ASME B73.3-2022
(Revision of ASME B73.3-2015)

Specification for Sealless Horizontal End Suction Centrifugal Pumps for Chemical Process

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AN AMERICAN NATIONAL STANDARD

The American Society of
Mechanical Engineers

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AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers
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FOREWORD

In 1991, ASME Standards Committee B73, Chemical Standard Pumps, formed a sealless pump working group to develop a standard for sealless pumps that would correspond to ASME B73.1M, Specification for Horizontal End Suction Centrifugal Pumps for Chemical Process.

Though these pumps are sealless (i.e., they do not use a dynamic seal to prevent leakage around the drive shaft), leakage can result from certain types of wear or misoperation. The user must take appropriate supplemental safety precautions when operating these pumps.

The first edition of this Standard was approved as an American National Standard by the American National Standards Institute (ANSI) on August 7, 1997.

In the following years, the sealless working group developed a revision of ASME B73.3M to reflect changes made in ASME B73.1M. In the 2003 revision of ASME B73.3, the presentation of units was changed to reflect that U. S. Customary units are the primary units of measurement. Some paragraphs were simplified and clarified and the sections on flanges and flange loading were revised, as were sound and vibration requirements. Information concerning ‘‘Operating Region’’ and ‘‘NPSH Margin” was added; auxiliary connection symbols and additional pump sizes were also added. Table 3 was revised to reflect changes in Frame 1 pump dimensions; Table 7 was added; and Form 1 was revised to reflect additional required values.

The 2015 revision of the Standard included several changes to reduce redundancy in ASME B73 standards and to better align with Hydraulic Institute standards (HI). Revisions were also made to further improve the reliability of ASME B73.3 pumps. Reference is now made to the HI standard for fluid circulation piping plans and a material classification code was added to ASME B73.3. The table for ASTM material specifications was expanded; a table for minimum requirements for auxiliary piping materials added; requirements for the bearing frame revised to assure more robust pumps; and plastic-lined magnetic drive pumps added to the scope of the standard. Close-coupled pumps were also added as an option and close-coupled pump baseplates shortened accordingly. 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 included with the pump and a new data sheet was developed and added to the standard. ASME B73.3 endorses the Electronic Data Exchange standard developed by HI and the FIATECH Automating Equipment Information Exchange (AEX) project.

Many of the modifications to the 2022 edition of this Standard align the requirements of ASME B73.3 with the 2020 revision of ASME B73.1. Revisions to ASME B73.3 include

(a) modified canned motor pump stator liner material, rotor liner material, and construction requirements
(b) new functional life requirement for canned motor pump (CMP) secondary control systems
(c) modified external bearing design requirements and clarified external bearing life requirements
(d) new and clarified requirements for greased for life external bearings
(e) modified magnetic drive pump (MDP) and CMP material classification codes including adding new materials such as Alloy C22 as well as many new wetted bearing materials
(f) new requirements for auxiliary piping
(g) new corrosion allowances
(h) new welding requirements including details on autogenous welding
(i) revised safety guard and coupling guard requirements
(j) additional baseplate options and requirements including nonmetallic baseplates and free-standing baseplates
(k) close-coupled motor adaptor requirements for MDPs
(l) modified requirements for vibration to reference HI standards
(m) published performance curve rated speeds for MDPs and CMPs
(n) details on hydrostatic test requirements along with adding thermoset polymer material pumps
(o) modified pump performance requirements, including the acceptance test grade to ANSI/HI 14.6-2016 Grade 1B
(p) modified connection welds and casting test requirements
(q) modified nameplate requirements for MDP and CMP
(r) details regarding document requirements, including details for Certified Mill Test Report and Statement of Compliance

ASME B73.3-2022 was approved by ANSI as an American National Standard on July 25, 2022.

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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(s), 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(s)

(4) the edition(s) 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 athttps://go.asme.org/B73committee.

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SPECIFICATION FOR SEALLESS HORIZONTAL END SUCTION CENTRIFUGAL PUMPS FOR CHEMICAL PROCESS

1 SCOPE

(a) This Standard is a design and specification standard that covers metallic and plastic-lined sealless centrifugal pumps of horizontal, end-suction single-stage, centerline discharge design. This Standard includes dimensional interchangeability requirements and certain design features to facilitate installation and maintenance and enhance reliability and safety of ASME B73.3 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, input shafts, baseplates, and foundation bolt holes [see Tables 1-1 through 1-5 (Tables 1-1M through 1-5M)]. Maintenance and operation requirements are not included in this Standard.

(b) This Standard has been revised to broaden the scope to include specialty designs developed for ASME B73.3 product line platforms. These specialty designs have many components in common with the ASME B73.3 models and meet the intent of the standard but not the standard's dimensional requirements. These specialty designs include pump models referred to as self-primer and single-stage low flow pumps.

2 REFERENCES

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

ANSI B11.19. Performance Requirements for Risk Reduction Measures: Safeguarding and other Means of Reducing Risk. American National Standards Institute.
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/AWS D1.1. Structural Welding Code — Steel. American Welding Society.
ANSI/HI 1.3. Rotodynamic Centrifugal Pumps for Design and Applications. Hydraulic Institute.
ANSI/HI 1.4. Rotodynamic Centrifugal Pumps for Manuals Describing Installation, Operation, and Maintenance. Hydraulic Institute.
ANSI/HI 5.1–5.6. Sealless Rotodynamic Pumps for Nomenclature, Definitions, Applications, Operation, and Test. Hydraulic 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 9.6.2-2021. Rotodynamic Pumps for Assessment of Applied Nozzle Loads. Hydraulic Institute.
ANSI/HI 9.6.4. Rotodynamic Pumps for Vibration Measurements and Allowable Values. Hydraulic Institute.
ANSI/HI 9.6.8. Rotodynamic Pumps — Guidelines for Dynamics of Pumping Machinery. Hydraulic Institute.
ANSI/HI 14.3. Rotodynamic Pumps for Design and Application. Hydraulic Institute.
ANSI/HI 14.6. Rotodynamic Pumps for Hydraulic Performance Acceptance Tests. Hydraulic Institute.
ANSI/HI 50.7. Electronic Data Exchange for Pumping Equipment. Hydraulic Institute.
ASME B16.5. Pipe Flanges and Flanged Fittings: NPS ½ through NPS 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.
ASME Boiler and Pressure Vessel Code, Section II. Materials — Part D, Properties [(Customary) or (Metric)]. The American Society of Mechanical Engineers.
ASME Boiler and Pressure Vessel Code, Section III. Rules for Construction of Nuclear Facility Components — Division 1, Subsection NCD, Class 2 and Class 3 Components. The American Society of Mechanical Engineers.

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ASME Boiler and Pressure Vessel Code, Section VIII. Rules for Construction of Pressure Vessels — Division 1 and Division 2, Alternate Rules. 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.
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 A395/A395M. Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures. ASTM International.
ASTM A434. 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.
IEEE 117. Standard Test Procedure for Thermal Evaluation of Systems of Insulating Materials for Random-Wound AC Electric Machinery. Institute of Electrical and Electronics Engineers.
ISO 281. Rolling Bearings — Dynamic load ratings and rating life. International Organization for Standardization.
ISO 9606 Series. Testing of Welders. International Organization for Standardization.

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ISO 21940-11. Mechanical vibration — Rotor balancing – Part 11: Procedures and tolerances for rotors with rigid behavior. International Organization for Standardization.
MSS SP-55. Quality Standard for Steel Castings for Valves, Flanges and Fittings and Other Piping Components — Visual Method for Evaluation of Surface Irregularities. Manufacturers Standardization Society of the Valve and Fittings Industry.

3 ALTERNATIVE DESIGNS

3.1 Extended Length Pump Design

An extended length pump design is an option for enhanced mechanical performance. Dimensions for an extended length pump design are included in this Standard. The extended length alternative shall conform to the design features of this Standard including those providing interchangeability with respect to mounting dimensions at the casing, size, and location of the suction and discharge nozzles [see column heads with "e" suffix in Tables 1-1 through 1-5 (Tables 1-1M through 1-5M) for dimensional limits].

3.2 Close-Coupled Design

Close-coupled magnetic drive pumps are allowed as an alternative design. The close-coupled arrangement shall conform to the design features of this Standard, including those providing interchangeability with respect to mounting dimensions at the casing and size and location of the suction and discharge nozzles except there is no requirement for a separate pump bearing frame. Dimensions for close-coupled pump baseplates are included in this Standard.

3.3 Alternative Designs

Other alternative 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 this Standard. All deviations from these specifications shall be described in detail.

4 NOMENCLATURE AND DEFINITIONS

4.1 Definitions of Terms

All nomenclature and definitions of pump components shall be in accordance with ANSI/HI 5.1–ANSI/HI 5.6.

canned motor pump (CMP): a type of sealless pump where the impeller is mounted on the end of the shaft that is overhung from its motor bearing supports. The impeller is mounted directly on the rotor assembly, making one rotor assembly. The bearings are supported by housings at each end of the rotor assembly. The motor components are protected from the process liquid by corrosion-resistant, nonmagnetic liners (shells). During operation, the motor section and bearings are cooled and lubricated by either the process liquid or a flush introduced from an external source.

close-coupled magnetic drive pump: a sealless magnetic drive pump as defined below except the outer magnet ring is mounted on the driver shaft.

flexibly coupled magnetic drive pump: a sealless MDP as defined herein where the outer magnet ring is mounted on the shaft of a frame that is separately coupled to a motor or power device and mounted on a common baseplate.

magnetic drive pump (MDP): a type of sealless pump where the impeller is mounted on a rotor assembly that contains the inner magnet ring of a magnetic drive. The process fluid is retained by a corrosion-resistant containment shell that separates the inner magnet ring and the outer magnet ring. The outer magnet ring is mounted on the shaft of a frame that is coupled to a motor or power device.

plastic lined sealless pump: a type of sealless MDP that consists of a metal outer casing covered internally by a plastic lining for chemical resistance. The metal outer casing gives structural rigidity for pressure containment and externally applied nozzle loads. The containment shell may consist of a reinforced outer shell with an insert for chemical resistance made of plastic or an engineered ceramic or other nonmetallic construction. All nonpressure-containing wetted parts are either covered by a plastic lining or made of an engineered ceramic.

4.2 Additional Definitions

autogenous welding: a process that fuses two or more metals without the addition of filler metal. A wide variety of materials and welding processes can be used for autogenous welding. Also called "fusion welding."

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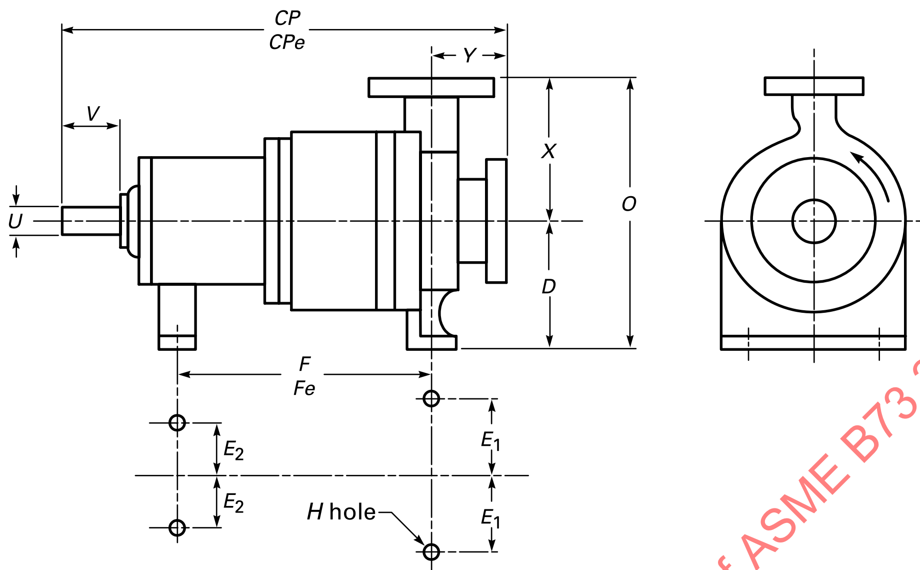
Table 1-1
Pump Dimensions for Flexibly Coupled Magnetic Drive Pumps (U.S. Customary)



Dimension Designation	Size: Suction × Discharge × Nominal Impeller Diameter	CP	CPe [Note (1)]	D [Note (2)]	$2E_1$ [Note (2)]	$2E_2$	F	Fe [Note (1)]	H	O [Note (2)]	U [Note (3)] Diameter	U [Note (3)] Keyway	V, Min.	X [Note (2)]	Y [Note (2)]
AA	1.5 × 1 × 6	17.5	21.5	5.25	6	0	7.25	11.25	0.625	11.75	0.875	0.188 × 0.094	2	6.5	4
AB	3 × 1.5 × 6	17.5	21.5	5.25	6	0	7.25	11.25	0.625	11.75	0.875	0.188 × 0.094	2	6.5	4
AC [Note (4)]	3 × 2 × 6	17.5	21.5	5.25	6	0	7.25	11.25	0.625	11.75	0.875	0.188 × 0.094	2	6.5	4
AA [Note (4)]	1.5 × 1 × 8	17.5	21.5	5.25	6	0	7.25	11.25	0.625	11.75	0.875	0.188 × 0.094	2	6.5	4
AB [Note (4)]	3 × 1.5 × 8	17.5	21.5	5.25	6	0	7.25	11.25	0.625	11.75	0.875	0.188 × 0.094	2	6.5	4
A10	3 × 2 × 6	23.5	28.5	8.25	9.75	7.25	12.5	17.5	0.625	16.5	1.125	0.25 × 0.125	2.63	8.25	4
A50	3 × 1.5 × 8	23.5	28.5	8.25	9.75	7.25	12.5	17.5	0.625	16.75	1.125	0.25 × 0.125	2.63	8.5	4
A60	3 × 2 × 8	23.5	28.5	8.25	9.75	7.25	12.5	17.5	0.625	17.75	1.125	0.25 × 0.125	2.63	9.5	4
A70	4 × 3 × 8	23.5	28.5	8.25	9.75	7.25	12.5	17.5	0.625	19.25	1.125	0.25 × 0.125	2.63	11	4
A05 [Note (4)]	2 × 1 × 10	23.5	28.5	8.25	9.75	7.25	12.5	17.5	0.625	16.75	1.125	0.25 × 0.125	2.63	8.5	4
A50	3 × 1.5 × 10	23.5	28.5	8.25	9.75	7.25	12.5	17.5	0.625	16.75	1.125	0.25 × 0.125	2.63	8.5	4
A60	3 × 2 × 10	23.5	28.5	8.25	9.75	7.25	12.5	17.5	0.625	17.75	1.125	0.25 × 0.125	2.63	9.5	4

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Table 1-1
Pump Dimensions for Flexibly Coupled Magnetic Drive Pumps (U.S. Customary) (Cont'd)

Dimension Designation	Size: Suction × Discharge × Nominal Impeller Diameter	Dimension, in.: *CP*	*CPe* [Note (1)]	*D* [Note (2)]	$2E_1$ [Note (2)]	$2E_2$	*F*	*Fe* [Note (1)]	*H*	*O* [Note (2)]	*U* [Note (3)]: Diameter	*U* [Note (3)]: Keyway	*V*, Min.	*X* [Note (2)]	*Y* [Note (2)]
A70	4 × 3 × 10	23.5	28.5	8.25	9.75	7.25	12.5	17.5	0.625	19.25	1.125	0.25 × 0.125	2.63	11	4
A40	4 × 3 × 10	23.5	28.5	10	9.75	7.25	12.5	17.5	0.625	22.5	1.125	0.25 × 0.125	2.63	12.5	4
A80 [Note (5)]	6 × 4 × 10	23.5	28.5	10	9.75	7.25	12.5	17.5	0.625	23.5	1.125	0.25 × 0.125	2.63	13.5	4
A20 [Note (4)]	3 × 1.5 × 13	23.5	28.5	10	9.75	7.25	12.5	17.5	0.625	20.5	1.125	0.25 × 0.125	2.63	10.5	4
A30	3 × 2 × 13	23.5	28.5	10	9.75	7.25	12.5	17.5	0.625	21.5	1.125	0.25 × 0.125	2.63	11.5	4
A40	4 × 3 × 13	23.5	28.5	10	9.75	7.25	12.5	17.5	0.625	22.5	1.125	0.25 × 0.125	2.63	12.5	4
A80 [Note (5)]	6 × 4 × 13	23.5	28.5	10	9.75	7.25	12.5	17.5	0.625	23.5	1.125	0.25 × 0.125	2.63	13.5	4
A90 [Note (5)]	8 × 6 × 13	33.88	39.88	14.5	16	9	18.75	24.75	0.875	30.5	2.375	0.625 × 0.313	4	16	6
A100 [Note (5)]	10 × 8 × 13	33.88	39.88	14.5	16	9	18.75	24.75	0.875	32.5	2.375	0.625 × 0.313	4	18	6
A105 [Note (5)]	6 × 4 × 15	33.88	39.88	14.5	16	9	18.75	24.75	0.875	30.5	2.375	0.625 × 0.313	4	16	6
A110 [Note (5)]	8 × 6 × 15	33.88	39.88	14.5	16	9	18.75	24.75	0.875	32.5	2.375	0.625 × 0.313	4	18	6
A120 [Note (5)]	10 × 8 × 15	33.88	39.88	14.5	16	9	18.75	24.75	0.875	33.5	2.375	0.625 × 0.313	4	19	6
A105 [Note (5)]	6 × 4 × 17	33.88	39.88	14.5	16	9	18.75	24.75	0.875	30.5	2.375	0.625 × 0.313	4	16	6
A110 [Note (5)]	8 × 6 × 17	33.88	39.88	14.5	16	9	18.75	24.75	0.875	32.5	2.375	0.625 × 0.313	4	18	6
A120 [Note (5)]	10 × 8 × 17	33.88	39.88	14.5	16	9	18.75	24.75	0.875	33.5	2.375	0.625 × 0.313	4	19	6

GENERAL NOTE: Due to the inherently different casing of centerline mounted pumps, mounting and centerline height dimensions may differ from those in this table.

NOTES:
(1) See para. 3.1. This extended length dimension, *CPe*, is a maximum value. Any dimension between the standard and maximum extended length is acceptable.
(2) For close-coupled pumps, only dimensions *D*, $2E_1$, *O*, *X*, and *Y* apply.
(3) *U* may be 1.625 in. diameter in A05 through A80 sizes to accommodate high torque values.
(4) Discharge flange may have tapped bolt holes.
(5) Suction flange may have tapped bolt holes.

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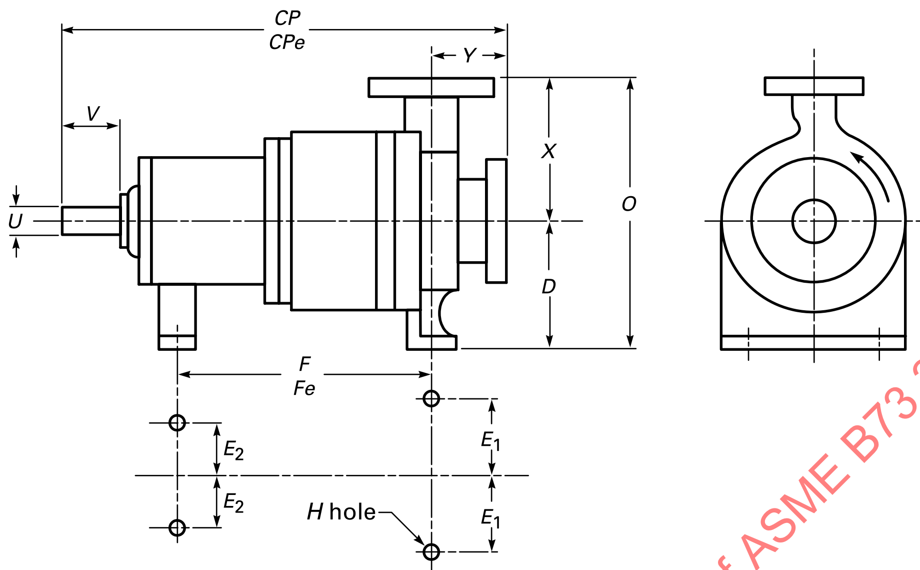
Table 1-1M
Pump Dimensions for Flexibly Coupled Magnetic Drive Pumps (SI)



Dimension Designation	Size: Suction × Discharge × Nominal Impeller Diameter	CP	CPe [Note (1)]	D [Note (2)]	$2E_1$ [Note (2)]	$2E_2$	F	Fe [Note (1)]	H	O [Note (2)]	U [Note (3)] Diameter	U [Note (3)] Keyway	V, Min.	X [Note (2)]	Y [Note (2)]
		Approximate Equivalent Dimension, mm													
AA	40 × 25 × 150	445	547	133	152	0	184	286	16	298	22.23	4.76 × 2.38	51	165	102
AB	80 × 40 × 150	445	547	133	152	0	184	286	16	298	22.23	4.76 × 2.38	51	165	102
AC [Note (4)]	80 × 50 × 150	445	547	133	152	0	184	286	16	298	22.23	4.76 × 2.38	51	165	102
AA [Note (4)]	40 × 25 × 200	445	547	133	152	0	184	286	16	298	22.23	4.76 × 2.38	51	165	102
AB [Note (4)]	80 × 40 × 200	445	547	133	152	0	184	286	16	298	22.23	4.76 × 2.38	51	165	102
A10	80 × 50 × 150	597	724	210	248	184	318	445	16	420	28.58	6.35 × 3.18	67	210	102
A50	80 × 40 × 200	597	724	210	248	184	318	445	16	425	28.58	6.35 × 3.18	67	216	102
A60	80 × 50 × 200	597	724	210	248	184	318	445	16	450	28.58	6.35 × 3.18	67	242	102
A70	100 × 80 × 200	597	724	210	248	184	318	445	16	490	28.58	6.35 × 3.18	67	280	102
A05 [Note (4)]	50 × 25 × 250	597	724	210	248	184	318	445	16	425	28.58	6.35 × 3.18	67	216	102
A50	80 × 40 × 250	597	724	210	248	184	318	445	16	425	28.58	6.35 × 3.18	67	216	102
A60	80 × 50 × 250	597	724	210	248	184	318	445	16	450	28.58	6.35 × 3.18	67	242	102

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Table 1-1M
Pump Dimensions for Flexibly Coupled Magnetic Drive Pumps (SI) (Cont'd)

Dimension Designation	Size: Suspension × Discharge × Nominal Impeller Diameter	Approximate Equivalent Dimension, mm													
		CP	*CPe* [Note (1)]	*D* [Note (2)]	$2E_1$ [Note (2)]	$2E_2$	*F*	*Fe* [Note (1)]	*H*	*O* [Note (2)]	*U* [Note (3)] Diameter	*U* [Note (3)] Keyway	*V*, Min.	*X* [Note (2)]	*Y* [Note (2)]
A70	100 × 80 × 250	597	724	210	248	184	318	445	16	490	28.58	6.35 × 3.18	67	280	102
A40	100 × 80 × 250	597	724	254	248	184	318	445	16	572	28.58	6.35 × 3.18	67	318	102
A80 [Note (5)]	150 × 100 × 250	597	724	254	248	184	318	445	16	597	28.58	6.35 × 3.18	67	343	102
A20 [Note (4)]	80 × 40 × 330	597	724	254	248	184	318	445	16	520	28.58	6.35 × 3.18	67	267	102
A30	80 × 50 × 330	597	724	254	248	184	318	445	16	546	28.58	6.35 × 3.18	67	292	102
A40	100 × 80 × 330	597	724	254	248	184	318	445	16	572	28.58	6.35 × 3.18	67	318	102
A80 [Note (5)]	150 × 100 × 330	597	724	254	248	184	318	445	16	597	28.58	6.35 × 3.18	67	343	102
A90 [Note (5)]	200 × 150 × 330	860	1 013	368	406	229	476	629	22	775	60.33	15.88 × 7.94	102	406	152
A100 [Note (5)]	250 × 200 × 330	860	1 013	368	406	229	476	629	22	826	60.33	15.88 × 7.94	102	457	152
A105 [Note (5)]	150 × 100 × 380	860	1 013	368	406	229	476	629	22	775	60.33	15.88 × 7.94	102	406	152
A110 [Note (5)]	200 × 150 × 380	860	1 013	368	406	229	476	629	22	826	60.33	15.88 × 7.94	102	457	152
A120 [Note (5)]	250 × 200 × 380	860	1 013	368	406	229	476	629	22	851	60.33	15.88 × 7.94	102	483	152
A105 [Note (5)]	150 × 100 × 430	860	1 013	368	406	229	476	629	22	775	60.33	15.88 × 7.94	102	406	152
A110 [Note (5)]	200 × 150 × 430	860	1 013	368	406	229	476	629	22	826	60.33	15.88 × 7.94	102	457	152
A120 [Note (5)]	250 × 200 × 430	860	1 013	368	406	229	476	629	22	851	60.33	15.88 × 7.94	102	483	152

NOTES:
(1) See para. 3.1. This extended length dimension, *CPe*, is a maximum value. Any dimension between the standard and maximum extended length is acceptable.
(2) For close coupled pumps, only dimensions *D*, $2E_1$, *O*, *X*, and *Y* apply.
(3) *U* may be 41.28 mm diameter in A05 through A80 sizes to accommodate high torque values.
(4) Discharge flange may have tapped bolt holes.
(5) Suction flange may have tapped bolt holes.

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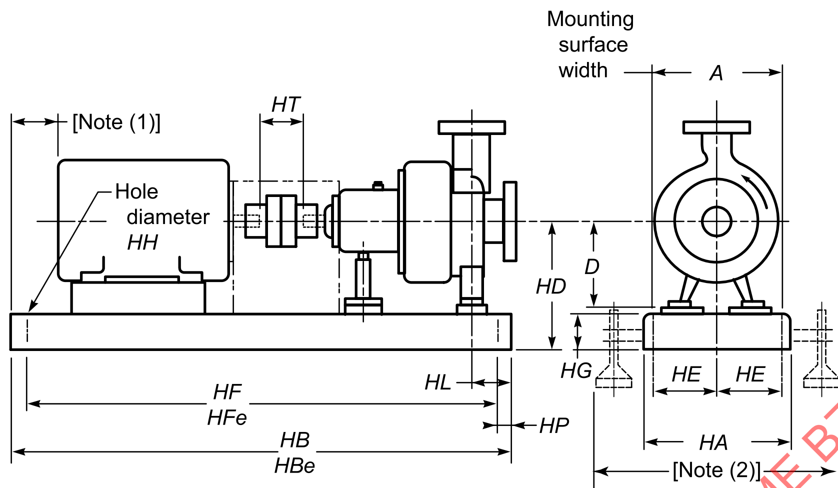
Table 1-2
Baseplate Dimensions for Flexibly Coupled Magnetic Drive Pumps (U.S. Customary)



Maximum NEMA Frame	Baseplate No. [Notes (3), (4)] For HB	Baseplate No. [Notes (3), (4)] For HBe	A, Min.	HA, Max. [Note (2)]	HB	HBe [Note (4)]	HT, Min.	HD, Max. [Note (5)] D = 5.25	HD, Max. [Note (5)] D = 8.25	HD, Max. [Note (5)] D = 10	HD, Max. [Note (5)] D = 14.50	HE	HF	HFe [Note (4)]	HG, Max.	HH	HL	HP
184T	139	143	12	15	39	43	3.5	9	...	...	...	4.5	36.5	40.5	3.75	0.75	4.5	1.25
256T	148	152	15	18	48	52	3.5	10.50	...	...	...	6	45.5	49.5	4.13	0.75	4.5	1.25
326TS	153	157	18	21	53	57	3.5	12.88	...	...	...	7.5	50.5	54.5	4.75	0.75	4.5	1.25
184T	245	250	12	15	45	50	3.5	...	12	13.75	...	4.5	42.5	47.5	3.75	0.75	4.5	1.25
215T	252	257	15	18	52	57	3.5	...	12.38	14.13	...	6	49.5	54.5	4.13	0.75	4.5	1.25
286T	258	263	18	21	58	63	3.5	...	13	14.75	...	7.5	55.5	60.5	4.75	1	4.5	1.25
365T	264	269	18	21	64	69	3.5	...	13.88	14.75	...	7.5	61.5	66.5	4.75	1	4.5	1.25
405TS	268	273	22	26	68	73	3.5	...	14.88	14.88	...	9.5	65.5	70.5	4.75	1	4.5	1.25
449TS	280	285	22	26	80	85	3.5	...	15.88	15.88	...	9.5	77.5	82.5	4.75	1	4.5	1.25
286T	368	374	22	26	68	74	5	...	...	...	19.25	9.5	65.5	71.5	4.75	1	6.5	1.25
405T	380	386	22	26	80	86	5	...	...	...	19.25	9.5	77.5	83.5	4.75	1	6.5	1.25
449T	398	3,104	22	26	98	104	5	...	...	...	19.25	9.5	95.5	101.5	4.75	1	6.5	1.25

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Table 1-2
Baseplate Dimensions for Flexibly Coupled Magnetic Drive Pumps (U.S. Customary) (Cont'd)

NOTES:
(1) Motor should not extend beyond the end of the baseplate.
(2) Contact manufacturer for additional space required for freestanding baseplates.
(3) Baseplate number denotes pump frame 1, 2, or 3 and baseplate *HB* or *HBe* in inches.
(4) See para. 3.1. The extended length dimension, *HBe*, is a fixed value. Whenever the pump to be mounted has *CPe* greater than *CP*, the baseplate for *HBe* must be used.
(5) Includes 0.13 in. shimming allowance where motor height controls.

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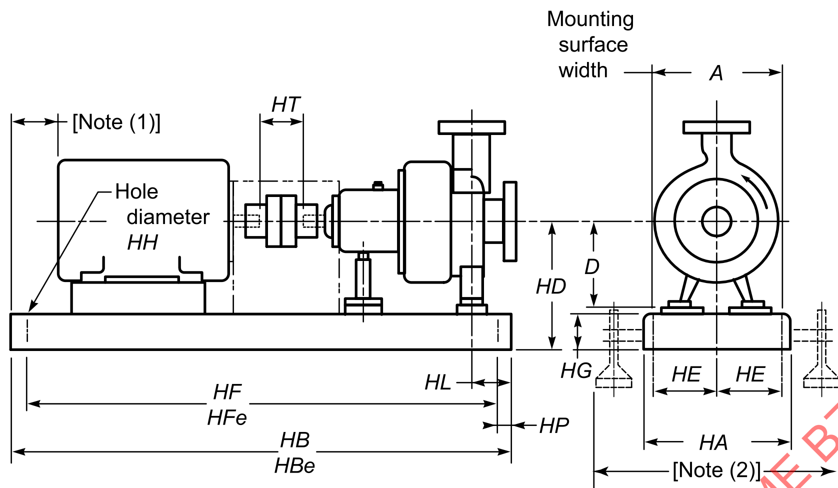
Table 1-2M
Baseplate Dimensions for Flexibly Coupled Magnetic Drive Pumps (SI)



Maximum NEMA Frame	Baseplate No. [Notes (3), (4)]		Approximate Equivalent Dimension, mm															
								HD, Max. [Note (5)]										
	For *HB*	For *HBe*	*A*, Min.	*HA*, Max. [Note (2)]	*HB*	*HBe* [Note (4)]	*HT*, Min.	*D* = 133	*D* = 210	*D* = 254	*D* = 368	*HE*	*HF*	*HFe* [Note (4)]	*HG*, Max.	*HH*	*HL*	*HP*
184T	139	143	305	381	991	1 993	89	229	...	...	...	114	927	1 029	95	19	114	32
256T	148	152	381	457	1 219	1 321	89	267	...	...	...	152	1 156	1 258	105	19	114	32
326TS	153	157	457	533	1 346	1 448	89	327	...	...	...	191	1 283	1 385	121	19	114	32
184T	245	250	305	381	1 143	1 270	89	...	305	349	...	114	1 080	1 207	95	19	114	32
215T	252	257	381	457	1 321	1 448	89	...	314	359	...	152	1 257	1 384	105	19	114	32
286T	258	263	457	533	1 473	1 600	89	...	330	375	...	191	1 410	1 537	121	25	114	32
365T	264	269	457	533	1 626	1 753	89	...	353	375	...	191	1 562	1 689	121	25	114	32
405TS	268	273	559	660	1 727	1 854	89	...	378	378	...	241	1 664	1 791	121	25	114	32
449TS	280	285	559	660	2 032	2 159	89	...	403	403	...	241	1 969	2 096	121	25	114	32
286T	368	374	559	660	1 727	1 880	127	...	...	...	489	241	1 664	1 817	121	25	165	32
405T	380	386	559	660	2 032	2 185	127	...	...	...	489	241	1 969	2 121	121	25	165	32
449T	398	3 104	559	660	2 489	2 642	127	...	...	...	489	241	2 426	2 579	121	25	165	32

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Table 1-2M
Baseplate Dimensions for Flexibly Coupled Magnetic Drive Pumps (SI) (Cont'd)

NOTES:
(1) Motor should not extend beyond the end of the baseplate.
(2) Contact manufacturer for additional space required for freestanding baseplates.
(3) Baseplate number denotes pump frame 1, 2, or 3 and baseplate *HB* or *HBe* in inches.
(4) See para. 3.1. The extended length dimension, *HBe*, is a fixed value. Whenever the pump to be mounted has *CPe* greater than *CP*, the baseplate for *HBe* must be used.
(5) Includes 3 mm shimming allowance where motor height controls.

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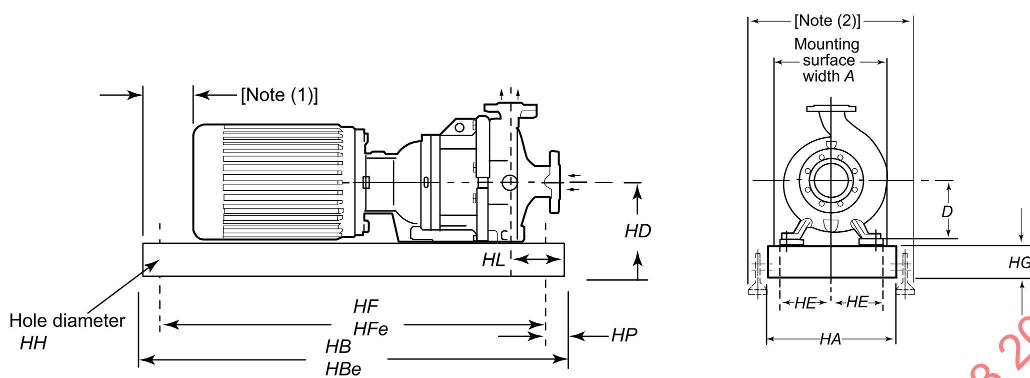
Table 1-3
Baseplate Dimensions for Close-Coupled Magnetic Drive Pumps (U.S. Customary)



Maximum NEMA Frame	Baseplate No. [Notes (3)–(5)] For HB	Baseplate No. [Notes (3)–(5)] For HBe	Dimension, in. *A*, Min.	*HA*, Max. [Note (2)]	*HB* [Note(5)]	*HBe* [Notes (4), (5)]	*HD*, Max. [Note (6)] *D* = 5.25	*HD*, Max. [Note (6)] *D* = 8.25	*HD*, Max. [Note (6)] *D* = 10	*HE*	*HF* [Note (5)]	*HFe* [Notes (4), (5)]	*HG*, Max.	*HH*	*HL*	*HP*
182–184TC	132	136	12	15	32	36	9	...	...	4.5	29.5	33.5	3.75	0.75	4.5	1.25
254–256TC	141	145	15	18	41	45	10.50	...	...	6	38.5	42.5	4.13	0.75	4.5	1.25
284–286TC/TSC	144	148	18	21	44	48	12.88	...	...	7.5	41.5	45.5	4.75	0.75	4.5	1.25
182–184TC	234	239	12	15	34	39	...	12	13.75	4.5	31.5	36.5	3.75	0.75	4.5	1.25
213–215TC	238	243	15	18	38	43	...	12.38	14.13	6	35.5	40.5	4.13	0.75	4.5	1.25
284–286TC/TSC	246	251	18	21	46	51	...	13	14.75	7.5	43.5	48.5	4.75	1	4.5	1.25
324–326TC/TSC	248	253	18	21	48	53	...	13.88	14.75	7.5	43.5	50.5	4.75	1	4.5	1.25
364–365TSC	248	253	18	21	48	53	...	13.88	14.75	7.5	45.5	50.5	4.75	1	4.5	1.25
404–405TSC	252	257	22	26	52	57	...	14.88	14.88	9.5	49.5	54.5	4.75	1	4.5	1.25

NOTES:
(1) Motor shall not extend beyond the end of the baseplate.
(2) Contact manufacturer for additional space required for freestanding baseplates.
(3) Baseplate number denotes pump frame 1 or 2 and baseplate *HB* or *HBe* in inches.
(4) See para. 3.1. The baseplate length for *HBe* shall be used for extended designs. This extended length dimension, *HBe*, is a fixed value.
(5) Alternatively, the baseplate dimensions for flexibly-coupled magnetic drive pumps in Table 1-2 may be used for close-coupled magnetic drive pumps.
(6) Includes 0.13 in. shimming allowance where motor height controls.

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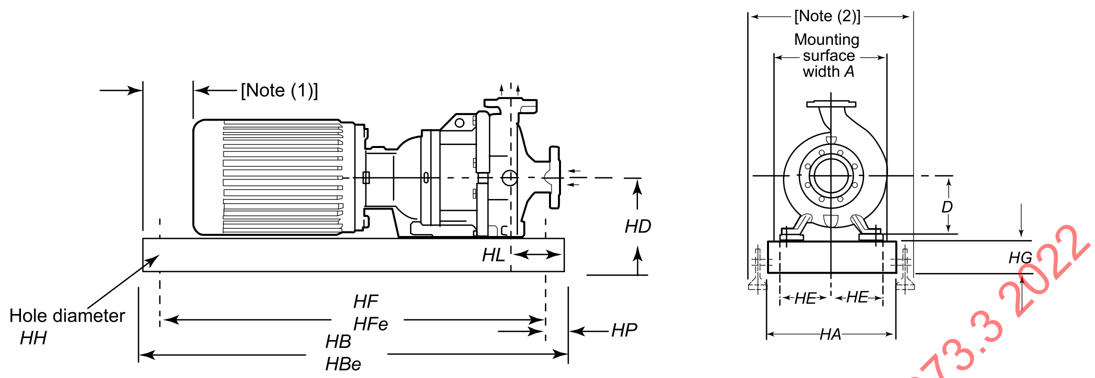
Table 1-3M
Baseplate Dimensions for Close-Coupled Magnetic Drive Pumps (SI)



Maximum NEMA Frame	Baseplate No. [Notes (3)–(5)] For *HB*	Baseplate No. [Notes (3)–(5)] For *HBe*	*A*, Min.	*HA*, Max. [Note (2)]	*HB* [Note (5)]	*HBe* [Notes (4), (5)]	*HD*, Max. [Note (6)] *D* = 133	*HD*, Max. [Note (6)] *D* = 210	*HD*, Max. [Note (6)] *D* = 254	*HE*	*HF* [Note (5)]	*HFe* [Notes (4), (5)]	*HG*, Max.	*HH*	*HL*	*HP*
			Approximate Equivalent Dimension, mm													
182–184TC	132	141	305	381	813	914	229	...	...	114	749	850	95	19	114	32
254–256TC	141	145	381	457	1 041	1 143	267	...	...	152	977	1 079	105	19	114	32
284–286TC/TSC	144	148	457	533	1 118	1 219	327	...	...	191	1 054	1 155	121	19	114	32
182–184TC	234	239	305	381	864	991	...	305	349	114	800	927	95	19	114	32
213–215TC	238	243	381	457	965	1 092	...	314	359	152	901	1 028	105	19	114	32
284–286TC/TSC	246	251	457	533	1 168	1 295	...	330	375	191	1 104	1 231	121	25	114	32
324–326TC/TSC	248	253	457	533	1 219	1 346	...	353	375	191	1 155	1 282	121	25	114	32
364–365TSC	248	253	457	533	1 219	1 346	...	353	375	191	1 155	1 282	121	25	114	32
404–405TSC	252	257	559	660	1 321	1 448	...	378	378	241	1 257	1 384	121	25	114	32

NOTES:
(1) Motor shall not extend beyond the end of the baseplate.
(2) Contact manufacturer for additional space required for freestanding baseplates.
(3) Baseplate number denotes pump frame 1 or 2 and baseplate *HB* or *HBe* in millimeters.
(4) See para. 3.1. The baseplate length for *HBe* shall be used for extended designs. This extended length dimension, *HBe*, is a fixed value.
(5) Alternatively, the baseplate dimensions for flexibly-coupled magnetic drive pumps in Table 1-2M may be used for close-coupled magnetic drive pumps.
(6) Includes 3 mm shimming allowance where motor height controls.

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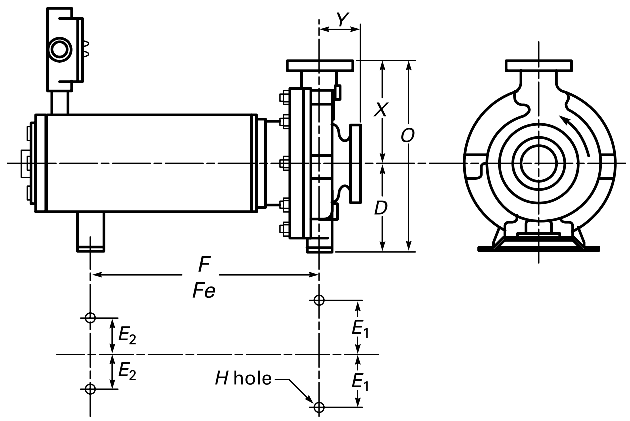
Table 1-4
Pump Dimensions for Canned Motor Pumps (U.S. Customary)



Dimension Designation	Size: Suspension × Discharge × Nominal Impeller Diameter	D	$2E_1$ [Note (1)]	$2E_2$ [Note (1)]	F [Note (1)]	Fe [Notes (1), (2)]	H	O	X	Y
		Dimension, in.								
AA	1.5 × 1 × 6	5.25	6	0	7.25	11.25	0.625	11.75	6.5	4
AB	3 × 1.5 × 6	5.25	6	0	7.25	11.25	0.625	11.75	6.5	4
AC [Note (3)]	3 × 2 × 6	5.25	6	0	7.25	11.25	0.625	11.75	6.5	4
AA [Note (3)]	1.5 × 1 × 8	5.25	6	0	7.25	11.25	0.625	11.75	6.5	4
AB [Note (3)]	3 × 1.5 × 8	5.25	6	0	7.25	11.25	0.625	11.75	6.5	4
A10	3 × 2 × 6	8.25	9.75	7.25	12.5	17.5	0.625	16.5	8.25	4
A50	3 × 1.5 × 8	8.25	9.75	7.25	12.5	17.5	0.625	16.75	8.5	4
A60	3 × 2 × 8	8.25	9.75	7.25	12.5	17.5	0.625	17.75	9.5	4
A70	4 × 3 × 8	8.25	9.75	7.25	12.5	17.5	0.625	19.25	11	4
A05 [Note (3)]	2 × 1 × 10	8.25	9.75	7.25	12.5	17.5	0.625	16.75	8.5	4
A50	3 × 1.5 × 10	8.25	9.75	7.25	12.5	17.5	0.625	16.75	8.5	4
A60	3 × 2 × 10	8.25	9.75	7.25	12.5	17.5	0.625	17.75	9.5	4
A70	4 × 3 × 10	8.25	9.75	7.25	12.5	17.5	0.625	19.25	11	4
A40	4 × 3 × 10	10	9.75	7.25	12.5	17.5	0.625	22.5	12.5	4
A80 [Note (4)]	6 × 4 × 10	10	9.75	7.25	12.5	17.5	0.625	23.5	13.5	4
A20 [Note (3)]	3 × 1.5 × 13	10	9.75	7.25	12.5	17.5	0.625	20.5	10.5	4
A30	3 × 2 × 13	10	9.75	7.25	12.5	17.5	0.625	21.5	11.5	4
A40	4 × 3 × 13	10	9.75	7.25	12.5	17.5	0.625	22.5	12.5	4
A80 [Note (4)]	6 × 4 × 13	10	9.75	7.25	12.5	17.5	0.625	23.5	13.5	4
A90 [Note (4)]	8 × 6 × 13	14.5	16	9	18.75	24.75	0.875	30.5	16	6
A100 [Note (4)]	10 × 8 × 13	14.5	16	9	18.75	24.75	0.875	32.5	18	6
A105 [Note (4)]	6 × 4 × 15	14.5	16	9	18.75	24.75	0.875	30.5	16	6
A110 [Note (4)]	8 × 6 × 15	14.5	16	9	18.75	24.75	0.875	32.5	18	6
A120 [Note (4)]	10 × 8 × 15	14.5	16	9	18.75	24.75	0.875	33.5	19	6
A105 [Note (4)]	6 × 4 × 17	14.5	16	9	18.75	24.75	0.875	30.5	16	6

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Table 1-4
Pump Dimensions for Canned Motor Pumps (U.S. Customary) (Cont'd)

	Dimension, in.									
	Size									
Dimension Designation	Suction × Discharge × Nominal Impeller Diameter	*D*	$2E_1$ [Note (1)]	$2E_2$ [Note (1)]	*F* [Note (1)]	*Fe* [Notes (1), (2)]	*H*	*O*	*X*	*Y*
A110 [Note (4)]	8 × 6 × 17	14.5	16	9	18.75	24.75	0.875	32.5	18	6
A120 [Note (4)]	10 × 8 × 17	14.5	16	9	18.75	24.75	0.875	33.5	19	6

NOTES:
(1) Alternative pump cradle — canned motor pumps do not require alignment and are normally supported by a pump cradle under the stator so a rigidly mounted pump casing is not necessary.
(2) See para. 3.1. This extended length dimension, *Fe*, is a maximum value. Any dimension between the standard and maximum extended length is acceptable.
(3) Discharge flange may have tapped bolt holes.
(4) Suction flange may have tapped bolt holes.

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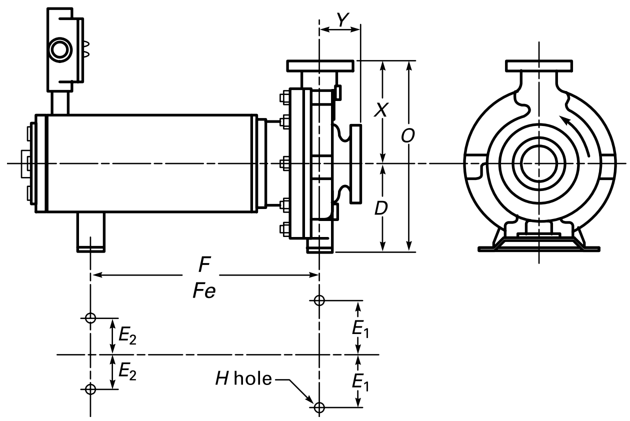
Table 1-4M
Pump Dimensions for Canned Motor Pumps (SI)



Dimension Designation	Approximate Equivalent Dimension, mm									
	Size									
	Suction × Discharge × Nominal Impeller Diameter	*D*	$2E_1$ [Note (1)]	$2E_2$ [Note (1)]	*F* [Note (1)]	*Fe* [Notes (1), (2)]	*H*	*O*	*X*	*Y*
AA	40 × 25 × 150	133	152	0	184	286	16	298	165	102
AB	80 × 40 × 150	133	152	0	184	286	16	298	165	102
AC [Note (3)]	80 × 50 × 150	133	152	0	184	286	16	298	165	102
AA [Note (3)]	40 × 25 × 200	133	152	0	184	286	16	298	165	102
AB [Note (3)]	80 × 40 × 200	133	152	0	184	286	16	298	165	102
A10	80 × 50 × 150	210	248	184	318	445	16	420	210	102
A50	80 × 40 × 200	210	248	184	318	445	16	425	216	102
A60	80 × 50 × 200	210	248	184	318	445	16	450	242	102
A70	100 × 80 × 200	210	248	184	318	445	16	490	280	102
A05 [Note (3)]	50 × 25 × 250	210	248	184	318	445	16	425	216	102
A50	80 × 40 × 250	210	248	184	318	445	16	425	216	102
A60	80 × 50 × 250	210	248	184	318	445	16	450	242	102
A70	100 × 80 × 250	210	248	184	318	445	16	490	280	102
A40	100 × 80 × 250	254	248	184	318	445	16	560	318	102
A80 [Note (4)]	150 × 100 × 250	254	248	184	318	445	16	597	343	102
A20 [Note (3)]	80 × 40 × 330	254	248	184	318	445	16	520	266	102
A30	80 × 50 × 330	254	248	184	318	445	16	546	292	102
A40	100 × 80 × 330	254	248	184	318	445	16	572	318	102
A80 [Note (4)]	150 × 100 × 330	254	248	184	318	445	16	597	343	102
A90 [Note (4)]	200 × 150 × 330	368	406	229	476	629	22	775	406	152
A100 [Note (4)]	250 × 200 × 330	368	406	229	476	629	22	826	457	152
A105 [Note (4)]	150 × 100 × 380	368	406	229	476	629	22	775	406	152
A110 [Note (4)]	200 × 150 × 380	368	406	229	476	629	22	826	457	152
A120 [Note (4)]	250 × 200 × 380	368	406	229	476	629	22	851	483	152
A105 [Note (4)]	150 × 100 × 430	368	406	229	476	629	22	775	406	152
A110 [Note (4)]	200 × 150 × 430	368	406	229	476	629	22	826	457	152

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Table 1-4M
Pump Dimensions for Canned Motor Pumps (SI) (Cont'd)

Dimension Designation	Approximate Equivalent Dimension, mm									
	Size: Suction × Discharge × Nominal Impeller Diameter	*D*	$2E_1$ [Note (1)]	$2E_2$ [Note (1)]	*F* [Note (1)]	*Fe* [Notes (1), (2)]	*H*	*O*	*X*	*Y*
A120 [Note (4)]	250 × 200 × 430	368	406	229	476	629	22	851	483	152

NOTES:

(1) Alternative pump cradle — canned motor pumps do not require alignment and are normally supported by a pump cradle under the stator so a rigidly mounted pump casing is not necessary.

(2) See para. 3.1. This extended length dimension, *Fe*, is a maximum value. Any dimension between the standard and maximum extended length is acceptable.

(3) Discharge flange may have tapped bolt holes.

(4) Suction flange may have tapped bolt holes.

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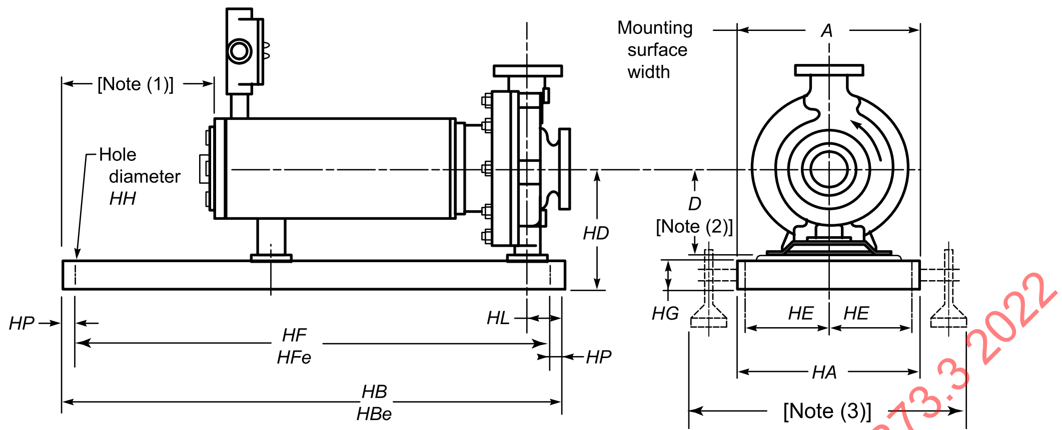
Table 1-5
Baseplate Dimensions for Canned Motor Pumps (U.S. Customary)



Dimension Designation	Size: Suction × Discharge × Nominal Impeller Diameter	*A*, Min. [Note (1)]	*HA*, Max. [Notes (1), (3)]	*HB*, Max. [Notes (1), (4)]	*HBe*, Max. [Notes (1), (4), (5)]	*HD*, Max.	*HE*	*HF*, Max. [Note (4)]	*HFe*, Max. [Notes (4), (5)]	*HG*, Max.	*HH*	*HL*	*HP*
AA	1.5 × 1 × 6	12	15	39	43	9	4.5	36.5	40.5	3.75	0.75	4.5	1.25
AB	3 × 1.5 × 6	15	18	48	52	10.5	6	45.5	49.5	4.13	0.75	4.5	1.25
AC [Note (6)]	3 × 2 × 6	18	21	58	62	12.88	7.5	55.5	59.5	4.75	0.75	4.5	1.25
AA [Note (6)]	1.5 × 1 × 8	18	21	58	62	12.88	7.5	55.5	59.5	4.75	0.75	4.5	1.25
AB [Note (6)]	3 × 1.5 × 8	18	21	58	62	12.88	7.5	55.5	59.5	4.75	0.75	4.5	1.25
A10	3 × 2 × 6	18	21	58	63	13	7.5	55.5	60.5	4.75	1	4.5	1.25
A50	3 × 1.5 × 8	18	21	58	63	13	7.5	55.5	60.5	4.75	1	4.5	1.25
A60	3 × 2 × 8	18	21	64	69	13.88	7.5	61.5	66.5	4.75	1	4.5	1.25
A70	4 × 3 × 8	18	21	64	69	13.88	7.5	61.5	66.5	4.75	1	4.5	1.25
A05 [Note (6)]	2 × 1 × 10	18	21	58	63	13.88	7.5	55.5	60.5	4.75	1	4.5	1.25
A50	3 × 1.5 × 10	18	21	64	69	13.88	7.5	61.5	66.5	4.75	1	4.5	1.25
A60	3 × 2 × 10	18	21	64	69	13.88	7.5	61.5	66.5	4.75	1	4.5	1.25
A70	4 × 3 × 10	22	26	68	73	14.88	9.5	65.5	70.5	4.75	1	4.5	1.25
A40	4 × 3 × 10	22	26	80	85	15.88	9.5	77.5	82.5	4.75	1	4.5	1.25
A80 [Note (7)]	6 × 4 × 10	22	26	80	85	15.88	9.5	77.5	82.5	4.75	1	4.5	1.25
A20 [Note (6)]	3 × 1.5 × 13	22	26	80	85	15.88	9.5	77.5	82.5	4.75	1	4.5	1.25

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Table 1-5
Baseplate Dimensions for Canned Motor Pumps (U.S. Customary) (Cont'd)

Dimension Designation	Size: Suction × Discharge × Nominal Impeller Diameter	Dimension, in.: *A*, Min. [Note (1)]	*HA*, Max. [Notes (1), (3)]	*HB*, Max. [Notes (1), (4)]	*HBe*, Max. [Notes (1), (4), (5)]	*HD*, Max.	*HE*	*HF*, Max. [Note (4)]	*HFe*, Max. [Notes (4), (5)]	*HG*, Max.	*HH*	*HL*	*HP*
A30	3 × 2 × 13	22	26	80	85	15.88	9.5	77.5	82.5	4.75	1	4.5	1.25
A40	4 × 3 × 13	22	26	80	85	15.88	9.5	77.5	82.5	4.75	1	4.5	1.25
A80 [Notes (6), (7)]	6 × 4 × 13	22	26	80	85	15.88	9.5	77.5	82.5	4.75	1	4.5	1.25
A90 [Notes (6), (7)]	8 × 6 × 13	22	26	80	86	19.25	9.5	77.5	83.5	4.75	1	6.5	1.25
A100 [Notes (6), (7)]	10 × 8 × 13	22	26	80	86	19.25	9.5	77.5	83.5	4.75	1	6.5	1.25
A105 [Note (7)]	6 × 4 × 15	22	26	80	86	19.25	9.5	77.5	83.5	4.75	1	6.5	1.25
A110 [Notes (6), (7)]	8 × 6 × 15	22	26	80	86	19.25	9.5	77.5	83.5	4.75	1	6.5	1.25
A120 [Notes (6), (7)]	10 × 8 × 15	22	26	80	86	19.25	9.5	77.5	83.5	4.75	1	6.5	1.25
A105 [Note (7)]	6 × 4 × 17	22	26	80	86	19.25	9.5	77.5	83.5	4.75	1	6.5	1.25
A110 [Note (7)]	8 × 6 × 17	22	26	80	86	19.25	9.5	77.5	83.5	4.75	1	6.5	1.25
A120 [Note (7)]	10 × 8 × 17	22	26	80	86	19.25	9.5	77.5	83.5	4.75	1	6.5	1.25

NOTES:
(1) Pump assembly shall not extend beyond the end of the baseplate.
(2) *D* dimension may change if a welded drain connection with flange or a cooling/heating jacket is required.
(3) Contact manufacturer for additional space required for freestanding baseplates.
(4) Baseplate dimensions *HB*, *HBe*, *HF*, and *HFe* are maximum dimensions. Any dimension up to the maximum values listed are acceptable.
(5) See para. 3.1. This extended length dimension, *HBe*, is a maximum value. Whenever the pump to be mounted has *Fe* greater than *F*, the baseplate for *HBe* must be used.
(6) Discharge flange may have tapped bolt holes.
(7) Suction flange may have tapped bolt holes.

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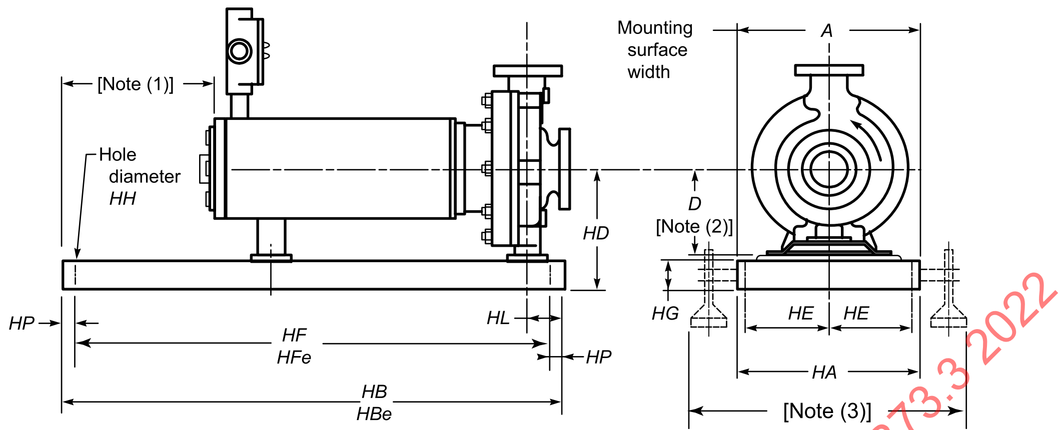
Table 1-5M
Baseplate Dimensions for Canned Motor Pumps (SI)



Dimension Designation	Size: Suction × Discharge × Nominal Impeller Diameter	*A*, Min. [Note (1)]	*HA*, Max. [Notes (1), (3)]	*HB*, Max. [Notes (1), (4)]	*HBe*, Max. [Notes (1), (4), (5)]	*HD*, Max.	*HE*	*HF*, Max. [Note (4)]	*HFe*, Max. [Notes (4), (5)]	*HG*, Max.	*HH*	*HL*	*HP*
		Approximate Equivalent Dimension, mm											
AA	40 × 25 × 150	305	381	991	1 092	229	114	927	1 029	95.3	19.1	114	31.8
AB	80 × 40 × 150	381	457	1 219	1 321	267	152	1 156	1 257	105	19.1	114	31.8
AC [Note (6)]	80 × 50 × 150	457	533	1 473	1 575	327	191	1 410	1 511	121	19.1	114	31.8
AA [Note (6)]	40 × 25 × 200	457	533	1 473	1 575	327	191	1 410	1 511	121	19.1	114	31.8
AB [Note (6)]	80 × 40 × 200	457	533	1 473	1 575	327	191	1 410	1 511	121	19.1	114	31.8
A10	80 × 50 × 150	457	533	1 473	1 600	330	191	1 410	1 537	121	25.4	114	31.8
A50	80 × 40 × 200	457	533	1 473	1 600	330	191	1 410	1 537	121	25.4	114	31.8
A60	80 × 50 × 200	457	533	1 626	1 753	353	191	1 562	1 689	121	25.4	114	31.8
A70	100 × 80 × 200	457	533	1 626	1 753	353	191	1 562	1 689	121	25.4	114	31.8
A05 [Note (6)]	50 × 25 × 250	457	533	1 473	1 600	353	191	1 410	1 537	121	25.4	114	31.8
A50	80 × 40 × 250	457	533	1 626	1 753	353	191	1 562	1 689	121	25.4	114	31.8
A60	80 × 50 × 250	457	533	1 626	1 753	353	191	1 562	1 689	121	25.4	114	31.8
A70	100 × 80 × 250	559	660	1 727	1 854	378	241	1 664	1 791	121	25.4	114	31.8
A40	100 × 80 × 250	559	660	2 032	2 159	403	241	1 969	2 096	121	25.4	114	31.8
A80 [Note (7)]	150 × 100 × 250	559	660	2 032	2 159	403	241	1 969	2 096	121	25.4	114	31.8
A20 [Note (6)]	80 × 40 × 330	559	660	2 032	2 159	403	241	1 969	2 096	121	25.4	114	31.8

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Table 1-5M
Baseplate Dimensions for Canned Motor Pumps (SI) (Cont'd)

Dimension Designation	Size: Suction × Discharge × Nominal Impeller Diameter	Approximate Equivalent Dimension, mm: *A*, Min. [Note (1)]	*HA*, Max. [Notes (1), (3)]	*HB*, Max. [Notes (1), (4)]	*HBe*, Max. [Notes (1), (4), (5)]	*HD*, Max.	*HE*	*HF*, Max. [Note (4)]	*HFe*, Max. [Notes (4), (5)]	*HG*, Max.	*HH*	*HL*	*HP*
A30	80 × 50 × 330	559	660	2 032	2 159	403	241	1 969	2 096	121	25.4	114	31.8
A40	100 × 80 × 330	559	660	2 032	2 159	403	241	1 969	2 096	121	25.4	114	31.8
A80 [Notes (6), (7)]	150 × 100 × 330	559	660	2 032	2 159	403	241	1 969	2 096	121	25.4	114	31.8
A90 [Notes (6), (7)]	200 × 150 × 330	559	660	2 032	2 184	489	241	1 969	2 121	121	25.4	165	31.8
A100 [Notes (6),(7)]	250 × 200 × 330	559	660	2 032	2 184	489	241	1 969	2 121	121	25.4	165	31.8
A105 [Note (7)]	150 × 100 × 380	559	660	2 032	2 184	489	241	1 969	2 121	121	25.4	165	31.8
A110 [Notes (6),(7)]	200 × 150 × 380	559	660	2 032	2 184	489	241	1 969	2 121	121	25.4	165	31.8
A120 [Notes (6), (7)]	250 × 200 × 380	559	660	2 032	2 184	489	241	1 969	2 121	121	25.4	165	31.8
A105 [Note (7)]	150 × 100 × 430	559	660	2 032	2 184	489	241	1 969	2 121	121	25.4	165	31.8
A110 [Note (7)]	200 × 150 × 430	559	660	2 032	2 184	489	241	1 969	2 121	121	25.4	165	31.8
A120 [Note (7)]	250 × 200 × 430	559	660	2 032	2 184	489	241	1 969	2 121	121	25.4	165	31.8

NOTES:
(1) Pump assembly shall not extend beyond the end of the baseplate.
(2) *D* dimension may change if a welded drain connection with flange or a cooling/heating jacket is required.
(3) Contact manufacturer for additional space required for freestanding baseplates.
(4) Baseplate dimensions *HB*, *HBe*, *HF*, and *HFe* are maximum dimensions. Any dimension up to the maximum values listed are acceptable.
(5) See para. 3.1. This extended length dimension, *HBe*, is a maximum value. Whenever the pump to be mounted has *Fe* greater than *F*, the baseplate for *HBe* must be used.
(6) Discharge flange may have tapped bolt holes.
(7) Suction flange may have tapped bolt holes.

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auxiliary connection: all the piping connected to the pump that is normally nonprocess wetted (e.g., CMP secondary containment flush and drain connection). Auxiliary connections include piping, tubing, and all attached components such as valves, instrumentation, and coolers.

auxiliary piping: all the piping connected to the pump 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, and coolers.

auxiliary process piping: all the piping connected to the pump that is normally process wetted, excluding the main piping connected at the pump suction and discharge flanges (e.g., casing drain, external flush connection). Auxiliary process piping includes piping, tubing, and all attached components such as valves, instrumentation, and coolers.

canned motor pump rotor: the primary driven component of a canned motor pump, consisting mainly of a shaft and rotor core, which is hermetically sealed from pumped fluid by a can or liner. Removable components such as collars, sleeves, and impeller are not considered part of the rotor.

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

nonpressure-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 nonwetted parts: pump parts that contain pressure but are not wetted by the pumped fluid (e.g., lined casing, cover).

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

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

sleeve bearing: a bearing consisting of a rotating member (journal) and a stationary member (bearing bushing).

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

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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. 5.11 for auxiliary piping.

5.1.1.1 The design pressure of the casing, casing cover, containment shell, and secondary containment, if applicable, 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.

For plastic-lined sealless pumps, the pressure limitation for the material of construction of the casing, casing cover, containment shell, and secondary containment, if applicable, shall have a design pressure at least equal to the pressure–temperature rating of ASME B16.42 Class 150 flanges. Pumps may be offered with higher design pressures than the minimum stated pressures. Pumps having lower design pressures than the minimum stated require approval by the purchaser.

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 The design pressure of any oil cooler shall be at least 100 psig (689 kPa gage) at 250°F (121°C).

5.1.1.4 The casing, casing cover, and containment shell (and secondary pressure-containing boundary and jackets, if applicable) 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).

5.1.1.5 All primary pressure-containing parts shall be capable of resisting a vacuum of 14.7 psi (760 mmHG) at 68°F (20°C).

5.1.2 Temperature Limits. Temperature limitations shall be as stated by the pump manufacturer, including temperature limitations of the liquid at the suction flange. 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. 5.11.

The application of the pump shall take into consideration the fluid characteristics as supplied by the user. This will require consideration of such characteristics as specific heat and vapor pressure of the liquid that establishes these limits.

5.1.2.1 Plastic lined sealless pumps should be designed for a minimum temperature range of −20°F to 250°F (−29°C to 121°C).

5.1.2.2 For services above 350°F (177°C), centerline mounting and oil sump cooling options should be made available.

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 Tables 1-1 and 1-4 (Tables 1-1M and 1-4M). Through bolt holes are preferred. When tapped holes are supplied, they shall be noted on the outline drawing.

5.2.1.1 For plastic-lined sealless pumps, the requirements of para. 5.2.1 apply except that raised face flanges shall be standard. The raised face portion of the flange is formed by the plastic lining.

5.2.2 Class 300 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.

5.2.2.1 Class 300 flanges are not required for plastic-lined sealless pumps.

5.2.3 *X* and *Y* Dimensions. All pumps regardless of flange rating shall conform to the *X* and *Y* dimensions shown in Tables 1-1 and 1-4 (Tables 1-1M and 1-4M).

5.2.4 Heavy Hex Nuts. 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, this 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 Boss(es). The 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. drain connection minimum (welded or NPT). Drain shall not be provided unless specified by the purchaser. When specified, it will be as indicated on the datasheet.

5.3.1.1 For plastic-lined sealless pumps, a drain shall be provided unless otherwise specified. The drain shall be at the lowest part of the pump casing. When provided, the drain shall be sealed by a blind flange and gasket. Screwed connections in plastic-lined pumps are prohibited.

5.3.1.2 The addition of a flanged drain connection may require an increase in the centerline height of the pump if there is distance, *D*, between the centerline of the pump and the mounting surface. Where this clearance is a matter of concern, it shall be reviewed and agreed upon between the purchaser and supplier.

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, with ½ in. NPT preferred. Boss(es) shall not be drilled and tapped when specified by the purchaser.

For plastic lined sealless pumps, suction and discharge gage connections are not required.

5.3.3 Support. The casing shall be supported by feet beneath the casing or a suitable support between the casing and the baseplate. For CMP, an alternative pump cradle between the stator and the baseplate is acceptable.

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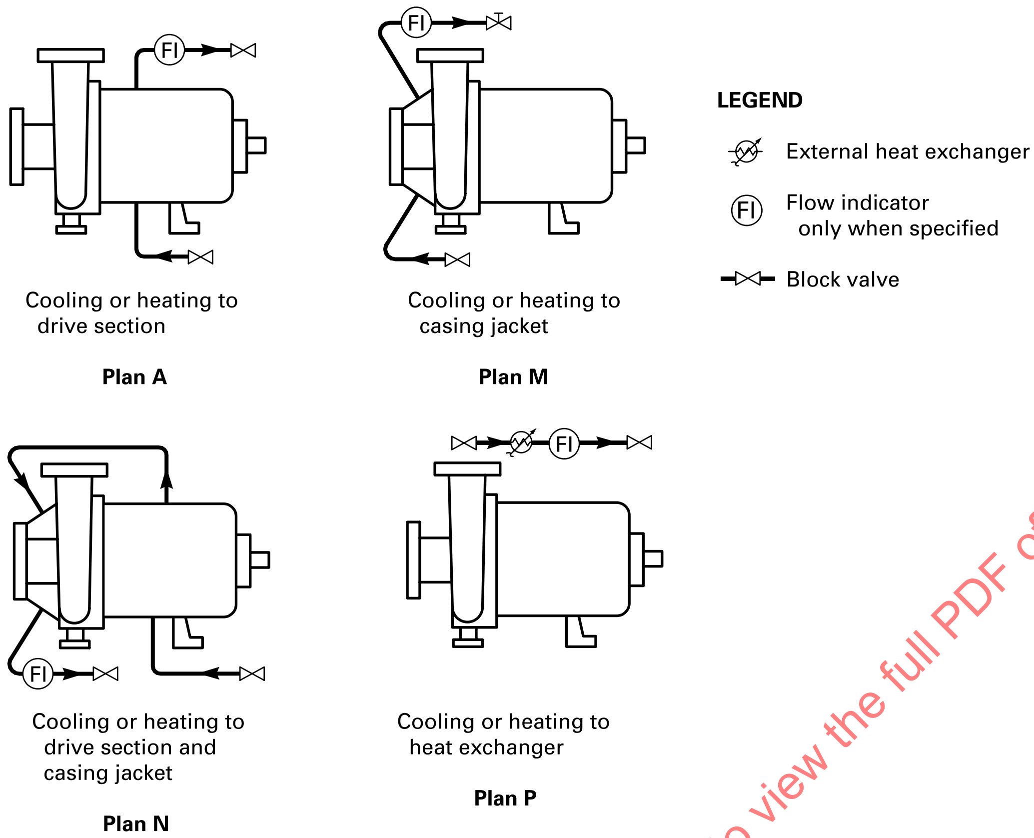
Figure 5.3.7.1-1
Cooling and Heating Piping Plans



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5.3.4 Disassembly. The design shall permit back removal of the rotating element(s) from the casing without disturbing the suction and discharge connections. The design shall also avoid disturbing the motor on flexibly coupled MDPs. Tapped holes for jackscrews or equivalent means shall be provided to facilitate the safe disassembly and reassembly of the rotating element(s) from the casing and to avoid the necessity of drive wedges or prying implements. Jackscrews shall not cause damage to parts that will interfere with reassembly and sealing when the parts are reused.

5.3.5 Self Priming Pumps. Self-priming designs should be used where the pump must evacuate gas from the suction line when the liquid level is below the pump when started. These designs incorporate integral chambers that, once initially filled, keep liquid in the casing for use during the priming cycle and expel gas out the discharge. This design does not require a check valve or any other equipment to maintain liquid in the casing after initial filling.

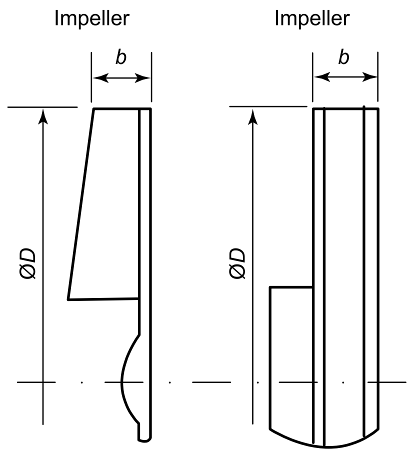
5.3.6 Low Flow Pumps. Low-flow pumps should include concentric volute designs that allow for reliable operation at best efficiency point (BEP) and minimum flow below that available with normal expanding volute designs.

5.3.7 Heating or Cooling

5.3.7.1 There are several methods of cooling or heating areas of most ASME B73.3 magnetic drive and canned motor pumps. The pump casing, bearing housing, and motor are areas that may have design features available for heating or cooling. Commonly used cooling/heating piping plans applied to ASME B73.3 pump applications are identified in Figure 5.3.7.1-1. Other configurations may be used if specified and agreed upon between the purchaser and supplier.

5.3.7.2 Jackets for heating or cooling the casing, motor, and/or pump components are optional. Connections shall be $^3/_8$ in. NPT minimum, with $^1/_2$ in. NPT preferred. When a jacket is used with steam, the inlet connection shall be located at the top quadrant of the jacket, and the drain connection shall be located at the bottom portion of the jacket to prevent the formation of water pockets. In some instances, the addition of a cooling/heating jacket connection may require an

Figure 5.4.2-1
Impeller Dimensions to Determine Single-Plane or Two-Plane Balance



Legend:
b = width
D = dimension

increase in the centerline height of the pump due to the small distance between the centerline of the pump to the mounting surface dimension, *D*. Where this clearance could be a matter of concern, this shall be reviewed and agreed upon between the purchaser and supplier.

5.3.7.3 Heating or cooling jackets are not a required option for plastic-lined sealless pumps.

5.3.8 Gaskets. All assembly gaskets shall be confined on the atmospheric side to prevent blowout. Design shall consider thermal cycling, which 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.

5.3.9 Bolting. The pressure-containing fasteners (including casing, containment shell, and secondary containment or control components, if applicable) 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 does not exceed the allowable bolt stresses given in Table 3 of ASME BPVC, Section II, Part D. In addition, the tapped holes for pressure-retaining bolting shall be of sufficient depth that thread engagement is $^7/_8$ times the nominal bolt diameter. 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 of open, semi-open, and closed designs are optional.

5.4.2 Balance. Impellers shall be balanced in accordance with ISO 21940-11 and meet Grade G-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 5.4.2-1 for impeller dimensions to determine single- or two-plane balance.

5.4.3 Attachment. For MDP rotating shaft designs, the impeller shall be keyed, threaded, or otherwise permanently fixed to the shaft. Threads shall be designed to tighten by correct rotation. For CMP rotating shaft designs, the impeller shall be keyed or otherwise permanently fixed to the shaft. For stationary shaft designs, the impeller may be an integral part of the rotor assembly. Other attachment designs may be used with the approval of the purchaser.

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5.5 Internal Drive Assembly

5.5.1 Mounting. For MDP rotating shaft designs, the inner magnet assembly shall be keyed, threaded, or permanently attached to the impeller drive shaft.

5.5.2 Balance. The rotor assembly or inner magnetic assembly shall be balanced in accordance with ISO 21940-1 and meet Grade G-6.3 after final machining. Rotor assemblies or inner magnet assemblies shall be two-plane balanced

5.5.3 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.

5.5.4 Fillets and Radii. All shaft shoulder fillets and radii shall be as large as practical and finished to reduce additional stress risers.

5.5.5 Internal Drive Assembly Bearings

5.5.5.1 Bearing Design. The bearing system shall be capable of absorbing all thrust and radial loads while the pump is operated within its allowable operating range. The thrust bearing should be designed to absorb thrust in either direction; however, no design shall be offered where a change in thrust direction affects the pump's hydraulic performance or reliability during normal operation. In a design that relies on thrusting in one direction during normal operation to maintain hydraulic performance and reliability, reverse thrusting shall be allowed only during start-up, shutdown, or abnormal operating conditions, e.g., vapor entrainment, insufficient net positive suction head available (NPSHA), or flow outside allowable operating region.

Bearings shall be designed and applied considering fluid characteristics, unit loading, speed, corrosion, erosion, wear, heat transfer, thermal cycling, fits, and material and friction characteristics.

5.5.5.2 Bearing Loading. Bearing loading, alignment, shaft deflection, surface finish, and wear-in characteristics of bearing materials shall be considered to prevent local surface failure.

5.5.5.3 Journals. The journals may be separate sleeves, finished shaft surface, or hardfaced/coated shaft areas for both rotating and nonrotating shaft designs.

5.5.5.4 Clearances. Materials used for journal sleeves, thrust collars, and bearings often have significantly different thermal expansion characteristics compared to shaft and other mating parts. Application guidelines and limits shall be established by the manufacturers for specific designs to avoid breakage or looseness under specified operating temperatures or temperature cycling.

5.5.5.5 Lubrication. Lubrication and/or cooling of the bearings shall be by the liquid pumped or by a clean, compatible, external fluid injection. Fluid circulation piping plan designations shown in ANSI/HI 5.1–5.6, Figure 5.3.2.12.1 shall be applied to ASME B73.3 MDP and CMP applications. A modified Plan 114 may also be applied as shown in Figure 5.5.5.5-1. Other configurations may be used if specified and agreed upon between the purchaser and supplier.

5.5.5.6 Heat Input. The bearings shall be provided with adequate fluid circulation and pressure that considers the maximum heat input of the drive assembly (including bearing friction) in relation to the fluid-specific gravity, the fluid-specific heat, fluid viscosity, laminar flow, turbulent flow, and vapor pressure. The pump design shall also ensure that the temperature and pressure in the rotor chamber prevents vaporization through the full operating range of the pump from minimum flow to maximum flow while providing continuous flow through the rotor chamber for cooling and bearing lubrication.

The pump design shall meet the following requirements:

(a) The ratio between circulation return pressure and the predicted vapor pressure at any point in the rotor chamber shall be a minimum of 1.1.

(b) The differential between circulation return pressure and the predicted vapor pressure at any point in the rotor chamber shall be a minimum of 16 ft (5 m) of process fluid.

(c) The difference between the predicted temperature and the saturation temperature of the circulating fluid at any point in the rotor chamber shall be a minimum of 30% of the total predicted temperature rise.

The user shall provide suction pressure, specific gravity, vapor pressure, specific heat, and viscosity data versus temperature for use in these calculations.

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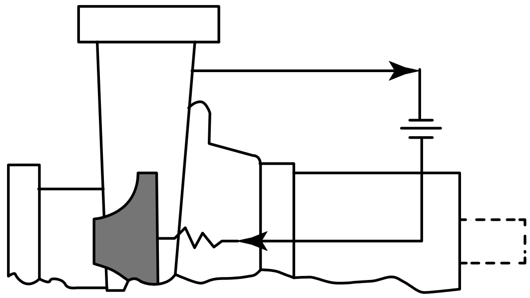
Figure 5.5.5.5-1
Plan 114 Modified



GENERAL NOTES:
(a) Recirculation from discharge is through optional orifice through drive section to suction.
(b) Bearing pressure is substantially higher than suction pressure.

Values at the pump suction temperature plus values at two higher temperatures shall be provided by the user. Values at maximum suction temperature, 10°F (−12.2°C) above maximum suction temperature and 20°F (−6.67°C) above maximum suction temperature are usually considered typical points for physical property values. The supplier and user should agree on the values used.

NOTE: If the supplier needs additional data, this shall be communicated to the user. Temperature values higher than 20°F (−6.67°C) above suction temperature may be required on higher horsepower pumps.

5.5.5.7 Bearing Environment. The design shall provide for removal of air or other noncondensables. The purchaser shall advise manufacturers of all changes in phase, solid content, or viscosity that may occur to the process fluid due to a change in temperature and/or pressure.

5.5.5.8 Filtration. When conditions of service require filtration of bearing lubricating fluid, a self-cleaning internal design may be used. If external filtration is required, the filter system should allow for indicating when filter change is required. Loss of flow to drive section shall be avoided.

5.6 Containment Design

5.6.1 Primary Pressure Containment. The containment shell and liner shall be the primary means of sealing; as a minimum they shall be manufactured of a material equal to or higher in corrosion/chemical resistance than the pump casing.

5.6.2 MDP Containment Shell. The MDP metallic primary and/or secondary containment shell(s) shall be designed in accordance with the table of allowable stress levels for the selected materials and the equations for the minimum required thickness as outlined in ASME BPVC, Section VIII, Division 1, UG-16(b). However, the shell may be thinner than the absolute minimum thickness stated.

ASME BPVC, Section VIII, Division 2 may be used in lieu of Division 1 for design. The manufacturer shall indicate whether Division 1 or Division 2 was used.

Alternative containment shell materials (including nonmetallic) and/or designs may be considered to obtain benefits such as reduction of eddy current heating and losses. However, because some nonmetallic shells may have temperature and/or pressure limits below that of the casing, alternate materials and designs are subject to approval by the purchaser.

5.6.2.1 For both metallic and plastic-lined MDP, all pressure-containing parts shall be capable of resisting a vacuum of 14.7 psi (760 mmHG) at 68°F (20°C).

5.6.2.2 Nonmetallic containment shells may consist of a plastic insert with an outer shell of reinforced thermoset polymer, engineered ceramic, or other type of nonmetallic construction. The containment shell's chemical resistance shall be equal to or greater than the casing lining material. The containment shell design pressure at 100°F (38°C) shall be the same as the casing and casing cover. The containment shell pressure versus temperature rating shall be stated by the manufacturer. Alternative designs are subject to approval by the purchaser.

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5.6.2.3 Metallic containment shells shall not be used in plastic-lined sealless pumps; however, nonmetallic containment shells may be used in metallic MDP.

5.6.3 CMP Liners

5.6.3.1 Stator Liner. The stator assembly consisting of the stator, stator liner, liner backing supports, stator housing, and electrical feed-through is a pressure-containing assembly and shall meet the requirements of para. 5.1 except as follows:

(a) The stator liner shall be of a material that is noncorrodible under application conditions.
(b) The minimum stator liner thickness shall be 0.015 in. (0.38 mm).
(c) The stator liner shall be hydrostatically tested in the stator assembly at 1.5 times the maximum allowable working pressure.

5.6.3.2 Rotor Liner

5.6.3.2.1 The rotor liner shall be of a material that is noncorrodible under application conditions.

5.6.3.2.2 Rotor liner materials not contained in Table 5.10.1.2-1 shall be subject to approval by the purchaser.

5.6.4 Secondary Control or Secondary Containment. Some installations should have a backup to control or contain the pumpage if the primary pressure containment (containment shell of MDP or liner of CMP) is breached. There are two basic methods for this secondary protection.

(a) Secondary control provides a structure surrounding the primary pressure containment that confines liquid release through primary pressure containment but does not completely contain it. Some leakage would be permitted through the secondary structure, but a rapid release of liquid would be prevented.
(b) Secondary containment provides a structure surrounding the primary pressure containment that fully contains all liquid released through the primary pressure containment. No leakage is permitted through the secondary structure.

The material of construction of the secondary pressure boundary shall be of a ductile material and evaluated for corrosion resistance when specifying either secondary control or secondary containment. The manufacturer shall specify materials of construction for the secondary containment or secondary control pressure boundary.

In the event of leakage through the primary pressure containment for either method, operation of the pump shall be discontinued immediately.

The purchaser shall be responsible for providing shutdown devices and procedures required for safety.

When specified, one of the following designs to control any leakage from the containment shell or the liner of the primary pressure containment shall be provided by the manufacturer.

5.6.4.1 Secondary Control

(a) Any leakage through the primary containment shall be minimized and safely directed by a boundary made up of devices, including a secondary pressure casing capable of maximum design pressure that shall have a functional life of at least 24 hr in the event of containment shell failure.
(b) The secondary control shall be drainable to a residual of a maximum of 2 in.^{3} (30 mL) or to a value agreed upon by the user and the manufacturer.
(c) The secondary control shall be provided with flush and drain connections.

5.6.4.2 Secondary Containment

(a) Any leakage through the primary containment shall be contained by secondary containment at the maximum allowable working pressure for a minimum of 48 hr.
(b) The secondary containment shall be drainable to a residual of a maximum of 2 in.^{3} (30 mL) or to a value agreed upon by the user and the manufacturer.
(c) The secondary containment shall be provided with flush and drain connections when specified.

5.6.4.2.1 Secondary Containment Verification. When specified, a means for periodically checking the secondary containment for sealing capability shall be provided by the manufacturer.

5.6.5 Draining. All pumped fluid-containing areas, including vendor-supplied piping, shall be drainable to a residual of a maximum of 2 in.^{3} (30 mL), or to a value agreed upon by the purchaser and manufacturer, and shall be suitable for flushing before disassembly.

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5.7 Bearings, Lubrication, and Bearing Frame (MDP)

5.7.1 External Bearings

5.7.1.1 Bearing Design. Two rolling element bearing assemblies shall be provided: one assembly free to float within the bearing frame to carry radial loading only, and the other assembly fixed or located axially.

(a) Nonmetallic cages shall not be used.
(b) Bearings shall not have filling slots.

5.7.1.2 Bearing 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 for all standard and optional bearing frame arrangements of bearings, lubrication, shafts, covers, and sealing.

NOTE: The minimum L_{10} bearing life above represents a worst-case scenario for certain sizes running at maximum rated speed. The actual L_{10} life for the typical ASME B73.3 pump rolling element bearings may be far in excess of 17,500 hr. Consult the pump manufacturer for the actual L_{10} life of the selected pump and rated operating conditions.

5.7.1.2.1 For close-coupled MDP, the supplier shall be responsible for assuring the motor bearing life, when calculated in accordance with ANSI/ABMA-9, ANSI/ABMA-11, and ISO 281, will provide a minimum L_{10} bearing life of 17,500 hr.

5.7.2 External-Bearing Lubrication

5.7.2.1 Oil bath lubrication is standard on flexibly coupled MDP.

5.7.2.2 Greased lubrication shall be standard for close-coupled MDP. When regreaseable lubrication is specified, a means for grease relief shall be provided.

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

5.7.2.4 Greased for life or regreaseable lubrication shall be optional on flexibly coupled MDP.

5.7.2.4.1 When regreasable lubrication is specified, a means for grease relief shall be provided.

5.7.2.4.2 When greased-for-life is specified, the bearings shall be double shielded and pre-filled 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.

5.7.3 Bearing Frame. The bearing frame 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 oil bath lubrication and includes labyrinth-type bearing isolators, a 1-in. (25-mm) bull's-eye oil sight glass, magnetic drain plug, and plugged top vent.

5.7.3.1 Sealing. The standard design includes labyrinth-type bearing isolators. Optional designs may be offered that allow for the use of a variety of other bearing frame seals, such as lip seals or magnetic oil seals, that may be specified by the purchaser. In 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.

5.7.3.2 Bearing Frame Drain. The bearing frame shall be provided with a tapped and plugged drain hole at its lowest point. A magnetic drain plug shall be used.

5.7.3.3 Lubricant Level Indication. The bearing frame for oil bath lubrication shall be provided with a 1-in. (25-mm) bull's-eye level indicator that is capable of optionally being installed on either side or both sides of the bearing frame. The proper oil level for the nonoperating pump shall be indicated on the outside of the bearing frame.

5.7.3.4 Constant Level Oiler. A constant level oiler is not part of the standard design, but one may be included as an option when specified. If a constant level oiler is supplied, it shall be set initially by the supplier for the proper level during operation.

5.7.3.5 Oil Cooling. If water cooling is required to maintain oil and bearing temperatures, the oil cooler shall be constructed of plain or finned tubing/pipe of a corrosion-resistant nonferrous metal or austenitic stainless steel. There shall be no welded or mechanical pressure joints inside the housing. The oil cooler shall be located so that it is completely submerged in oil when the oil reservoir is filled to normal level.

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5.8 Outer Magnet Assembly (MDP)

5.8.1 Mounting. The outer magnet assembly shall be positively driven and runout shall be limited to prevent contact with stationary components during normal operation. Connections shall not loosen during reverse rotation.

5.8.2 Containment Shell Protection. The pump shall be designed to delay the outer magnet ring from contacting the containment shell in the event of a shaft or bearing failure. When specified, the design shall use a device of nonsparking material to minimize any source of ignition.

5.8.3 Corrosion Resistance. The surfaces of ferrous materials of the outer carrier, frame, and magnets shall have a heat resistant paint or coating to protect these surfaces from corrosion.

5.8.4 Balance. The outer magnet assembly shall be balanced in accordance with ISO 21940-11 and meet Grade G-6.3 after final machining. Outer magnet assemblies shall be two-plane balanced.

5.8.5 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.

5.8.6 Fillets and Radii. All shaft shoulder fillets and radii shall be as large as practical and finished to reduce additional stress risers.

5.9 Stator Assembly (CMP)

5.9.1 Stator Windings. The stator windings shall be protected by a corrosion-resistant liner suitable for the specified conditions.

5.9.2 Filled Stators. For filled stators, the secondary containment components of the stator assembly shall meet the requirements of para. 5.6.3.2. The supplier shall provide the user with the Material Safety Data Sheet (MSDS) of the filling medium in the stator assembly. The user must confirm that the stator filling medium is compatible with the process fluid in the event of a primary containment failure.

5.9.3 Temperature Rating. Motor stator windings shall be designed to operate at or below the temperature values established for the grade of insulation in accordance with IEEE 117. Maximum fluid temperature, motor winding temperature rise due to motor inefficiency, heat input of the process fluid, filling of the stator cavity with a heat conductive medium, pump fluid circulation plan, and auxiliary cooling plan shall all be considered in determining the maximum motor winding temperature for the application.

5.9.4 Motor Design Life. Motor sizing, stator insulation rating, cooling fluid temperature and flow, thermal isolation, and the use of jackets or heat exchangers shall be designed and selected to provide a minimum of 175,000 hr design life at specified operating conditions.

5.9.5 Thermal Protection. Thermal protection shall be provided. The manufacturer shall advise the temperature setting and supply the applicable wiring diagrams. When specified, lower temperature setting thermal protection shall be provided.

5.9.6 Hazardous Locations. Motors, electrical components, and electrical installations shall be suitable for the area electrical classification (Class, Group, Division, and T Code) as well as national and local codes as specified by the purchaser.

5.10 Materials of Construction

5.10.1 General

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

5.10.1.2 The pump material classification code in Table 5.10.1.2-1 shall be used to specify the pump materials of construction for metallic MDP and CMP.

For plastic-lined MDP, the pump material classification code in Table 5.10.1.2-1 with Base Code MDP-X shall be used to specify the pump's metallic, nonmetallic, and plastic materials of construction for the casing, impeller, cover, pump shaft, containment shell, and secondary containment/control (if furnished). The following common polymer materials are used in plastic-lined MDP:

(a) polytetrafluoroethylene (PTFE): offers nearly universal chemical resistance with a temperature limit of 350°F (177°C)

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Table 5.10.1.2-1
Magnetic Drive and Canned Motor Pump Material Classification Codes

Prefix — Pump Type

MDP = Magnetic Drive Pump; CMP = Canned Motor Pump

Base Code —MDP and CMP

Part Name	73 304 SS	73 316 SS	73 A20	73 LSS	73 CD4	73 C276	73 PFA	73 ETFE	73 X
Casing	304 SS	316 SS	Alloy 20	316L SS	CD4 MCu	Alloy C276	PFA	ETFE	As specified
Impeller	304 SS	316 SS	Alloy 20	316L SS	CD4 MCu	Alloy C276	Carbon-filled PFA	Carbon-filled ETFE	As specified
Cover (MDP) or bearing housings (CMP)	304 SS	316 SS	Alloy 20	316L SS	CD4 MCu	Alloy C276	Carbon-filled PFA [Note (1)]	Carbon-filled ETFE [Note (1)]	As specified
Pump shaft	304 SS	316 SS	Alloy 20	316L SS	Duplex 2205	Alloy C276	As specified	As specified	As specified
Secondary containment/ control	As specified	As specified	As specified	As specified	As specified	As specified	As specified	As specified	As specified

First Suffix — MDP and CMP Process Contact Parts (Limited Allowable Corrosion and Noncorrodible Parts)

Part Name	A	B	C	D	X
Containment shell — MDP only	316L SS	Alloy C276	PFA	ETFE	As specified
Rotor liner, stator liner, and motor end covers — CMP only	316L SS	Alloy C276	...	...	As specified

Second and Third Suffixes — Product Lubricated Bearing Materials

Material	2nd Suffix — Rotating Parts	3rd Suffix — Stationary Parts
Silicon carbide		
Alpha sintered	A	A
Alpha sintered with diamond-like coating	B	B
Carbon graphite		
Resin-impregnated	C	C
PTFE-impregnated	D	D
Antimony-impregnated	E	E
SiC-impregnated	F	F
Tungsten carbide		
Cobalt binder	G	G
Nickel binder	H	H
Composite bearings		
PFA/CF (carbon fiber) reinforced composite	J	J
Carbon-filled PTFE	K	K
Glass-filled PTFE	L	L

Fourth Suffix — Pressure Containing Fasteners

Part Name	A	B	C	X
Casing fasteners	Carbon steel	304 or 316 SS	Carbon steel with PTFE fluoropolymer coating	As specified
Container shell fasteners — MDP only	Carbon steel	304 or 316 SS	Carbon steel with PTFE fluoropolymer coating	As specified
Secondary containment fasteners or control fasteners (if furnished)	Carbon steel	304 or 316 SS	Carbon steel with PTFE fluoropolymer coating	As specified

Fifth Suffix — Casing Gasket

Part Name	AF	T	G	E	V	TV	K	X
Casing gasket	Aramid fiber	Modified PTFE	Flexible graphite [Note (2)]	EPDM O-ring	FKM O-ring	PTFE encapsulated FKM O-ring	FFKM O-ring	As specified

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Table 5.10.1.2-1
Magnetic Drive and Canned Motor Pump Material Classification Codes (Cont'd)

Sixth Suffix — Other Wetted Gaskets								
Part Name	**AF**	**T**	**G**	**E**	**V**	**K**	**TV**	**X**
Other wetted gaskets	Aramid fiber	Modified PTFE	Flexible graphite [Note (2)]	EPDM O-ring	FKM O-ring	FFKM O-ring	PTFE encapsulated FKM O-ring	As specified

Seventh Suffix —Drive Magnets (MDP Only)			
Part Name	**N**	**S**	**X**
Drive magnets	Neodymium iron boron	Samarium cobalt	As specified

GENERAL NOTES:
(a) Nonmetallic materials designate the wetted portion of component.
(b) EPDM = ethylene propylene diene monomer; ETFE = ethylene tetrafluoroethylene; FFKM = perfluoroelastomer; FKM = fluorocarbon elastomer; PFA = perfluoroalkoxy alkanes; PTFE = polytetrafluoroethylene; SiC = silicon carbide

NOTES:
(1) Manufacturer to advise. Wetted shaft material shall have fluid compatibility equal to or better than primary wetted component materials.
(2) Flexible graphite gasket is reinforced graphite sheet.

(b) perfluoroalkoxy alkane (PFA): offers nearly universal chemical resistance with a temperature limit of 350°F (177°C)

(c) ethylene tetrafluoroethylene (ETFE): offers very good chemical resistance with a temperature limit of 250°F (121°C)

(d) polyvinylidene fluoride (PVDF): offers good chemical resistance with a temperature limit of 250°F (121°C). [Tables 5.10.1.2-2 and 5.10.1.2-3 illustrate pump material classification codes for a magnetic drive and canned motor pump, respectively.]

5.10.1.3 The pump part materials shall be in accordance with the specific ASTM material specifications in Table 5.10.1.3-1 for each of the listed material designations. When the supplier is providing materials based on a recognized international standard (ISO, EN, JIS, etc.), the corresponding ASTM designation should be made available to the purchaser upon request.

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

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

5.11 Auxiliary Piping

5.11.1 Auxiliary piping and system process contacting components shall, as a minimum, be available with the materials of construction in accordance with Table 5.11.1-1.

5.11.2 Auxiliary piping and system components normally in contact with the pumped fluid shall have a pressure–temperature rating equal to, or greater than the MAWP of the pump. Auxiliary piping that may be exposed to pumped fluid in the event of a primary containment failure shall meet this requirement.

5.11.3 Auxiliary piping and system 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. Welded and flanged auxiliary piping specified by the purchaser shall be in accordance with ASME B31.3. The corrosion allowance to maintain mechanical integrity for piping shall be considered when selecting the pipe material and schedule.

NOTE: Welded and flanged auxiliary piping should be used for hazardous fluids.

5.11.4 When tubing is used as auxiliary piping, it shall be made of a noncorrodible material as specified by the user. Tubing should not be used in highly hazardous services.

5.11.5 The requirements in ANSI/HI 5.1–5.6 regarding auxiliary piping shall be met.

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Table 5.10.1.2-2
Magnetic Drive Pump Example: MDP-316-B-A-A-C-T-V-S

Component	Material
Casing	316 SS
Impeller	316 SS
Cover	316 SS
Pump shaft	316 SS
Containment shell	Alloy C276
Secondary containment/control	As specified
Rotating product lubricated bearing materials	Alpha sintered SiC
Stationary product lubricated bearing materials	Alpha sintered SiC
Casing fasteners	Carbon steel with PTFE fluoropolymer coating
Containment shell fasteners	Carbon steel with PTFE fluoropolymer coating
Secondary containment or control fasteners (if furnished)	Carbon steel with PTFE fluoropolymer coating
Casing gasket	Modified PTFE
Other wetted gaskets	FKM O-ring
Drive magnets	Samarium cobalt

Table 5.10.1.2-3
Canned Motor Pump Example: CMP-316-B-H-C-C-T-K

Component	Material
Casing	316 SS
Impeller	316 SS
Bearing housings	316 SS
Pump shaft	316 SS
Rotor sleeve, stator liner, motor end covers	Alloy C276
Secondary containment/control	As specified
Rotating product lubricated bearing materials	Nickel-bound tungsten carbide
Stationary product lubricated bearing materials	Resin-impregnated carbon graphite
Casing fasteners	Carbon steel with PTFE fluoropolymer coating
Secondary containment or control fasteners (if furnished)	Carbon steel with PTFE fluoropolymer coating
Casing gasket	Modified PTFE
Other wetted gaskets	FKM O-ring

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Table 5.10.1.3-1
ASTM Material Specifications

Material Designation	Pressure-Containing Castings Wetted and/or Nonwetted by Pumped Fluid	Pressure-Retaining and Nonpressure-Retaining Castings Nonwetted by Pumped Fluid	Bar Stock	Pressure-Retaining Bolts and Studs	Nuts
Cast iron	...	A48	...	...	...
Ductile iron	A395 Grade 60-40-18	A395 Grade 60-40-18 or A536	...	...	...
Carbon steel	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 stainless steel	A744 Grade CF8	A744 Grade CF8 or A743 Grade CF8	...	A193 Grade B8	A194 Grade 8
316 stainless steel	A744 Grade CF8M	A744 Grade CF8M or A743 Grade CF8M	A276 Type 316	A193 Grade B8M	A194 Grade 8M
Alloy 20 stainless steel	A744 Grade CN7M	A744 Grade CN7M	B473 N08020	B473 N08020	B473 N08020
316L stainless steel	A744 Grade CF3M	A744 Grade CF3M or A743 Grade CF3M	...	...	...
Duplex stainless steel	A995 Grade 1B (CD4MCuN)	A890 Grade 1B (CD4MCuN)	A276 S32205	A276 S32205	A276 S32205
Monel	A494 Grade M35-1	A494 Grade M35-1	B164 N04400	...	...
Nickel	A494 Grade CZ100	A494 Grade CZ100	B160 N02200	...	...
Alloy B2	A494 Grade N7M	A494 Grade N7M	B335 N10665	...	...
Alloy C4	A494 Grade CW2M	A494 Grade CW2M	B575 N06455	...	...
Alloy C276	A494 Grade CW6M or A494 Grade CW2M or A494 Grade CX2MW	A494 Grade CW6M or A494 Grade CW2M or A494 Grade CX2MW	B574 N10276	...	...
Titanium	B367 Grade C3	B367 Grade C3	B348 Grade 2	...	...

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Table 5.11.1-1
Minimum Requirements 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 Min.	ASME B16.11 Class 2000 Min.
Carbon steel	A519 (seamless)	A108	A106 Grade B (seamless)	A105
316 stainless steel	Seamless A269 Grade TP316	Bar Stock: A479, Type 316 Forgings: A182, Grade F316	Seamless A312 Grade TP316	A182 Grade F316

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5.12 Corrosion Allowance

The materials of the wetted components shall be mutually selected by the purchaser and pump supplier to provide a minimum life of 2 yr (when operated in accordance with the manufacturer's instructions and pressure–temperature limits in the specified pumped fluid).

5.12.1 Unless otherwise specified, the casing shall have a corrosion allowance of at least 0.12 in. (3.0 mm), except that containment shells and liners shall be in accordance with para. 5.6.

NOTE: The vendor is encouraged to propose alternative corrosion allowances if materials of construction with superior corrosion resistance are used and if they result in lower cost without affecting safety and reliability.

5.13 Direction of Rotation

The direction of rotation shall be clockwise when 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.

5.14 Dimensions

Pump dimensions shall conform to Table 1-1 or Table 1-4 (Table 1-1M or Table 1-4M). Baseplate dimensions shall conform to Table 1-2, Table 1-3, or Table 1-5 (Table 1-2M, Table 1-3M, or Table 1-5M).

5.15 Welding

5.15.1 All welding, including weld repairs, shall be performed in accordance with procedures qualified to the requirements of Table 5.15.1-1. When specified, all post foundry casting repairs shall use the 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.

5.15.2 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.

5.15.3 Specified connections welded to the pressure casings shall be installed as indicated in paras. 5.15.3.1 through 5.15.3.3.

5.15.3.1 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.

5.15.3.2 Post-weld heat treatment, if required, shall be carried out after all welds, including piping welds, have been completed.

5.15.3.3 If specified, proposed connection designs shall be submitted to the purchaser for approval before fabrication. The drawing shall show weld designs, size, materials, and pre-weld and post-weld heat treatments.

Table 5.15.1-1
Welding Requirements

Requirement	Applicable Code or Standard
Welder/operator qualification	ASME BPVC, Section 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, Section IX; or ANSI/ASME B31.3
Nonpressure-retaining structural welding, such as baseplates or supports	ANSI/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, Part UG, UG-93(d)(3)
Post-weld heat treatment	Applicable material specification, EN 13445-4; ASME BPVC, Section VIII, Division 1, Part UW, UW-40; or ANSI/ASME B31.3

5.15.4 Autogenous welding may be applied to containment shells and to both stator liners and rotor sleeves plus their respective assemblies equal to or less than 0.078 in. (2 mm) thick on sealless pumps. If autogenous welding is applied, only butt joints with square edges are permitted. No root gap between parent parts is permitted. Autogenous welding shall be performed in accordance with procedures qualified to the requirements of Table 5.15.1-1.

5.16 Miscellaneous Design Features

5.16.1 Safety Guards. Guards shall be provided for the coupling and any exposed rotating element to prevent personnel from contacting rotating parts during operation.

5.16.1.1 Performance Criteria. All guards shall meet the performance criteria and maximum gap/opening allowances based on the distance between the guard and the rotating hazard required by ANSI B11.19.

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

5.16.1.3 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.

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

5.16.1.5 Hazard Communication. Guards shall be ANSI Safety Yellow (RAL 1003) or ANSI Safety Orange (RAL 2004).

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

5.16.1.7 Safety Guards. Safety guards are not applicable to close-coupled MDP or CMP.

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

5.16.3 Lifting Rings (MDP). A lifting ring or other equivalent device shall be provided to facilitate handling the frame and associated assembly if its mass exceeds 60 lb (27 kg). For MDPs on bedplates, eyebolts on motors and/or pumps are not suitable for lifting the entire pump and motor assembly. The pump manufacturer's manual shall provide lifting instructions.

5.16.4 Tapped Openings. All tapped openings that may be exposed to the pumped fluid under pressure (including the secondary containment where furnished) 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 on ductile iron pumps. Threaded plugs shall not be used in the heating or cooling jacket piping connections; instead, snap-in plugs or waterproof tape shall be used to relieve possible pressure accumulation until piping is installed.

5.16.5 Venting. The entire unit, including casing, drive section, and piping supplied by the manufacturer, shall be self-venting or furnished with vent connections.

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5.16.6 Identification. The manufacturer's part identification number and material designation shall be cast and clearly die stamped or etched on the casing, cover, impeller, and containment shell. The manufacturer shall provide identification on the product lubricated bearings (tagging is acceptable) to assist in parts identification prior to assembly.

5.16.7 Installation. All equipment provided shall be designed for unsheltered outdoor installation and operation at specified ambient temperatures.

5.16.8 Frame (MDP). The frame shall be designed to resist a torque at least as high as the decoupling torque strength of the largest drive magnets available for that frame.

When the frame clamps the rear cover plate to the pump casing, it is classified as a pressure-retaining part and shall be made of a suitable ductile material such as cast ductile iron or cast carbon steel. When the bearing frame is specified for secondary control or secondary containment it shall be constructed of a ductile material.

5.16.9 Baseplates

5.16.9.1 General. When provided, baseplates shall be single piece and designed in accordance with ANSI/HI 14.3, which includes grouted (fabricated steel or cast iron), nonmetallic, and freestanding baseplates. The purchaser shall specify the type and desired features.

(a) The requirements of para. 5.16.9 do not apply to CMPs.

(b) The requirements of para. 5.16.9 do not apply to close-coupled MDPs where the motor is fully supported by the pump only. In cases where the motor requires additional foot support due to weight, the requirements of this section apply.

NOTE: CMPs and closed-coupled MDP do not require alignment of the driver and driven components due to the inherent design features.

5.16.9.2 ASME B73 Standard Baseplate (MDP). When an ASME B73 baseplate is specified, the baseplate shall have the following options available and provided:

(a) fabricated steel construction with continuous welding (no skip welds)

(b) pump and motor mounting surfaces machined flat and parallel within 0.002 in./ft (0.17 mm/m)

(c) full drain rim with surface sloped to minimum 1 in. NPT drain connection to allow complete drainage

(d) motor alignment adjusters

(e) devices to allow lifting of complete unit (pump, motor, baseplate, and attached auxiliaries)

5.16.9.3 Industrial Duty Grouted Fabricated Steel Baseplate (MDP). When an industrial duty fabricated steel baseplate is specified, the baseplate shall include

(a) a fully decked and fabricated steel construction.

(b) cross member supports designed to provide stiffness and lock into grout.

(c) continuous welding (no skip welds) on all top surface welds.

(d) welded pump and motor mounting surfaces machined flat and parallel within 0.002 in./ft (0.17 mm/m). The pads shall be larger than the foot of the mounted equipment, including extra width of shims.

(e) driver mounting pads machined to allow for the installation of shims at least $\frac{1}{8}$ in. thick.

(f) full drain rim with surface sloped to a minimum 1 in. NPT drain connection to allow complete drainage.

(g) motor alignment adjusters.

(h) devices to allow lifting of complete unit (pump, motor, baseplate, and attached auxiliaries).

(i) end caps to increase stiffness and retain grout.

(j) at least 2 in. (50 mm) radii in the plan view for the outside corners of the baseplate in contact with the grout.

(k) the bottom surface primed for epoxy grouting.

(l) at least one 4 in. (100 mm) grout hole centrally located in each section created by structural members. Sufficient vent holes shall be provided to allow complete venting of each section or high spot. Vent holes shall be a minimum $\frac{1}{2}$ in. (13 mm) in diameter.

5.16.9.4 Nonmetallic Baseplate. When a nonmetallic baseplate is specified, the baseplate shall include the following features:

(a) nonmetallic baseplates available for grouted, concrete filled (pedestal), or free-standing installation.

NOTE: Freestanding, nonmetallic baseplates may not be suitable for large horsepower applications due to the transferred motor torque to the baseplate. Check with the manufacturer for allowable horsepower.

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(b) nonmetallic materials that shall be a polymer composite material (i.e., polymer concrete, filled epoxy, or other filled polymeric materials). When specified, the baseplate material(s) selection shall be compatible with the pumped fluid.
(c) threaded stainless steel inserts permanently fixed within the baseplate material, required for all pump and motor feet bolting. When specified, the insert material(s) selection shall be compatible with the pumped fluid or the local environment.
(d) individual pump and motor mounting surfaces coplanar within 0.002 in./ft (0.17 mm/m). Parallel flatness between pump and motor mounting surfaces shall be within 0.005 in./ft (0.42 mm/m). The mounting surfaces shall be larger than the foot of the mounted equipment, including extra width of shims.
(e) a catch basin/drain pan under the pump with a minimum $\frac{1}{2}$ in. NPT drain port.
(f) separate metallic or nonmetallic motor mounting blocks if required to establish the correct motor shaft centerline.
Supplier shall inform the purchaser when the specified nonmetallic baseplate does not conform to the dimensions shown in Table 1-2.

5.16.9.5 Cast Iron Baseplate. When a cast iron baseplate is specified, the baseplate shall include the following:
(a) single piece cast iron construction (see ASTM A48/A48M)
(b) 1 in. (25 mm) radius corners
(c) integral cast-in cross bracing for reinforcement to maximize rigidity and torsional stiffness and lock-in grout
(d) machined pads for pump and motor mounting that are larger than the foot of the mounted equipment, including extra width of shims
(e) motor and pump mounting pads machined flat and parallel within 0.005 in./ft (0.042 mm/m)
(f) 4 in. (100 mm) diameter grout hole and 1 in. (25 mm) diameter vent holes
(g) optional primer for epoxy grout on the underside
(h) optional 316SS drip pan with $\frac{1}{2}$ in. NPT drain connection

5.16.9.6 Freestanding Baseplate. When a freestanding baseplate is specified, the baseplate features shall comply with the following specifications:
(a) Standard designs shall be available to accommodate motor sizes up to and including those shown below.

Motor Number of Poles	Motor Nameplate (max) hp (kW)
2	75 (55)
4	60 (45)
6	40 (30)

NOTE: Users may choose to mount ASME B73.3 pumps and motors that are larger than those in the chart above to free-standing bases. However, this normally requires the free-standing base to incorporate cross-bracing and is outside the scope of this Standard. The user is cautioned that all free-standing base designs, including cross-braced designs, must be structurally rigid to limit the movement of the driver shaft relative to the pump shaft to 0.002 in. (0.05 mm) parallel offset when the driver nameplate horsepower plus the maximum moment on the suction nozzle (same direction as shaft rotation) is applied.

(b) The essential design feature of freestanding baseplates is a closed cross section formed by welding a bottom plate to the channel flanges. This forms a closed cross section that is much stiffer in both bending and torsion than an open channel. Open channel or cast-iron baseplates that are intended for and rely on a grouted installation for proper stiffness are not allowed for use as a free-standing baseplate.
(c) All top surface welds shall feature continuous welding (no skip welds).
(d) The top plate minimum thickness shall be $\frac{1}{2}$ in. (12 mm) for baseplate length less than 60 in. and $\frac{5}{8}$ in. (16 mm) when baseplate length is equal to or greater than 60 in. Minimum bottom plate thickness shall be $\frac{1}{2}$ in. (12 mm).
(e) Welded pump and motor mounting surfaces shall be machined flat and parallel within 0.005 in./ft. The pads shall be larger than the foot of the mounted equipment, including extra width of shims.
(f) Driver mounting pads shall be machined to allow for the installation of shims at least $\frac{1}{8}$ in. thick.
(g) Freestanding baseplates shall have four stilts/feet with one pair located so that it is in a plane that passes through the pump discharge nozzle centerline and the other pair located at the approximate center of gravity of the motor.
(h) No grout holes shall be cut in baseplate.
(i) The baseplate shall be so structurally rigid as to limit the movement of the driver shaft relative to the pump shaft to 0.002 in. (0.05 mm) parallel offset when the driver nameplate horsepower plus the maximum moment on the suction nozzle (same direction as shaft rotation) is applied.

5.16.9.6.1 Freestanding foot-mounted baseplates shall meet the load and deflection criteria of ANSI/HI 9.6.2-2021, para. 9.6.2.3.6.1.1.

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5.16.9.6.2 Freestanding spring-mounted baseplates shall meet the stress and rigidity requirements of ANSI/HI 1.3, para. 1.3.8.4; allowable nozzle loads shall be mutually agreed upon between the purchaser and supplier.

5.16.10 Close-Coupled Motor Adaptor

5.16.10.1 Close-coupled motor adaptors shall be designed to ensure concentricity between motor- mounting flange, outer magnet assembly, and containment shell. Runout shall be limited to prevent contact with stationary components during normal operation. Connections shall not loosen during reverse rotation.

5.16.10.2 Outer magnet assembly shall be positively driven by the motor shaft.

5.16.10.3 Close-coupled motor adaptors shall be designed such that rotating components within the adaptor are totally enclosed within the adaptor.

5.16.10.4 If the motor adaptor forms part of the pressure retaining structure, it shall be manufactured in a ductile material.

5.17 Monitoring Devices

5.17.1 Description. Devices or instruments that indicate or control the condition of the sealless pump to preclude misuse or damage to the unit should be available when specified.

5.17.2 Temperature Probe. Sensing of temperature of the recirculation fluid and/or the containment shell should be available when specified. Location of temperature sensors shall be agreed upon between the purchaser and manufacturer.

5.17.2.1 Sensing of temperature of the recirculation fluid and/or the containment shell for plastic-lined MDP is optional but not required.

5.17.3 Bearing Wear Detector (CMP). A device to detect axial and radial wear for a minimum of one bearing should be available when specified.

5.17.4 Vibration. When vibration transducers are specified they must be mounted in a way that does not adversely affect the accuracy of the measurements. Acceptable mounting methods for permanent rigid mount or temporary mount transducers shall be in accordance with ANSI/HI 9.6.4. MDP bearing housing measurement locations and directions for flexibly-coupled type OH1 (ASME B73.1) pumps and close-coupled type OH7 pumps shall be in accordance with ANSI/HI 9.6.4 (see Figure 9.6.4.2.3.1). For CMP-type OH9 pumps, the location shall be on the motor end cover in the horizontal, vertical, and axial positions as shown in Figure 5.17.4-1.

5.17.5 Motor

5.17.5.1 Electrical Supply Instrument. A device that monitors the motor should be available when specified. This device may detect one or more of the following:

(a) power
(b) phase imbalance
(c) under current
(d) over current
(e) single phasing
(f) short circuit or internal malfunction

5.17.5.2 Motor Winding Temperature. A device (e.g., RTD, thermocouple, thermistor) that monitors the motor winding temperature should be available when specified.

5.17.6 Circulation Fluid. A device to monitor the flow rate of the circulation fluid should be available when specified. This requirement only applies to pumps with external circulation and does not apply to internal circulated pumps.

5.17.7 Direction of Rotation Indicator (CMP). A direction of rotation indicator should be available when specified.

5.17.8 Leak Detection. A device to detect leakage from the primary containment liner for CMP or the containment shell for MDP shall be available when specified.

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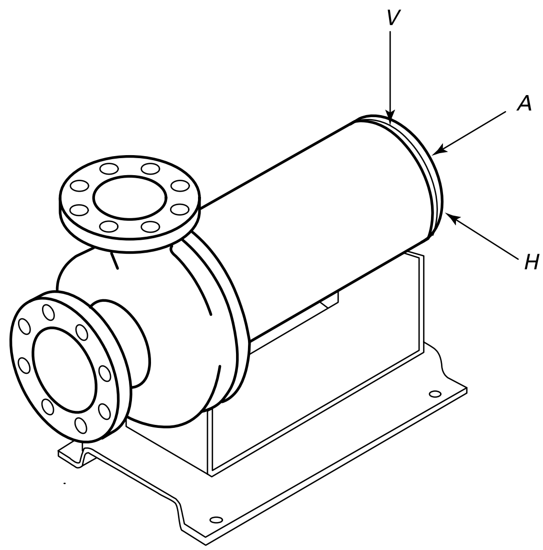
Figure 5.17.4-1
CMP Vibration Measurement Locations



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6 GENERAL INFORMATION

6.1 Application

Application of sealless pumps requires more consideration than that for conventional centrifugal pumps. Users applying this type of equipment should read para. 5.3 of ANSI/HI 5.1–5.6.

6.1.1 Terminology. Terminology shall be in accordance with ANSI/HI 5.1–5.6 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. Tests, if specified, shall be conducted in accordance with the standards of 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 the 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, Figure 9.6.4.2.5.1a, for type OH7 and OH11 MDP or type OH9 CMP unless otherwise agreed upon between the purchaser and supplier.

6.1.5 Operating Region

6.1.5.1 Allowable Operating Region. Pumps shall be designed to

(a) operate continuously between 120% of the flow at the best efficiency point and the minimum flows specified by the manufacturer, and

(b) meet the requirements of paras. 5.5.5, 5.7.1.2, and 6.1.4 when pumping water at ambient conditions

CAUTION: The manufacturer's minimum flow may not consider minimum thermal flow for a specific installation; therefore, the practical minimum operating flow may be higher than shown and may be determined by performing a heat balance per para. 5.5.5.6. Pumped fluid is heated as it goes through the drive section of a sealless pump and the minimum thermal flow is that 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 or inadequate cooling of the CMP motor winding. Refer to ANSI/HI 1.3 and ANSI/HI 5.3 for detailed application information.

6.1.6 NPSHR. NPSHR is defined 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 purchaser and supplier.

Table 6.1.8.1.1-1 Published Performance Curve Rated Speeds

		Frequency			
		60 Hz		50 Hz	
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

6.1.7 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 NPSHR) should be made available for all specific operating flows. 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.

6.1.8 Performance Curves. Performance curves published in print or electronic format shall be based on tests conducted in accordance with ANSI/HI 14.6. Accuracy of the curves shall be such 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: Head and efficiency at flows greater than BEP may have greater variation than the tolerances stated above.

Published performance curves shall be used for preliminary sizing only and are based on water performance. Published performance curves may not include eddy current and parasitic losses associated with both MDP and CMP products. If such information is published, it shall indicate whether efficiency and power-curve values contain these losses. For CMP and close-coupled MDP, it shall state whether published efficiency is based on pump efficiency or overall efficiency (wire to water) and if curve power is based on pump shaft power or motor input electrical power.

6.1.8.1 Published Performance Curve Rated Speeds

6.1.8.1.1 MDP

6.1.8.1.1.1 Table 6.1.8.1.1-1 of curve speeds shall be used for rated speeds except when para. 6.2.1.5(c) is specified by the purchaser.

6.1.8.1.1.2 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.

6.1.8.1.2 CMP. CMP performance test results shall be published for the manufacturer's motor nominal speed.

6.2 Tests and Inspections

Unless otherwise agreed, the supplier shall give at least 5 working days of advanced notification of an observed or witnessed test or inspection.

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6.2.1 Hydrostatic

6.2.1.1 Hydrostatic Test

(a) Metallic Pumps. After machining, all metallic pressure-containing parts or metal-backed plastic-lined parts shall be hydrostatically tested for a minimum of 10 min 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.

(b) Thermoplastic Material Pumps. After machining, all metallic pressure-containing parts or metal-backed plastic-lined parts shall be hydrostatically tested for a minimum of 10 min 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.

(c) Thermoset Polymer Material Pumps. Irreversible damage can occur to the reinforcement of thermoset-reinforced parts put under excessive pressure. After machining, the casing and covers shall be hydrostatically tested for a minimum of 10 min with water at 1.1 times the maximum design pressure for the material of construction used. No visible leakage through the part shall be permitted.

Due to a combination of material of construction, processing techniques, and thicker wall sections, the length of time to which a part is exposed to pressure may need to be increased to ensure that the part is liquid tight. The decision to test a part longer than 10 min is left to the manufacturer since they are ultimately responsible for providing a liquid-tight part. An increase in test time can also be requested by the purchaser, with the understanding that there may be an additional charge for this service. The manufacturer should be able to verify through test records that adequate sampling was done to prove that the parts can sustain 1.5 times the maximum design pressure. When a 1.5 hydrostatic test pressure is requested, all parties should agree to the consequences of possible irreversible damage.

6.2.1.2 Secondary Control or Secondary Containment. When secondary control or secondary containment is specified, the following hydrostatic testing must also be performed. The secondary containment components, or in the case of secondary control, the secondary pressure casing, shall be tested in accordance with para. 5.6.5 of ANSI/HI 5.1–5.6 or pneumatic tested in accordance with ND-6112 of ASME BPVC, Section III, Division 1, Subsection ND. For MDP, secondary containment/control components shall be hydrostatically tested for a minimum of 10 min with water at 1.5 times the maximum design pressure corresponding to 100°F (38°C) for the material of construction used.

6.2.1.2.1 For nonmetallic containment shells, irreversible damage may occur to reinforced plastic parts that are put under excessive pressure. Containment shells of reinforced plastic material shall be hydrostatically tested for a minimum of 10 min, with water at a minimum of 1.1 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. The manufacturer should be able to verify through test records that adequate sampling was done to prove that the parts can sustain 1.5 times the maximum design pressure. When a 1.5 hydrostatic test pressure is requested, all parties should agree to the consequences of possible irreversible damage.

6.2.1.3 Assembled Pump Hydrostatic Test. When specified by the purchaser, the assembled pump shall be in accordance with Appendix B of ANSI/HI 14.6.

6.2.1.4 Hermetic Integrity Test. When specified by the purchaser, a hermetic integrity test shall be performed on the pump unit after final assembly. Prior to testing, all liquid shall be removed from all internal cavities. The assembled pump shall be tested in accordance with ANSI/HI 5.6.3.

CAUTION: Wetted material moisture retention characteristics should be reviewed against the application prior to testing. No disassembly is permitted after this test. This test shall be performed in accordance with para. 5.6.3 of ANSI/HI 5.1–5.6.

6.2.1.5 Performance

(a) When performance tests are required, they shall be conducted in accordance with ANSI/HI 14.6. When testing at rated speed is not possible, test speed should not be less than 80% or more than 120% of rated speed. If testing at other speeds, eddy current and parasitic losses can vary significantly. The purchaser and supplier shall agree on corrections to pump power input prior to testing. If applying MDP or CMP to very low specific gravity (S. G.) liquids, testing at speeds less than 80% of rated may be required to avoid decoupling a MDP or overloading the motor on CMP. In such cases, an agreement must be reached between the purchaser and supplier prior to testing.

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(b) Performance acceptance grade 1B shall be used for all pump input powers. ANSI/HI 14.6-2016 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 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.

NOTE: The referenced ANSI/HI 14.6-2016 acceptance grade 1B requires the manufacturer to guarantee that the measured pump curve (corrected for speed and specific gravity) will touch or pass through a tolerance band of ± 3% total head and a ± 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 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.

(c) Performance test results shall be corrected as follows:

(1) MDP performance tests results shall be corrected for the rated speeds listed in Table 6.1.8.1-1. When specified, the actual nameplate rated speed of the job driver (if provided) shall be used as the rated speed for impeller diameter selection and performance guarantee.

NOTE: 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. The manufacturer's catalog pump curve speeds (see Table 6.1.8.1-1) 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 for reference only or are optional test points.

(2) CMP performance tests results shall be corrected for the manufacturer's rated motor speed.

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

(e) 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.

(f) 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.

6.2.1.6 Additional Data. Additional data, when specified, may be taken during the performance test. These data may include vibration, bearing housing temperature, oil sump temperature, etc. 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.

6.2.1.7 NPSHR Test. When specified, NPSHR tests 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: A NPSHR test does not necessarily include a performance test. The purchaser must specify both if desired.

6.2.1.8 Winding Integrity Test for Canned Motor Pumps. The motor test shall be conducted in accordance with para. 5.6.4 of ANSI/HI 5.1–5.6.

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 shall 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 procedures and criteria must be agreed upon by the purchaser and supplier.

6.2.2.3 Inspection of Connection and Castings. As a minimum, the wetted pressure-containing boundary 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 section(s) pertaining to the welding or joining and inspection technique(s) 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.

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Table 6.2.2.3-1
Specified Nondestructive Testing Levels

Item	Level 0	Level 1	Level 2	Level 3 Highly Hazardous Services
Wetted pressure-containing parts – cast [Note (1)]	...	VI	Level 1 plus MT (or PT) of critical areas	Level 2 plus RT (or UT) of critical areas
Wetted pressure-containing parts – wrought [Note (1)]	...	VI	Level 1 plus MT (or PT) of critical areas	Level 2 plus UT of critical areas
Auxiliary connection welds	Per manufacturer's standard inspection requirements	VI	Level 1 plus MT (or PT)	Level 1 plus 100% MT (or 100% PT)
Auxiliary process piping – socket welded	...	VI	Level 1 plus 100% MT (or 100% PT)	Same as Level 2
Auxiliary process piping – butt-welded [Note (2)]	...	VI, plus 5% RT	Level 1 plus 100% MT (or 100% PT) and 5% RT	VI, plus 100% MT (or 100% PT) and 10% RT

GENERAL NOTES:
(a) MT = magnetic particle inspection
(b) PT = liquid penetrant inspection
(c) RT = radiographic inspection
(d) UT = ultrasonic examination
(e) VI = visual inspection

NOTES:
(1) "Wetted pressure-containing parts" includes all items of the pressure boundary (e.g., the casing itself, nozzles, flanges). "Critical areas" 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" applies if this designation is specified by the purchaser.
(2) It is not practical to RT butt-welded auxiliary casing connection due to complex geometry and thickness variations.

6.2.2.3.2 When a Level 1 inspection of cast parts wetted by the process fluid is specified, a visual inspection shall be conducted in accordance with MSS 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 the purchaser and manufacturer.

6.3 Nameplates

All nameplates shall be of 24 US Standard Gauge (minimum) AISI 300 series stainless steel and shall be securely attached to the pump. The nameplate data shall be based on rated application conditions.

6.3.1 MDP. The MDP nameplate shall be stamped or embossed with the following information in units consistent with the data sheet:
(a) pump model
(b) standard ASME B73.3 dimension designation
(c) pump serial number
(d) pump size
(e) magnetic coupling torque rating for 100°F (38°C)
(f) impeller diameter installed
(g) maximum allowable impeller diameter (for the installed magnetic coupling)

(1) Maximum allowable impeller shall be the largest impeller that the supplied magnetic coupling/motor combination can adequately drive to the end of curve accounting for the specified data sheet rated speed and data sheet rated fluid conditions (temperature, specific gravity, and viscosity).

(2) If the purchaser requires conditions other than rated conditions for establishing the maximum diameter impeller, these should be clarified during the proposal stage.

6.3.2 CMP. The CMP nameplate shall be stamped or embossed with the following information in units consistent with the data sheet:
(a) pump model
(b) standard ASME B73.3 dimension designation

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(c) pump serial number
(d) pump size
(e) impeller diameter installed
(f) maximum impeller diameter based on installed motor size

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. It is the intent of this Standard that information be furnished in a similar form from all sources to improve clarity and foster efficient use 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) manufacturer's cooling/heating piping drawing (if applicable)
(d) pump fluid circulation plan
(e) performance curve with rated point
(f) motor input power from shutoff to end of curve flow, if specified
(g) cross-sectional drawing with parts list
(h) manual describing installation, operation, and maintenance
(i) motor wiring diagram (CMP)
(j) coupling data (if applicable)
(k) driver data (if applicable)
(l) Statement of Compliance (when specified) (see para. 7.4.6)
(m) Certified Mill Test Reports (CMTR) for wetted pump parts (when specified) (see para. 7.4.7)
(n) alignment tolerance limits (if applicable)
(o) documentation for specified performance test

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 drawings included herein and identified as Figures 7.3.1-1 and 7.3.1-2.

(b) Tapped openings, when supplied, shall be identified with the markings in Table 7.3.1-1.

7.3.2 Sealless Centrifugal Pump Data Sheet

(a) *Data Sheet.* The ASME Sealless 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. An electronic or printed copy of the data sheet shall be used for inquiry, proposal, and as-built.

(b) *Electronic Data.* See Nonmandatory Appendix A.

7.3.3 Fluid Circulation Piping Drawing

(a) The fluid circulation piping drawing shall be included if the pump is fitted with a circulation piping system supplied by the pump manufacturer.

(b) The fluid circulation piping drawing shall contain information and uniform nomenclature consistent with the sample schematics and references given in para. 5.5.5.5.

7.3.4 Cooling/Heating Piping Drawing

(a) A cooling/heating piping drawing shall be included if the pump assembly is fitted with a heating/cooling piping system supplied by the pump manufacturer.

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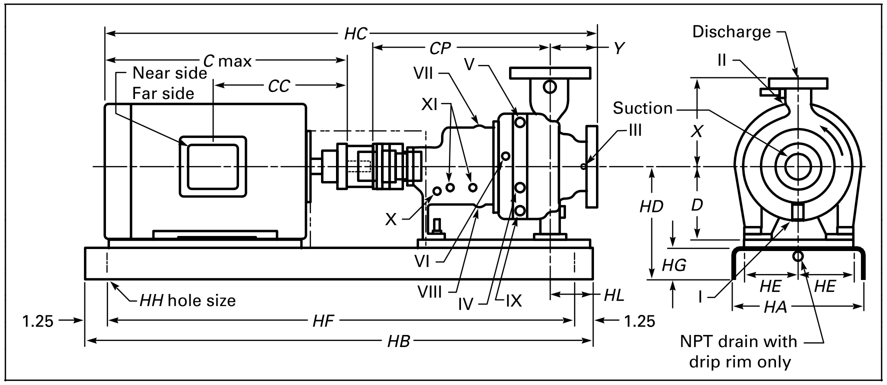
Figure 7.3.1-1
Pump and Driver Outline Drawing for MDP



Pump Size ________ **Model** ________ **Frame Size** ________

Flange Holes

Suction: Thru ☐ Tapped ☐

Discharge: Thru ☐ Tapped ☐

☐ 150# ANSI flanges
☐ 300# ANSI flanges
☐ Flat face flanges
☐ Raised face flanges

Weight (lb)

Pump ________
Driver ________
Baseplate (incl. cplg. & guard) ________

Coupling Specifications

Mfr. ________
Type ________
Coupling Bores } Pump ________ / Driver ________

Motor Specifications

Mfr. ________
Frame ________
hp ________ sf ________ Enclosure ________
rpm ________ Voltage ________
Hz ________ Phase ________

HC ________ *CC* ________ *C* ________ *D* ________ *X* ________ *CP* ________ *Y* ________

Baseplate	*HA*	*HB* or *HBe*	*HE*	*HF* or *HFe*	*HL*	*HG*	*HH*	T or TS Motor Frame	*HD*			
									D = $5^1/_4$	*D* = $8^1/_4$	*D* = 10	*D* = $14^1/_2$

Tapped Openings

No.	NPT Size	Qty.	Purpose	Marking	Furnished Yes	Furnished No	Usage
I			Casing drains				
II			Discharge gage or flush connection				
III			Suction gage or flush connection				
IV			Containment shell drain				
V			Return flush temperature and/or outlet				
VI			Containment shell temperature				
VII			Frame connection: top				
VIII			Frame connection: drain				
IX			Containment shell flush inlet				
X			Oil drain				
XI			Frame cooling				

Type of Baseplate

Steel: ☐ without drip rim ☐ with drip rim

Cast iron: ☐ without drip rim ☐ with drip rim

Nonmetallic: ☐ without drip rim ☐ with drip rim

Adjustable foot supports ☐
Drip pan ☐

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 inches. Weights are approximate.

Dwg. No. ________

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

Lubrication of Bearings

☐ Oil ☐ Oil mist
☐ Grease
☐ Grease-lubed for life
Type of oil lubricator: ________

Casing

☐ Plain
☐ Jacketed
☐ Traced
☐ Other

Customer/user ________
Location ________
Cust. P.O. no. ________ Ser. no. ________
Item no. ________ Equip. no. ________
Factory order no. ________
Certified by ________ Date ________
Rev. ________ Date ________

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