SECTION 23 21 23 - HYDRONIC PUMPS

PART I - GENERAL

1.1 SECTION INCLUDES

A. Single-stage Centrifugal Pumps

1. In-line Close-coupled
2. Base-mounted End Suction
3. Horizontal Split Case
4. Pump Seals

1.2 RELATED SECTIONS

A. Section 23 21 13 – Hydronic Piping

B. *Section 23 07 16 – HVAC Equipment Insulation*

C. *Section 23 09 13 - Instrumentation and Control Devices for HVAC*

D. *Section 26 60 00 – Common Motor Requirements*

E. *Section 26 29 23 – Variable Frequency Motor Controllers*

1.3 REFERENCES

A. Hydraulic Institute Standards

B. NEMA Standards

C. ASME B31.9 – Building Services Piping

D. International Mechanical Code

E. Illinois Steel Products Procurement Act

1.4 QUALITY ASSURANCE

A. Products and execution shall be in compliance with applicable codes and standards including those referenced above in paragraph *1.3 REFERENCES above*.

B. Installation, start-up and operation shall be in compliance with Manufacturer's recommendations and IOM.

1.5 SUBMITTALS

A. General information

1. Manufacturer, type, full unit description
2. Suction, discharge connection, impeller size
3. Dimensional data, materials of construction, shipping weight
4. Detailed sectional drawings of pump, seals, bearing assembly
5. Pressure, temperature rating

B. Performance Information

1. Capacity (GPM), head (ft.), NPSHR, efficiency (%)
2. Pump performance curve with design operating point identified

3. Series of Curves - Iindicating rrelationship of CFM, SP, RPM, % efficiency and BHP for variable speed applications

C. Seals

1. Manufacturer, type, description
2. Face materials, elastomers

D. Motor

1. Manufacturer, enclosure type, frame size, nominal efficiency (%)
2. Horsepower (HP), phase (Ph.), rotational speed (RPM),
3. Voltage (V), full load amperage (FLA), frequency (Hz),
4. Service Factor (SF)

E. Miscellaneous

1. Wiring diagram
2. Options, accessories information
3. Vibration Isolator Information (if applicable)
4. Installation and operation manual
5. Certified factory test report (if applicable)

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Pump assembly shall be protected from physical damage and weather during transport.

B. Pump assembly shall be stored indoors protected from physical damage and exposure to dust and debris.

C. Pump assembly shall be protected from physical damage and exposure to dust and debris during construction.

1.7 MANUFACTURER'S SITE SERVICES

A. For double suction pumps, manufacturers factory trained service technician shall provide pump start-up services.

1. Start-up services shall be as indicated in section entitled *STARTUP* in PART 3 of these specifications.
2. Signed and dated start-up report and warranty certificate shall be provided to AE.
3. Start-up report shall provide pertinent information confirming that all requirements of contract documents have been satisfied, including specified and/or scheduled performance requirements.
4. Start-up report shall provide confirmation that water quality is acceptable for use with specified pump seals, as installed.

1.8 WARRANTY

A. Pump assembly, including motor, shall be warranted to be free from defects in material and workmanship and to perform as specified for period of one year from date of startup or 18 months from date of delivery, whichever occurs first. Defective product shall be repaired or replaced at no cost to Owner.

PART 2 – PRODUCTS

[Note to AE: Include bypass flow through bag filter and remote bypass valve when determining pump GPM]

[Note to AE: Pump selection shall be based upon 60 Hz motor frequency at design operating point. However, if desired, capacity can be increased in the future by "over-speeding" the motor via VFD. Electric motor operation above 60 Hz. has become accepted practice. However, pump speed can only be increased within the limits of FLA. Thus, motor HP may need to be "oversized" initially to provide an amperage buffer for future. Initial pump selection shall not be based upon frequency less than 60 Hz. in anticipation of future speed increase. This approach limits available motor HP. Pump motors shall never be operated in excess of 80 Hz.]

2.1 CENTRIFUGAL PUMPS

A. Approved for UIUC projects
   1. In-line, close coupled, $\leq$ 2 HP
   2. Base mounted, end suction, $\leq$ 6" suction connection
   3. Double suction, horizontal split case, $\geq$ 8" suction connection

B. Disallowed for UIUC projects
   1. Close-coupled base mounted (e.g. Bell and Gossett Series 1531)
   2. Double suction, vertical (radial) split case (e.g. Bell and Gossett VSC, VSCS)

2.2 IN-LINE CENTRIFUGAL PUMPS, CLOSE COUPLED

A. Size
   1. 2 HP and smaller

B. Design
   1. In-line, close-coupled
   2. Pipeline mounted, supported by piping only
   3. Common inlet-outlet center line
   4. NPT or flanged connections
   5. "Back pull-out"
      a. Serviceable without disturbing pipe connections

C. Performance
   1. As indicated in schedule
   2. Pump shall be selected as close as possible to best efficiency range

D. Volute
   1. Cast Iron
   2. 175 PSIG working pressure
   3. Inlet straitening vane(s)
   4. Tapped and plugged suction, discharge, vent and drain openings
   5. Renewable bronze casing wear ring

E. Impellor

1. Bronze, enclosed
2. Mounted directly on motor shaft
3. Keyed and locked to shaft
4. Hydraulically and dynamically balanced

F. Shaft
1. High strength carbon steel or stainless steel
2. Bronze or stainless steel shaft sleeve

G. Seal
1. See section below entitled *PUMP SEALS, MECHANICAL* for requirements
2. Rated 225F continuous operation

H. Motor
1. 2 HP maximum
2. Compliant with *Section 26 60 00 – Common Motor Requirements*
3. Characteristics as indicated in schedule
   a. Phase, voltage, full load amps, efficiency, frequency (Hz.)
   b. 1750 RPM maximum
4. 3 phase motors shall have VFDs provided by Electrical Contractor. Coordination shall be provided.

I. Basis of design
1. Bell and Gossett Series 90 (Series 60 flexible coupled not allowed)

J. Approved Manufacturers
1. Bell and Gossett
2. Aurora
3. Armstrong

2.3 IN-LINE CENTRIFUGAL PUMPS, CLOSE COUPLED, STAINLESS STEEL

A. Pump shall satisfy all requirements of section entitled *IN-LINE CENTRIFUGAL PUMPS, CLOSE COUPLED* with following exceptions:
1. Following components shall be Type 316 stainless steel
   a. Volute
   b. Impeller
   c. Wear ring
   d. Seal housing
   e. Shaft sleeve

2.4 BASE-MOUNTED END-SUCTION CENTRIFUGAL PUMPS

A. Size
1. 6” suction connection and smaller

B. Design

1. Base-mounted, end suction, flexible coupled
2. “Back pull-out” with drop-out spacer coupling
3. Impellor and bearing assembly removable without…
    a. disturbing piping
    b. removing impeller from shaft
    c. moving motor
    d. shaft realignment

C. Performance
1. As indicated in schedule
2. Pump shall be selected as close as possible to best efficiency point

D. Vibration
1. 0.15 in./sec. maximum

E. Volute
1. Cast Iron
2. 175 PSIG working pressure
3. Integral volute “support foot”
    a. Provide full support of weight of piping
        (a) Allow removal of rotating assembly without volute movement
        (b) Eliminate need for realignment
4. Tapped and plugged suction, discharge, vent and drain openings
5. Renewable bronze casing wear ring

F. Impeller
1. Bronze or stainless steel, enclosed
2. Keyed and locked to shaft
3. Hydraulically and dynamically balanced

G. Shaft
1. High strength carbon steel
2. Replaceable bronze or stainless steel shaft sleeve

H. Seal
1. See section below entitled *PUMP SEALS, MECHANICAL* for requirements.
2. Recirculation / flush lines and appurtenances shall be provided as specified therein.
3. Seal shall be rated 250F continuous operation.

I. Drip capture
1. Drip capture feature or stainless steel drip pan with NPT connection

J. Bearing assembly
1. Cast iron housing

2. Easily separable from volute
3. Greasable sealed antifriction ball or roller bearings
4. OSHA approved coupling guard

K. Motor

1. Compliant with *Section 26 60 00 – Common Motor Requirements*
2. Characteristics as indicated in schedule
    a. RPM, phase, voltage, full load amps, efficiency, frequency (Hz.)
    b. 1,750 RPM maximum
3. 3 phase motors shall have VFDs provided by Electrical Contractor. Coordination shall be provided.

L. Frame/base plate

1. Channel steel, fully enclosed sides
2. Fully groutable through top access
3. Motor positioning rails
4. Completely rigid

M. Approved Manufacturers

1. Bell and Gossett
2. Armstrong
3. Aurora

2.5 BASE-MOUNTED END-SUCTION CENTRIFUGAL PUMPS, STAINLESS STEEL

A. Pump shall satisfy all requirements of section entitled *BASE-MOUNTED END-SUCTION CENTRIFUGAL PUMPS* with following exceptions:

1. Following components shall be Type 316 stainless steel
    a. Volute
    b. Impeller
    c. Wear ring
    d. Seal housing
    e. Shaft sleeve

2.6 DOUBLE-SUCTION HORIZONAL SPLIT-CASE CENTRIFUGAL PUMPS

A. Size

1. 8” suction connection and larger

B. Design

1. Base-mounted
2. Double suction
3. Horizontal split case
4. Flexible coupled

C. Performance

1. As indicated in schedule
2. Pump shall be selected as close as possible to best efficiency point

D. Vibration
   1. 0.15 in./sec. maximum

E. Volute
   1. Cast iron, 175 PSIG working pressure
   2. Upper casing removable without disturbing piping
      a. Jack screws, alignment dowels
      b. Eye bolt or lifting lugs
   3. Lower casing with integrally cast flanges, bearing supports, support feet
   4. Tapped and plugged suction, discharge, vent and drain openings
   5. Renewable bronze casing wear ring

F. Frame/base plate
   1. Common base plate for pump and motor
   2. Structural steel, completely rigid, fully enclosed sides
   3. Fully groutable through top access
   4. Threaded jack screws for motor positioning

G. Impeller
   1. Bronze, enclosed
   2. Keyed and locked to shaft
   3. Hydraulically and dynamically balanced
   4. Renewable bronze impellor wear ring

H. Shaft
   1. High strength carbon steel
   2. Replaceable bronze shaft sleeve

I. Seals
   1. See section below entitled *PUMP SEALS, MECHANICAL* for requirements.
   2. Recirculation / flush lines and appurtenances shall be provided as specified therein.

J. Drip capture
   1. Drip capture feature or stainless steel drip pan with NPT connection

K. Bearing assemblies
   1. Cast iron housing/retainer
   2. Easily separable from volute
   3. Greasable sealed antifriction ball or roller bearings
   4. Rated L-10 100,000 hr. service life
   5. Water slinger

L. Coupling

1. Flexible, drop out spacer type allowing pump servicing without repositioning motor
2. OSHA approved coupling guard

M. Motor

1. Compliant with *Section 26 60 00 – Common Motor Requirements*
2. Characteristics as indicated in schedule
    a. RPM, phase, voltage, full load amps, efficiency, frequency (Hz.)
    b. 1,750 RPM maximum
3. Motor shall have VFD provided by Electrical Contractor. Coordination shall be provided.

N. Approved Manufacturers

1. Flowserve
2. Goulds
3. Peerless, if approved by AE and Owner

[Note to AE: Given the multiple types and complexity of mechanical seals, a separate section has been provided to address them independently of pumps.]

2.2 PUMP SEALS, MECHANICAL

A. Close Coupled In-Line Pumps (≤ 2 HP)

1. Component seal, rotary design
    a. Carbon / ceramic or carbon/silicon carbide seal faces
    b. Cup-mounted seals
    c. 316 SS, Hastelloy seat springs

B. Vertical Split Coupled In-line Pumps (≥ 3 HP)

1. ≤ 10 HP: Component seals, rotary design
    a. Carbon / ceramic seal faces
    b. Unspecified O-Ring material
    c. 316 SS, Hastelloy seat springs
    d. Recirculation / clean water flush lines not required for standard applications
2. ≥ 15 HP: Balanced cartridge seal, stationary design
    a. Carbon / silicon carbide seal faces
    b. Viton O-Rings
    c. 316 SS, Hastelloy seat springs
    d. Recirculation / flush lines shall be provided as specified for double suction pumps

C. Close Coupled Base-mounted Pumps (Not allowed by UIUC)

D. End Suction Pumps (≤ 6” suction connection size

1. ≤ 10 HP: Component seal, rotary design
    a. Cup-mounted seals

b. 316 SS, Hastelloy seat springs

c. Recirculation / clean water flush lines not required for standard applications

2. ≥ 15 HP: Balanced cartridge seal, stationary design

a. Viton cup-mounted seals

b. 316 SS, Hastelloy seat springs

1) Recirculation / flush lines shall be provided as specified for double suction pumps

[Note to AE: With approval of Owner requirements for recirculation and flush lines and appurtenances may be deleted. This may be appropriate for certain applications.]

E. Double Suction Pumps (≥ 8" suction connection size)

1. Balanced cartridge seals, stationary design. Component seals not allowed.

a. Carbon / silicon carbide seal faces

b. Viton O-Rings

c. 316 SS, Hastelloy seat springs

d. Approved Manufacturer

1) John Crane #3740 split seal

e. Clean water systems (e.g. chilled water)

1) Recirculation lines (connection to top of volute not allowed)

(a) In-line filter housing with 5 micron replaceable cartridge, each seal

(b) Rotameter, each seal

(c) Flush water throttling device, each seal

i. Adjusted to 5-10 GPH each

f. Dirty water systems (e.g. cooling tower water)

1) Clean water (i.e. domestic water) flush lines

(a) In-line filter housing with 5 micron replaceable cartridge, each seal

(b) Rotameter, each seal

(c) Flush water throttling device, each seal

i. Adjusted to 5-10 GPH each

(d) Close-tolerance throat bushing, each seal

i. Provided when limitation of flow into closed loop system is required

ii. Adjusted to 15 FPS velocity through annular space

(e) Solenoid valve (for shut off of domestic water when pump is off)

[Note to AE: With approval of Owner requirements for recirculation and flush lines and appurtenances may be deleted. This may be appropriate for some applications.]

F. Steam Condensate Pumps

1. Component seal, rotary design

a. Carbon / silicon carbide seal faces

b. Aflas or Viton O-Rings

c. Discharge flush line

[Note to AE: Following is the equivalent of "Pump Seals 101" to facilitate pump seal selection. More than you ever wanted to know about pump seals.]

A. Single vs. Double Seals:

1. Single seals are standard and preferred for most applications. Double seals are used to positively contain system fluids.

B. Component vs. Cartridge Seals:

1. Component seals are standard and least expensive.

2. Component seals are multi-piece requiring assembly as they are installed.

3. Cartridge seals are preassembled and are installed as a single unit.

C. Standard vs. Split Seals:

1. Split seals allow replacement without removal of bearings which greatly reduces time and labor required.

D. Face material:

1. Specify both face materials but allow manufacturer to determine which is rotating and which is stationary.

2. Carbon/ceramic is standard, carbon / silicon carbide is superior for most applications including split seals.

3. Tungsten carbide is less brittle, good for face-to-face impact due to movement, also good for sticky fluid (not applicable for HVAC).

4. Tungsten carbide cannot be used for split seals because the material won't "snap".

5. Other materials available as "problem solvers".

E. Rotary vs. Stationary Design:

1. Rotary design is industry standard for small pumps (end suction pumps).

2. Rotary design has a spring-loaded rotating face.

3. Stationary design has a spring-loaded stationary face. Unaffected by "parallelness" of connection between seal and pump gland. Stationary seals only need to correct once.

4. Rotary seals are constantly flexing, exercising springs.

F. Seal elastomer materials:

1. There is no industry standard.

2. Buna is undesirable.

3. EPDM is an upgrade for higher temp but is not suitable for hydrocarbons.

4. Viton is an upgrade for higher temp and chemical resistance.

5. Viton is especially good for acidic fluid, EPDM is good for caustic fluid.

6. AFLAS is a newer O-ring material. It is becoming standard on industrial applications. Good for high temp and chemical resistance, both acidic and caustic (and several other applications).

G. Seal elastomer design, O-ring vs. Cup-mounted:

1. Both are adequate for new seals.

2. Cup-mounted seals are better when seat becomes pitted.

H. Flush lines:

1. Recirculation or clean water flush lines should always be used on larger pumps. They are less important on smaller pumps.

2. Flush lines serve purpose of cooling and preventing build-up of particulate in seals. Also facilitates air venting of seal.

3. Recirculation lines are for clean fluid (e.g. chilled water).

4. Flush lines should be piped from suction side of end suction pumps, cleaner source, additional cleaning due to counter flow centrifugal action within seal.

5. Flush lines should be piped from discharge side of double suction pumps. There is no choice due to relative pressures. Avoid connection to top of volute to avoid dirty water at that location due to centrifugal action of particulate within volute.

6. Clean water flush is required for dirty fluid (e.g. cooling tower water).

7. When limitation of flow into system is required, close-tolerance throat bushings are required. Adjust flow to achieve 15 FPS across annual space.

8. Recirculation lines are required for all steam condensate pumps, primarily for cooling. Must be piped from discharge side to prevent cavitation due to low pressure at suction side.

9. Throttling device and rotameter recommended in each line on larger pumps, for standard application. Adjust flow to 5-10 GPH.

10. When close tolerance throat bushings are used, throttling device should always be used. Adjust flow to 15 FPS through annular space.

PART 3 - EXECUTION

3.1 INSTALLATION

A. In-line pumps

1. In-line pumps shall be rigidly connected to and supported by adjacent piping. Pipe hanger shall be provided each side of pump.

2. Pump shall be located and oriented to provide adequate access for servicing.

3. Where pump and pipe sizes are different, concentric reducer shall be provided at pump discharge connection and eccentric reducer at pump suction connection.

a. Eccentric reducer shall be oriented with top of pipe level.

[Note to AE: Regarding base-mounted pumps… Base-mounted pumps shall typically be "hard-mounted" and "hard-piped" with no flexible pipe connectors or spring supports. This has been standard practice at the University for many years, especially for pumps located on slab-on-grade. It is acknowledged that in a limited number of cases pumps located on upper floors and/or near highly sensitive lab equipment may require spring-supported inertia bases and flexible pipe connectors to minimize transmission of vibration. Pump horsepower shall be treated as a primary factor in making such determination. Large pumps are much more likely to require vibration isolation via flexible support than smaller ones. In cases where transmission of vibration through piping systems is of particular concern, use of spring hangers may be appropriate. In such cases, a typical recommendation is provision of spring hangers for the first three supports either side of the pump. At the end of the day, hard-mounted and hard-piped pump installations shall be treated as default.]

B. Base-mounted pumps, fixed (“hard-mounted”)

1. Concrete curb shall be provided.
    a. Curb shall be 2.5 times weight of pump assembly, minimum.
    b. Curb shall be 4” thick, minimum.
    c. Curb shall extend 6” beyond pump frame on all sides, minimum.
    d. Curb shall be anchored into concrete floor.
2. Pump base shall be rigidly anchored to curb, leveled and fully grouted.
3. Piping shall be rigidly attached to pump suction and discharge connections.
    a. Piping shall be independently supported to prevent loading on pump volute.

C. Base-mounted pumps with spring supported inertia base

[Note to AE: All pumps supported by springs shall have inertia bases, no exceptions.]

1. Concrete curb shall be provided.
    a. Same requirements as *concrete curb* above
2. Concrete inertia base and spring supports shall be provided.
    a. Inertia base shall be steel construction with welded-in reinforcing bars.
    b. Inertia base dimensions, weight and spring design shall be sized by vibration isolator manufacturer.
    c. Inertia base shall be filled with concrete and leveled.
    d. Pump base shall be rigidly anchored to inertia base, leveled and fully grouted.
3. Flexible pipe connectors shall be provided at pump suction and discharge connections.
    a. Connected piping shall be supported independently to prevent loading on flexible connectors and pump volute.
        1) Flexible connectors shall be as recommended by vibration isolator manufacturer and as specified elsewhere in project documents.

[Note to AE: Metal bellows flexible pipe connectors, although they allow physical flexibility, are ineffective as vibration isolators. To accomplish effective isolation spherical “rubber” isolators must be used (e.g. Mason Industries “Safeflex”). Unfortunately, in the experience of the University rubber flex connectors have proven to be more vulnerable to failure, especially in hot water applications. So, metal bellows shall be treated as default. Rubber shall be used only for truly critical applications.]

G. All base-mounted pumps

[Note to AE: On end suction pumps, a suction diffuser or straight length of pipe may be provided immediately upstream of pump suction connection. Straight length of pipe is preferred but space constraints may not accommodate. When straight pipe is used it shall be a minimum of 5 pipe diameters in length, however 10 pipe diameters in length is preferred. A suction diffuser shall not be used by default. Regardless, it may be necessary to edit spec language below for a given project based upon space constraints. Any edits shall be reflected on project drawings.]

1. Length of straight pipe shall be provided at pump suction connection. Straight pipe shall be 5-10 pipe diameters in length. Pipeline strainer shall be provided upstream of straight pipe as indicated on drawings.
2. For end suction pumps, suction diffuser may be used in lieu of strainer and straight pipe at pump suction connection only if indicated on project drawings.

a. Adjustable support leg shall be provided under suction diffuser as indicated in manufacturer's IOM.

3. Length of pipe, 5 pipe diameters minimum, shall be provided at pump discharge prior to first valve or device.

[Note to AE: If impractical to provide required straight run of pipe at double suction pump suction and/or discharge, long radius elbow(s) may be provided. Elbow(s) shall be oriented in vertical plane to ensure balanced flow at pump impeller. Such exception shall be clearly indicated on project drawings. Spec language below shall be edited as required.]

4. Where pump and pipe sizes are different, eccentric reducer shall be provided at pump suction connection and concentric reducer at pump discharge connection.

a. Eccentric reducer shall be oriented with top of pipe level.

5. Flat face pipe flanges on pipe or flexible connectors shall be mated with flat face pump flanges.

6. After pipe connection is complete pump and motor shall be aligned using laser level procedures.

a. After alignment is complete pump shall be pinned to motor base, unless directed otherwise by AE.

b. Alignment report shall be provided to AE.

7. Pressure gauge, manifold and associated valves shall be provided as indicated on drawings.

8. Seal recirculation/flush lines shall be provided if/as specified.

H. Double–suction Pumps

1. Straight run requirements for end suction pumps shall apply to double suction pumps unless clearly indicated otherwise on project drawings.

2. Pipe fittings, strainers, valves, etc. shall be configured to maintain equal loading on both sides of pump impeller to maintain hydraulically balanced system.

3. Valve shafts shall be oriented parallel to pump shaft.

I. Instrumentation

1. Instrumentation shall be provided as indicated within project documents, including P&ID.

2. Instrumentation may include:

a. Motor winding temperature sensors

b. Motor bearing temperature sensors

c. Motor bearing vibration sensors

d. Pump bearing vibration sensors

2.3 START-UP

A. Prior to placing pump in service, following shall be verified:

1. Proper pump installation including pump orientation, support base, piping, associated devices and instrumentation

2. Proper pump/motor alignment

3. Proper pump rotation

4. Voltages within manufacturers acceptable range

5. Proper overload protection
6. Water quality acceptable for use with specified pump seals

B. Prior to starting pump and placing into service, following shall be accomplished:
   1. Pump bearings shall be lubricated if recommended by Manufacturer.
   2. Flow rate of seal recirculating/flush lines shall be adjusted per specification.
   3. Pump shall be primed and air vented.

C. Pump shall be started and proper operation observed and verified.

D. Operation without vibration shall be confirmed
   1. Vibration of installed and operating pump shall not be detectable by technician, AE or Owner.
   2. If in judgment of AE or Owner, vibration level is deemed unacceptable, vibration analysis shall be performed by qualified technician. Field balance of pump shall be provided as required to bring vibration level within specified limits.

E. Signed and dated start-up report including any vibration analysis and correction shall be provided to AE.

F. After initial system cleaning has been completed as addressed in *Section 23 34 16 – Chemical Treatment for Hydronic Systems,* removal of start-up strainer screen shall be verified.

END OF SECTION 23 21 23

This section of the *U of I Facilities Standards* establishes minimum requirements only.
It should not be used as a complete specification.