ASME B73.2-2016

[Revision of ASME B73.2-2003 (R2008)]

Specification for Vertical In-Line Centrifugal Pumps for Chemical Process

AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

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The American Society of Mechanical Engineers

Two Park Avenue • New York, NY • 10016 USA

Date of Issuance: April 14, 2017

This Standard will be revised when the Society approves the issuance of a new edition. There will be no written interpretations of the requirements of this Standard issued to this edition.

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The B73 Committee Page can be found at go.asme.org/B73committee. There is an option available to automatically receive an e-mail notification when errata are posted to a particular code or standard. This option can be found on the appropriate Committee Page after selecting "Errata" in the "Publication Information" section.

The American Society of Mechanical Engineers
Two Park Avenue, New York, NY 10016-5990

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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 was 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 utilization 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 NPSH margin were incorporated into this 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 the Standard includes a number of revisions. Reference is made to the current API practices for mechanical seal configurations and cooling and heating plans. A mechanical seal configuration code that is aligned with the API sealing standard and a material classification code have been added to B73.2. A universal cover has been offered as an option to the Standard as an alternate sealing cover. Requirements for the bearing frame have been revised to ensure more robust pumps. Nomenclature for the pump sizes has been added to align with the more commonly used sizes identified in B73.1. Approximate hydraulic performance for the B73.2 pumps has been established. The default performance test acceptance grade has been 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 B73.1 and B73.2 Standards has been developed and added. This Standard endorses the Electronic Data Exchange standard, which was developed by the Hydraulic Institute and Fiatech AEX project. These revisions have been made to further improve the reliability of the B73.2 pumps. These changes also better align with the HI and API pump standards.

Suggestions for improvement to this Standard are welcome and should be sent to the Secretary, B73 Main Committee, The American Society of Mechanical Engineers, Two Park Avenue, New York, NY 10016-5990.

This revision was approved as an American National Standard on November 16, 2016.

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 Standards are developed and maintained with the intent to represent the consensus of concerned interests. As such, users of this Standard may interact with the Committee by proposing revisions or a case, and attending Committee meetings. Correspondence should be addressed to:

Secretary, B73 Standards Committee
The American Society of Mechanical Engineers
Two Park Avenue
New York, NY 10016-5990
http://go.asme.org/Inquiry

Proposing Revisions. Revisions are made periodically to the Standard 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 periodically.

The Committee welcomes proposals for revisions to this Standard. Such proposals should be as specific as possible, citing the paragraph number(s), the proposed wording, and a detailed description of the reasons for the proposal, including any pertinent documentation.

Proposing a Case. Cases may be issued to provide alternative rules when justified, to permit early implementation of an approved revision when the need is urgent, or to provide rules not covered by existing provisions. Cases are effective immediately upon ASME approval and shall be posted on the ASME Committee Web page.

Requests for Cases shall provide a Statement of Need and Background Information. The request should identify the Standard and the paragraph, figure, or table number(s), and be written as a Question and Reply in the same format as existing Cases. Requests for Cases should also indicate the applicable edition(s) of the Standard to which the proposed Case applies.

Attending Committee Meetings. The B73 Standards Committee regularly holds meetings and/or telephone conferences that are open to the public. Persons wishing to attend any meeting and/or telephone conference should contact the Secretary of the B73 Standards Committee. Future Committee meeting dates and locations can be found on the Committee Page at go.asme.org/B73committee.

SPECIFICATION FOR VERTICAL IN-LINE CENTRIFUGAL PUMPS FOR CHEMICAL PROCESS

1 SCOPE

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 B73.2 pumps. It is the intent of this Standard that 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). Maintenance and operation requirements are not included in this Standard.

2 REFERENCES

The following documents form a part of this Standard to the extent specified herein. The latest edition shall apply:

ANSI B11.19, Performance Requirements for Safeguarding

Publisher: Association for Manufacturing Technology (AMT), 7901 Westpark Drive, McLean, VA 22102-4206 (www.amtonline.org)

ANSI/ABMA 9, Load Ratings and Fatigue Life for Ball Bearings

ANSI/ABMA 11, Load Ratings and Fatigue Life for Roller Bearings

Publisher: American Bearing Manufacturers Association (ABMA), 2025 M Street, NW, Suite 800, Washington, DC 20036 (www.americanbearings.org)

ANSI/HI 1.1-1.2, Rotodynamic Centrifugal Pumps for Nomenclature and Definitions

ANSI/HI 1.3, Rotodynamic Centrifugal Pumps for Design and Application

ANSI/HI 1.4, Rotodynamic Centrifugal Pumps for Manuals Describing Installation, Operation and Maintenance

ANSI/HI 9.1-9.5, Pumps — General Guidelines for Types, Applications, Definitions, Sound Measurements, and Documentation

ANSI/HI 9.6.1, Rotodynamic Pumps Guideline for NPSH Margin

ANSI/HI 9.6.2, Rotodynamic Pumps for Assessment of Applied Nozzle Loads

ANSI/HI 9.6.4, Rotodynamic Pumps for Vibration Measurements and Allowable Values

ANSI/HI 14.6, Rotodynamic Pumps for Hydraulic Performance Acceptance Tests

Publisher: Hydraulic Institute (HI), 6 Campus Drive, Parsippany, NJ 07054-4406 (www.pumps.org)

ANSI/NEMA MG 1, Motors and Generators

Publisher: National Electrical Manufacturers Association (NEMA), 1300 North 17th Street, Suite 900, Arlington, VA 22209 (www.nema.org)

API 610, Centrifugal Pumps for Petroleum, Petrochemical and Natural Gas Industries

API 682, Pumps-Shaft Sealing Systems for Centrifugal and Rotary Pumps

Publisher: American Petroleum Institute (API), 1220 L Street, NW, Washington, DC 20005 (www.api.org)

ASME B16.5, Pipe Flanges and Flanged Fittings

ASME B16.11, Forged Fittings, Socket-Welding and Threaded

ASME B16.42, Ductile Iron Pipe Flanges and Flanged Fittings, Classes 150 and 300

Publisher: The American Society of Mechanical Engineers (ASME), Two Park Avenue, New York, NY 10016-5990 (www.asme.org)

ASTM A48/A48M, Standard Specification for Gray Iron Castings

ASTM A105/A105M, Standard Specification for Carbon Steel Forgings for Piping Applications

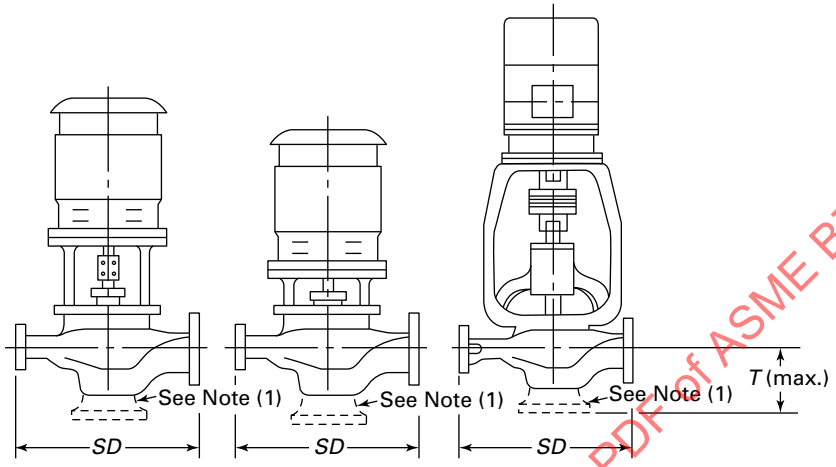
ASTM A106/A106M, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service

ASTM A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished

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 A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High-Temperature or High Pressure Service and Other Special Purpose Applications

Table 1 Pump Dimensions



Type VC Type VM Type VB

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 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 A216/A216M, Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service

ASTM A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service

ASTM A276, Standard Specification for Stainless Steel Bars and Shapes

ASTM A312/A312M, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes

ASTM A395/A395M, Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures

ASTM A434/A434M, Standard Specification for Steel Bars, Alloy, Hot-Wrought or Cold-Finished, Quenched and Tempered

ASTM A479/A479M, Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels

ASTM A494/A494M, Standard Specification for Castings, Nickel and Nickel Alloy

ASTM A519, Standard Specification for Seamless Carbon and Alloy Steel Mechanical Tubing

ASTM A536, Standard Specification for Ductile Iron Castings

ASTM A743/A743M, Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application

ASTM A744/A744M, Standard Specification for Castings, Iron-Chromium-Nickel, Corrosion Resistant, for Severe Service

ASTM A890/A890M, Standard Specification for Castings, Iron-Chromium-Nickel-Molybdenum Corrosion-Resistant, Duplex (Austenitic/Ferritic) for General Application

ASTM A995/A995M, Standard Specification for Castings, Austenitic-Ferritic (Duplex) Stainless Steel, for Pressure-Containing Parts

ASTM B160, Standard Specification for Nickel Rod and Bar

ASTM B164, Standard Specification for Nickel-Copper Alloy Rod, Bar and Wire

ASTM B335, Standard Specification for Nickel-Molybdenum Alloy Rod

ASTM B348, Standard Specification for Titanium and Titanium Alloy Bars and Billets

ASTM B367, Standard Specification for Titanium and Titanium Alloy Castings

ASTM B473, Standard Specification for UNS N08020, UNS N08024, and UNS N08026 Nickel Alloy Bar and Wire

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 Alloy Rod

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 Alloy Plate, Sheet, and Strip

Publisher: American Society for Testing and Materials (ASTM International), 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959 (www.astm.org)

AWS B1.11, Guide for the Visual Examination of Welds

Publisher: American Welding Society (AWS), 8669 NW 36 Street, No. 130, Miami, FL 33166 (www.aws.org)

ISO 281, Rolling bearings — Dynamic load ratings and rating life

ISO 1940-1, Mechanical vibration — Balance quality requirements for rotors in a constant (rigid) state — Part 1: Specification and verification of balance tolerances

ISO 13709, Centrifugal pumps for petroleum, petrochemical and natural gas industries

ISO 21049, Pumps — Shaft sealing systems for centrifugal and rotary pumps

Publisher: International Organization for Standardization (ISO), Central Secretariat, Chemin de Blandonnet 8, Case Postale 401, 1214 Vernier, Geneva, Switzerland (www.iso.org)

MSS SP-55, Quality Standard for Steel Castings for Valves, Flanges, Fittings, and Other Piping Components — Visual Method for Evaluation of Surface Irregularities

Publisher: Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS), 127 Park Street, NE, Vienna, VA 22180 (www.msshq.org)

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 NOMENCLATURE AND DEFINITIONS

4.1 Definition of Terms

The nomenclature and definitions of pump components shall be in accordance with ANSI/HI 1.1-1.2 except as noted below.

4.2 Additional Definitions

auxiliary piping: includes all piping connected to the pump, seal chamber, packing 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.

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: refers to seal chamber, universal cover, or packing box.

supplier: 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 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 the particular component and material of construction used (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 marking requirements are not applicable and 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. 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), or raised-face flanges may be offered as an option.

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

5.2.4 Heavy Hex Nuts. Where heavy hex nuts cannot be used, 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 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, this is a consideration for metallic and semi-metallic (i.e., spiral wound) gaskets where significant preload may be required to achieve sufficient tightness.

5.3 Casing

5.3.1 Drain Connection Boss(es). Pump casing shall have boss(es) to provide for drain connection(s) in the lowest part of the casing. Boss size shall accommodate

½ in. NPT minimum. Boss(es) shall be drilled and tapped when specified by the purchaser.

5.3.2 Auxiliary Connection Boss(es). The suction and discharge nozzles shall have boss(es) for gage connections. Boss size shall accommodate ¼ in. NPT minimum, ½ in. NPT preferred. Bosses shall be drilled and tapped when 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.

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 B73.2 pumps. The sealing cover, pump casing, and bearing housing are areas of the pump that may have design features available for heating or cooling.

5.3.5.2 Jackets for heating or cooling the casing and/or sealing cover are optional. Connections shall be ⅜ in. NPT minimum, with ½ in. NPT preferred. When a jacket is to be used for heating by steam, the inlet connection shall be located at the top of the jacket, and the drain connection shall be located at the bottom of the jacket to prevent the formation of water pockets. Jackets for liquid cooling shall have the outlet at the top to prevent the formation of vapor pockets and a drain at the bottom for freeze protection.

5.3.6 Gasket. The casing-to-cover gasket(s) shall be confined on the atmospheric side to prevent blowout. Design shall consider thermal cycling that may occur as a condition of service. Gaskets shall be selected so the required seating stress is compatible with the available bolt load (strength and area). The gasket material shall be suitable for the service conditions and flange facing/finish.

5.3.7 Bolting. The pressure-containing 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 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 be provided with 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 meet ISO 1940-1 Grade 6.3 after final machining.

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 packing 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 provide 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) shaft rotated on centers: 0.001 in. (0.025 mm) full indicator movement (FIM) reading at any point; and

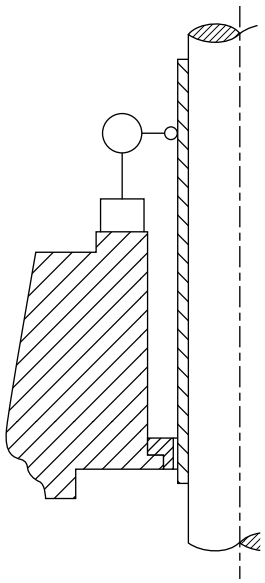
(b) outside diameter of shaft or removable sleeve when installed in pump: 0.002 in. (0.05 mm) FIM at the gland end of sealing cover (see Fig. 1).

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 1.3.

5.5.5 Running Clearances. Clearances must be sufficient to prevent internal rubbing when the pump is subjected to the maximum allowable flange loads (para. 6.1.2) while running within the allowable operating region (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 9.6.4

Fig. 1 Shaft Sleeve Runout



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.

5.6 Shaft Sealing

5.6.1 Design. The following are the three basic types of sealing covers:

(a) seal chamber
(b) universal cover
(c) packing box

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

The seal chamber is designed to accommodate mechanical seals only and can be of 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 packing 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.

Details and tutorials on piping plans for mechanical seals can be found in API 682 (ISO 21049). Piping plan designations found in API 682 (i.e., Plan 11, Plan 53A, etc.) will be applied to ASME B73 pump applications. Details and designations on piping plans involving pump heating or cooling (i.e., bearing bracket cooling, heating and cooling jackets, etc.) can be found in API 610 (ISO 13709). 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 the specific design of components and hardware that may be contained in these Standards.

5.6.2 Seal Chamber. 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 Figs. 2 and 3.

The secondary seal contact surface(s) shall not exceed a roughness of 63 μin. (1.60 μm) 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.

5.6.2.1 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 runout having significant effect on seal performance include the following:

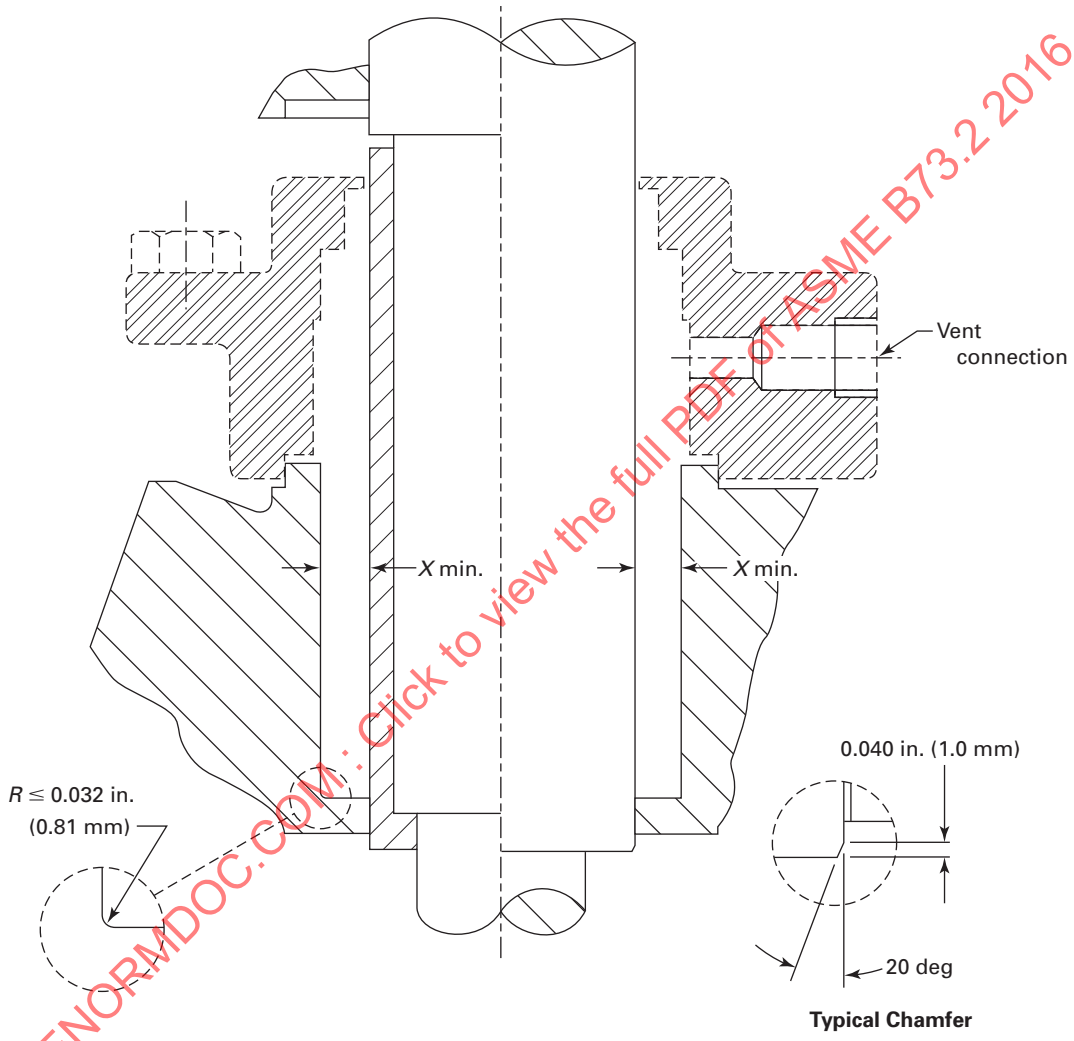
(a) Seal Chamber Face Runout. This is a measure of the perpendicularity of the seal chamber face with respect to the pump shaft. It is measured by mounting a dial indicator on the pump shaft and measuring FIM at the face of the seal chamber. The maximum allowable runout is 0.003 in. (0.08 mm) FIM (see Fig. 4).

(b) Seal Chamber Register Runout. Provisions shall be made for centering the gland with either an inside or outside diameter register. This register shall be concentric with the shaft or sleeve within 0.005 in. (0.13 mm) FIM (see Fig. 5).

5.6.3 Universal Cover. The universal cover shall be as indicated in Table 2. The runout requirements from para. 5.6.2.1 apply for face and register fits.

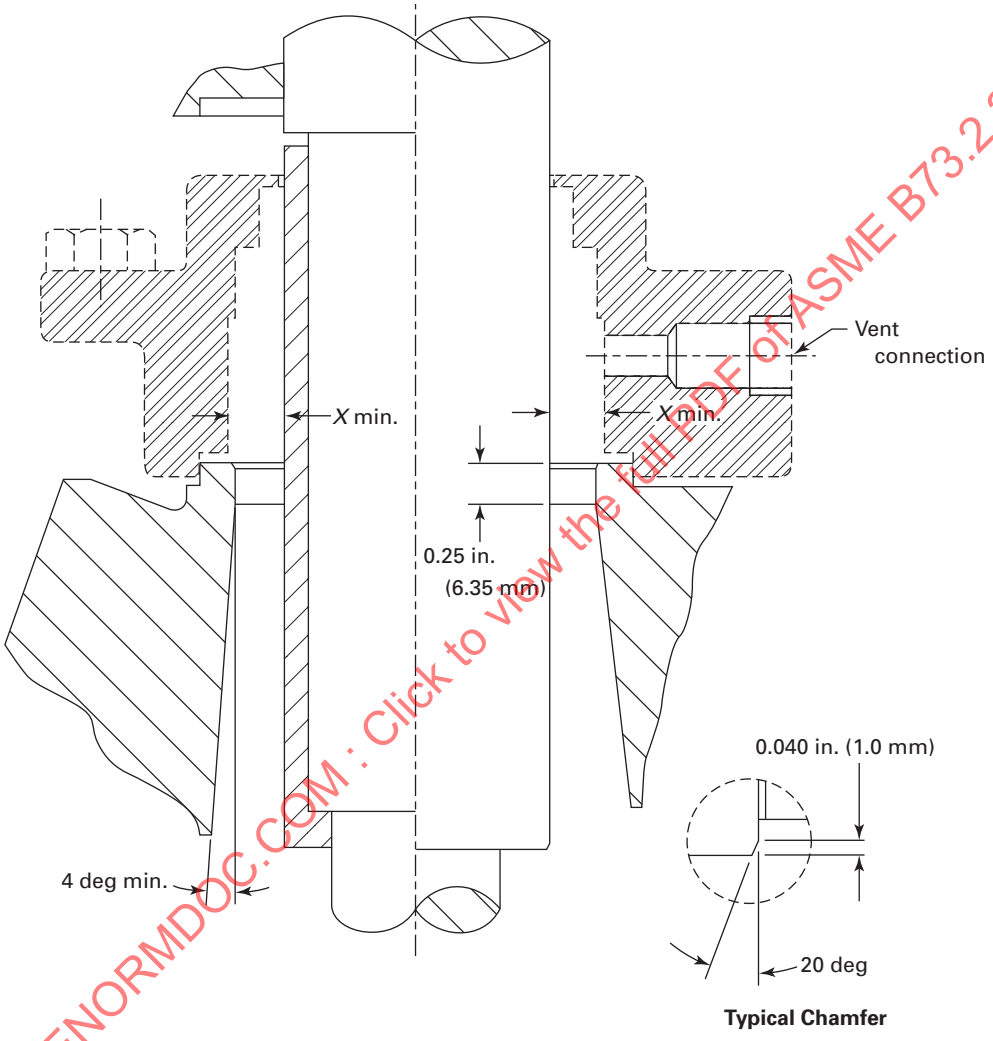
NOTE: The seal operating cavity is the responsibility of the mechanical seal supplier and should be incorporated into the seal gland.

Fig. 2 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)

Fig. 3 Tapered Seal Chamber



Typical Chamfer

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)

Fig. 4 Face Runout

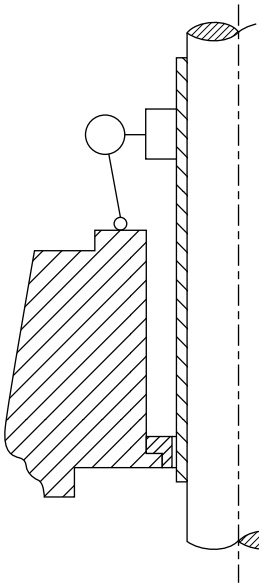
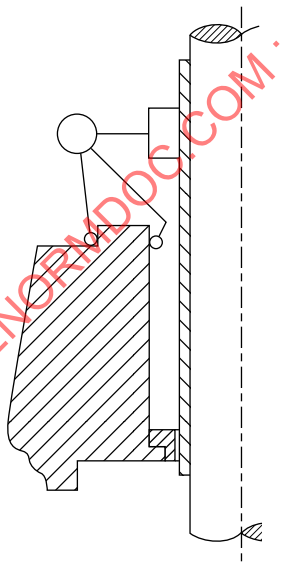


Fig. 5 Register Concentricity



5.6.4 Packing Box. The packing box packing bore surface shall not exceed a roughness of 63 μin. (1.60 μm) AA. One flush connection shall be provided as a minimum. Additional connections to the packing box are optional. The size shall be ¼ in. NPT minimum, with ½ in. NPT preferred. Registers shall maintain the packing box bore concentric with the axis of the pump shaft within 0.005 in. (0.13 mm) FIM. The packing box face shall be perpendicular to the axis of the assembled pump shaft within 0.003 in. (0.08 mm) FIM. Figure 6 shows the recommended packing box dimensions. The packing box also 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 Space in the various seal chamber designs shall provide for the seal configurations identified in Mandatory Appendix II.

5.6.5.2 Space in the packing box and exterior clearance area shall provide 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

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.

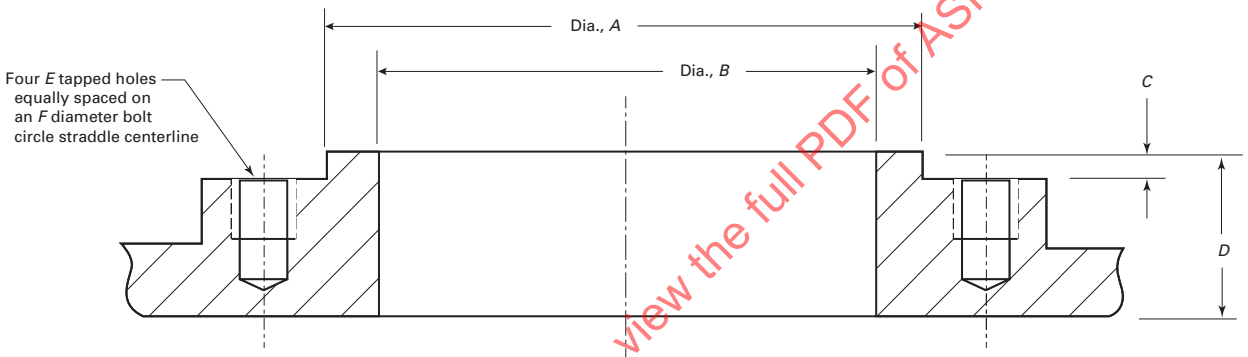
5.6.6.3 Cartridge Seal Glands. Cartridge seals shall either center on the shaft or pilot on the seal chamber.

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 (ISO 21049) Category 1. The requirement to apply API 682 must be designated on the Pump Data Sheet (Mandatory Appendix I) 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

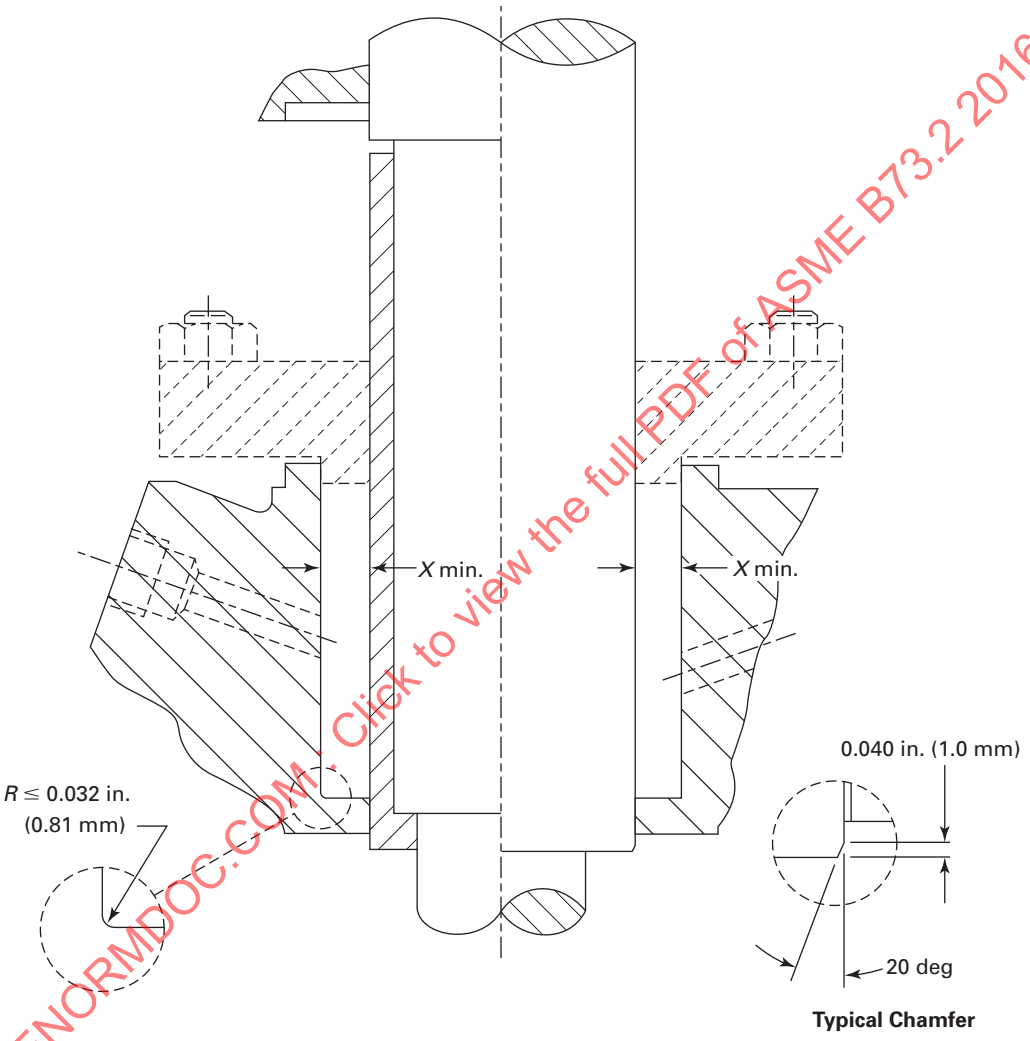
Table 2 Universal Cover Dimensions



Feature	*SD* Dimension 14.96/16.93	*SD* Dimension 18.9 and Above	*SD* Dimension 18.9 and Above Option
A	3.374 ± .001	4.249 ± .001	4.624 ± .001
B	2.876 ± .001	3.501 ± .001	3.876 ± .001
C	0.19	0.25	0.25
D	1.55	1.75	2.12
E	$\frac{3}{8}$″-16 UNC	$\frac{5}{8}$″-11 UNC	$\frac{5}{8}$″-11 UNC
F	4.25	5.50	5.875

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

Fig. 6 Packing 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)

Table 3 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 & 145-LP	1⅛	2¾	2¾	8¼	9⅛	10
182 & 184-LP	1⅛	2¾	2¾	8¼	9⅛	10
213 & 215-LP	1⅝	2¾	2¾	8¼	9⅛	10
254 & 256-LP	1⅝	2¾	2¾	8¼	9⅛	10
284 & 286-LP	2⅛	4	4½	13½	14¾	16½
324 & 326-LP	2⅛	4	4½	13½	14¾	16½
364 & 365-LP	2⅛	4	4½	13½	14¾	16½
404 & 405-LP	2⅛	4	4½	13½	14¾	16½
444 & 445-LP	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.

coupling, permitting removal of the pump shaft, shaft seal, and impeller without disturbing the motor (see Table 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 3).

(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.

(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. For pumps that have their own bearing housings and bearings designed to handle the pump loads, see Table 1.

(a) Motors for VB pumps shall be NEMA C-face foot or footless motors, available in all standard enclosures.

(b) Shaft and accessories dimensions shall be in accordance with ANSI/NEMA MG 1-11.34.

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

(d) The pump shaft is attached to the motor shaft by a flexible spacer coupling, permitting removal of the pump shaft, seal, and impeller without disturbing the motor.

5.7.4 Motor Horsepower Selection. Motors shall be selected having nameplate horsepower ratings at least as high as in Table 4, based on the pump rated bhp in the Table. Where it appears that using this Table leads to unnecessary oversizing of the motor, an alternative size may be offered in addition to the Table selection.

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, and the combined hydraulic thrust load and weight of all rotating parts.

5.7.5.2 Life. After tentative selection of the motor size and motor manufacturer, the pump manufacturer shall be responsible for assuring the motor bearing life, when calculated in accordance with ANSI/ABMA 9, ANSI/ABMA 11, and ISO 281, and will provide for a minimum L'10h 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. If the calculated bearing life fails to meet this specification, the pump manufacturer shall determine whether to use a different motor whose bearings will meet the specification, or to reduce the loads sufficiently in order to comply.

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 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: one assembly free to float within the frame to carry radial load only, and the other

Table 4 Motor Horsepower Selection

For Pump Rated bhp up to [Note (1)]	Select Motor With Nameplate, hp Rating		Maximum Allowable Motor Load, hp [Note (2)]	Percent of Margin, Motor hp	For Pump Rated bhp up to [Note (1)]	Select Motor With Nameplate, hp Rating		Maximum Allowable Motor Load, hp [Note (2)]	Percent of Margin, Motor hp
	SF 1.0	SF 1.15				SF 1.0	SF 1.15		
0.70	1	...	1.00	43	21.00	25	...	25.00	19
0.82	...	1	1.15	41	24.40	...	25	28.75	18
1.08	1.5	...	1.50	39	25.50	30	...	30.00	17.5
1.25	...	1.5	1.72	38	29.50	...	30	34.50	17
1.46	2	...	2.00	37	34.50	40	...	40.00	16
1.70	...	2	2.30	35	40.00	...	40	46.00	15
2.25	3	...	3.00	33.5	43.80	50	...	50.00	14
2.62	...	3	3.45	31.5	50.90	...	50	57.50	13
3.85	5	...	5.00	29.5	53.30	60	...	60.00	12.5
4.49	...	5	5.75	28	62.00	...	60	69.00	11.5
5.93	7.5	...	7.50	26.5	67.50	75	...	75.00	11
6.90	...	7.5	8.62	25	78.00	...	75	86.25	10.5
8.10	10	...	10.00	23.5	91.00	100	...	100.00	10
9.36	...	10	11.50	23	104.50	...	100	115.00	10
12.30	15	...	15.00	22	113.50	125	...	125.00	10
14.25	...	15	17.25	21	131.00	...	125	144.00	10
16.60	20	...	20.00	20.5	136.50	150	...	150.00	10
19.20	...	20	23.00	20	156.50	...	150	172.50	10

GENERAL NOTE: 1 hp = 0.746 kW.

NOTES:

(1) bhp at the specified operating condition.

(2) Motor nameplate hp times service factor.

assembly arranged to carry radial loading, axial thrust, and weight of the pump rotor assembly.

5.7.6.2 Life. Bearings shall be selected in accordance with ANSI/ABMA 9, ANSI/ABMA 11, and ISO 281. The minimum L10h 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.

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 utilized. 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. 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 frame shall be constructed to protect the bearings from water, dust, and other contaminants and provide lubrication for the bearings. The standard design is for grease lubrication.

5.7.8.1 Sealing. The standard design is to include lip seals. In addition, optional designs may be offered with the purchaser's approval. 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. As an option, the bearing frame shall be provided 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 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 6 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 with 316 SS as a minimum. If 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 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 7.

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).

5.10 Direction of Rotation

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.

5.12 Miscellaneous Design Features

5.12.1 Safety Guards. Each coupling shall be furnished with a coupling guard. The coupling guard shall prevent personnel from contacting rotating components. An auxiliary guarding device to prevent personnel from contacting rotating components or to control spray from packing box/seal chamber leakage shall be provided when specified. Regional regulations and purchaser requirements may require additional guards. All guards shall meet the performance criteria of ANSI B11.19.

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

5.12.3 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.

5.12.4 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.

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

5.12.6 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

Table 5 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	NA	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	Arimid 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 6 Material of Construction

Material Designation	ASTM Material Code by Application				
	Casting Wetted by Pumped Fluid	Casting Not Wetted by Pumped Fluid	Bar Stock	Pressure-Retaining Bolts and Studs	Nuts
	Standard Available Pump Materials				
Cast iron	...	A48	...	...	...
Ductile iron	A395 Gr 60-40-18	A395 Gr 60-40-18 or A536	...	...	...
Carbon steel	A216 Gr WCB	...	A108 Gr 1144 or A434 Gr 4140	A193 Gr B7	A194 Gr 2H
Carbon steel with PTFE coating	...	...	...	A193 Gr B7 with PTFE coating	A194 Gr 2H with PTFE coating
304 SS	...	...	...	A193 Gr B8	A194 Gr 8
316 SS	A744 Gr CF-8M	A744 Gr CF-8M or A743 Gr CF8M	A276 Type 316 SS	A193 Gr B8M	A194 Gr 8M
Alloy 20 stainless steel	A744 Gr CN-7M	A744 Gr CN-7M	B473 N08020	B473 N08020	B473 N08020
316L SS	A744 Gr CF-3M	A744 Gr CF-3M	...	...	...
Duplex stainless steel	A995 Gr 1B	A743 Gr CF3M	A276 Gr S32205	A276 Gr S32205	A276 Gr S32205
Monel	A494 Gr M-35-1	A890 Gr 1B	B164 N04400	...	...
Nickel	A494 Gr CZ-100	A494 Gr CZ-100	B160 N02200	...	...
Alloy B2	A494 Gr N-7M	A494 Gr N-7M	B335 N10665	...	...
Alloy C4	A494 Gr CW-2M	A494 Gr CW-2M	B575 N06455	...	...
Alloy C276	A494 Gr CW-6M A494 Gr CW-2M	A494 Gr CW-6M A494 Gr CW-2M	B574 N10276	...	...
Titanium	B367 Gr C-3	B367 Gr C-3	B348 Gr 2	...	...

GENERAL NOTES:
(a) For glands and gland fastening, see para. 5.6.6.
(b) PTFE = polytetrafluoroethylene.

Table 7 Minimum Requirement for Auxiliary Piping Materials

Material Designation	ASTM Material Requirements by Type				
	Tubing	Tube Fittings		Pipe	Pipe Fittings
	Size range: 3/8-in. O.D. to 3/4-in. O.D. Minimum wall thickness: 0.035 in.	Compression Type		Schedule 40 Minimum	ASME B16.11 Class 2000 Minimum
Carbon steel	Seamless A519	A108		Seamless A106 Gr B	A105
		Bar Stock	Forgings		
316 SS	Seamless A269 Gr TP316	A479 Type 316	A182 Gr F316	Seamless A312 Gr TP316	A182 Gr F316

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. 5.12.7.

5.12.7 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.

5.12.8 Drainage. A threaded drain connection(s) (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 1.1-1.2 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 must be determined separately.

6.1.4 Vibration. The vibration level measured on the pump bearing frame, when specified, 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 (B73.2 pumps).

6.1.5 Hydraulic Coverage. Tables 8 and 9 show the approximate hydraulic coverage for 50 Hz and 60 Hz.

6.1.6 Allowable Operating Region. Pumps shall be designed to operate continuously between 120% of the flow at the best efficiency point (BEP) and the minimum flows shown in Table 10, unless specifically noted otherwise by the manufacturer, and 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.

CAUTION: The values in Table 10 do not consider minimum thermal flow for a specific installation; therefore, the practical minimum operating flow may be higher than shown. Pumped fluid is heated as it goes through a pump, and the minimum thermal flow is where the temperature rises enough through the pump that recirculation of some of the flow reduces the available net positive suction head below that required by the pump, resulting in cavitation or vaporization of the pumped fluid. Refer to ANSI/HI 1.3 for detailed application information.

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 NPSH Margin. An operating 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. This margin should be increased if variables exist that will increase the NPSHR of the pump. Refer to ANSI/HI 9.6.1 for additional application information.

6.1.9 Performance Curves. Published performance curves in printed or electronic format shall be based on tests conducted in accordance with ANSI/HI 14.6. Accuracy of the curves shall be that 90% of pumps purchased "untested," when operated between minimum allowable flow and BEP, 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.

Table 8 Approximate Performance of Standard Pumps (60 Hz)

Dimension Designation		Size		1,750 rpm				3,500 rpm			
				Capacity		Total Head		Capacity		Total Head	
in.	(mm)	in.	(mm)	gpm	m^3/h	ft	m	gpm	m^3/h	ft	m
2015/15	(50-40-380)	2 × 1.5 × 6	(50 × 40 × 150)	54	12	30	9	104	24	121	37
3015/15	(80-40-380)	3 × 1.5 × 6	(80 × 40 × 150)	90	20	31	9	176	40	125	38
3020/17	(80-50-430)	3 × 2 × 6	(80 × 50 × 150)	156	35	32	10	295	67	134	41
2015/17	(50-40-430)	2 × 1.5 × 8	(50 × 40 × 200)	79	18	57	17	151	34	233	71
3020/17	(80-50-430)	3 × 2 × 7	(80 × 50 × 180)	150	34	40	12	294	67	158	48
3015/19	(80-40-480)	3 × 1.5 × 8	(80 × 40 × 200)	115	26	60	18	234	53	242	74
4030/22	(100-80-560)	4 × 3 × 8	(100 × 80 × 200)	270	61	62	19	545	124	252	77
6040/24	(150-100-610)	6 × 4 × 9	(150 × 100 × 200)	515	117	62	19	1,030	234	255	78
2015/19	(50-40-480)	2 × 1.5 × 10	(50 × 40 × 250)	78	18	95	29	147	33	398	121
3015/19	(80-40-480)	3 × 1.5 × 10	(80 × 40 × 200)	144	33	90	27	275	62	380	116
3020/20	(80-50-510)	3 × 2 × 10	(80 × 50 × 250)	206	47	89	27	406	92	364	111
4030/25	(100-80-635)	4 × 3 × 10	(100 × 80 × 250)	345	78	85	26	678	154	344	105
6040/28 [Note (1)]	(150-100-710)	6 × 4 × 10	(150 × 100 × 250)	1,100	250	92	28	1,820	413	230	70
3015/24	(80-40-610)	3 × 1.5 × 13	(80 × 40 × 330)	225	51	144	44	...	...	...	...
3020/24	(80-50-610)	3 × 2 × 13	(80 × 50 × 330)	324	73	148	45	...	...	...	...
4030/28 [Note (1)]	(100-80-710)	4 × 3 × 13	(100 × 80 × 330)	648	147	163	50	875	202	425	129
6040/30 [Note (1)]	(150-100-760)	6 × 4 × 13	(150 × 100 × 330)	1,172	266	155	47	...	...	...	...

GENERAL NOTE: This Standard does not cover exact hydraulic performance of pumps. Information on approximate head and capacity at the best efficiency point for standard pumps is for general information only. Consult manufacturers regarding hydraulic performance data for specific applications.

NOTE:

(1) Liquid end may be modified for condition, or maximum impeller diameter may be limited due to limitation of the pump's rotor assembly.

Table 9 Approximate Performance of Standard Pumps (50 Hz)

Dimension Designation		Size		1,450 rpm				2,900 rpm			
				Capacity		Total Head		Capacity		Total Head	
in.	(mm)	in.	(mm)	gpm	m^3/h	ft	m	gpm	m^3/h	ft	m
2015/15	(50-40-380)	2 × 1.5 × 6	(50 × 40 × 150)	46	11	21	6	88	20	80	25
3015/15	(80-40-380)	3 × 1.5 × 6	(80 × 40 × 150)	77	18	21	6	145	33	82	25
3020/17	(80-50-430)	3 × 2 × 6	(80 × 50 × 150)	130	30	22	7	242	55	89	27
2015/17	(50-40-430)	2 × 1.5 × 8	(50 × 40 × 200)	65	15	39	12	126	29	156	48
3020/17	(80-50-430)	3 × 2 × 7	(80 × 50 × 180)	124	28	27	8	243	55	109	33
3015/19	(80-40-480)	3 × 1.5 × 8	(80 × 40 × 200)	99	23	40	12	187	43	164	50
4030/22	(100-80-560)	4 × 3 × 8	(100 × 80 × 200)	224	51	41	12	448	102	167	51
6040/24	(150-100-610)	6 × 4 × 8	(150 × 100 × 200)	420	95	43	13	855	194	180	55
2015/19	(50-40-480)	2 × 1.5 × 10	(50 × 40 × 250)	66	15	64	20	125	29	261	80
3015/19	(80-40-480)	3 × 1.5 × 10	(80 × 40 × 200)	110	25	62	19	242	55	246	75
3020/20	(80-50-510)	3 × 2 × 10	(80 × 50 × 250)	169	38	61	19	334	76	244	74
4030/25	(100-80-635)	4 × 3 × 10	(100 × 80 × 250)	295	67	59	18	555	126	236	72
6040/28 [Note (1)]	(150-100-710)	6 × 4 × 10	(150 × 100 × 250)	880	200	62	19	1,540	350	157	36
3015/24	(80-40-610)	3 × 1.5 × 13	(80 × 40 × 330)	191	43	97	30	. . .	. . .	. . .	. . .
3020/24	(80-50-610)	3 × 2 × 13	(80 × 50 × 330)	268	61	101	31	. . .	. . .	. . .	. . .
4030/28 [Note (1)]	(100-80-710)	4 × 3 × 13	(100 × 80 × 330)	530	120	111	34	858	195	364	111
6040/30 [Note (1)]	(150-100-760)	6 × 4 × 13	(150 × 100 × 330)	989	225	103	31	. . .	. . .	. . .	. . .

GENERAL NOTE: This Standard does not cover exact hydraulic performance of pumps. Information on approximate head and capacity at the best efficiency point for standard pumps is for general information only. Consult manufacturers regarding hydraulic performance data for specific applications.

NOTE:

(1) Liquid end may be modified for condition, or maximum impeller diameter may be limited due to limitation of the pump's rotor assembly.

Table 10 Minimum Continuous Flow

Dimension Designation		Size		Minimum Continuous Flow, % BEP [Note (1)]	
in.	(mm)	in.	(mm)	3,500 rpm/ 2,900 rpm 60 Hz/50 Hz	1,750 rpm/ 1,450 rpm 60 Hz/50 Hz
2015/15	(50-40-380)	2 × 1.5 × 6	(50 × 40 × 150)	15	10
3015/15	(80-40-380)	3 × 1.5 × 6	(80 × 40 × 150)	15	10
3020/17	(80-50-430)	3 × 2 × 6	(80 × 50 × 150)	20	10
3020/17	(80-50-430)	3 × 2 × 7	(80 × 50 × 180)	20	10
2015/17	(50-40-430)	2 × 1.5 × 8	(50 × 40 × 200)	20	10
3015/19	(80-40-480)	3 × 1.5 × 8	(80 × 40 × 200)	20	10
4030/22	(100-80-560)	4 × 3 × 8	(100 × 80 × 200)	20	10
2015/19	(50-40-480)	2 × 1.5 × 10	(50 × 40 × 250)	25	10
3015/19	(80-40-480)	3 × 1.5 × 10	(80 × 40 × 200)	30	15
3020/20	(80-40-510)	3 × 2 × 10	(80 × 50 × 250)	30	15
4030/25	(100-80-635)	4 × 3 × 10	(100 × 80 × 250)	30	15
4030/28	(100-80-710)	4 × 3 × 13	(100 × 80 × 330)	40	40
6040/24	(150-100-610)	6 × 4 × 9	(150 × 100 × 200)	25	25
3015/24	(80-40-610)	3 × 1.5 × 13	(80 × 40 × 200)	30	15
3020/24	(80-50-610)	3 × 2 × 13	(80 × 50 × 330)	40	15
6040/28	(150-100-710)	6 × 4 × 10	(150 × 100 × 250)	40	20
6040/30	(150-100-760)	6 × 4 × 13	(150 × 100 × 330)	. . .	40

GENERAL NOTE: See para. 6.1.6 for caution using values in this Table.

NOTE:

(1) Limits refer to actual hydraulic performance, not the approximate values in Tables 8 and 9. Consult manufacturers regarding hydraulic performance data for specific applications.

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.

6.2 Tests and Inspections

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

6.2.1 Tests

6.2.1.1 Hydrostatic. After 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.

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.

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

(d) 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) A complete written record of the relevant test information including performance curves, the date of the tests, and the signature of the person(s) 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.

6.2.2 Inspections

6.2.2.1 Final Inspections. 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. When a visual inspection of weld connection 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.

6.2.2.4 Inspection of Castings. When inspection of cast parts wetted by the process fluid is specified, a visual inspection shall be conducted in accordance with Manufacturers Standardization Society (MSS) Standard SP-55 for evaluation of cast surfaces. Inspection of the castings by other nondestructive methods such as dye penetrant or x-ray may be agreed upon between manufacturer and purchaser.

6.3 Nameplates

The nameplate(s) is to be of 24 U.S. Standard Gage (minimum) 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 documentation specified covers 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 available, if requested. It is the intent that information be furnished in a similar form from all sources to improve clarity and foster efficient utilization of the documentation.

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)

7.3 Document Description

7.3.1 Pump and Driver Outline Drawing

(a) The pump and driver outline drawing may contain all information shown on, and may be arranged as, the sample outline drawing included herein and identified as Fig. 7.

(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
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
GBO	Gas barrier/buffer outlet

7.3.2 Centrifugal Pump Data Sheet

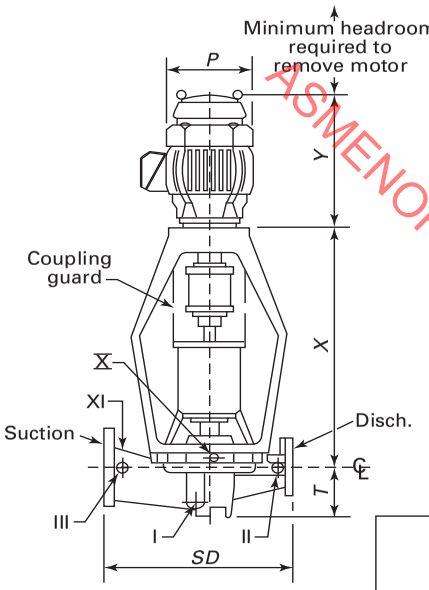
(a) Data Sheet. The ASME Centrifugal Pump Data Sheet in Mandatory Appendix I shall be used as the data sheet for all pumps covered by this Standard when the data sheet is initiated by the purchaser. The data sheet, electronic or printed copy, shall be used for inquiry, proposal, and as-built.

(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.

Fig. 7 Sample Outline Drawing



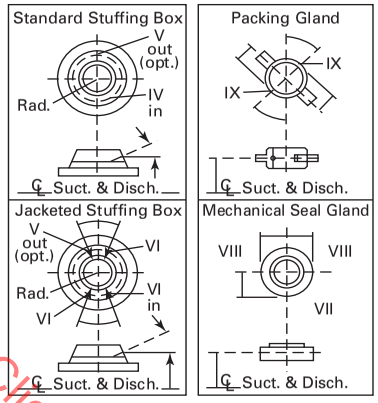
Flange Holes

- ☐ 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	**Casing**	**Shaft Type**
☐ Oil mist	☐ Plain	☐ Sleeved
☐ Grease	☐ Jacketed	☐ Nonsleeved
☐ Grease — lubed for life	☐ Traced	

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)			14.96 (380)	
2015/17 (50-40-430)	2 (50)	1.50 (40)	16.93 (430)	6.89 (175)
2015/19 (50-40-480)			18.90 (480)	
3015/15 (80-40-380)			14.96 (380)	
3015/19 (80-40-480)	3 (80)	1.50 (40)	18.90 (480)	7.87 (200)
3015/24 (80-40-610)			24.02 (610)	
3020/17 (80-50-430)			16.93 (430)	
3020/20 (80-50-510)	3 (80)	2 (50)	20.08 (510)	7.87 (200)
3020/24 (80-50-610)			24.02 (610)	
4030/22 (100-80-560)			22.05 (560)	
4030/25 (100-80-635)	4 (100)	3 (80)	25.00 (635)	8.86 (225)
4030/28 (100-80-710)			27.95 (710)	
6040/24 (150-100-610)			24.02 (610)	
6040/28 (150-100-710)	6 (150)	4 (100)	27.95 (710)	9.84 (250)
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 _____

(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 a title block including the information on the title block of the pump data sheet, Form I-1 or Form I-1M, and have a blank space for the user's identification stamp 1½ in. × 3 in. (40 mm × 80 mm) minimum.

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 heating/cooling 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 published, proposal, as-built, and 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 above. 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. 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 pump configuration actually 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 will 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 1.1-1.2.

7.3.8 Instruction Manual

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

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

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

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

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

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

(g) A guideline for developing instruction manuals may be found in ANSI/HI 1.4.

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

(b) This list shall be submitted along with the first document in order to apprise the purchaser of the documents that 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) A list of all pump parts with pump identification numbers, part numbers, and material descriptions shall be supplied. This list shall be as-built.

(b) A list of recommended spare parts shall be supplied and shall be 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 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. For example, these may include the following:

(a) minimum mechanical seal flush flow

(b) seal chamber/packing 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 this Standard.

MANDATORY APPENDIX I
ASME CENTRIFUGAL PUMP DATA SHEET

See Forms I-1 and 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
APRIL 2012

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: _____

Item name: _____ Purchaser / location: _____

Item tag number: _____ Job number: _____

Service: _____ Purchaser order number: _____

Unit: _____ Supplier / location: _____

P&ID number: _____ Supplier order / serial numbers: _____ / _____

● GENERAL

No. of pumps req.: _____ Motor item number: _____

▲ Pump size: _____ Motor provided by: _____

▲ Pump model: _____ Motor mounted by: _____

▲ Pump type: _____ Variable-speed operation: ☐ YES ☐ NO

● Operating Conditions

Point #	Rated 1	Additional duty points (max., min., or VS) 2	3	4	5	
Flow:						(gpm)
Head:						(ft)
NPSHA:						(ft)
Suct. pres.:						(psig)
▲ Speed:						(rpm)

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)

Total differential head @ rated impeller: _____ (ft)

Maximum differential head @ rated impeller: _____ (ft)

Point #	1	2	3	4	5	
NPSHR:						(ft)

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	MAX.	NORMAL	MIN.	
Pumping temperature:					(°F)

*At pumping temperatures designated above

Specific gravity*:				
Vapor pressure*:				(psia)
Viscosity*:				(cP)
Specific heat*:				(Btu/lb °F)

Atm pressure boiling point: _____ (°F) @ _____ (psia)

Liquid: ☐ Hazardous ☐ Flammable pH: _____

☐ Other: _____

Corrosion / erosion caused by: _____

% solids: _____ Max. particle size: _____ (in.)

Other:

● Site Conditions and Utilities

Location:

☐ Indoor ☐ Outdoor Altitude: _____ (ft)

Range of ambient temperatures: min. / max.: _____ / _____ (°F)

Electrical 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. _____ (psig)

Chloride concentration: **(ppm)**

● General Remarks

Number	Date	Data Revision Description	By	Approved

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
APRIL 2012

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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:**
☐ Flood ☐ Pure mist ☐ Shielded (grease)
☐ Grease ☐ Purge mist ☐ Sealed (grease)
☐ Magnetic drain plug in housing required
▲☐ Oil cooler required
■☐ Oil viscosity: ISO grade: _____ Other: _____

Nozzle Connections:

	▲ Size	▲ Rating	▲ Facing
Suction:			
Discharge:			

● **Aux. case connection:** ☐ Drain required
▲ Size: _____ (in.)
☐ Threaded ☐ Welded and flanged

▲ **Materials**
Material class code: _____
Casing: _____
Impeller: _____
Cover: _____
Shaft: _____
Shaft sleeve: _____
Baseplate: _____
Casing gasket: _____
Impeller 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: _____
Size: _____
Model: _____
Spacer length: _____ (in.)
Coupling guard type:
☐ Pump supplier's standard
☐ Baseplate mounted
☐ Non-spark coupling guard required
Remarks: _____

▲ **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
☐ Pregrouted
☐ Ungrouted (anchored)
☐ Free standing ▲ Pump CL to foundation _____ (in.)
☐ Vertical in-line pump case support bracket
Design: ☐ Purchaser specification _____
☐ Pump supplier's standard
Remarks: _____

● **Paint, Shipment, and Storage Preparation**
Paint:
☐ Pump supplier's standard
☐ Other: _____
Shipment:
☐ Domestic ☐ Export ☐ Export boxing required
Storage:
☐ Outside ☐ Under roof ☐ Environmentally controlled
☐ Short term ☐ Long term (>6 months)
Environment: _____
☐ Supplier's standard preservation specification
Purchaser storage specification: _____
■ Unit shipping weight: (lb)

● **Tests and Inspections**

Test:	Unwitnessed	Witnessed	Certificate
Hydrostatic:	☐	☐	☐
Leak:	☐	☐	☐
NPSHR:	☐	☐	☐
Performance:	☐	☐	☐

Opt. perf. acceptance criteria: ☐ Power ☐ Efficiency ☐ Neither
Additional data: ☐ Vibration ☐ Bearing temp.
☐ Other perf. data: _____
☐ Final inspection required Days notification required: _____
☐ Dismantle and inspect after test
☐ Casting repair procedure approval required
Material certification required:
☐ Casing ☐ Cover ☐ Impeller ☐ Shaft
☐ Other: _____
Inspection required for connection welds:
☐ Manufacturer's standard ☐ Visual inspection
Inspection required for castings:
☐ Manufacturer's standard ☐ Visual inspection
☐ Other:

● **Manufacturer Documentation Required**
For supplier data requirements, refer to: _____
Remarks: _____

ASME B73	Form I-1 Centrifugal Pump Data Sheet Rev. No.:_____ Rev. Date:_____	Issue Date APRIL 2012
	ASME Centrifugal Pumps (U.S. Customary Units) ASME B73.1, ASME B73.2	Page 3 of 4

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

▲ **Shaft Sealing** ☐ Mechanical seal ☐ Packing
Furnished by: ☐ Supplier ☐ Purchaser
Installed by: ☐ Supplier ☐ Purchaser

▲ **Seal Chamber** ☐ Taper bore ☐ Large cylindrical bore
☐ Universal cover ☐ Packing box
Throat bushing: ☐ None ☐ Fixed bushing
☐ Floating bushing
Throat bushing material: _____
Jacketed seal chamber/packing box: ☐ Yes ☐ No
For: ☐ Heating ☐ Cooling
Remarks: _____

▲ **Mechanical Seal** ☐ Cartridge ☐ Component
(ref. Mand. App. II) ☐ Arrangement 1 (single seal)
☐ Arrangement 2 (dual unpressurized seal)
☐ Arrangement 3 (dual pressurized seal)
Flexible element: ☐ Rotating ☐ Stationary
B73.1 or B73.2 Mand. App. II configuration code: _____
API 682 Category 1: ☐ Yes ☐ No
Manufacturer: _____
Model: _____
Manufacturer code: _____
Drawing number: _____
Remarks: _____

▲ **Seal Materials — Single or Inner Seal**
Seal faces: Rotating face: _____
Stationary face: _____
Secondary seals: Rotating face: _____
Stationary face: _____
Sleeve: _____
Springs: _____ Bellows: _____
Metal parts: _____
Remarks: _____

▲ **Seal Materials — Outer Seal**
Seal faces: Rotating face: _____
Stationary face: _____
Secondary seals: Rotating face: _____
Stationary face: _____
Sleeve: _____
Springs: _____ Bellows: _____
Metal parts: _____
Remarks: _____

▲ **Seal Gland** Material: _____
Ports: ☐ Flush ☐ Drain ☐ Vent ☐ Quench
☐ Buffer/barrier fluid inlet ☐ Buffer/barrier fluid outlet
Throttle bushing: ☐ Yes ☐ No
Throttle bushing material: _____
Remarks: _____

▲ **Flush Plan — Single or Inner Seal**
Piping plan number(s): _____
External flush fluid: _____
Supply temperature: Min. _____ Max. _____ (°F)
Specific gravity: _____ Specific heat: _____ (Btu/lb °F)
Vapor pressure: _____ psia @ _____ (°F)
Flow rate required: Min. _____ Max. _____ (gpm)
Maximum flow rate allowed by process: _____ (gpm)
Pressure required: Min. _____ Max. _____ (psig)
Maximum pressure allowed by process: _____ (psig)
Temperature required: Min. _____ Max. _____ (°F)
Inner seal flush plan piping: ☐ Tube ☐ Pipe
☐ Other: _____
Tube/pipe size: _____
Tube/pipe material: ☐ 316 SS ☐ Other _____
Tube/pipe specification: _____
Tube/pipe connections: ☐ Threaded ☐ Socket weld
☐ Unions ☐ Butt weld ☐ Tube fitting
☐ Other: _____
Furnished by: ☐ Supplier ☐ Purchaser
Remarks: _____

▲ **Flush Plan — Outer Seal**
Piping plan number(s): _____
External flush fluid: _____
Supply temperature: Min. _____ Max. _____ (°F)
Specific gravity: _____ Specific heat: _____ (Btu/lb °F)
Vapor pressure: _____ psia @ _____ (°F)
Flow rate required: Min. _____ Max. _____ (gpm)
Maximum flow rate allowed by process: _____ (gpm)
Pressure required: Min. _____ Max. _____ (psig)
Maximum pressure allowed by process: _____ (psig)
Temperature required: Min. _____ Max. _____ (°F)
MAWP flush plan: _____ psig @ min. temp. _____ (°F)
_____ psig @ max. temp. _____ (°F)
Outer seal flush plan piping: ☐ Tube ☐ Pipe
☐ Other: _____
Tube/pipe size: _____
Tube/pipe material: ☐ 316 SS ☐ Other _____
Tube/pipe specification: _____
Tube/pipe connections: ☐ Threaded ☐ Socket weld
☐ Unions ☐ Butt weld ☐ Tube fitting
☐ Other: _____
Furnished by: ☐ Supplier ☐ Purchaser
Remarks: _____

▲ **Quench** ☐ Yes ☐ No
Quench fluid: _____
Flow rate: _____
Remarks: _____