ASME B73.2-2023
(Revision of ASME B73.2-2016)

Specification for Vertical In-Line Centrifugal Pumps for Chemical Process

AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

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Two Park Avenue • New York, NY • 10016 USA

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FOREWORD

The vertical in-line style of centrifugal pump was introduced for chemical process use. These pumps have certain advantages that have led to growing acceptance of this configuration for chemical process applications. In January 1969, in response to this interest, the Manufacturing Chemists Association (MCA) requested that the American National Standards Institute (ANSI) develop a standard. In 1971, the scope of B73 was expanded to include vertical in-line pumps, using the MCA draft of February 1971 as a basis.

American National Standard B73.2 was developed and approved by the B73 Standards Committee; final approval by ANSI was granted on April 21, 1975.

Shortly thereafter, the American National Standards Committee B73 revised the Standard, introducing new information on critical speed, bearing housing design, vibration, bearing frame adapter, and bearings. The 1984 edition included, for the first time, an appendix that covered documentation of pump and driver outline drawing, a vertical in-line pump data sheet, mechanical seal drawing, stuffing box piping plans, and cooling/heating piping plans.

That edition was approved by letter ballot of the B73 Main Committee on April 25, 1983. Following acceptance by the Sponsor, the revision was referred to ANSI for designation as an American National Standard. Designation was granted on March 23, 1984.

In 1986, the Committee began discussing revisions that resulted in changes to the section on jackets. Additionally, the information on the stuffing box and seal chamber was expanded. Modifications were also made to the appendix drawings and plans.

These revisions were approved by the B73 Committee. Following B73 approval, the proposal was submitted to ANSI for recognition as an American National Standard. Approval was granted on January 22, 1991.

With the expanding use of ASME B73 pumps in the chemical process industry and their growing acceptance in the hydrocarbons processing industry, the B73 Committee has continued to improve the B73.2 Standard. The 2003 revision of the Standard incorporated the addition of the technical documentation of the pump as a mandatory portion of the Standard, which previously appeared as a nonmandatory appendix. The incorporation was partly in response to the needs of the user community for compliance to U.S. government regulations covering chemical process equipment and pumps, specifically OSHA Process Safety Management, 29 CFR 1910.119. Recent publications by the Hydraulic Institute (HI) in areas such as preferred operating region and net positive suction head margin were incorporated into the revision. Additionally, the materials of construction section was expanded to include readily available corrosion-resistant alloy. In total, these revisions to the Standard were intended to better serve process industries and expand the use of ASME B73 pumps worldwide.

The 2016 edition of ASME B73.2 was approved as an American National Standard on November 16, 2016. It included revisions to the American Petroleum Institute (API) practices for mechanical seal configurations and cooling and heating plans. A mechanical seal configuration code aligned with the API sealing standard and a material classification code were also added. A universal cover was offered as an option to the Standard as an alternate sealing cover. Requirements for the bearing frame were revised to ensure more robust pumps. Nomenclature for the pump sizes was added to align with the more commonly used sizes identified in ASME B73.1. Approximate hydraulic performance for the ASME B73.2 pumps were established. The default performance test acceptance grade was revised to reflect the new HI/ISO performance test standard. More detail was added to the required drawings, curve, and documentation that should be included with the pump. A new data sheet common to the ASME B73.1 and ASME B73.2 Standards was developed and added. This Standard endorsed the Electronic Data Exchange standard, which was developed by HI and the Fiatech AEX project. These revisions were made to further improve the reliability of the ASME B73.2 pumps. These changes also better aligned with the HI and API pump standards.

This 2023 revision of ASME B73.2 includes updates to align with the 2020 revision of ASME B73.1. Tables for Approximate Performance of Standard Pumps and Minimum Continuous Flow were removed from ASME B73.2. Tables for Published Performance Curve Rated Speeds and Nondestructive Testing Levels were added. In addition, coupling requirements were added for Type VB pumps, external bearing design requirements were modified, welding requirements were modified, jacket requirements for heating and cooling were updated, safety guard and coupling guard requirements were added, multiple HI references were updated, an option for a welded casing drain connection was added, and details

regarding document requirements including details for Certified Mill Test Report and Statement of Compliance were added. An illustration was added with impeller dimensions used to select between a single-plane or two plane-balance.

ASME B73.2-2023 was approved by ANSI as an American National Standard on November 14, 2023.

ASME B73 COMMITTEE
Chemical Standard Pumps

(The following is the roster of the committee at the time of approval of this Standard.)

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General. ASME codes and standards are developed and maintained by committees with the intent to represent the consensus of concerned interests. Users of ASME codes and standards may correspond with the committees to propose revisions or cases, report errata, or request interpretations. Correspondence for this Standard should be sent to the staff secretary noted on the committee's web page, accessible at https://go.asme.org/B73committee.

Revisions and Errata. The committee processes revisions to this Standard on a periodic basis to incorporate changes that appear necessary or desirable as demonstrated by the experience gained from the application of the Standard. Approved revisions will be published in the next edition of the Standard.

In addition, the committee may post errata on the committee web page. Errata become effective on the date posted. Users can register on the committee web page to receive e-mail notifications of posted errata.

This Standard is always open for comment, and the committee welcomes proposals for revisions. Such proposals should be as specific as possible, citing the paragraph number, the proposed wording, and a detailed description of the reasons for the proposal, including any pertinent background information and supporting documentation.

Cases

(a) The most common applications for cases are

(1) to permit early implementation of a revision based on an urgent need

(2) to provide alternative requirements

(3) to allow users to gain experience with alternative or potential additional requirements prior to incorporation directly into the Standard

(4) to permit the use of a new material or process

(b) Users are cautioned that not all jurisdictions or owners automatically accept cases. Cases are not to be considered as approving, recommending, certifying, or endorsing any proprietary or specific design, or as limiting in any way the freedom of manufacturers, constructors, or owners to choose any method of design or any form of construction that conforms to the Standard.

(c) A proposed case shall be written as a question and reply in the same format as existing cases. The proposal shall also include the following information:

(1) a statement of need and background information

(2) the urgency of the case (e.g., the case concerns a project that is underway or imminent)

(3) the Standard and the paragraph, figure, or table number

(4) the editions of the Standard to which the proposed case applies

(d) A case is effective for use when the public review process has been completed and it is approved by the cognizant supervisory board. Approved cases are posted on the committee web page.

Interpretations. The committee does not issue interpretations for this Standard.

Committee Meetings. The B73 Standards Committee regularly holds meetings that are open to the public. Persons wishing to attend any meeting should contact the secretary of the committee. Information on future committee meetings can be found on the committee web page at https://go.asme.org/B73committee.

SPECIFICATION FOR VERTICAL IN-LINE CENTRIFUGAL PUMPS FOR CHEMICAL PROCESS

1 SCOPE

(a) This Standard is a design and specification standard that covers metallic centrifugal pumps of vertical shaft single-stage design with suction and discharge nozzles in-line. This Standard includes dimensional interchangeability requirements and certain design features to facilitate installation and maintenance and enhance reliability and safety of ASME B73.2 pumps. The intent of this Standard is to ensure pumps of the same standard dimension designation from all sources of supply shall be interchangeable with respect to mounting dimensions, size, and location of suction and discharge nozzles (see Table 1-1). Maintenance and operation requirements are not included in this Standard.

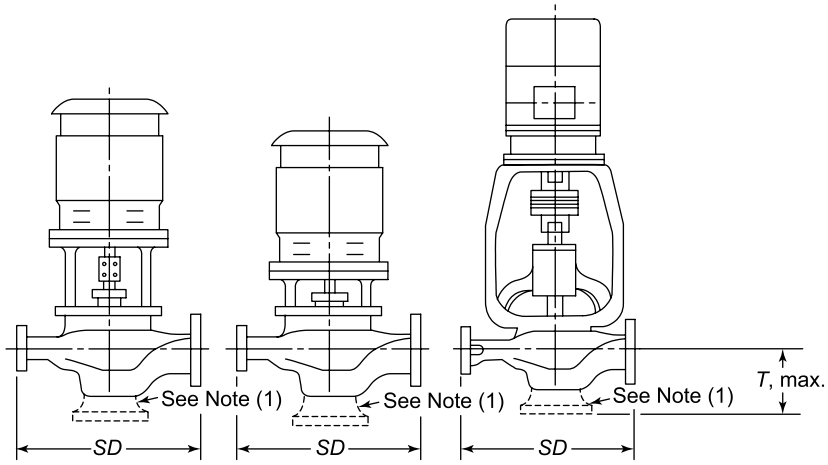
(b) Sealless pumps (magnetic drive and canned motor) are covered in ASME B73.3.

2 REFERENCES

The following is a list of publications referenced in this Standard. Unless otherwise specified, the latest edition shall apply.

ANSI/ABMA 9. Load Ratings and Fatigue Life for Ball Bearings. American Bearing Manufacturers Association.
ANSI/ABMA 11. Load Ratings and Fatigue Life for Roller Bearings. American Bearing Manufacturers Association.
ANSI/AGMA 9000-D11. Flexible Couplings - Potential Unbalance Classification. American Gear Manufacturers Association.
ANSI/AGMA 9002-C14. Bores and Keyways for Flexible Couplings, Inch Series. American Gear Manufacturers Association.
ANSI B11.19. Performance Requirements for Risk Reduction Measures: Safeguarding and Other Means of Reducing Risk. American National Standards Institute.
ANSI/HI 9.1-9.5. Pumps–General Guidelines for Materials, Sound Testing, and Decontamination. Hydraulic Institute.
ANSI/HI 9.6.1. Rotodynamic Pumps Guideline for NPSH Margin. Hydraulic Institute.
ANSI/HI 9.6.2. Rotodynamic Pumps for Assessment of Applied Nozzle Loads. Hydraulic Institute.
ANSI/HI 9.6.3. Rotodynamic Pumps–Guideline for Operating Regions. Hydraulic Institute.
ANSI/HI 9.6.4. Rotodynamic Pumps for Vibration Measurements and Allowable Values. Hydraulic Institute.
ANSI/HI 9.6.8. Rotodynamic Pumps–Guideline for Dynamics of Pumping Machinery. Hydraulic Institute.
ANSI/HI 14.1-14.2. Rotodynamic Pumps for Nomenclature and Definitions. Hydraulic Institute.
ANSI/HI 14.3. Rotodynamic Pumps for Design and Application. Hydraulic Institute.
ANSI/HI 14.4. Rotodynamic Pumps for Installation, Operation and Maintenance. Hydraulic Institute.
ANSI/HI 14.6. Rotodynamic Pumps for Hydraulic Performance Acceptance Tests. Hydraulic Institute.
ANSI/NEMA MG 1. Motors and Generators. National Electrical Manufacturers Association.
ANSI Z535.1. Standard for Safety Colors. American National Standards Institute.
API 610. Centrifugal Pumps for Petroleum, Petrochemical, and Natural Gas Industries. American Petroleum Institute.
API 682. Pumps — Shaft Sealing Systems for Centrifugal and Rotary Pumps. American Petroleum Institute.
ASME Boiler Pressure and Vessel Code. The American Society of Mechanical Engineers.
ASME B16.5. Pipe Flanges and Flanged Fittings: NPS ½ Through 24 Metric/Inch Standard. The American Society of Mechanical Engineers.
ASME B16.11. Forged Fittings, Socket-Welding and Threaded. The American Society of Mechanical Engineers.
ASME B16.42. Ductile Iron Pipe Flanges and Flanged Fittings, Classes 150 and 300. The American Society of Mechanical Engineers.
ASME B31.3. Process Piping. The American Society of Mechanical Engineers.
ASTM A48/A48M. Standard Specification for Gray Iron Castings. ASTM International.
ASTM A105/A105M. Standard Specification for Carbon Steel Forgings for Piping Applications. ASTM International.
ASTM A106/A106M. Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service. ASTM International.

Table 1-1
Pump Dimensions



Dimension Designation [Note (2)]		Size (Suction × Discharge × Nominal Impeller Diameter)		*SD*		*T*, max	
in.	(mm)	in.	(mm)	in. (+0.10, −0.08)	[mm (+2.5, −2.0)]	in.	(mm)
2015/15	(50-40-380)	2 × 1.5 × 6	(50 × 40 × 150)	14.96	(380)	6.89	(175)
2015/17	(50-40-430)	2 × 1.5 × 8	(50 × 40 × 200)	16.93	(430)	6.89	(175)
2015/19	(50-40-480)	2 × 1.5 × 10	(50 × 40 × 250)	18.9	(480)	6.89	(175)
3015/15	(80-40-380)	3 × 1.5 × 6	(80 × 40 × 150)	14.96	(380)	7.87	(200)
3015/19	(80-40-480)	3 × 1.5 × 8	(80 × 40 × 200)	18.9	(480)	7.87	(200)
3015/19	(80-40-480)	3 × 1.5 × 10	(80 × 40 × 250)	18.9	(480)	7.87	(200)
3015/24	(80-40-610)	3 × 1.5 × 13	(80 × 40 × 330)	24.02	(610)	7.87	(200)
3020/17	(80-50-430)	3 × 2 × 6	(80 × 50 × 150)	16.93	(430)	7.87	(200)
3020/17	(80-50-430)	3 × 2 × 7	(80 × 50 × 180)	16.93	(430)	7.87	(200)
3020/20	(80-50-510)	3 × 2 × 10	(80 × 50 × 250)	20.08	(510)	7.87	(200)
3020/24	(80-50-610)	3 × 2 × 13	(80 × 50 × 330)	24.02	(610)	7.87	(200)
4030/22	(100-80-560)	4 × 3 × 8	(100 × 80 × 200)	22.05	(560)	8.86	(225)
4030/25	(100-80-635)	4 × 3 × 10	(100 × 80 × 250)	25	(635)	8.86	(225)
4030/28	(100-80-710)	4 × 3 × 13	(100 × 80 × 330)	27.95	(710)	8.86	(225)
6040/24	(150-100-610)	6 × 4 × 9	(150 × 100 × 225)	24.02	(610)	9.84	(250)
6040/28	(150-100-710)	6 × 4 × 10	(150 × 100 × 250)	27.95	(710)	9.84	(250)
6040/30	(150-100-760)	6 × 4 × 13	(150 × 100 × 330)	29.92	(760)	9.84	(250)

NOTES:
(1) Optional separate pedestal.
(2) Pump designation defines design, flange sizes, and *SD* dimension (e.g., VC, VB 2015/15).

ASTM A108. Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished. ASTM International.
ASTM A182/A182M. Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service. ASTM International.
ASTM A193/A193M. Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service. ASTM International.
ASTM A194/A194M. Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both. ASTM International.
ASTM A216/A216M. Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service. ASTM International.
ASTM A269. Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service. ASTM International.
ASTM A276. Standard Specification for Stainless Steel Bars and Shapes. ASTM International.
ASTM A312/A312M. Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes. ASTM International.
ASTM A351/A351M. Standard Specification for Castings, Austenitic, for Pressure-Containing Parts. ASTM International.
ASTM A395/A395M. Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures. ASTM International.
ASTM A434/A434M. Standard Specification for Steel Bars, Hot-Wrought or Cold-Finished, Quenched and Tempered. ASTM International.
ASTM A479/A479M. Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels. ASTM International.
ASTM A494/A494M. Standard Specification for Castings, Nickel and Nickel Alloy. ASTM International.
ASTM A519. Standard Specification for Seamless Carbon and Alloy Steel Mechanical Tubing. ASTM International.
ASTM A536. Standard Specification for Ductile Iron Castings. ASTM International.
ASTM A743/A743M. Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application. ASTM International.
ASTM A744/A744M. Standard Specification for Castings, Iron-Chromium-Nickel, Corrosion Resistant, for Severe Service. ASTM International.
ASTM A890/A890M. Standard Specification for Castings, Iron-Chromium-Nickel-Molybdenum Corrosion-Resistant, Duplex (Austenitic/Ferritic) for General Application. ASTM International.
ASTM A995/A995M. Standard Specification for Castings, Austenitic-Ferritic (Duplex) Stainless Steel, for Pressure-Containing Parts. ASTM International.
ASTM B160. Standard Specification for Nickel Rod and Bar. ASTM International.
ASTM B164. Standard Specification for Nickel-Copper Alloy Rod, Bar and Wire. ASTM International.
ASTM B335. Standard Specification for Nickel-Molybdenum Alloy Rod. ASTM International.
ASTM B348. Standard Specification for Titanium and Titanium Alloy Bars and Billets. ASTM International.
ASTM B367. Standard Specification for Titanium and Titanium Alloy Castings. ASTM International.
ASTM B473. Standard Specification for UNS N08020, UNS N08024, and UNS N08026 Nickel Alloy Bar and Wire. ASTM International.
ASTM B574. Standard Specification for Low-Carbon Nickel-Chromium-Molybdenum, Low-Carbon Nickel-Molybdenum-Chromium, Low-Carbon Nickel-Molybdenum-Chromium-Tantalum, Low-Carbon Nickel-Chromium-Molybdenum-Copper, and Low-Carbon Nickel-Chromium-Molybdenum-Tungsten. ASTM International.
ASTM B575. Standard Specification for Low-Carbon Nickel-Chromium-Molybdenum, Low-Carbon Nickel-Chromium-Molybdenum-Copper, Low Carbon Nickel-Chromium-Molybdenum-Tantalum, Low-Carbon Nickel-Chromium-Molybdenum-Tungsten, and Low-Carbon Nickel-Molybdenum-Chromium. ASTM International.
AWS B1.11. Guide for the Visual Examination of Welds. American Welding Society.
AWS D1.1. Structural Welding Code — Steel. American Welding Society.
EN 13445-4. Unfired pressure vessels - Part 4: Fabrication. European Committee for Standardization.
HI 50.7. Electronic Data Exchange for Pumping Equipment. Hydraulics Institute.
ISO 281. Rolling bearings — Dynamic load ratings and rating life. International Organization for Standardization.
ISO 21049. Pumps — Shaft sealing systems for centrifugal and rotary pumps. International Organization for Standardization.
ISO 21940-11. Mechanical vibration — Rotor balancing — Part 11: Procedures and tolerances for rotors with rigid behaviour. International Organization for Standardization.

MSS SP-55. Quality Standard for Steel Castings for Valves, Flanges, Fittings and Other Piping Components — Visual Method for Evaluation of Surface Irregularities. Manufacturers Standardization Society of the Valve and Fittings Industry.
MSS SP-93. Quality Standard for Steel Castings and Forgings for Valves, Flanges, Fittings, and Other Piping Components Liquid Penetrant Examination Method. Manufacturers Standardization Society of the Valve and Fittings Industry.
NFPA 704. Standard System for the Identification of the Hazards of Materials for Emergency Response. National Fire Protection Association.

3 ALTERNATIVE DESIGN

Alternate designs will be considered, provided they meet the intent of this Standard and cover construction characteristics that are equivalent to and otherwise in accordance with these specifications. All deviations from these specifications shall be described in detail.

4 DEFINITIONS

4.1 Definition of Terms

The definitions of pump components shall be in accordance with ANSI/HI 14.1-14.2 except as noted below.

4.2 Additional Definitions

auxiliary piping: all piping connected to the pump, seal chamber, stuffing box, or seal piping plan excluding the main piping connected at the pump suction and discharge flanges. Auxiliary piping includes piping, tubing, and all attached components such as valves, instrumentation, coolers, and seal reservoirs.

in-line pump: an overhung impeller-type pump whose driver is supported exclusively by the pump and whose suction and discharge connections have a common centerline that is perpendicular to, and intersects, the shaft axis.

non-pressure-containing nonwetted parts: pump parts that do not contain or retain pressure and are not wetted by the pumped fluid (e.g., pedestal, coupling, bearing frame).

non-pressure-containing wetted parts: pump parts that do not contain or retain pressure but are wetted by the pumped fluid (e.g., wear ring).

pressure-containing wetted parts: pump parts that contain pressure and are wetted by the pumped fluid (e.g., casing and sealing cover).

pressure-retaining nonwetted parts: pump parts that retain pressure but are not wetted by the pumped fluid (e.g., adapter and fasteners).

sealing cover: the seal chamber, universal cover, or stuffing box.

supplier: the manufacturer or manufacturer's representative that supplies the equipment.

5 DESIGN AND CONSTRUCTION FEATURES

5.1 Pressure and Temperature Limits

5.1.1 Pressure Limits. Pressure limitations shall be stated by the pump manufacturer. See para. 5.8.3 for auxiliary piping.

5.1.1.1 The design pressure of the casing, including seal chamber or stuffing box and gland, shall be at least as great as the pressure-temperature rating of ASME B16.5 Class 150 flanges or ASME B16.42 Class 150 flanges for the material used.

5.1.1.2 The design pressure of any optional jackets shall be at least 100 psig (689 kPa) gage at 340°F (171°C). Heating jackets may be required for jacket temperatures to 500°F (260°C) with a reduction in pressure corresponding to the reduction in yield strength of the jacket material.

5.1.1.3 Casing, sealing cover, gland, and jackets shall be designed to withstand a hydrostatic test at 1.5 times the maximum design pressure for each component and its material of construction (see para. 6.2.1.1).

5.1.2 Temperature Limits. Temperature limitations shall be stated by the pump manufacturer. Pumps should be available for temperatures up to 500°F (260°C). Jacketing and other modifications may be required to meet the operating temperature. See para. 5.8.3 for auxiliary piping.

5.2 Flanges

5.2.1 General. Suction and discharge nozzles shall be flanged. Flange drilling, facing, and minimum thickness shall conform to ASME B16.5 Class 150 or ASME B16.42 Class 150 standards except that

(a) marking requirements are not applicable and

(b) the maximum acceptable tolerance on parallelism of the back of the flange shall be 3 deg.

Flanges shall be flat-faced at the full raised-face thickness (minimum) called for in the ASME standards for the material of construction. Raised-face flanges may be offered as an option. Bolt holes shall straddle the horizontal and vertical centerline. Bolt holes may be tapped when adequate space for nuts is not available behind flanges, as noted in Table 1-1. Through bolt holes are preferred. When tapped holes are supplied, they shall be noted on the outline drawing.

5.2.2 Class 300 Option. As an option, Class 300 flanges in accordance with ASME B16.5 or ASME B16.42 may be offered with pressure ratings subject to the manufacturer's casing pressure–temperature limitations. Class 300 flanges shall be flat-faced at full raised-face thickness (minimum); raised-face flanges may be offered as an option.

5.2.3 Pump Dimensions. All pumps regardless of flange rating shall conform to the *SD* dimensions shown in Table 1-1.

5.2.4 Drilling. Where heavy hex nuts cannot be used, or if through or blind tapped holes are supplied, the location shall be noted on the outline drawing.

NOTE: ASME B16.5 and ASME B16.42 indicate the use of heavy hex nuts for certain flange connections. On many ASME B73 pumps, heavy hex nuts cannot be used due to available space. Standard hex nuts are often substituted. The use of standard hex nuts may not allow the achievement of full bolt stress, which may impact proper gasket compression. With most gasket materials, this does not reduce the gasket's ability to properly seal. However, it is a consideration for metallic and semimetallic (i.e., spiral wound) gaskets where significant preload may be required to achieve sufficient tightness.

5.3 Casing

5.3.1 Drain Connection Bosses. Pump casing shall have bosses to provide for drain connections in the lowest part of the casing. Boss size shall accommodate ½ in. NPT minimum or a welded drain connection as required. Bosses shall not be drilled and tapped unless specified by the purchaser.

5.3.2 Auxiliary Connection Bosses. The suction and discharge nozzles shall have bosses for gage connections. Boss size shall accommodate ¼ in. NPT minimum, but ½ in. NPT is preferred. Bosses shall not be drilled and tapped unless specified by the purchaser.

5.3.3 Support. The casing shall be designed to be supported by the suction and discharge flanges alone when mounted with the shaft in the vertical position. However, all casings shall be designed to accommodate an optional auxiliary support base that shall be able to maintain the pump assembly in the upright position when detached from the piping.

5.3.4 Disassembly. The design shall permit removal of the back pull-out assembly from the casing without disturbing the suction and discharge connections. Tapped holes for jackscrews, slots for wedges, or equivalent means shall be provided to facilitate removal of the back pull-out assembly. Jackscrews shall not cause damage to parts that will interfere with reassembly and sealing when the parts are reused.

5.3.5 Heating or Cooling

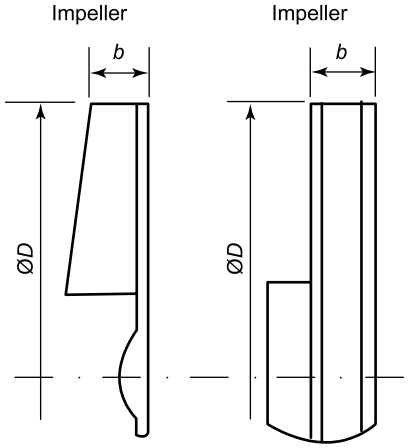
5.3.5.1 There are several methods of cooling or heating areas of most ASME B73 pumps. Areas of the pump that may have design features available for heating or cooling are the sealing cover, pump casing, and bearing housing.

5.3.5.2 Jackets for heating or cooling the casing or sealing cover or both are optional. Connections shall be ⅜ in. NPT minimum, with ½ in. NPT preferred. Jackets for the casing shall have a port at the top and a port at the bottom. Jackets for the cover may have the connections on the same horizontal plane.

NOTE: Purchaser should be aware that a jacket on the cover cannot be completely drained of all liquid.

5.3.6 Gaskets. The casing-to-cover gaskets shall be confined on the atmospheric side to prevent blowout.

Figure 5.4.3-1
Impeller Dimensions to Determine Single-Plane or Two-Plane Balance



5.3.7 Bolting. The pressure-retaining fasteners shall be designed to account for maximum allowable working pressure (MAWP) and be capable of maintaining a seal on the gasket during operation. The fasteners shall have a sufficient bolt area to ensure that the resulting tensile stresses during design loading do not exceed the allowable bolt stresses given in ASME Boiler and Vessel Pressure Code (BPVC), Section II, Part D, Table 3. When there are sufficient strength differences between the material of the tapped hole and the fastener, the design shall consider possible shearing of the threads of the tapped connection.

5.4 Impeller

5.4.1 Types. Impellers may be of the open, semi-open, or closed design.

5.4.2 Adjustment. If axial adjustment is required by the design, the pump shall have a means for external adjustment of the impeller clearance without disassembly of the pump except for the coupling guard.

5.4.3 Balance. Impellers shall be balanced in accordance with ISO 21940-11 and meet Grade 6.3 after final machining. Impellers shall be single-plane balanced if the ratio of the impeller diameter to impeller peripheral width is 6 or greater. For ratios less than 6, impellers shall be two-plane balanced. See Figure 5.4.3-1.

5.4.4 Attachment. The impeller may be keyed or threaded to the shaft with pump rotation to tighten. Shaft threads and keyways shall be protected so they will not be wetted by the pumped fluid.

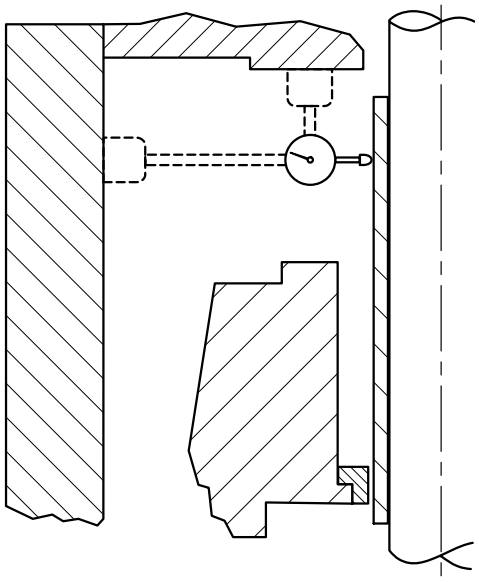
5.5 Shaft

5.5.1 Diameter. The seal mounting surface includes the shaft or shaft sleeve outside diameter within the seal chamber or stuffing box and enough length beyond to accommodate outside seals. The diameter of the seal mounting surface shall be sized in increments of 0.125 in. (3.18 mm). To allow for the use of mechanical seals, the tolerance on that diameter shall not exceed nominal to minus 0.002 in. (0.05 mm).

5.5.2. Finish. Surface finish of the shaft or sleeve through the sealing cover and at bearing housing seals shall not exceed a roughness of 32 μin. (0.8 μm) AA, unless otherwise required.

5.5.3 Runout. Shaft runout shall be limited as follows:
(a) the shaft shall be rotated on centers 0.001 in. (0.025 mm) full indicator movement (FIM) reading at any point; and
(b) the outside diameter of shaft or removable sleeve when installed in pump shall be 0.002 in. (0.05 mm) FIM at the gland end of sealing cover (see Figure 5.5.3-1)

Figure 5.5.3-1
Shaft Sleeve Runout



5.5.4. Deflection. Dynamic shaft deflection at the impeller centerline shall not exceed 0.005 in. (0.13 mm) anywhere within the allowable operating region as specified in para. 6.1.6. Hydraulic loads and shaft deflection shall be calculated in accordance with ANSI/HI 14.3.

NOTE: Shaft deflection at the impeller centerline will be significantly greater than the shaft deflection at the primary seal faces. Based on impeller centerline deflection of 0.005 in. (0.13 mm), shaft deflection at the primary seal faces will normally be 0.003 in. (0.08 mm) or less.

5.5.5 Running Clearances. Clearances must be sufficient to prevent internal rubbing when the pump is subjected to the maximum allowable flange loads (see para. 6.1.2) while running within the allowable operating region (see para. 6.1.6).

5.5.6 Critical Speed. The first lateral critical speed of the rotating assembly shall be at least 120% of the maximum operating speed. A "dry critical speed" calculation is adequate to verify compliance. ANSI/HI 9.6.8 shall be used to calculate static deflections used for the critical speed calculation.

5.5.7 Fillets and Radii. All shaft shoulder fillets and radii shall be made as large as practical and finished to minimize stress risers.

5.5.8 Solid Shaft/Shaft Sleeve. Solid shaft (no sleeve) is preferred whenever mechanical seals are used and the metallurgy or seal design does not preclude their use. Shaft sleeves shall be provided whenever shaft packing is used.

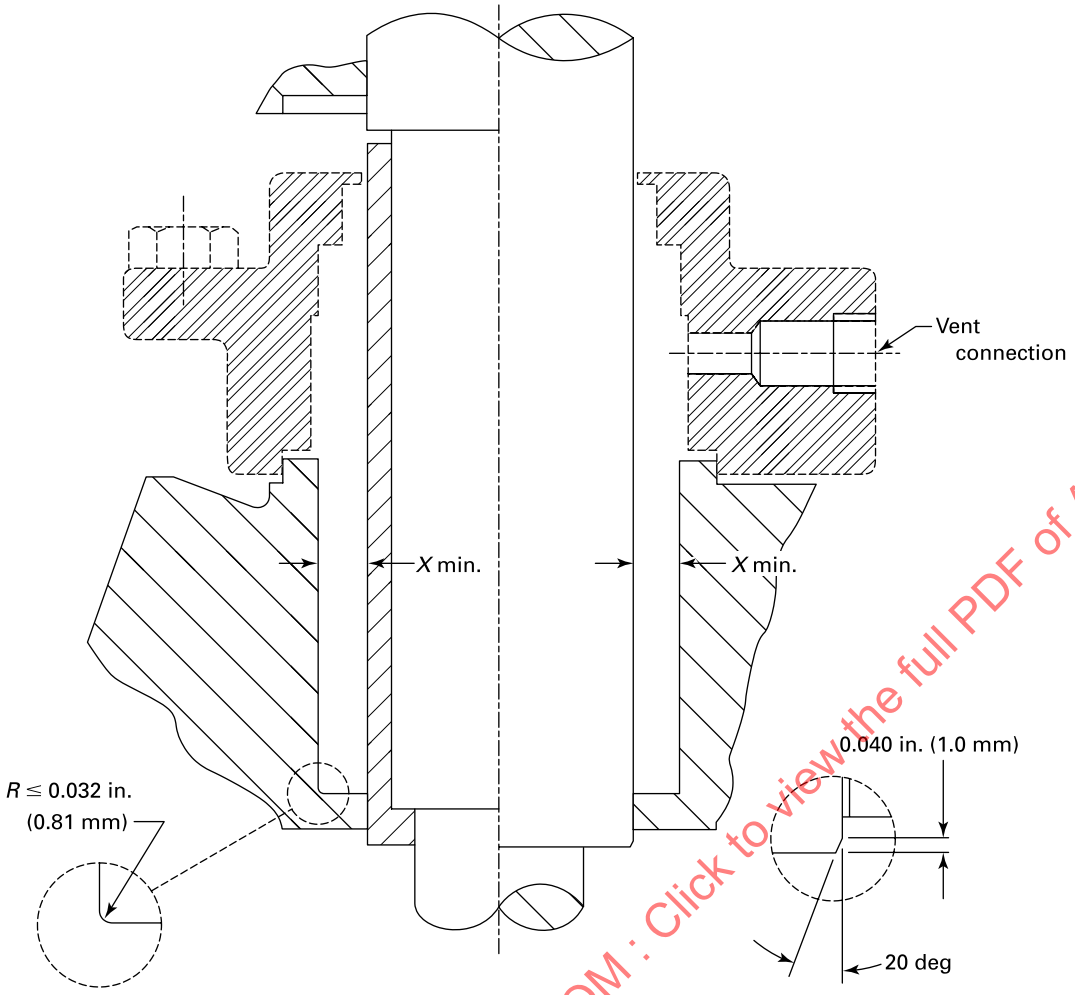
5.6 Shaft Sealing

5.6.1 Design. The following are the three basic types of sealing covers:
(a) seal chamber
(b) universal cover
(c) stuffing box

The seal chamber and stuffing box are standard arrangements. The universal cover should be available as an option.

The seal chamber is designed to accommodate mechanical seals only; there are several designs for various types of seals. The design includes a separate gland plate where required. The universal cover is designed to provide a standard dimensional platform for installation of cartridge-mounted mechanical seals. The stuffing box is designed for packing but may be able to accommodate some sizes and types of mechanical seals without the advantages of the seal chamber or universal cover.

Figure 5.6.2-1
Cylindrical Seal Chamber



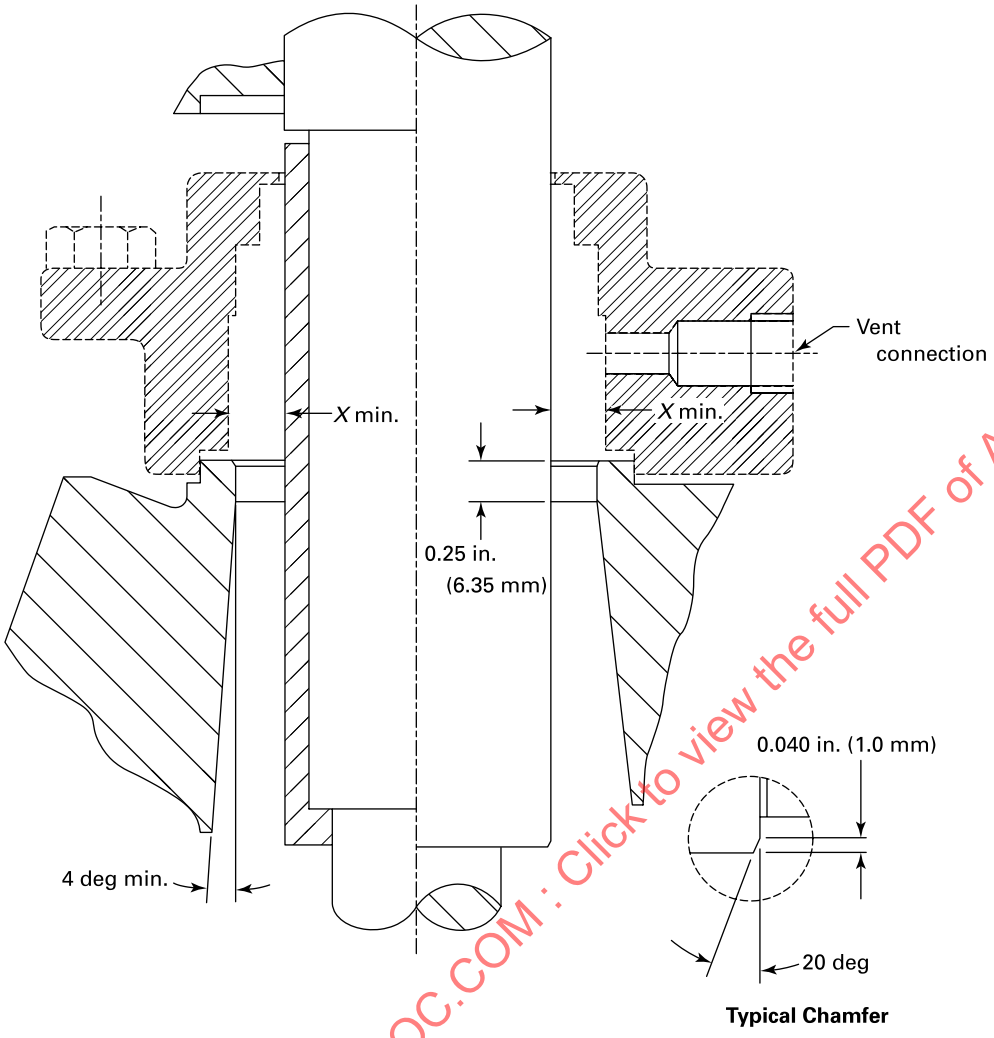
Shaft or Sleeve Diameter	Radial Clearance *X* Min.
Up to 1.5 in. (38 mm)	*X* = 0.750 in. (19 mm)
More than 1.5 in. (38 mm)	*X* = 0.875 in. (22.2 mm)

Details and tutorials on piping plans for mechanical seals can be found in API 682 (ISO 21049). Piping plan designations found in API 682 (e.g., Plan 11, Plan 53A) will be applied to ASME B73 pump applications. Details and designations on piping plans involving pump heating or cooling (e.g., bearing bracket cooling, heating and cooling jackets) can be found in API 610. The piping plan references from API 682 and API 610 shall only apply to the schematic and general description of the piping plan and not to the specific design of components and hardware that may be contained in these Standards.

5.6.2 Seal Chamber

(a) Seal Chamber Design. The seal chamber can be a cylindrical or a tapered design. The tapered bore seal chamber shall have a minimum of 4-deg taper open toward the pump impeller and shall include features that prevent the accumulation of solid particles in the chamber, unless otherwise specified. The seal chamber shall be designed to incorporate the details quantified in Figures 5.6.2-1 and 5.6.2-2.

Figure 5.6.2-2
Tapered Seal Chamber



Shaft or Sleeve Diameter	Radial Clearance *X* Min.
Up to 1.5 in. (38 mm)	*X* = 0.750 in. (19 mm)
More than 1.5 in. (38 mm)	*X* = 0.875 in. (22.2 mm)

The secondary seal contact surface or surfaces shall not exceed a roughness of 63 in. (1.60 m) AA. Seal chamber bore corners and entry holes, such as those used for flushing or venting, shall be suitably chamfered or rounded to prevent damage to secondary seals at assembly.

The seal chamber shall include means of eliminating trapped air or gas. Vent connections, when required for this purpose, shall be located at the highest practical point; drains, when provided, shall be located at the lowest practical point. The location of piping connections to the seal chamber for other functions is optional. A primary flush plan is not recommended for single mechanical seals with tapered bore seal chambers and may impede their operation.

The size of all piping connections to the seal chamber shall be ¼ in. NPT minimum, with ½ in. NPT preferred.

(b) Seal Chamber Runout. Mechanical seal performance is highly dependent on the runout conditions that exist at the mechanical seal chamber. Pumps shall be designed for compliance with the runout limits shown below. On smaller pump sizes, the actual measurement of these runout values may not be possible or practical on an assembled pump. Types of

Figure 5.6.2-3
Face Runout

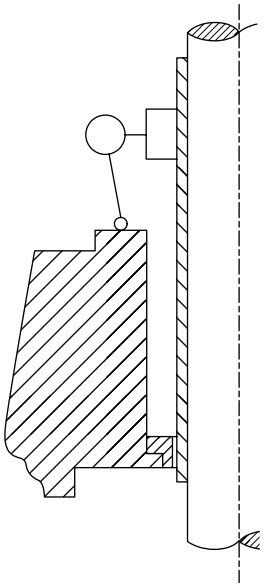
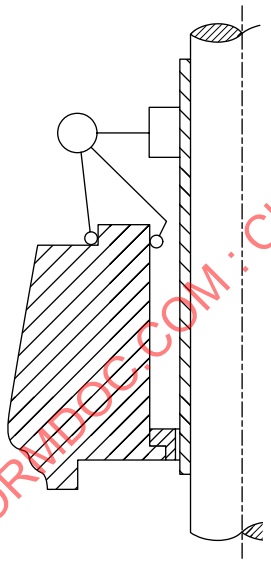


Figure 5.6.2-4
Register Concentricity



runout having significant effect on seal performance include the following:

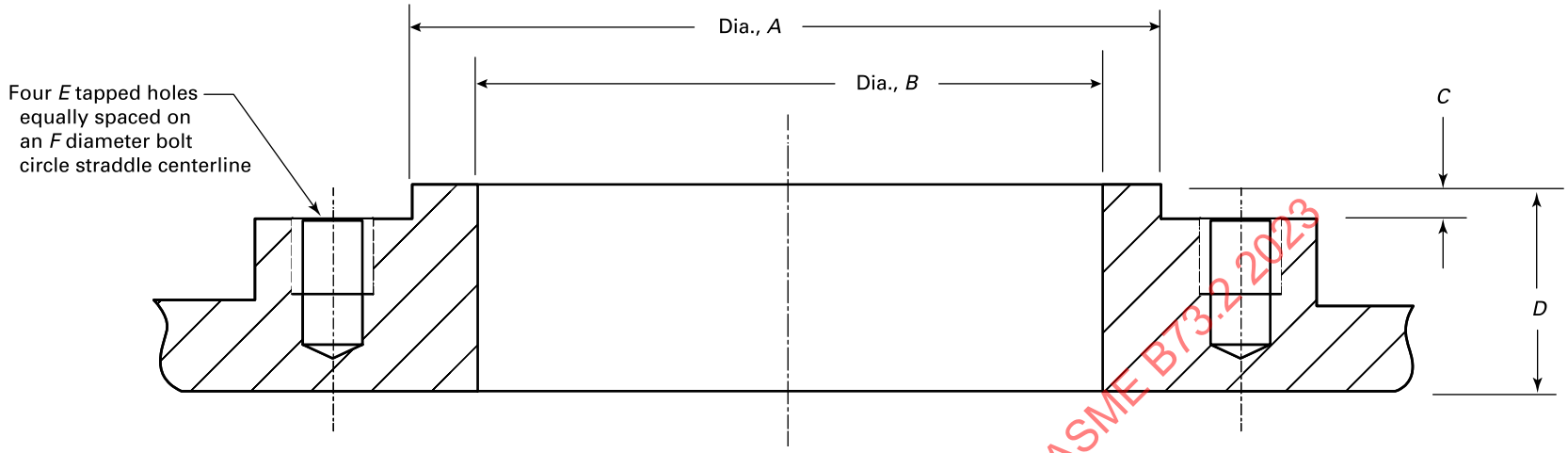
(1) Seal Chamber Face Runout. Seal chamber face runout is a measure of the perpendicularity of the seal chamber face with respect to the pump shaft. It is measured by mounting a dial indicator on the pump shaft and measuring FIM at the face of the seal chamber. The maximum allowable runout is 0.003 in. (0.08 mm) FIM (see Figure 5.6.2-3).

(2) Seal Chamber Register Runout. Provisions shall be made for centering the gland with either an inside or an outside diameter register. This register shall be concentric with the shaft or sleeve within 0.005 in. (0.13 mm) FIM (see Figure 5.6.2-4).

5.6.3 Universal Cover. The universal cover shall be as indicated in Table 5.6.3-1. The runout requirements from para. 5.6.2(b) apply for face and register fits.

NOTE: The seal operating cavity is the responsibility of the mechanical seal supplier and should be incorporated into the seal gland.

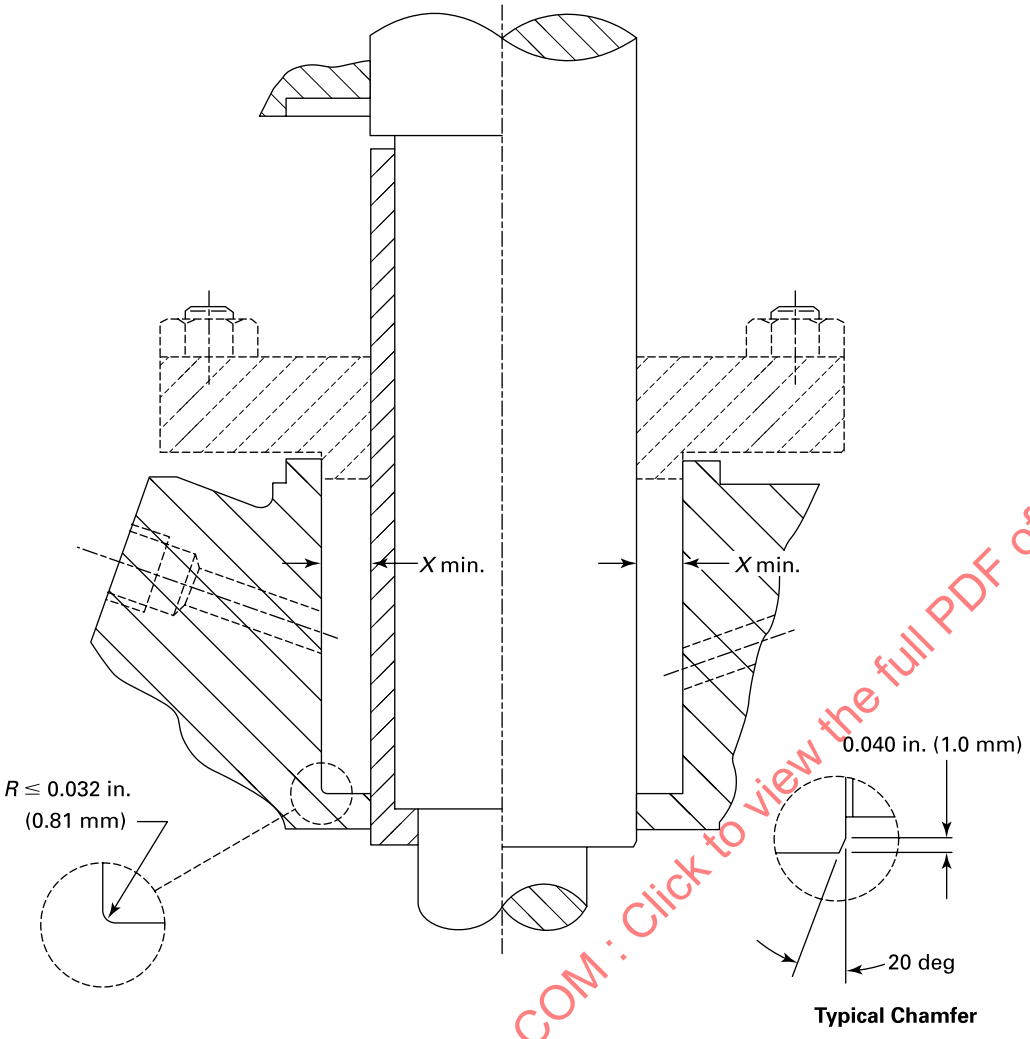
Table 5.6.3-1
Universal Cover Dimension



Feature	*SD* Dimension 14.96 or 16.93	*SD* Dimension 18.9 and Above	*SD* Dimension 18.9 and Above Option
A	3.374 ± 0.001	4.249 ± 0.001	4.624 ± 0.001
B	2.876 ± 0.001	3.501 ± 0.001	3.876 ± 0.001
C	0.19	0.25	0.25
D	1.55	1.75	2.12
E	$^{3}/_{8}$ in.-16 UNC	$^{5}/_{8}$ in.-11 UNC	$^{5}/_{8}$ in.-11 UNC
F	4.25	5.50	5.875

GENERAL NOTE: All dimensions in inches (1 in. = 25.4 mm).

Figure 5.6.4-1
Stuffing Box



Shaft or Sleeve Diameter	Radial Clearance *X* Min.
Up to 1.5 in. (38 mm)	*X* = 0.312 in. (7.94 mm)
More than 1.5 in. (38 mm)	*X* = 0.375 in. (9.52 mm)

5.6.4 Stuffing Box. The stuffing box packing bore surface shall not exceed a roughness of 63 in. (1.60 m) AA. At least one flush connection shall be provided. Additional connections to the stuffing box are optional. The size shall be ¼ in. NPT minimum, with ½ in. NPT preferred. Registers shall maintain the stuffing box bore concentric with the axis of the pump shaft within 0.005 in. (0.13 mm) FIM. The stuffing box face shall be perpendicular to the axis of the assembled pump shaft within 0.003 in. (0.08 mm) FIM. Figure 5.6.4-1 shows the recommended stuffing box dimensions. The stuffing box shall be suitable for proper installation and operation of some sizes and types of mechanical seals, including means of venting trapped air or gas at the highest practical point.

5.6.5 Space Requirements

5.6.5.1 The various seal chamber designs shall provide space for the seal configurations identified in Mandatory Appendix II.

Table 5.7.1-1
Nominal Shaft Extension and Mounting Dimensions for Vertical Solid Shaft P-Base In-Line Pump Motors

NEMA Frames	Shaft Diameter, *U*	Length of Shaft With *U* Diameter, *V*	Shaft Protrusion Below Base, *AH*	Rabbet Diameter, *AK*	Bolt Circle, *AJ*	Base Diameter, *BD*
143 and 145LP	1⅛	2¾	2¾	8¼	9⅛	10
182 and 184LP	1⅛	2¾	2¾	8¼	9⅛	10
213 and 215LP	1⅝	2¾	2¾	8¼	9⅛	10
254 and 256LP	1⅝	2¾	2¾	8¼	9⅛	10
284 and 286LP	2⅛	4	4½	13½	14¾	16½
324 and 326LP	2⅛	4	4½	13½	14¾	16½
364 and 365LP	2⅛	4	4½	13½	14¾	16½
404 and 405LP	2⅛	4	4½	13½	14¾	16½
444 and 445LP	2⅛	4	4½	13½	14¾	16½

GENERAL NOTE: All dimensions in inches (1 in. = 25.4 mm). See ANSI/NEMA MG 1-18.251 for complete dimensions.

5.6.5.2 The stuffing box and exterior clearance area shall provide space for
(a) five rings of packing plus a lantern ring and repacking space
(b) throat bushing, a lantern ring, and three rings of packing

5.6.6 Gland

5.6.6.1 Bolting. Pumps shall be designed for four gland bolts, but glands shall be
(a) two-bolt or four-bolt for packing.
(b) four-bolt for mechanical seals. The minimum gland bolt size shall be ⅜ in. (9.5 mm).

5.6.6.2 Gasket. The gland-to-seal chamber gasket or O-ring used for mechanical seals shall be confined on the atmospheric side to prevent blowout.

5.6.6.3 Cartridge Seal Glands. Cartridge seals shall either center on the shaft or pilot on the seal chamber.

5.6.7 Alternative Seal Specification. As an alternative to the mechanical seal specifications found in this Standard, seals may be provided in accordance with API 682, Category 1. The requirement to apply API 682 must be designated on the Pump Data Sheet [see Form I-1 (Form I-1M)] or on the purchasing specification. Seals provided in accordance with API 682 are only intended for ASME B73 pumps using a cylindrical seal chamber, self-venting tapered seal chamber, or universal cover. The seal chamber design and mechanical seal interface specifications shall be applied from ASME B73.2, not from API 682.

5.7 Driver and Coupling Design

5.7.1 Type VC (Vertical Coupled) Design. The pump shaft is attached to the motor shaft by a rigid spacer coupling, permitting removal of the pump shaft, shaft seal, and impeller without disturbing the motor (see Table 1-1).
(a) Drive motor for VC pumps shall be NEMA P-base in-line pump motor, available in all standard enclosures. These P-base motors shall have mounting and shaft extension dimensions per ANSI/NEMA MG 1-18.251 (see Table 5.7.1-1).
(b) Tolerance for mounting and shaft dimensions for P-base motors shall also be per ANSI/NEMA MG 1-18.250.

5.7.2 Type VM (Vertical Motorshaft) Design. For pumps that have the impeller mounted on an extended motor shaft, see Table 1-1.
(a) Motors for VM pumps shall be NEMA JM or JP solid shaft, designed for vertical operation (JMV, JPV), with mounting and shaft dimensions per ANSI/NEMA MG 1-18.614. Alternative shaft extension dimensions may be offered.
(b) Tolerances for mounting and shaft dimensions for the JMV/JPV motors shall be per ANSI/NEMA MG 1-4.4.4.

5.7.3 Type VB (Vertical Bearing Housing) Design

(a) For pumps that have their own bearing housings and bearings designed to handle the pump loads, see Table 1-1.
(1) Motors for VB pumps shall be NEMA C-face foot or footless motors, available in all standard enclosures.
(2) Shaft and accessories dimensions shall be in accordance with ANSI/NEMA MG 1-11.34.

(3) Tolerance for C-face for mounting foot or footless motors shall be in accordance with ANSI/NEMA MG 1-4.4.4.

(b) When specified for Type VB pumps, the couplings between driver and pump shall be supplied by the supplier.

(1) Couplings shall be spacer type. The distance between the pump and driver shaft ends will permit removal of the back pull out assembly (bearing housing, adapter, impeller, seal, pump coupling hub) without disturbing the driver, driver coupling hub, or the pump casing.

(2) Unless specified otherwise, couplings should be elastomeric or metallic flexible element spacer type.

NOTE: Elastomeric-type couplings are typically supplied on drivers of 100 HP and below.

(3) Unless specified otherwise, couplings shall be selected for a minimum service factor based on the driver rating and the coupling supplier's recommended service factor for the driver type used. Maximum allowable service factor shall be within the coupling manufacturer's specified limits.

(4) If specified, couplings shall be balanced to ISO 21940-11, Grade G6.3.

(5) Unless specified otherwise, coupling hubs shall be supplied with a clearance fit as per ANSI/AGMA 9002-C14. When interference fit is specified, straight bore hubs shall be supplied with an interference fit as per ANSI/AGMA 9002-C14. Hubs shall be supplied with tapped puller holes.

(6) Metallic flexible diaphragm or disc type couplings (when provided) shall be designed to positively retain the spacer if a flexible element fails.

5.7.5 Bearings — VC and VM Pumps

5.7.5.1 Design. The motor bearings shall carry the hydraulic radial load imposed by the pump as well as the combined hydraulic thrust load and weight of all rotating parts.

5.7.5.2 Life. After selection of the motor size and motor manufacturer, the pump manufacturer shall validate the motor bearing life. When calculated in accordance with ANSI/ABMA 9, ANSI/ABMA 11, and ISO 281, bearing life shall provide for a minimum L_{10} bearing life of 17,500 hr in the allowable operating region as per para. 6.1.6 and for all allowable standard and optional arrangements of lubrication, shafts, covers, sealing, and impellers.

5.7.5.3 End Play. End play in the shaft from the motor thrust bearing and its assembly due to internal bearing clearances and tolerances shall be kept to a minimum and shall not exceed either the internal pump clearances or pump shaft seal requirements. The maximum allowable shaft end play value shall be provided with the pump documentation.

5.7.6 Bearings — Type VB Pumps

5.7.6.1 Design. Two rolling element bearing assemblies shall be provided as follows:

(a) one assembly free to float within the frame to carry radial load only

(b) one assembly arranged to carry radial loading, axial thrust, and weight of the pump rotor assembly

5.7.6.1.1 The bearing provided for radial-only loading shall be a single row deep groove ball bearing or roller bearing.

5.7.6.1.2 The bearing provided for both radial and thrust loading shall be either a double row angular contact or a paired single-row angular contact mounted back-to-back.

5.7.6.1.3 Nonmetallic cages shall not be used. Machined brass cages shall be provided for paired single-row angular contact bearings and when specified for double row angular contact bearings.

5.7.6.1.4 Single- or double-row bearings shall not have filling slots.

5.7.6.2 Life. Bearings shall be selected in accordance with ANSI/ABMA 9, ANSI/ABMA 11, and ISO 281. The minimum L_{10} bearing life shall be 17,500 hr in the allowable operating region as defined in para. 6.1.6 and for all standard and optional arrangements of bearings, lubrication, shafts, covers, sealing, and impellers.

NOTE: The minimum L_{10} bearing life above represents a worst-case scenario for certain sizes running at maximum rated speed with maximum impeller diameter and flows at the edge of the allowable operating region. The actual L_{10} life for the typical ASME B73.2 pump may be far in excess of 17,500 hrs. Consult the pump manufacturer for the actual L_{10} life of the selected pump and rated operating conditions if desired.

5.7.6.3 End Play. The maximum end play in the shaft assembly shall not exceed the internal axial clearance for the thrust bearing used. Minimum and maximum shaft end play values shall be published in the pump manufacturer's instruction manual.

5.7.7 Lubrication — Type VB Pumps

5.7.7.1 Greased bearing lubrication shall be standard. Greased-for-life or regreaseable lubrication shall be specified on the pump data sheet.

5.7.7.1.1 When greased-for-life is specified, the bearings shall be double shielded and prefilled with grease by the bearing manufacturer. A corrosion resistant metal tag shall be affixed to the bearing housing stating that the housing is equipped with greased-for-life bearings and that further lubrication is not necessary.

NOTE: Double-shielded bearings are not available for single-row angular contact bearings.

5.7.7.1.2 When regreaseable lubrication is specified, a means for grease relief shall be provided.

5.7.7.2 Pure oil mist lubrication shall be optional. When pure oil mist lubrication is specified, the location of the inlets, drains, and vents should be mutually agreed between the purchaser and the supplier.

5.7.8 Bearing Frame — Type VB Pumps. Bearing frames shall be constructed to protect the bearings from water, dust, and other contaminants and to provide lubrication for the bearings. The standard design is for grease lubrication.

5.7.8.1 Sealing. The standard design includes lip seals. In addition, optional labyrinth-type bearing isolators should be available when specified. In those cases where the bearing frame seal does not allow the bearing frame pressure to equalize with atmospheric pressure during operation, an expansion chamber or breather is necessary.

5.7.8.2 Bearing Frame Drain. The bearing frame shall be provided as an option with a tapped and plugged drain hole at its lowest point.

5.8 Materials of Construction

5.8.1 General

5.8.1.1 The identifying material of a pump shall be that of which the casing is constructed.

5.8.1.2 The pump material classification code in Table 5.8.1.2-1 shall be used to specify the pump materials of construction.

5.8.1.3 The pump part materials shall be in accordance with the specific ASTM material specifications in Table 5.8.1.3-1 for each of the listed material designations.

5.8.1.4 Other materials shall be agreed upon by the purchaser and the supplier.

5.8.1.5 No repair by plugging, peening, or impregnation is allowed on any parts wetted by the pumped fluid.

5.8.2 Gland Material

5.8.2.1 Mechanical seal gland materials shall be in accordance with the ASTM designations in Table 5.8.1.2-1, with 316 SS as a minimum. If the gland is wetted by the pumped fluid and the casing is a higher alloy than 316 SS, the gland shall be constructed of the same material specified for the casing or, with purchaser approval, a material having an equivalent or better corrosion resistance.

5.8.2.2 Gland bolt, stud, and nut materials shall be in accordance with the ASTM designations in Table 5.8.1.2-1, with 304 SS as a minimum. Grade B7 and Grade 2H carbon steel are not allowed for gland bolt, stud, and nut materials.

5.8.3 Auxiliary Piping

5.8.3.1 Auxiliary piping shall, as a minimum, be available with the materials of construction in accordance with Table 5.8.3.1-1.

5.8.3.2 Auxiliary piping in contact with the pumped fluid shall have a pressure–temperature rating equal to or greater than the maximum allowable working pressure (MAWP) of the pump. Auxiliary piping that may become exposed to pumped fluid in the event of a seal failure shall meet this requirement.

5.8.3.3 Auxiliary piping and components normally in contact with the pumped fluid shall have a corrosion resistance to the pumped fluid that is equal to or better than that of the casing.

5.9 Corrosion Allowance

The casing, cover, and gland shall have a corrosion allowance of at least 0.12 in. (3.0 mm).

Table 5.8.1.2-1
Pump Material Classification Code

Base Code — Pressure Casing and Impeller							
Part Name	**73DI-**	**73DI/SS-**	**73SS-**	**73A20-**	**73CD4-**	**73HC276-**	**73X-**
Casing	Ductile iron	Ductile iron	316 SS	Alloy 20	Duplex SS	Alloy C276	As specified
Impeller	Ductile iron	316 SS	316 SS	Alloy 20	Duplex SS	Alloy C276	As specified
Cover	Ductile iron	Ductile iron	316 SS	Alloy 20	Duplex SS	Alloy C276	As specified
Seal gland	316 SS	316 SS	316 SS	Alloy 20	Alloy 20	Alloy C276	As specified

First Suffix — Shaft			
Part Name	**A**	**B**	**X**
Shaft	Solid shaft	Sleeved shaft	As specified
Wetted area of shaft with no sleeve	316 SS minimum, same as casing for higher alloy	NA	As specified
Shaft sleeve	NA	316 SS minimum, same as casing for higher alloy	As specified
Shaft with sleeve	Carbon steel with NNA	Carbon steel with 316 SS sleeve or 316 SS with higher alloy sleeve	As specified

Second Suffix — Fasteners				
Part Name	**CS**	**SS**	**TCS**	**X**
Casing fasteners	Carbon steel	304 SS or 316 SS	Carbon steel with PTFE fluoropolymer	As specified
Gland fasteners	304 SS or 316 SS	304 SS or 316 SS	304 SS or 316 SS	As specified

Third Suffix — Casing Gasket				
Part Name	**AF**	**T**	**G**	**X**
Casing gasket	Aramid fiber	Modified PTFE	Flexible graphite	As specified

GENERAL NOTES:
(a) As an example, the pump material classification code 73DI-A-TCS-T indicates the following:
(1) casing = ductile iron
(2) impeller = ductile iron
(3) cover = ductile iron
(4) seal gland= 316 SS
(5) shaft = 316 SS solid shaft
(6) casing fasteners = carbon steel with PTFE coating
(7) gland fasteners = 304 SS or 316 SS
(8) casing gasket = modified PTFE
(b) NA = not applicable.
(c) PTFE = polytetrafluoroethylene.
(d) Carbon steel may be offered as an alternative casing material for ductile iron.

Table 5.8.1.3-1
Material of Construction

Material Designation	Casting Wetted by Pumped Fluid		Casting Not Wetted by Pumped Fluid		Bar Stock	Pressure-Retaining Bolts and Studs	Nuts
	Pressure-Containing	Non-Pressure-Retaining/ Containing	Pressure-Retaining	Non-Pressure-Retaining/ Containing			
	Casting						
Cast iron	...	A48	...	A48	...	...	...
Ductile iron	A395 Grade 60-40-18	A395 Grade 60-40-18	A395 Grade 60-40-18 or A536	A395 Grade 60-40-18 or A536	...	...	...
Carbon steel	A216 Grade WCB	A216 Grade WCB	A216 Grade WCB	A216 Grade WCB	A108 Grade 1144 or A434 Grade 4140	A193 Grade B7	A194 Grade 2H
Carbon steel with PTFE coating	...	...	...	...	...	A193 Grade B7 Coated with PTFE fluoropolymer coating	A194 Grade 2H Coated with PTFE fluoropolymer coating
304 SS	...	...	...	...	...	A193 Grade B8 Class 2 or 2B	A194 Grade 8
316 SS	A351 Grade CF8M or A744 CF8M	A744 Grade CF8M	A744 Grade CF8M or A743 Grade CF8M	A744 Grade CF8M or A743 Grade CF8M	A276 Type 316 SS	A193 Grade B8M Class 2 or B8M2 or B8M3	A194 Grade 8M
Alloy 20 stainless steel	A351 Grade CN7M or A744 CN7M	A744 Grade CN7M	A744 Grade CN7M or A743 Grade CN7M	A744 Grade CN7M or A743 Grade CN7M	B473 N08020	B473 N08020	B473 N08020
316L SS	A351 Grade CF3M or A744 CF3M	A744 Grade CF3M	A744 Grade CF3M or A743 Grade CF3M	A744 Grade CF3M or A743 Grade CF3M	...	...	...
Duplex stainless steel	A995 Grade 1B (CD4MCuN)	A890 Grade 1B (CD4MCuN)	A890 Grade 1B (CD4MCuN)	A890 Grade 1B (CD4MCuN)	A276 Grade S32205	A276 Grade S32205	A276 Grade S32205
Monel	A494 Grade M35-1	A494 Grade M35-1	...	...	B164 04400	...	...
Nickel	A494 Grade CZ100	A494 Grade CZ100	...	...	B160 02200	...	...
Alloy B2	A494 Grade N7M	A494 Grade N7M	...	...	B335 10665	...	...
Alloy C4	A494 Grade CW2M	A494 Grade CW2M	...	...	B575 06455	...	...
Alloy C276	A494 Grade CW6M or A494 Grade CW2M	A494 Grade CW6M or A494 Grade CW2M	...	...	B574 N10276	...	...

Table 5.8.1.3-1
Material of Construction (Cont'd)

Material Designation	Casting Wetted by Pumped Fluid		Casting Not Wetted by Pumped Fluid		Bar Stock	Pressure-Retaining Bolts and Studs	Nuts
	Pressure-Containing	Non-Pressure-Retaining/ Containing	Pressure-Retaining	Non-Pressure-Retaining/ Containing			
	Casting						
Alloy C22	A494 Grade CX2MW	A494 Grade CX2MW	...	...	B574 N06022	...	...
Titanium	B367 Grade C3	B367 Grade C3	...	...	B348 Grade 2	...	...

GENERAL NOTES:
(a) For glands and gland fastening, see para. 5.6.6.
(b) PTFE = polytetrafluoroethylene.
(c) For pressure-retaining non-wetted components see para 5.13.7.

Table 5.8.3.1-1
Minimum Requirement for Auxiliary Piping Materials

Pipe or Component	Size, Type, or Class	ASTM Material Requirements	
		Carbon Steel	316 SS
Tubing	$^{3}/_{8}$-in. to $^{3}/_{4}$-in. O.D. 0.035-in. min. wall thickness	Seamless A519	Seamless A269 Gr TP316
Tube fittings	Compression type	A108	Bar stock: A479 Type 319 Forgings: A182 Gr F316
Pipe	Schedule 40 min.	Seamless A106 Gr B	Seamless A312 Gr TP316
Pipe fittings	ASME B16.11 Class 2000 min.	A105	A182 Gr F316

5.10 Direction of Rotation

The direction of rotation shall be clockwise viewed from the motor end of the pump. An arrow showing the direction of rotation shall be provided, either cast on the casing or stamped on a plate of durable construction affixed to the pump in a prominent location.

5.11 Dimensions

Pump dimensions shall conform to Table 1-1.

5.12 Welding

5.12.1 Welding and weld repairs shall be performed in accordance with procedures qualified to the requirements of Table 5.12.1-1. When specified, all post-foundry casting repairs shall have the used welding procedures, examinations, and weld repair acceptance criteria submitted to the purchaser for information. Alternative standards may be proposed by the manufacturer for the purchaser's approval.

5.12.2 The manufacturer shall be responsible for the review of all repairs and repair welds to ensure they are properly heat-treated and nondestructively examined for soundness and compliance with the applicable qualified procedures.

5.12.3 Specified connections welded to pressure casings shall be installed per paras. 5.12.3.1 through 5.12.3.3.

5.12.3.1 Auxiliary piping welded to alloy steel casings shall be of a material with the same nominal properties as the casing material. If the casing is stainless steel, auxiliary piping shall be of low-carbon austenitic stainless steel. Other materials compatible with the casing material and intended service may be used with the purchaser's approval.

5.12.3.2 Postweld heat treatment, if required, shall be carried out after all welds, including piping welds, have been completed.

5.12.3.3 If specified, proposed connection designs shall be submitted to the purchaser for approval before fabrication. The drawing shall show weld designs, size, materials, and preweld and postweld heat treatments.

5.13 Miscellaneous Design Features

5.13.1 Safety Guards. Guards shall be provided for the coupling and any exposed rotating element including the area between the bearing housing and the mechanical seal to prevent personnel from contacting rotating parts during operation.

5.13.1.1 Performance Criteria. All guards shall meet the performance criteria and maximum gap or opening allowances based on the distance between the guard and the rotating hazard in accordance with ANSI B11.19.

5.13.1.2 Accessibility. Guards shall be securely attached and removable without disturbing the guarded rotating components.

Table 5.12.1-1
Welding Requirements

Requirement	Applicable Code or Standard
Welder/operator qualification	ASME BPVC IX or ISO 9606 (all parts)
Welder procedure qualification	Applicable material specification or, where weld procedures are not covered by the material specification, ISO 15609 (all parts), ASME BPVC IX, or ASME B31.3
Non-pressure-retaining structural welding, such as pedestals or supports	AWS D1.1
Magnetic-particle or liquid-penetrant examination of the plate edges	MSS-SP-93; ASME B31.3; or ASME BPVC, Section VIII, Division 1, UG-93(d)(3)
Postweld heat treatment	Applicable material specification; EN 13445-4; ASME BPVC VIII, Division 1, UW 40; or ASME B31.3

5.13.1.3 Material Construction. Guards of metal construction are preferred. Alternate materials may be provided with purchaser approval. Sheet metal may be expanded metal, perforated sheet metal, or solid sheet metal depending on ventilation requirements.

5.13.1.4 Attachment. Guards shall be securely fastened to equipment framework to protect against unauthorized adjustment or circumvention.

5.13.1.5 Hazard Communication. Guards shall be ANSI Safety Yellow or ANSI Safety Orange per ANSI Z535.1.

5.13.1.6 Coupling Guards. Coupling area safety guards shall be constructed of steel, brass, or aluminum unless otherwise specified by the purchaser.

5.13.1.7 Seal Area Guards

5.13.1.7.1 Safety guards used for the area between the bearing housing and the mechanical seal shall be sufficiently vented to prevent the accumulation of seal emissions, liquid, or vapor.

5.13.1.7.2 Seal area safety guards shall be constructed of steel, stainless steel, brass, or aluminum unless otherwise specified by the purchaser.

5.13.1.7.3 When specified, the seal area safety guard shall also serve as a seal area spray guard. This is intended to provide protection from directional spray in the event of seal leakage that could pose a hazard to personnel located near the pump. Spray guards shall be constructed of a solid sheet material.

5.13.2 Threads. All threaded parts, such as bolts, nuts, and plugs, shall conform to ASME standards, unless otherwise specified.

5.13.3 Lifting Rings. A lifting ring or other equivalent device shall be provided to facilitate handling the frame, driver pedestal, or adapter and associated assembly if its mass exceeds 60 lb (27 kg). Eyebolts on motors are not suitable for lifting the entire pump and motor assembly. The pump manufacturer's manual shall provide lifting instructions.

5.13.4 Tapped Openings. All tapped openings, including those in the mechanical seal gland that may be exposed to the pumped fluid under pressure, shall be plugged with threaded metal plugs. Plugs normally in contact with the pumped fluid shall be of the same material as the casing, except that carbon steel plugs may be used in ductile iron pumps. Threaded plugs shall not be used in the heating or cooling jackets, including glands with heating or cooling passages. Instead, snap-in plugs or waterproof tape shall be used to relieve possible pressure accumulation until piping is installed. All tapped openings in the mechanical seal gland shall be identified to designate their purpose. This designation should be cast or stamped immediately adjacent to the opening. The markings shall be in accordance with para. 7.3.1. When a steam quench is specified, the inlet connection shall be located at the highest point on the gland, and the drain connection shall be located at the lowest point on the gland to prevent the formation of water pockets.

5.13.5 Identification. The manufacturer's part identification number and material designation shall be cast, clearly die stamped, or engraved on the casing, cover, and impeller.

5.13.6 Driver Pedestal and Adapter. The driver pedestal on Type VB and Type VC pumps and adapter on Type VM pumps shall be designed to resist a torque at least as high as the ultimate torque strength of the pump shaft at the coupling end. When the driver pedestal or adapter is used to clamp the rear cover to the casing, the material properties of the driver pedestal and adapter shall meet the requirement of para. 5.13.7.

5.13.7 Pressure-Retaining Nonwetted Components. Pressure-retaining nonwetted components shall be made of a material that is classified as ductile throughout the full range of operating temperatures, such as cast ductile iron or cast carbon steel.

5.13.8 Drainage. One or more threaded drain connections (½ in. NPT preferred) shall be provided so that liquid will drain from the driver pedestal or adapter and cover.

6 GENERAL INFORMATION

6.1 Application

6.1.1 Terminology. Terminology shall be in accordance with ANSI/HI 14.1-14.2 and ANSI/HI 14.6, except as net positive suction head required (NPSHR) is clarified in para. 6.1.7.

6.1.2 Nozzle Loading. Allowable nozzle loading imposed by the piping shall be in accordance with ANSI/HI-9.6.2.

6.1.3 Sound. The maximum sound pressure level produced by the pump and driver shall comply with the limit specified by the purchaser. A test, if specified, shall be conducted in accordance with ANSI/HI 9.1-9.5. Driver noise data shall be determined separately.

6.1.4 Vibration. When specified, the vibration level measured on the pump bearing frame at the supplier's test facility at rated condition point (speed ±5%, flow ±5%) shall not exceed the allowable "factory" pump bearing housing vibration limits shown in ANSI/HI 9.6.4 for types OH3, OH4, and OH5 pumps (ASME B73.2 pumps).

6.1.5 Allowable Operating Region. Pumps shall be designed to operate continuously between 120% of the flow at the best efficiency point (BEP) and the minimum flow specified by the manufacturer, and to meet the requirements of paras. 5.5.4 (shaft deflection), 5.7.5.2 and 5.7.6.2 (bearing life), and 6.1.4 (vibration) when pumping water at ambient conditions.

6.1.6 Preferred Operating Region. Pumps shall be designed with a preferred operating region in accordance with ANSI/HI 9.6.3 when pumping water at ambient conditions.

6.1.7 NPSHR. NPSHR is defined as per ANSI/HI 14.6 except this value is equal to or greater than NPSH3. Under special circumstances, NSPHR may be less than NPSH3, if agreed upon between the supplier and the purchaser.

6.1.8 Net Positive Suction Head Margin. An operating net positive suction head (NPSH) margin is necessary to ensure satisfactory operation. A minimum margin of 3 ft (0.9 m) or a margin ratio of 1.2 (whichever yields a higher NPSH requirement) should be made available for all specified operating flows. This margin should be increased if variables exist that will increase the NPSHR of the pump. See ANSI/HI 9.6.1 for additional application information.

6.1.9 Performance Curves. Performance curves published in electronic or printed format shall be based on tests conducted in accordance with ANSI/HI 14.6. Accuracy of the curves shall be such that when 90% of pumps purchased "untested" are operated between minimum allowable flow and BEP, they will perform to the published curve within the following tolerances:

(a) head +5%, −5%

(b) efficiency, −5%

NOTE: The published performance curves shall be used for preliminary sizing only and are based on water performance with a simple sealing device such as packing or a single mechanical seal. Other sealing configurations may add to the power requirement. Head and efficiency at flows greater than BEP may have greater variation than the tolerances stated above.

6.1.9.1 Published Performance Curve Rated Speeds

6.1.9.1.1 The curve speeds in Table 6.1.9.1.1-1 shall be used for rated speeds except when para 6.2.1.2(b) is specified by purchaser.

6.1.9.1.2 Published performance curves that illustrate multiple impeller diameters shall use the motor speed based on the maximum horsepower for the largest impeller diameter on that curve.

6.2 Tests and Inspections

Unless otherwise agreed upon, the supplier shall give at least five working days advanced notification of an observed or witnessed test or inspection.

Table 6.1.9.1.1-1
Published Performance Curve Rated Speeds

		Frequency			
		60HZ		50HZ	
Motor Rating Range, HP (kW)	No. of Poles	Synchronous Speed	Curve Speed	Synchronous Speed	Curve Speed
1 to 10 (0.75 to 7.5)	2	3,600	3,510	3,000	2,900
	4	1,800	1,750	1,500	1,450
	6	1,200	1,160	1,000	950
	8	900	870	750	725
15 to 25 (11 to 18.5)	2	3,600	3,540	3,000	2,950
	4	1,800	1,770	1,500	1,475
	6	1,200	1,175	1,000	975
	8	900	880	750	730
30 to 125 (22 to 90)	2	3,600	3,550	3,000	2,950
	4	1,800	1,780	1,500	1,475
	6	1,200	1,180	1,000	975
	8	900	890	750	740
150 to 500 (110 to 375)	2	3,600	3,570	3,000	2,975
	4	1,800	1,785	1,500	1,485
	6	1,200	1,190	1,000	990
	8	900	890	750	740

6.2.1 Tests

6.2.1.1 Hydrostatic. Following machining, casings, covers, and jackets shall be hydrostatically tested for 10 min minimum with water at 1.5 times the maximum design pressure corresponding to 100°F (38°C) for the material of construction used. No visible leakage through the part shall be permitted. Drilled and tapped connections added post-hydro require a visual inspection only to ensure no voids exist and threads are well formed.

NOTE: The pressure rating of jackets may not be the same as required for pressure-containing parts wetted by the pumped fluid.

6.2.1.2 Performance

(a) Procedure. When performance tests are required, they shall be conducted in accordance with ANSI/HI 14.6.

(b) Acceptance Criteria. Performance acceptance Grade 1B shall be used for all pump input powers. ANSI/HI 14.6 performance acceptance Grade 1B includes power or efficiency as an optional guarantee requirement. When specified, the acceptance criteria shall include either power or efficiency at the rated condition point. Power acceptance criteria shall include all causes (cumulative tolerances are not acceptable). Measured test data shall be corrected for speed and specific gravity of the rated condition point. The corrected values shall be within the tolerance bands of Grade 1B.

NOTES:

(1) The referenced ANSI/HI 14.6 acceptance grade 1B requires that the manufacturer guarantee that the measured pump curve (corrected for speed and specific gravity) will touch or pass through a tolerance band of ±3% total head or ±5% flow surrounding the rated condition point. Due to the typical specific speed and resultant curve shape of pumps supplied in accordance with this Standard, the total head tolerance is likely the controlling parameter. The optional power criteria specify the corrected measured power does not exceed 104% of the rated value and the optional efficiency criteria specify the corrected measured efficiency be no more than 3% below the rated value.

(a) Performance tests results shall be corrected for the rated speeds listed in Table 6.1.9.1.1-1.

(b) When specified, the actual nameplate rated speed of the job driver shall be used as the rated speed for impeller diameter selection and performance guarantee.

(2) If the pump driver is not in the manufacturer's scope of supply, the purchaser should provide the actual rated speed of the intended driver to the manufacturer for impeller diameter selection and performance guarantee. Manufacturers catalog pump curve speeds (see Table 6.1.9.1.1-1) may not accurately represent actual running speed of the job driver. For variable speed applications, there is typically one guaranteed condition point; other operating points are to be used for reference only or as optional test points.

Table 6.2.2.3-1
Specified Nondestructive Testing Levels

Part Type	Level 1	Level 2	Level 3
Wetted pressure-retaining parts — cast [Note (1)]	VI	Level 1 plus 100% MT or 100% PT	Level 2 plus RT critical casting sections [Note (2)] or 100% UT plus wall thickness verification
Auxiliary connection welds	VI	Level 1 plus MT or PT	Level 1 plus MT or PT
Process piping: butt weld	VI plus 10% RT	Level 1 plus MT or PT	Level 1 plus MT or PT
Process piping: socket weld [Note (3)]	VI	Level 1 plus MT or PT	Level 1 plus MT or PT

Legend:
MT = magnetic-particle inspection
PT = liquid-penetrant inspection
RT = radiography
UT = ultrasonic inspection
VI = visual inspection

NOTES:
(1) "Wetted pressure-retaining parts" include all items of the pressure boundary (e.g., the casing itself and parts such as nozzles and flanges).
(2) "Critical casting sections" are casing inlet nozzle locations, casing outlet nozzle locations, and casing wall thickness changes. The manufacturer shall submit details of the critical areas proposed to receive MT/PT/RT/UT inspection for purchaser's approval. "Highly hazardous services" apply if this designation is specified by the purchaser.
(3) It is not practical to RT butt-welded auxiliary casing connections due to complex geometry and thickness variations.

(c) Vibration Measurements. When specified, the performance test shall include vibration measurements in accordance with para. 6.1.4.

(d) Retest. If the tested impeller is required to be trimmed less than 5% of trimmed diameter due to failure to meet acceptance criteria, a retest after trimming is not necessary. Trims of greater than 5% require a retest. If a new impeller is required, a retest is required.

(e) Record of Test. A complete written record of the relevant test information including performance curves, the date of the tests, and the signature of the person or persons responsible for conducting the tests shall be delivered as part of the pump documentation.

6.2.1.3 Additional Data. Additional data, when specified, may be taken during the performance test. These data may include such things as vibration and bearing housing temperature. Unless otherwise specified, the additional data will be taken at the rated duty point. When these data are specified, they shall be conducted in accordance with ANSI/HI 14.6.

6.2.1.4 Leak. When specified by the purchaser, the assembled pump shall be leak tested using a procedure and acceptance criteria as agreed upon. If the assembly is to contain a mechanical seal, consult with the seal manufacturer for the seal static pressure limits before exposing it to the test pressure.

6.2.1.5 NPSHR. When NPSHR tests are required, they shall be conducted in accordance with ANSI/HI 14.6. Unless otherwise agreed to by the purchaser and supplier, the NPSH test will be a Type II test, which is for determination of NPSH3 at the rated flow only.

NOTE: An NPSHR test does not necessarily include a performance test. The purchaser must specify both if desired.

6.2.2 Inspections

6.2.2.1 Final Inspection. A final inspection may be specified by the purchaser. If specified, the purchaser or purchaser's representative will be given access to the completed pump assembly for visual inspection of the assembly prior to shipment.

6.2.2.2 Dismantle and Inspect After Test. If specified, the pump shall be dismantled and inspected after test. Inspection procedure and criteria must be agreed upon by the purchaser and supplier.

6.2.2.3 Inspection of Connection Welds and Castings. As a minimum, the wetted pressure-containing boundary including casing, sealing cover, and auxiliary piping shall be inspected by the manufacturer's standard quality control procedures. When specified by the purchaser, the inspections shall be in accordance with the inspection levels in Table 6.2.2.3-1. Visual inspection (VI), ultrasonic inspection (UT), liquid-penetrant inspection (PT), magnetic-particle

inspection (MT), and radiography (RT) methods and acceptance criteria shall be in accordance with the sections, articles, and appendices of the ASME BPVC that pertain to the welding/joining and inspection techniques used.

6.2.2.3.1 When a Level 1 inspection of weld connections is specified, it shall be conducted in accordance with AWS B1.11 for evaluation of size of weld, undercut, and splatter. A complete written record of welder, date of welding, method, and filler material must be retained.

6.2.2.3.2 When a Level 1 inspection of cast parts is specified, a visual inspection shall be conducted in accordance with MSS SP-55 for evaluation of cast surfaces.

6.3 Nameplates

Nameplates shall be of a minimum 24 U.S. standard gauge AISI 300 series stainless steel and shall be securely attached to the pump. It shall include pump model, standard dimension designation, serial number, size, impeller diameter (maximum and installed), material of construction, and maximum design pressure for 100°F (38°C).

7 DOCUMENTATION

7.1 General

The specified documentation is the minimum required to provide clear communication between the pump user and pump manufacturer and to facilitate the safe design, installation, and operation of the pump. Additional data as required for specific purposes shall be made available if requested. Information should be furnished in a similar form from all sources for clarity and efficiency of use.

7.2 Requirements

The following documents shall be supplied for each pump item furnished. There can be a difference between proposal and purchase documents.

(a) pump and driver outline drawing
(b) centrifugal pump data sheet
(c) mechanical seal drawing (if applicable)
(d) mechanical seal piping drawing (if applicable)
(e) cooling/heating piping drawing (if applicable)
(f) performance curve with rated point
(g) cross-section drawing with parts list
(h) manual describing installation, operation, and maintenance
(i) coupling data (if applicable)
(j) driver data (if applicable)
(k) Statement of Compliance (when specified) (see para. 7.4.6)
(l) Certified Mill Test Reports (CMTR) for wetted pump parts (when specified) (see para. 7.4.7)

7.3 Document Description

7.3.1 Pump and Driver Outline Drawing

(a) Figure 7.3.1-1 shows a suggested arrangement for a pump and driver outline drawing as well as what information it may contain.

(b) Tapped openings, when supplied, shall be identified with the following markings:

Marking	Purpose
I	Casing drain
II	Discharge gage or flush connection
III	Suction gage or flush connection
X	Oil drain
XI	Bearing frame cooling
F	Mechanical seal flush or lantern ring
FI	Flush inlet
FO	Flush outlet
LBI	Liquid barrier/buffer inlet

Table continued

Marking	Purpose
LBO	Liquid barrier/buffer outlet
V	Vent
D	Drain
Q	Quench
C/HI	Cooling/heating inlet
C/HO	Cooling/heating outlet
CSD	Containment seal drain
CSV	Containment seal vent
GBI	Gas barrier/buffer inlet

7.3.2 ASME Centrifugal Pump Data Sheet

(a) Data Sheet. The ASME Centrifugal Pump Data Sheet in Mandatory Appendix I shall be used as the data sheet for all pumps covered by this Standard when the data sheet is initiated by the purchaser. The data sheet may be in electronic or printed format and shall be used for inquiry, proposal, and as built.

(b) Electronic Data. See Nonmandatory Appendix A.

7.3.3 Mechanical Seal Drawing

(a) A mechanical seal drawing shall be included if the pump is fitted with a mechanical shaft seal.

(b) The drawing shall show the general arrangement of the mechanical seal, identifying all parts with name, part number, and material of construction.

(c) If a throat bushing is to be installed in the seal cavity, it is to be clearly indicated and identified on the seal drawing.

(d) Drawings for noncartridge seals shall include dimensions complete with the seal setting dimension referred to on the seal chamber face.

(e) The drawings shall have both

(1) a title block that includes the information on the title block of the pump data sheet [see Form I-1 (Form I-1M)] and

(2) a blank space measuring a minimum of $1\frac{1}{2}$ in. × 3 in. (40 mm × 80 mm) for the user's identification stamp

7.3.4 Mechanical Seal Piping Drawing

(a) A mechanical seal piping drawing or schematic shall be provided if the pump includes a mechanical seal piping system.

(b) The mechanical seal piping drawing or schematic shall contain information and uniform nomenclature consistent with the references given in para. 5.6.1.

7.3.5 Cooling/Heating Piping Drawing

(a) A cooling/heating piping drawing or schematic shall be provided if the pump includes a cooling/heating piping system.

(b) The cooling/heating piping drawing or schematic shall contain all information and uniform nomenclature consistent with the references given in para. 5.6.1.

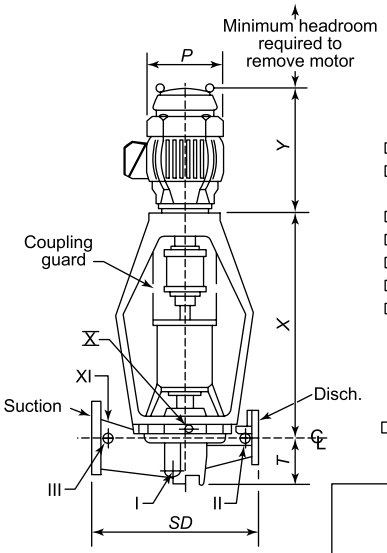
7.3.6 Performance Curve

7.3.6.1 Single-Speed Performance. The single-speed performance curve shall be the composite (family) type curve for full impeller diameter range, plotting head against flow and including efficiency, minimum flow, NPSHR, power consumption, and speed. Power consumption shall be provided at all flows including shutoff. Performance curves may be categorized as either published, proposal, as-built, or test.

(a) The published, or catalog, performance curve shall be as stated above and is based on water. These performance curves are normally found in the manufacturer's catalogs or electronic media and do not reflect a pump configured for a specific pumping application.

(b) The proposal performance curve shall be as stated in (a). The design impeller diameter shall be indicated with the rated duty point identified on the curve. It is not necessary to include the complete composite (family) curves; however, the maximum and minimum impeller diameter head-flow curves must be included. When the pumped fluid viscosity or specific gravity affects the pump performance, the proposal performance curve shall be corrected for these effects.

Figure 7.3.1-1
Sample Outline Drawing



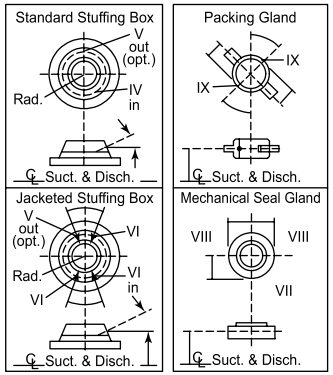
Flange Holes

- ☐ Through
- ☐ Tapped

- ☐ 125 lb. ANSI flanges
- ☐ 150 lb. ANSI flanges
- ☐ 300 lb. ANSI flanges
- ☐ Flat face flanges
- ☐ Raised face flanges

Pump type

☐ VC ☐ VM ☐ VB



Motor Specifications

Mfr. _____
Frame _____
hp _____ s.f. _____
rpm _____
Enclosure _____
Voltage _____
Hertz _____
Phase _____
☐ Packing type

Weight (lb)
Pump _____
Driver _____

Mechanical Seal Specifications

Mfr. _____
Type _____
Code _____
Dwg. No. _____
For Piping B/M, see drawing No. _____
No. Rings _____ Size _____

Coupling Specifications

Mfr. _____
Type _____ Size _____
Coupling Bores: Pump _____ Driver _____

Motor	Furnished by	☐ Others	☐ Pump mfg.
	Mounted by	☐ Others	☐ Pump mfg.
Coupling	Furnished by	☐ Others	☐ Pump mfg.
	Mounted by	☐ Others	☐ Pump mfg.
Coupling Guard	Furnished by	☐ Others	☐ Pump mfg.
	Mounted by	☐ Others	☐ Pump mfg.

Lubrication of Bearings
☐ Oil mist
☐ Grease
☐ Grease — lubed for life

Casing
☐ Plain
☐ Jacketed
☐ Traced

Shaft Type
☐ Sleeved
☐ Nonsleeved

Type of oil lubricator _____

Dimensions Determined by Motor				
NEMA Frame	X	Y	P	Wt.

Standard Pump Designation	ANSI 125, 150, 250, 300 Flange Sizes		*SD* +0.10 −0.08	*T* max.
	Suction	Discharge		
2015/15 (50-40-380)	2 (50)	1.50 (40)	14.96 (380)	6.89 (175)
2015/17 (50-40-430)			16.93 (430)	
2015/19 (50-40-480)			18.90 (480)	
3015/15 (80-40-380)	3 (80)	1.50 (40)	14.96 (380)	7.87 (200)
3015/19 (80-40-480)			18.90 (480)	
3015/24 (80-40-610)			24.02 (610)	
3020/17 (80-50-430)	3 (80)	2 (50)	16.93 (430)	7.87 (200)
3020/20 (80-50-510)			20.08 (510)	
3020/24 (80-50-610)			24.02 (610)	
4030/22 (100-80-560)	4 (100)	3 (80)	22.05 (560)	8.86 (225)
4030/25 (100-80-635)			25.00 (635)	
4030/28 (100-80-710)			27.95 (710)	
6040/24 (150-100-610)	6 (150)	4 (100)	24.02 (610)	9.84 (250)
6040/28 (150-100-710)			27.95 (710)	
6040/30 (150-100-760)			29.92 (760)	

Topped Openings						
No.	Size	Qty.	Purpose	Furnished		Usage
				Yes	No	

USAGE NOMENCLATURE
A - piped by manufacturer
B - piped by user
C - plugged by manufacturer
D - open (warning) remove shipping plug
E - other

Drawing is not to scale. All dimensions are in in. (mm). Weights are in lb (kg) approximate.

Dwg. No. _____

Customer/user _____
Location _____
Customer P.O. no. _____ Serial no. _____
Item no. _____ Equip no. _____
Factory order no. _____
Certified by _____ Date _____
Rev. _____ Date _____

Mechanical seal losses shall be reflected in the proposal performance curve. The proposal performance curves are normally supplied as part of a pump proposal and reflect a pump that has been configured for the specific pumping application.

(c) As-built, or as-configured, performance curves shall be as stated for the proposal performance curves and they must be for the specific pump configuration supplied to the purchaser. As-built, or as-configured, performance curves are provided as part of the pump final documentation package.

7.3.6.2 Variable-Speed Performance. When variable-speed operation is specified, variable-speed performance curves shall be provided. The requirements and categories of variable-speed curves are the same as for single-speed curves (see para. 7.3.6.1), except that the curve will show a composite of curves with a single impeller trim when operated over a range of speeds. The speed for each curve shall be clearly indicated.

7.3.6.3 Performance Test Curve. The performance test curve, if specified, shall be at rated speed and as described in para. 6.2.1.2(e) and provided as part of the pump final documentation package.

7.3.7 Cross-Section Drawing. The cross-section drawing shall show all components of the pump. It shall be complete with a parts list referenced to the drawing. Nomenclature and definitions should be in accordance with ANSI/HI 14.1-14.2.

7.3.8 Instruction Manual. The instruction manual should include information on the correct installation, preparation for start-up, starting up, and operation; a trouble checklist; and maintenance information for the pump model furnished.

(a) Any limitation or warning on the installation, operation, etc., of the unit shall be clearly defined.

(b) The instruction manual shall be in electronic or printed format.

(c) The use of a single manual to describe many similar models of pumps should be avoided to reduce user confusion on the exact model furnished.

(d) If an adjustable alignment feature is provided, the recommended tolerance for coupling alignment shall be supplied to the purchaser.

(e) The instruction manual for the pump driver, mechanical seal, coupling, etc., shall be furnished if included in the scope of supply.

(f) A guideline for developing instruction manuals may be found in ANSI/HI 14.4.

7.3.9 Coupling Data. When flexible couplings are supplied, the coupling data shall include manufacturer, type, model, size, spacer length, materials of construction, and hub-to-shaft attachment method.

7.3.10 Driver. The driver data shall include manufacturer, nameplate, and dimensional data.

7.4 Specially Requested Documentation

Documentation in addition to that listed in para. 7.3 shall be made available when specified.

7.4.1 Master Document List

(a) The master document list is a composite list of all documents submitted by the manufacturer and includes the title of the document and drawing or other identification numbers, including revision dates.

(b) This list shall be submitted along with the first document submitted so the purchaser will be aware of which documents will follow.

(c) Revisions to this document list shall be made as required.

7.4.2 External Forces or Moments on Nozzles List. This list summarizes the allowable external forces and moments on pump suction and discharge nozzles (see para. 6.1.2).

7.4.3 Parts List

(a) The manufacturer shall supply a list of all pump parts with pump identification numbers, part numbers, and material descriptions. This list shall be as-built.

(b) The manufacturer shall supply a list of recommended spare parts subdivided into the following two categories:

(1) for start-up

(2) for 3-yr operation

(c) The spare parts list for auxiliary equipment shall be supplied with the pump. This would include, as applicable, mechanical seal, coupling, driver, gearboxes, etc.

(d) These lists shall be presented to the purchaser before the equipment is shipped, and they shall reflect the as-built equipment.

7.4.4 Special Operating or Design Data. Special operating and design data required by the purchaser shall be supplied. These may include the following:

(a) minimum mechanical seal flush flow
(b) seal chamber or stuffing box pressure
(c) maximum allowable casing pressure and temperature
(d) maximum allowable jacket pressure and temperature

7.4.5 Special Testing, Painting, and Preparation. Any required special testing, painting, or preparation shall be specified on the centrifugal pump data sheet or purchase order.

7.4.6 Statement of Compliance. A statement of compliance shall be included, if specified. This statement shall include assurance that the pump is being supplied according to the requirements of the purchase specifications.

7.4.7 CMTR. The manufacturer's physical and chemical data from mill reports (or certification) of wetted parts shall be included when specified.

MANDATORY APPENDIX I
ASME CENTRIFUGAL PUMP DATA SHEET

See Form I-1 (Form I-1M) on the following pages.

ASME B73

Form I-1 Centrifugal Pump Data Sheet

Rev No.:_____ Rev Date:_____

ASME Centrifugal Pumps (U.S. Customary Units)
ASME B73.1, ASME B73.2

Issue Date
March 2023

Page 1 of 4

Usage key - data provided by: ● Purchaser ■ Supplier ▲ Supplier if not by purchaser

Issued for: ☐ Proposal ☐ Purchase ☐ As built

Facility name / location: _____ P&ID number: _____
Item name: _____ Purchaser / location: _____
Item tag number: _____ Job number: _____
Service: _____ Purchaser order number: _____
Unit: _____ Supplier / location: _____
Number of pumps required: _____ Supplier order / serial numbers: _____ /

● GENERAL

▲ Pump size: _____ Driver item number: _____
▲ Pump model: _____ Driver provided by: _____
▲ Pump type: ☐ Horizontal End Suction[4] ☐ Vertical In-line[5] ☐ Repeller[4] Driver mounted by: _____
☐ Recessed Impeller[4] ☐ Self Priming[4] ☐ Low Flow[4] Variable speed operation ☐ YES ☐ NO

[4]ASME B73.1 only; [5]ASME B73.2 only

● Operating Conditions

	Rated	Maximum	Normal	Minimum	Other	
Flow:						(gpm)
[1]At flow designated above						
Head[1]:						(ft)
NPSHA[1]:						(ft)
Suct pres[1]:						(psig)

System design:
Suction pressure: min. / max.: _____ / _____ (psig)
Suction temperature: min. / max.: _____ / _____ (°F)
☐ Stand alone operation
☐ Parallel operation with item no.: _____
☐ Series operation with item no.: _____
Service:
☐ Continuous ☐ Intermittent: _____ starts/day
System control method:
☐ Speed ☐ Throttle ☐ System Resistance Only

■ Performance

Performance curve number: _____
▲ Speed: _____ (rpm) ☐ B73 curve speed ☐ Job driver nameplate
Maximum differential head @ rated impeller: _____ (ft)

[3]at specified flow	Rated	Maximum	Normal	Minimum	Other	
Head[3]:						(ft)
NPSHR[3]:						(ft)
Speed(if variable)[3]:						(rpm)

Minimum continuous stable flow: _____ (gpm)
Allowable operating region: _____ to: _____ (gpm)
Best efficiency point for rated impeller: _____ (gpm)
Suction specific speed: _____
Impeller diameter Rated: _____ Max: _____ Min: _____ (in)
Pump rated power: _____ (BHP) Efficiency: _____ (%)
Maximum power with rated impeller: _____ (BHP)
Case pressure rating:
Maximum allowable working pressure: _____ (psig) @ _____ (°F)
Hydrostatic test pressure: _____ (psig)

● Pumped Fluid

Pumped fluid: _____

	Rated	Maximum	Normal	Minimum	
Pumping temperature:					(°F)
[2]At pumping temperatures designated above					
Specific gravity[2]:					
Vapor pressure[2]:					(psia)
Viscosity[2]:					(cP)
Specific heat[2]:					(Btu/lb °F)

Atm pressure boiling point: _____ (°F) @ _____ (psia)
Liquid: ☐ Hazardous ☐ Flammable pH _____
☐ Other: _____
Fluid Rating System: ☐ NFPA 704 ☐ HMIS
Health: _____ Flammability: _____ Instability: _____
Corrosion / erosion caused by: _____
% solids: _____ ☐ % Volume ☐ % Weight
Max. particle size: _____ (in)
Other:

● Site Conditions and Utilities

Location: ☐ Indoor ☐ Outdoor Altitude: _____ (ft)
Range of ambient temperatures: min. / max.: _____ / _____ (°F)
Area classification: ☐ Nonhazardous
Cl: _____ Div or Zone: _____ Gr: _____ T Code: _____

Electricity	Voltage	Phase	Hertz
Drivers			
Heating			

Cooling water: Source: _____
Supply temp.: _____ (°F) Max. return temp.: _____ (°F)
Supply pressure: _____ (psig) Design press.: _____ (psig)
Min. return press. _____ (psig) Max. allow. D.P. _____ (psi)
Chloride concentration: _____ (ppm)

● General Remarks

Number	Date	Data Revision Description	By	Approved

ASME B73	Form I-1 Centrifugal Pump Data Sheet (Cont'd) Rev No.:_____ Rev Date:_____	Issue Date March 2023
	ASME Centrifugal Pumps (U.S. Customary Units) ASME B73.1, ASME B73.2	Page 2 of 4

Usage key - data provided by: ● Purchaser ■ Supplier ▲ Supplier if not by purchaser

Mechanical Data

▲ **Impeller Type:**
☐ Closed ☐ Open ☐ Semi-open

▲ **Casing Mounting:**
☐ Foot ☐ Centerline ☐ Vertical In-line

■ **Bearings:**
▲ Bearing manufacturer: _____
Radial bearing type: _____ No.: _____
Thrust bearing type: _____ No.: _____
▲ Bearing isolators: ☐ Labyrinth (standard) ☐ Magnetic seal
Manufacturer: _____

▲ **Lubrication:**
☐ Oil bath[4] ☐ Pure mist ☐ Shielded (grease)
☐ Grease ☐ Purge mist ☐ Sealed (grease)
☐ Magnetic drain plug in housing[4] ▲ ☐ Oil cooler[4]
■ ☐ Oil viscosity: ISO grade: _____ Other: _____

Nozzle Connections: ▲ Size ▲ Rating ▲ Facing

Suction:			
Discharge:			

● **Aux. case connection:** ☐ Drain
▲ Size: _____ NPT / NPS
☐ Threaded ☐ Welded and flanged

▲ **MATERIALS**

Material class code: _____
Casing: _____
Impeller: _____
Cover: _____
Shaft: _____
Shaft sleeve: _____
Baseplate/support base: _____
Casing gasket: _____
Impeller o-ring / gasket: _____
Casing fasteners: _____
Gland fasteners: _____
Bearing housing: _____
Bearing housing adapter: _____
Bearing isolators: _____
Coupling guard: _____
Mechanical seal materials - see page 3

▲ **Coupling Between Pump and Driver**

Specification: _____
Manufacturer: _____
Type: _____
Model / Size: _____
Spacer length: _____ (in)
☐ Coupling balanced to ISO 21940-11, grade G6.3
☐ Straight bore hub with interference fit
Coupling guard type:
☐ Pump supplier's standard ASME B73 Guard
☐ Purchaser Specification: _____
☐ Non-spark coupling guard
Remarks: _____

[4]ASME B73.1 only; [5]ASME B73.2 only)

▲ **Driver**

Power rating: _____ (HP) Speed: _____ (rpm)
Drive HP selected for max. S.G. _____ & max. visc.: _____ (cP)
Driver specification: _____
Driver manufacturer: _____
Driver enclosure: _____ Driver frame: _____
Remarks: _____

● **Baseplate**

Type: ☐ Grouted[4]
☐ Concrete filled (nonmetallic pedestal baseplate)
☐ Free standing[4] ▲ Pump CL to foundation _____ (in)
☐ Vertical in-line pump case support base[5]
Design: ☐ Purchaser specification _____
☐ ASME B73 standard[4]
☐ Industrial duty grouted fabricated steel[4]
☐ Nonmetallic[4]
☐ Cast iron[4]
Remarks: _____

● **Paint, Shipment, and Storage Preparation**

Paint:
☐ Pump supplier's standard
☐ Other: _____
Shipment:
☐ Domestic ☐ Export ☐ Export boxing
Storage:
☐ Outside ☐ Under roof ☐ Environmentally controlled
☐ Short term ☐ Long term (>3 months)
Environment: _____
☐ Supplier's standard preservation specification
Purchaser storage specification: _____
■ Unit shipping weight: (lbs)

● **Tests and Inspections**

Test:	Non-witnessed	Witnessed	Certificate
Hydrostatic:	☐	☐	☐
Leak:	☐	☐	☐
NPSHR:	☐	☐	☐
Performance:	☐	☐	☐

Opt perf acceptance criteria: ☐ Power ☐ Efficiency ☐ Neither
Additonal data: ☐ Vibration ☐ Brg temp
☐ Other perf. data: _____
☐ Final inspection Days notification required: _____
☐ Dismantle and inspect after test
☐ Casting repair procedure approval required
☐ Statement of Compliance
☐ Certified Mill Test Reports:
☐ Casing ☐ Cover ☐ Impeller ☐ Shaft
☐ Other: _____
Inspection required for connection welds and castings:
☐ Manufacturer's standard ☐ Level 1 ☐ Level 2 ☐ Level 3
☐ Other: _____
Remarks: _____