

NC State University Design and Construction Guidelines

Division 23 Hydronic Pumps

1.0 Purpose

- A. The following guidelines apply to the selection of pumps primarily for circulating water. It is the goal of NC State to purchase pumps that are selected to provide a long service life, minimal maintenance, styles that allow for ease of maintenance, and operate efficiently for the condition of operation.

2.0 General Requirements:

- A. Pump motors to be 74% energy efficient, minimum. The motor shall be sized to handle the full range, from shut-off head to free delivery for the selected impeller.
- B. Pumps to be selected with a reasonable safety factor for conditions, such as pipe roughness and partial loading of strainers
- C. Pump nameplates shall be stainless steel, suitably secured to the pump.
- D. If water has been de-mineralized, modify pump specification to require 316 SS casings, shafts, impellers wear rings, etc.
- E. Pumps should be selected near the midpoints of their curves.
 - 1. The final selection shall place the operating point on the selected impeller curve at or to the left of the point of maximum efficiency.
 - 2. The final selection shall not deviate more than 5% below the point of maximum efficiency.
 - 3. Pump selections shall be based on minimum operating efficiency of 75%.
 - 4. The maximum impeller size shall not be used in any of the pump selections.
- F. Pump submittal data shall include pump speed and characteristic curves for performance of the impeller selected for each pump.
 - 1. Curves shall indicate capacity vs. head, efficiency, and brake horsepower for the full range, from shut-off head to free delivery. NPSH margins shall be included.
 - 2. Submittal data shall include the selected impeller size and the maximum impeller size available.
 - 3. The motor shall be sized to handle the full range, from shut-off head to free delivery for the selected impeller.
- G. Where multiple pumps are installed in mechanical rooms, sufficient space shall be provided between pumps (include pipe and valves) to allow for ease of maintenance.
 - 1. Adequate spacing for maintaining pump lubrication, and replacement of components, such as pump seals, motors, etc.

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2. Provide straight sections of piping, 5 diameters minimum, on the suction and discharge of pumps.
 3. Use long radius elbows within 10 diameters of the suction side of pumps.
- H. Pump to be equipped with vent valve.
- I. Flexible connectors shall be placed in the suction and discharge piping. Flexible connectors shall be placed within 5 feet of the pump. Negligible weight from piping is to be supported by the pump. Piping is to be supported to prevent transmission of significant weight on to the pump.
- J. Base plates shall be cast iron with drip rim and grouted in place.

3.0 Equipment

- A. Close-coupled, in-line centrifugal pumps
1. Manufacturers:
 - a) Armstrong Pumps Inc.
 - b) Aurora Pump; Division of Pentair Pump Group.
 - c) Bell & Gossett; Div. of ITT Industries.
 - d) PACO Pumps.
 - e) Peerless Pump; a Member of the Sterling Fluid Systems Group.
 - f) Taco, Inc.
 - g) Weinman; Div. of Crane Pumps & Systems.
 2. Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump; designed for installation with pump and motor shafts mounted horizontally or vertically. Rate pump for 250-psig minimum working pressure and a continuous water temperature of 225 deg F.
 - a) In-line pumps shall be limited to 500 GPM maximum
 - b) Maximum installed pump height shall be 60" from floor.
 3. Pump Construction:
 - a) Casing: Radially split, Class 30 cast iron, with replaceable bronze wear rings threaded gauge tapings at inlet and outlet, and threaded companion-flange, union end connections.
 - b) Casings shall have tapped and plugged openings for vent, drain, and suction and discharge gauge connections. Provide a gauge, with valves, for suction and discharge pressure.

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- c) Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
 - d) Pump Shaft: High strength S.A.E. 1045 carbon steel with a replaceable, 316 stainless shaft sleeve. Shaft sized to provide minimum deflection, not over 0.002 inches, at the design operating point.
 - e) Balanced Mechanical Seal (for leak-less operation): Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N EPT bellows and gasket. Include water slinger on shaft between motor and seal. Arrangement to provide a portion of the pumped liquid to lubricate and cool the seal faces.
 - f) Seals shall be suitable for conditions encountered with the specific application of the pumps. An internal seal system consisting of tubing that connects the volute to the stuffing box shall be provided. A tap shall be provided over the mechanical seal to introduce clear liquid from an external source, if desired.
 - g) Packing Seal: Stuffing box, with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
 - h) Pump Bearings: Permanently lubricated ball bearings, Oil lubricated; bronze-journal or thrust type . Bearings shall be selected for a minimum life of 200,000 hours. For central plants or large mechanical rooms, bearings shall be oil lubricated. A constant level bottle oiler connected to the oil reservoir shall provide lubrication. For non-central plants pumps and small mechanical rooms pumps, bearings shall be grease lubricated.
 - i) Motor: Single speed, with permanently greased lubricated ball bearings, unless otherwise indicated; and rigidly mounted to pump casing.
 - (1) Motors shall be designed to NEMA Premium motor efficiency
 - (2) Permanently lubricated ball bearings are available up through 5 hp.
 - (3) Larger motors have grease-lubricated ball bearings
- B. Close-coupled, end-suction centrifugal pumps
- 1. Manufacturers:
 - a) Armstrong Pumps Inc.
 - b) Aurora Pump; Division of Pentair Pump Group.
 - c) Bell & Gossett; Div. of ITT Industries.
 - d) Goulds Pumps; Water Technologies Group.
 - e) PACO Pumps.

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- f) Peerless Pump; a Member of the Sterling Fluid Systems Group.
 - g) Taco, Inc.
 - h) Weinman; Div. of Crane Pumps & Systems.
2. Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally. Rate pump for 250-psig minimum working pressure and a continuous water temperature of 225 deg F.
3. End suction pumps shall be limited to 500 GPM maximum at shall be selected to operate at speeds not greater than 1800 RPM.
4. Pump Construction:
- a) Casing: Radially split, Class 30 cast iron, with replaceable bronze wear rings, tapped and plugged drain plug at bottom of volute, tapped and plugged air vent at top of volute, threaded gauge tappings at inlet and outlet, and threaded companion-flange connections. Provide a gauge, with valves, for inlet and outlet tappings.
 - b) Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
 - c) Pump Shaft: high strength S.A.E. 1045 carbon steel with a replaceable, 316 stainless shaft sleeve. Shaft sized to provide minimum deflection, not over 0.002 inches, at the design operating point.
 - d) Unbalanced Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N EPT bellows and gasket. Include water slinger on shaft between motor and seal. Arrangement to provide a portion of the pumped liquid to lubricate and cool the seal faces.
 - e) Seals shall be suitable for conditions encountered with the specific application of the pumps. An internal seal system consisting of tubing that connects the volute to the stuffing box shall be provided. A tap shall be provided over the mechanical seal to introduce clear liquid from an external source, if desired.
 - f) Pump Bearings: Permanently lubricated ball bearings, Oil lubricated; bronze-journal or thrust type .
 - (1) Bearings shall be selected for a minimum life of 200,000 hours.
 - (2) For central plants or large mechanical rooms, bearings shall be oil lubricated. A constant level bottle oiler connected to the oil reservoir shall provide lubrication. For non-central plants pumps and small mechanical rooms pumps, bearings shall be grease lubricated.

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- g) Motor: Single speed, with permanently grease lubricated ball bearings, unless otherwise indicated; rigidly mounted to pump casing with integral pump support.
 - (1) Motors shall be designed to NEMA Premium motor efficiency.
 - (2) Permanently lubricated ball bearings are available up through 5 hp. Larger motors have grease-lubricated ball bearings.
- C. Separately coupled, horizontal, in-line centrifugal pumps
- 1. Manufacturers:
 - a) Armstrong Pumps Inc.
 - b) Aurora Pump; Division of Pentair Pump Group.
 - c) Bell & Gossett; Div. of ITT Industries.
 - d) PACO Pumps.
 - e) Taco, Inc.
 - 2. Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically. Rate pump for 250-
psig minimum working pressure and a continuous water temperature of 225
deg F.
 - a) In-line pumps shall be limited to 500 GPM maximum
 - b) Maximum installed pump height shall be 60" from floor.
 - 3. Pump Construction:
 - a) Casing: Radially split, Class 30 cast iron, with threaded gauge tappings at inlet and outlet, and threaded companion-flange, union end connections. Casings shall have tapped and plugged openings for vent, drain, and suction and discharge gauge connections. Provide a gauge, with valves, for suction and discharge pressure.
 - b) Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, and keyed to shaft. Trim impeller to match specified performance.
 - c) Pump Shaft: High strength S.A.E. 1045 carbon steel with a replaceable, 316 stainless shaft sleeve. Shaft sized to provide minimum deflection, not over 0.002 inches, at the design operating point
 - d) Balanced Mechanical Seal (for leak-less operation): Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N EPT bellows and gasket. Include water slinger on shaft between motor and seal. Arrangement to provide a portion of the pumped liquid to lubricate and cool the seal faces.
 - e) Seals shall be suitable for conditions encountered with the specific application of the pumps. An internal seal system consisting of tubing

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that connects the volute to the stuffing box shall be provided. A tap shall be provided over the mechanical seal to introduce clear liquid from an external source, if desired.

- f) Pump Bearings: Permanently lubricated ball bearings, Oil lubricated; bronze-journal or thrust type
 - (1) Bearings shall be selected for a minimum life of 200,000 hours.
 - (2) For central plants or large mechanical rooms, bearings shall be oil lubricated. A constant level bottle oiler connected to the oil reservoir shall provide lubrication. For non-central plants pumps and small mechanical rooms pumps, bearings shall be grease lubricated.
- g) Motor: Single speed, with permanently greased lubricated ball bearings, unless otherwise indicated; and rigidly mounted to pump casing.
 - (1) Motors shall be designed to NEMA Premium motor efficiency
 - (2) Permanently lubricated ball bearings are available up through 5 hp. Larger motors have grease-lubricated ball bearings.

D. Separately coupled, vertical, in-line centrifugal pumps

- 1. Manufacturers:
 - a) Armstrong Pumps Inc.
 - b) Aurora Pump; Division of Pentair Pump Group.
 - c) Bell & Gossett; Div. of ITT Industries.
 - d) PACO Pumps.
 - e) Taco, Inc.
- 2. Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump; designed for installation with pump and motor shafts mounted horizontally or vertically. Rate pump for 250-psig minimum working pressure and a continuous water temperature of 225 deg F.
 - a) In-line pumps shall be limited to 500 GPM maximum
 - b) Maximum installed pump height shall be 60" from floor. Height measured from centerline of fluid flow.
- 3. Pump Construction:
 - a) Casing: Radially split, Class 30 cast iron, with threaded gauge tappings at inlet and outlet, and threaded companion-flange union end connections. Casings shall have tapped and plugged openings for vent, drain, and suction and discharge gauge connections. Provide a gauge, with valves, for suction and discharge pressure.

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4. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, and keyed to shaft. Trim impeller to match specified performance.
 5. Pump Shaft: High strength S.A.E. 1045 carbon steel with a replaceable, 316 stainless shaft sleeve. Shaft sized to provide minimum deflection, not over 0.002 inches, at the design operating point
 6. Shaft Coupling: Axially split spacer coupling.
 7. Balanced Mechanical Seal (for leak-less operation): Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N EPT bellows and gasket. Include water slinger on shaft between motor and seal. Arrangement to provide a portion of the pumped liquid to lubricate and cool the seal faces.
 8. Seals shall be suitable for conditions encountered with the specific application of the pumps. An internal seal system consisting of tubing that connects the volute to the stuffing box shall be provided. A tap shall be provided over the mechanical seal to introduce clear liquid from an external source, if desired.
 9. Pump Bearings: Permanently lubricated ball bearings, Oil lubricated; bronze-journal or thrust type
 - a) Bearings shall be selected for a minimum life of 200,000 hours.
 - b) For central plants or large mechanical rooms, bearings shall be oil lubricated. A constant level bottle oiler connected to the oil reservoir shall provide lubrication. For non-central plants pumps and small mechanical rooms pumps, bearings shall be grease lubricated.
 10. Motor: Single speed, with permanently greased lubricated ball bearings, unless otherwise indicated; and rigidly mounted to pump casing.
 - a) Motors shall be designed to NEMA Premium motor efficiency
 - b) Permanently lubricated ball bearings are available through 5 hp. Larger motors have grease-lubricated ball bearings
- E. Separately coupled, base-mounted, end-suction centrifugal pumps
1. Manufacturers:
 - a) American-Marsh Pumps.
 - b) Armstrong Pumps Inc.
 - c) Aurora Pump; Division of Pentair Pump Group.
 - d) Bell & Gossett; Div. of ITT Industries.
 - e) PACO Pumps.
 - f) Taco, Inc.
 - g) Weinman; Div. of Crane Pumps & Systems.
 2. Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, end-suction pump; designed for installation with pump and motor shafts

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mounted horizontally. Rate pump for 250-psig minimum working pressure and a continuous water temperature of 225 deg F. End suction pumps shall be limited to 500 GPM maximum and shall be selected to operate at speeds not greater than 1800 RPM.

3. Pump Construction:

- a) Casing: Radially split, Class 30 cast iron, with replaceable bronze wear rings, tapped and plugged drain plug at bottom of volute, tapped and plugged air vent at top of volute, threaded gauge tappings at inlet and outlet, and threaded companion-flange, flanged connections.
- b) Provide a gauge, with valves, for inlet and outlet tappings.
- c) Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
- d) Pump Shaft: high strength S.A.E. 1045 carbon steel with a replaceable, 316 stainless shaft sleeve. Shaft sized to provide minimum deflection, not over 0.002 inches, at the design operating point.
- e) Unbalanced Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N, EPT bellows and gasket. Include water slinger on shaft between motor and seal. Arrangement to provide a portion of the pumped liquid to lubricate and cool the seal faces.
- f) Seals shall be suitable for conditions encountered with the specific application of the pumps. An internal seal system consisting of tubing that connects the volute to the stuffing box shall be provided. A tap shall be provided over the mechanical seal to introduce clear liquid from an external source, if desired.
- g) Shaft Coupling: Molded rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor; [EPDM coupling sleeve for variable-speed applications].
- h) Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.
- i) Pump Bearings: Permanently lubricated ball bearings, Oil lubricated; bronze-journal or thrust type
 - (1) Bearings shall be selected for a minimum life of 200,000 hours.
 - (2) For central plants or large mechanical rooms, bearings shall be oil lubricated. A constant level bottle oiler connected to the oil reservoir shall provide lubrication. For non-central plants pumps and small mechanical rooms pumps, bearings shall be grease lubricated.

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- j) Motor: Single speed, with permanently greased lubricated ball bearings, unless otherwise indicated; rigidly mounted to pump casing with integral pump support.
 - (1) Motors shall be designed to NEMA Premium motor
 - (2) Permanently lubricated ball bearings are available up through 5 hp. Larger motors have grease-lubricated ball bearings
 - k) Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.
- F. Close-coupled, double-suction, horizontal split-case, centrifugal pumps
- 1. Manufacturers:
 - a) Armstrong Pumps Inc.
 - b) Aurora Pump; Division of Pentair Pump Group.
 - c) Bell & Gossett; Div. of ITT Industries.
 - d) Goulds Pumps; Water Technologies Group.
 - e) PACO Pumps.
 - f) Peerless Pump; a Member of the Sterling Fluid Systems Group.
 - g) Taco, Inc.
 - h) Weinman; Div. of Crane Pumps & Systems.
 - 2. Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, end-suction pump; designed for installation with pump and motor shafts mounted horizontally. Rate pump for 250-psig minimum working pressure and a continuous water temperature of 225 deg F.
 - a) Double suction pumps shall be used at flow rates above 500 gpm and are selected to operate at speeds not greater than 1200 RPM.
 - b) Exception: If the head requirements are greater than 175 feet, then selected pump to operate at speeds not greater than 1800 RPM
 - 3. Pump Construction
 - a) Casing: Radially split, Class 30 cast iron, with replaceable bronze wear rings, tapped and plugged drain plug at bottom of volute, tapped and plugged air vent at top of volute, threaded gauge tappings at inlet and outlet, and threaded companion-flange, flanged connections. Provide a gauge, with valves, for inlet and outlet tappings.
 - b) Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.

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- c) Pump Shaft: high strength S.A.E. 1045 carbon steel with a replaceable, 316 stainless shaft sleeve. Shaft sized to provide minimum deflection, not over 0.002 inches, at the design operating point.
- d) Balanced Mechanical Seal (for leak-less operation): Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N EPT bellows and gasket. Include water slinger on shaft between motor and seal. Arrangement to provide a portion of the pumped liquid to lubricate and cool the seal faces.
- e) Seals shall be suitable for conditions encountered with the specific application of the pumps. An internal seal system consisting of tubing that connects the volute to the stuffing box shall be provided. A tap shall be provided over the mechanical seal to introduce clear liquid from an external source, if desired.
- f) Pump Bearings: Permanently lubricated ball bearings, Oil lubricated; bronze-journal or thrust type.
 - (1) Bearings shall be selected for a minimum life of 200,000 hours.
 - (2) Bearing housings shall be removable.
 - (3) For central plants or large mechanical rooms, bearings shall be oil lubricated. A constant level bottle oiler connected to the oil reservoir shall provide lubrication. For non-central plants pumps and small mechanical rooms pumps, bearings shall be grease lubricated.
- g) Motor: Single speed, with permanently greased lubricated ball bearings, unless otherwise indicated; rigidly mounted to pump casing with integral pump support.
 - (1) Motors shall be designed to NEMA Premium motor efficiency
 - (2) Permanently lubricated ball bearings are available up through 5 hp. Larger motors have grease-lubricated ball bearings.

G. Pump Specialty Fittings

- 1. Suction Diffuser: Angle pattern, 300-psig pressure rating, ductile-iron body and end cap, pump-inlet fitting; with bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and factory-fabricated support.
- 2. Triple-Duty Valve: Angle or straight pattern, 300-psig pressure rating, ductile-iron body, pump-discharge fitting; with drain plug and bronze-fitted shutoff, balancing, and check valve features. Brass gauge ports with integral check valve, and orifice for flow measurement

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4.0 Installation

A. Pump Installation

1. Suspend vertically mounted, in-line centrifugal pumps independent of piping. Install pumps with motor and pump shafts vertical.
2. Install continuous-thread hanger rods and elastomeric hangers, spring hangers, spring hangers with vertical-limit stop of sufficient size to support pump weight.

B. Connections

1. Install check valve and throttling triple-duty valve on discharge side of pumps.
2. Install Y-type strainer, suction diffuser and shutoff valve on suction side of pumps.

C. Alignment

1. Preliminary motor alignment to occur before any grouting or piping takes place.
2. Base plate shall be set flat and level and bolted.
3. Grouting only to occur after preliminary alignment is satisfactory and approved by pump manufacturer.
4. Provide shimming for motor and coupling alignment within tolerance and the bolts tightened.