUBMERSIBLE OR SEWAGE PUMPS

A. Pumps: Duplex vertical centrifugal, fully submersible, screenless, having integral NEMA 6 motor housed in an air-filled cast-iron shell, Class F insulated windings, prelubricated double seal bearings, stainless steel shaft, and impeller locknut. Motor end bell shall serve as a terminal box.

B. Impeller: Cast-iron, 2 vane type, statically and dynamically balanced. Mechanical seal shall have dual rotating carbon faces and companion stationary ceramic seats, spring loaded

between faces. Seals housed in an oil filled chamber.

C. Accessory Items: Brass and neoprene component compression sealing assembly, Buna-N O-rings, type 50 neoprene jacketed power cable, and NEMA 6 junction box.

D. Control Panel: NEMA 3R, duplex arrangement, containing motor disconnect switches, starters, automatic alternator, test-off-auto selector switches, "run" lights, control transformer, audible visual alarm with silencing switch, terminal strip and internal wiring.

E. Mercury Switches: Sealed in polypropylene floats and furnished with PVC coated UL listed cable, and bracketed to a galvanized suspension rod. Switches control pump operation and energize alarm system in the event of high water. Second pump starts if first stops or fails to carry load. During normal operation, pumps alternate.

F. Pump Basin: Cast-iron, fiberglass, or cast-in-place concrete, sized as indicated on Contract Drawings. Basin depth shall be at least 3' deeper than lowest inlet, unless otherwise specified. Provide a steel pump access cover with appropriate openings for pump removal, wiring and vent. Cover shall be gas tight.

G. Check Valve: Provide check valve(s) in each discharge line and connect together into a single main. Extend basin vent to a suitable location outdoors or as indicated on plans.