ASME B73.2M-1991
(REVISION OF ANSI/ASME B73.2M-1984)

Specification for Vertical In-Line Centrifugal Pumps for Chemical Process

AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

AN AMERICAN NATIONAL STANDARD

Specification for Vertical In-Line Centrifugal Pumps for Chemical Process

ASME B73.2M-1991

(REVISION OF ANSI/ASME B73.2M-1984)

The American Society of Mechanical Engineers

345 East 47th Street, New York, N.Y. 10017

Date of Issuance: August 16, 1991

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

FOREWORD

(This Foreword is not part of ASME B73.2M-1991.)

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

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

Shortly thereafter, the American National Standards Committee B73 undertook to revise the standard, and as a result new information on critical speed, bearing housing design, vibration, bearing frame adapter, and bearings was introduced. The 1984 edition included, for the first time, Appendix information that covers documentation of pump and driver outline drawing, vertical in-line pump data sheet, mechanical seal drawing, stuffing box piping plan, and cooling/heating piping plans.

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

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

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

Suggestions for improvement in this Standard will be welcome and should be sent to the American Society of Mechanical Engineers, United Engineering Center, 345 East 47th Street, New York, NY 10017.

ASME STANDARDS COMMITTEE B73
Chemical Standard Pumps

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

OFFICERS

J. A. Reynolds, *Chairman*
R. McGinnis, *Secretary*

COMMITTEE PERSONNEL

W. Adams, Durametallic Corp., Kalamazoo, Michigan
A. Budris, Dresser Industries, Harrison, New Jersey
F. Buse, Ingersoll-Rand, Phillipsburg, New Jersey
R. Cerza, *Alternate*, Goulds Pumps, Inc., Seneca Falls, New York
G. Clasby, Duriron Co., Dayton, Ohio
R. Dolman, Newark, Delaware
R. Hart, E.I. DuPont de Nemours & Co., Wilmington, Delaware
P. Lahr, Goulds Pumps, Inc., Seneca Falls, New York
R. Monroe, Monsanto Co., St. Louis, Missouri
J. Raba, National Electrical Manufacturers Association, Washington, D.C.
C. Ramsey, Dow Chemical Co., Freeport, Texas
R. Renson, John Crane, Inc., Larchmont, New York
J. Reynolds, Union Carbide Corp., South Charleston, West Virginia
K. Schoenherr, Algonquin, Illinois
J. Swalley, *Alternate*, E.I. DuPont de Nemours & Co., Wilmington, Delaware

CONTENTS

SPECIFICATION FOR VERTICAL IN-LINE CENTRIFUGAL PUMPS FOR CHEMICAL PROCESS

1 SCOPE

This Standard covers motor-driven centrifugal pumps of vertical shaft, single stage design with suction and discharge nozzles in-line. It includes dimensional interchangeability requirements and certain design features to facilitate installation and maintenance. 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 and size and location of suction and discharge nozzles (see Table 1).

2 ALTERNATIVE DESIGN

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

3 NOMENCLATURE AND DEFINITIONS

3.1 Source

All nomenclature and definitions of pump components shall be in accordance with the Hydraulic Institute Standards.

3.2 In-Line Pump

An in-line pump is a pump whose driving unit is supported exclusively by the pump, and whose suction and discharge connections have a common centerline that intersects the shaft axis.

4 DESIGN AND CONSTRUCTION FEATURES

4.1 Pressure and Temperature Limits

4.1.1 Pressure Limits. The design pressure of the casing, including stuffing box and gland, shall be at least as great as the pressure–temperature rating of ASME/ANSI B16.1 Class 125 or ASME/ANSI B16.5 Class 150 flanges for the material used. The pressure–temperature rating for cast ductile iron shall be the same as for cast carbon steel. Casing, covers, and jackets shall be designed to withstand a hydrostatic test at 1.5 times the maximum design pressure for the part and the material of construction used (see para. 5.2.1).

4.1.2 Temperature Limits. Pumps should be available for operating temperatures up to 260°C (500°F). Cast iron shall be limited to 150°C (300°F) maximum. Jacketing and other modifications may be required to meet the operating temperature.

4.1.3 Statement. Pressure–temperature limitations shall be stated by the pump manufacturer.

4.2 Flanges

Suction and discharge nozzles shall be flanged, with flange dimensions conforming to ASME/ANSI B16.1 Class 125 cast iron or ASME/ANSI B16.5 Class 150 steel standards as to bolt circle, and number and size of bolt holes. Flanges shall be flat-faced at the full raised-face thickness (minimum) called for in ANSI standards for the material of construction. Bolt holes shall straddle the centerline. As an option, Class 250 cast iron flanges per ASME/ANSI B16.1 or Class 300 flanges per ASME/ANSI B16.5, except flat-faced at full thickness, subject to the manufacturer's casing pressure–temperature limitations, may be offered. SD dimensions shall be the same for all class flanges (see Table 1).

4.3 Casing

4.3.1 Drain Connection Boss(es). Pump casing shall have cast boss(es) to provide for drain connection(s). Boss size shall accommodate $\frac{1}{2}$ in. NPT minimum. Drilling and tapping of the boss(es) is optional.

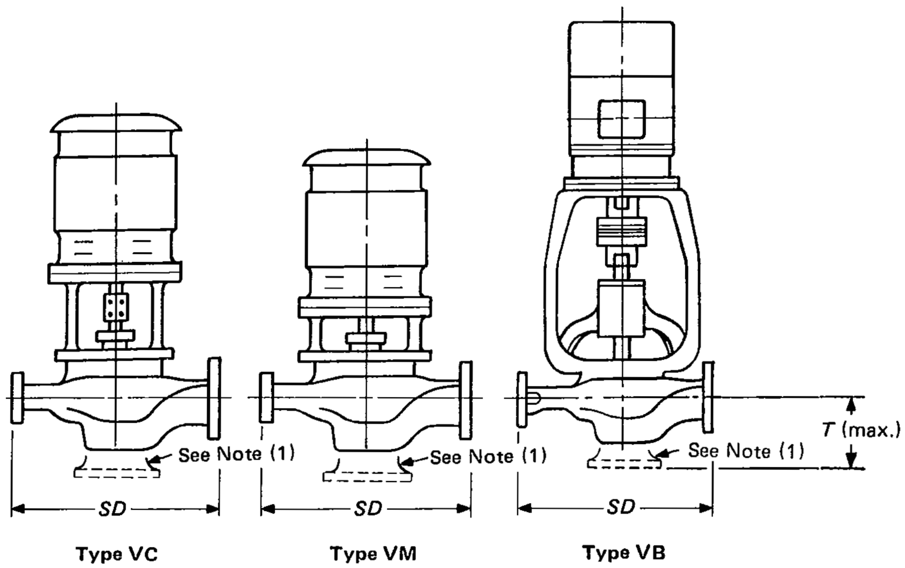


TABLE 1 PUMP DIMENSIONS

Dimensions, mm					Dimensions, in.				
Standard Pump Designation [Note (2)]	Metric Flange Sizes		SD +2.5 −2.0	T Maximum	Standard Pump Designation [Note (2)]	ANSI 125, 150, 250, or 300 Flange Sizes		SD +0.10 −0.08	T Maximum
	Suction	Discharge				Suction	Discharge		
VC, VB, VM					VC, VB, VM				
50-40-380	50	40	380	175	2015/15	2	1½	14.96	6.89
50-40-430	50	40	430	175	2015/17	2	1½	16.93	6.89
50-40-480	50	40	480	175	2015/19	2	1½	18.90	6.89
80-40-380	80	40	380	200	3015/15	3	1½	14.96	7.87
80-40-480	80	40	480	200	3015/19	3	1½	18.90	7.87
80-40-610	80	40	610	200	3015/24	3	1½	24.02	7.87
80-50-430	80	50	430	200	3020/17	3	2	16.93	7.87
80-50-510	80	50	510	200	3020/20	3	2	20.08	7.87
80-50-610	80	50	610	200	3020/24	3	2	24.02	7.87
100-80-560	100	80	560	225	4030/22	4	3	22.05	8.86
100-80-635	100	80	635	225	4030/25	4	3	25.00	8.86
100-80-710	100	80	710	225	4030/28	4	3	27.95	8.86
150-100-610	150	100	610	250	6040/24	6	4	24.02	9.84
150-100-710	150	100	710	250	6040/28	6	4	27.95	9.84
150-100-760	150	100	760	250	6040/30	6	4	29.92	9.84

NOTES:
(1) Optional separate pedestal.
(2) Pump designation defines design, flange sizes, and *SD* dimension (e.g., VC, VB 50-40-380).

4.3.2 Gage Connection Bosses. The suction and discharge nozzles shall have bosses for gage connections. Boss size shall accommodate $\frac{1}{4}$ in. NPT minimum, $\frac{1}{2}$ in. NPT preferred. Drilling and tapping of the bosses is optional.

4.3.3 Support. The casing shall be designed to be supported by the suction and discharge flanges alone when mounted with the shaft in the vertical position; however, all casings shall be designed to accommodate an optional auxiliary support.

4.3.4 Disassembly. The complete rotating element shall be removable for inspection and maintenance without disturbing the suction or discharge pipe connections. Tapped holes for jackscrews, or equivalent means, shall be provided to facilitate disassembly of the casing and stuffing box cover and to avoid the necessity of drive wedges or prying implements.

4.3.5 Jackets. Jackets for heating or cooling the casing, stuffing box, or seal chamber are optional. Jackets shall be designed for a minimum operating pressure of 690 kPa gage (100 psig) at 170°C (340°F). Heating jackets may be required for jacket temperatures to 260°C (500°F) with a corresponding reduction in pressure. Connections shall be $\frac{1}{2}$ in. NPT minimum.

Jacket inlet and outlet connections shall be identified by casting or stamped designations, J-In and J-Out, immediately adjacent to the connection.

4.3.6 Gasket(s). The casing-to-cover gasket(s) shall be confined on the atmospheric side to prevent blowout.

4.4 Impeller

4.4.1 Types. Impellers of open, semiopen, and closed designs are optional.

4.4.2 Adjustment. Means for external adjustment of the impeller axial clearance shall be provided if adjustment is required by the design.

4.4.3 Balance. All impellers shall be single plane spin balanced as a minimum. However, when the ratio of the maximum outside diameter divided by the width at the periphery including the shroud(s) is less than six, a two-plane spin balance may be required.

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

4.5 Shaft

4.5.1 Diameter. The shaft or sleeve diameter through the stuffing box or seal chamber shall be sized in increments of 3.2 mm ($\frac{1}{8}$ in.) from 25 mm (1 in.) minimum diameter. To provide for the use of mechanical seals, the tolerance on shaft diameter through the seal chamber shall not exceed nominal to minus 0.05 mm (0.002 in.).

4.5.2 Finish. Surface finish of the shaft or sleeve through the stuffing box or seal chamber and at rubbing contact bearing housing seals shall not exceed an arithmetic roughness average of 0.8 μm (32 μin.), unless otherwise required for the mechanical seal.

4.5.3 Runout. Shaft runout shall be limited as follows:

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

(b) outside diameter of shaft or removable sleeve in pump: 0.05 mm (0.002 in.) full indicator movement at the gland end of stuffing box, or seal chamber.

4.5.4 Deflection. Dynamic shaft deflection at the impeller centerline shall not exceed 0.13 mm (0.005 in.) at maximum load.[1]

4.5.5 Running Clearances. Running clearance must be sufficient to prevent internal rubbing contact.

4.5.6 Critical Speed. The first lateral critical speed of the rotating assembly shall be at least 120% of the maximum operating speed.

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

4.6 Shaft Sealing

4.6.1 Design. Two basic types of sealing covers shall be offered, one called a seal chamber and a second called a stuffing box. The seal chamber is designed to accommodate mechanical seals only and can be of several designs for various types of seals. The design includes a separate gland plate where required. The stuffing box is intended for packing but

[1]*Maximum load* for deflection calculation is defined as the maximum radial hydraulic load on the contract impeller at any point on its curve based upon contract specific gravity or 1.0, whichever is higher. Consult manufacturer when liquid specific gravity exceeds 1.0.

is designed to accommodate mechanical seals as an alternative. A separate universal cover adapter to accommodate either a seal chamber or stuffing box is optional.

4.6.2 Seal Chamber. The seal chamber can be a cylindrical or a tapered design. The tapered bore seal chamber shall have a minimum of a 4 deg. taper open toward the pump impeller.

The seal chamber shall be designed to incorporate the details quantified on Figs. 1 and 2.

The secondary seal contact surface(s) shall not exceed a roughness of 1.6 μm (63 μin).

Seal chamber bore corners and entry holes, such as those used for flushing or venting, shall be suitably chamfered or rounded to prevent damage to secondary seals at assembly.

The seal chamber shall include means of eliminating trapped air or gas. Vent connections, when required for this purpose, shall be located at the highest practical point; drains, when provided, shall be located at the lowest practical point. The location of piping connections to the seal chamber for other functions is optional.

The size of all piping connections to the seal chamber and seal gland shall be $\frac{1}{4}$ in. NPT minimum, with $\frac{3}{8}$ in. NPT preferred.

4.6.3 Stuffing Box. The stuffing box packing bore surface shall not exceed a roughness of 1.6 μm (63 μin.). One lantern ring connection shall be provided. A second connection is optional. The box also shall be suitable for proper installation and operation of mechanical seals, including means of eliminating trapped air or gas at the highest practical point. The location of piping connections to the stuffing box and gland is optional. The size shall be $\frac{1}{4}$ in. NPT minimum, $\frac{3}{8}$ in. NPT preferred. Figure 3 shows the recommended stuffing box dimensions.

4.6.4 Seal Chamber and Stuffing Box Runout. Mechanical seal performance is highly dependent on the runout conditions that exist at the mechanical seal chamber or stuffing box. Types of runout having significant effect on seal performance include:

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

(b) Register Runout. Provisions shall be made for centering the gland with either an inside or outside diameter register. This register shall be concentric with the shaft and shall have a total indicator runout reading no greater than 0.13 mm (0.005 in.) FIM (see Fig. 5).

(c) Shaft/Shaft Sleeve Runout. This is a measure of runout at the shaft mounted sleeve O.D. with respect to a fixed point in space. It is usually measured by mounting a dial indicator at a fixed point in space, such as the face of the seal chamber, and measuring the FIM runout at the shaft mounted sleeve O.D. The maximum allowable shaft sleeve runout is 0.05 mm (0.002 in.) (see Fig. 6).

4.6.5 Space Requirements

4.6.5.1 Space in the various seal chamber designs shall provide for one or more of the following configurations of cartridge or noncartridge seals:

(a) single inside mechanical seal, balanced or unbalanced, with or without a throat bushing, and with or without a throttle bushing;

(b) double seal, balanced or unbalanced inboard and outboard;

(c) outside mechanical seal, balanced or unbalanced, with or without a throat bushing;

(d) tandem seals, either balanced or unbalanced.

4.6.5.2 Space in the stuffing box and exterior clearance area shall provide for:

(a) five rings of packing plus a lantern ring and repacking space;

(b) throat bushing, a lantern ring, and three rings of packing;

(c) single inside mechanical seal, balanced or unbalanced, with or without a throat bushing.

4.6.6 Gland

4.6.6.1 Bolting. Pumps shall be designed for four gland bolts, but glands shall be:

(a) two-bolt or four-bolt for packing;

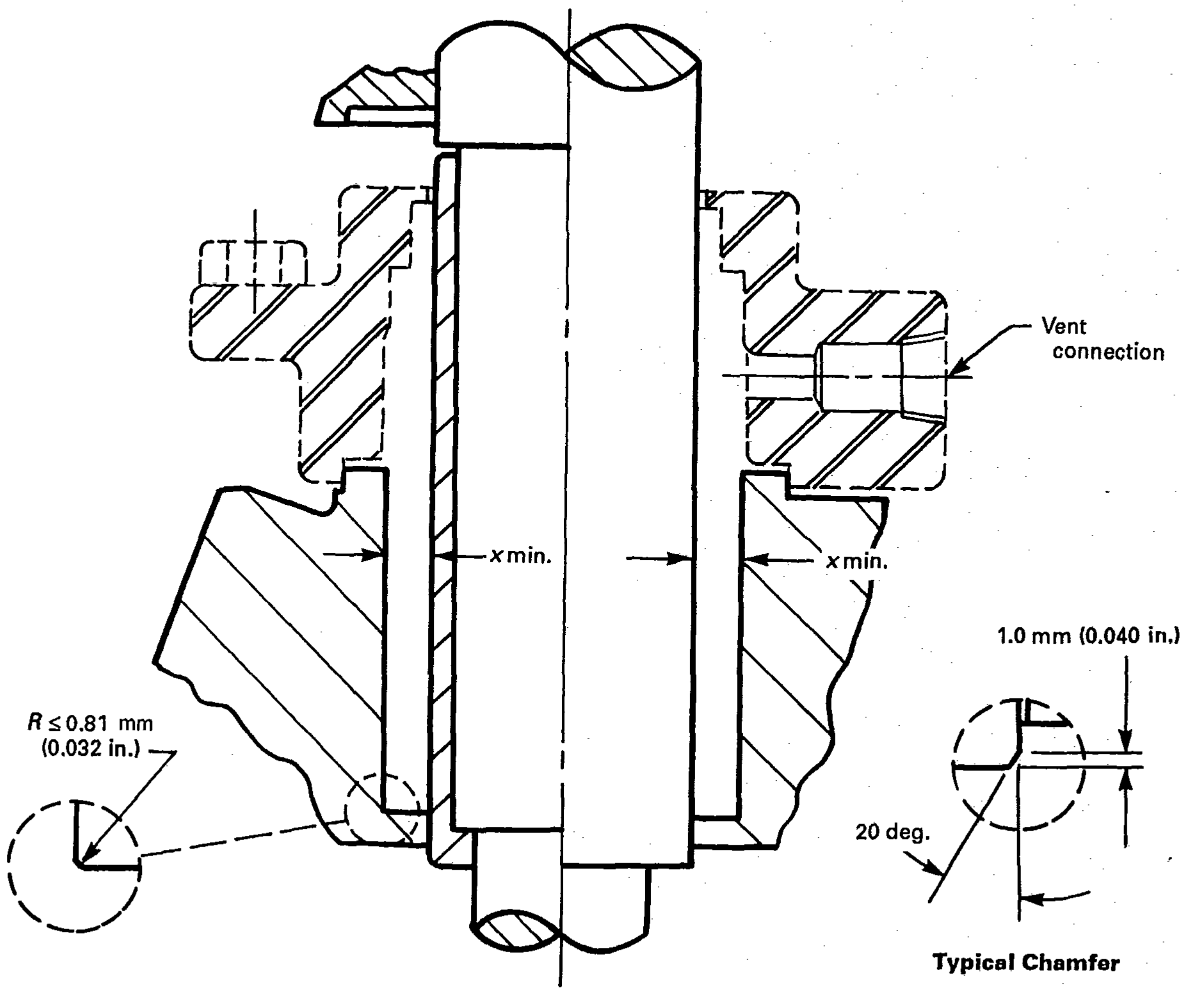
(b) four-bolt for mechanical seals.

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

4.6.6.3 Materials of Construction. The mechanical seal gland shall be 316 SS minimum. Other materials shall be the purchaser's option.

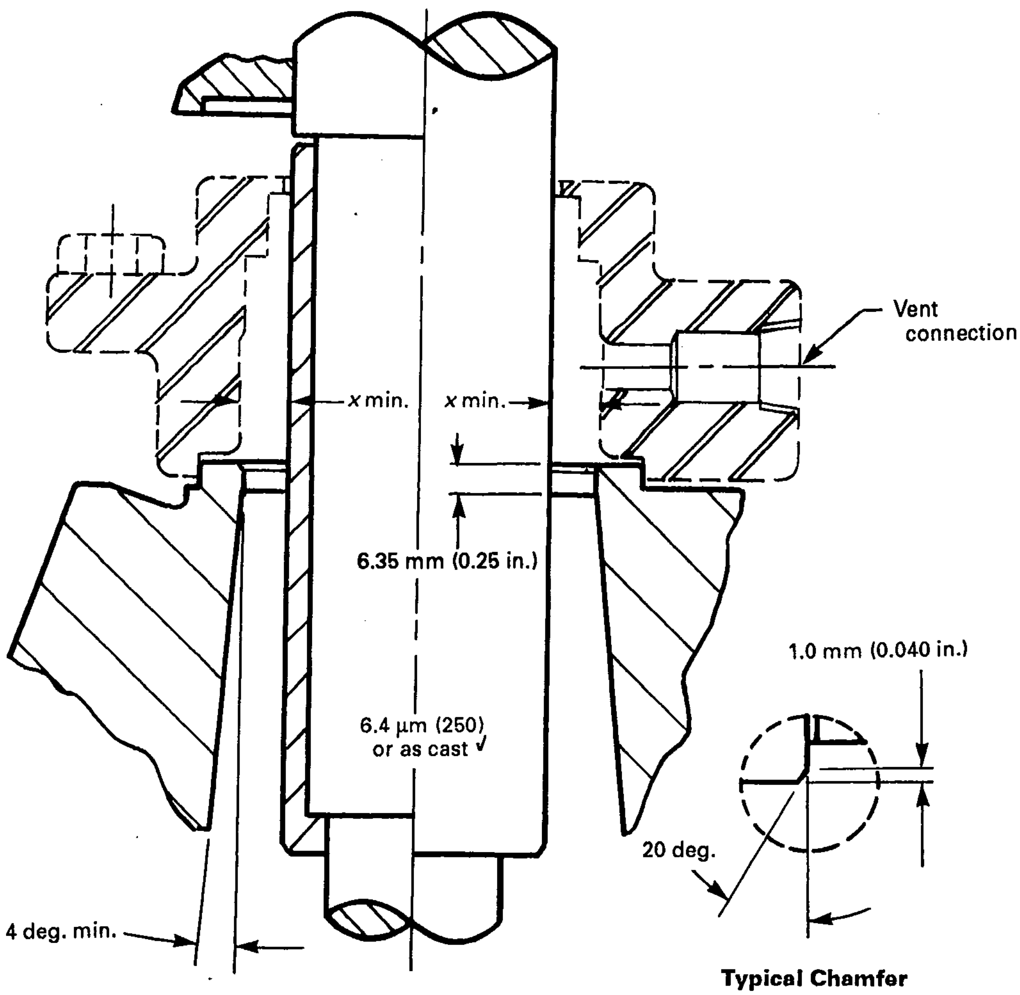
4.7 Driver and Coupling Design

4.7.1 Coupled Design VC (Vertical Coupled). The pump shaft is attached to the motor shaft by a rigid spacer coupling, permitting removal of the



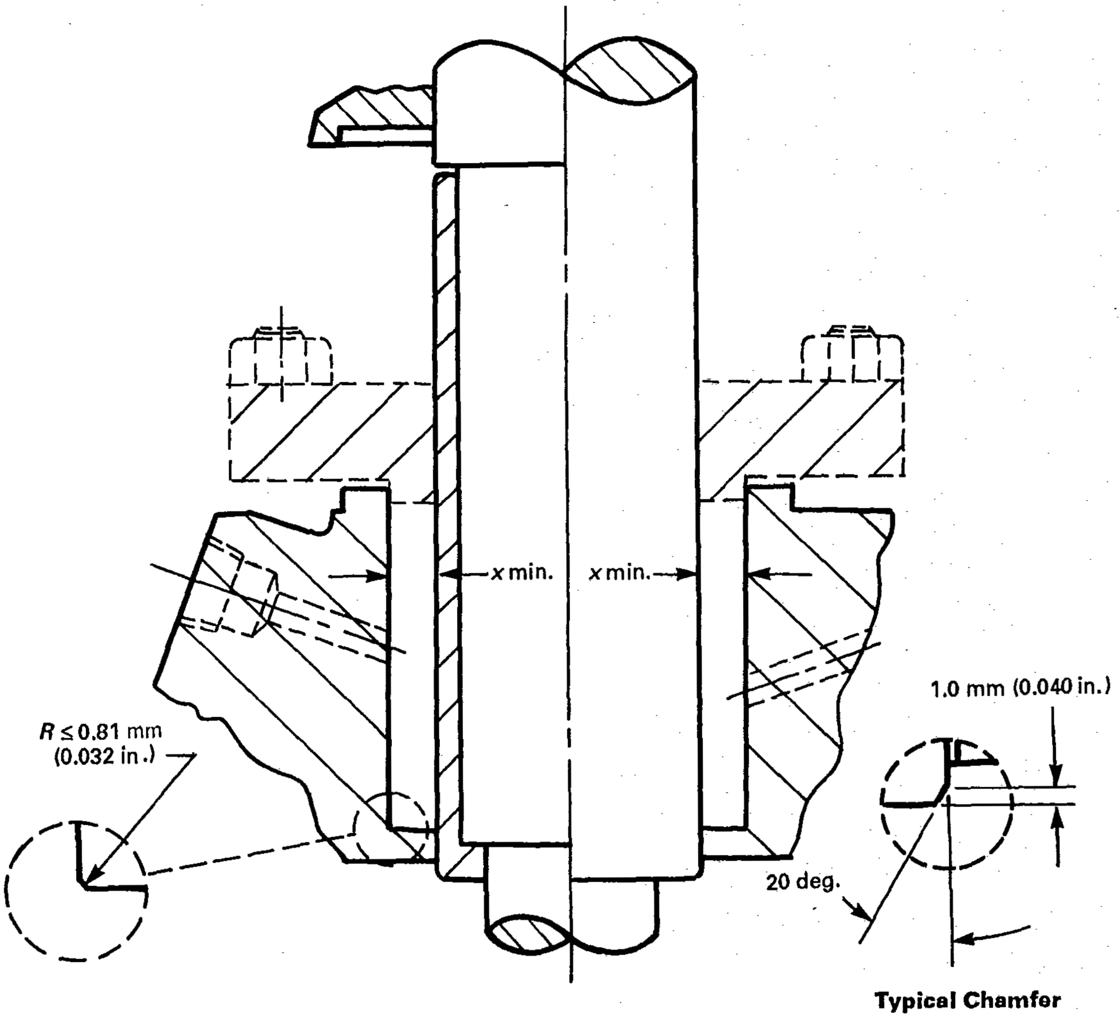
Shaft or Sleeve Diameter	Radial Clearance x Minimum
Up to 38 mm (1.5 in.)	x = 19 mm (0.750 in.)
More than 38 mm (1.5 in.)	x = 22.2 mm (0.875 in.)

FIG. 1 CYLINDRICAL SEAL CHAMBER



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

FIG. 2 TAPERED SEAL CHAMBER



Shaft or Sleeve Diameter	Radial Clearance x Minimum
Up to 38 mm (1.5 in.)	x = 7.94 mm (5/16 in.)
More than 38 mm (1.5 in.)	x = 9.52 mm (3/8 in.)

FIG. 3 STUFFING BOX

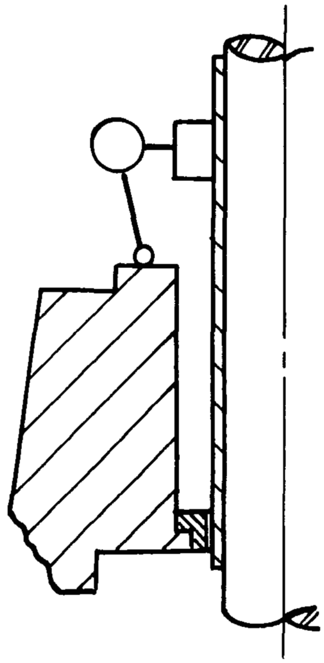


FIG. 4 FACE RUNOUT

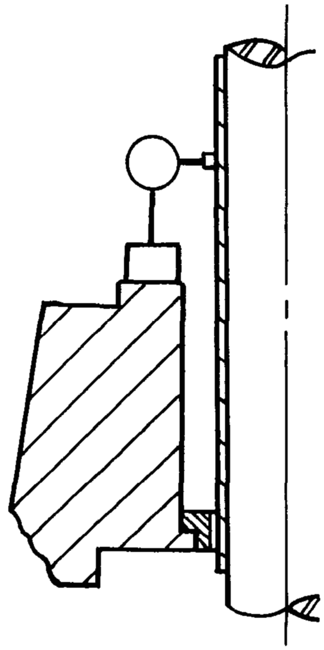


FIG. 6 SHAFT SLEEVE RUNOUT

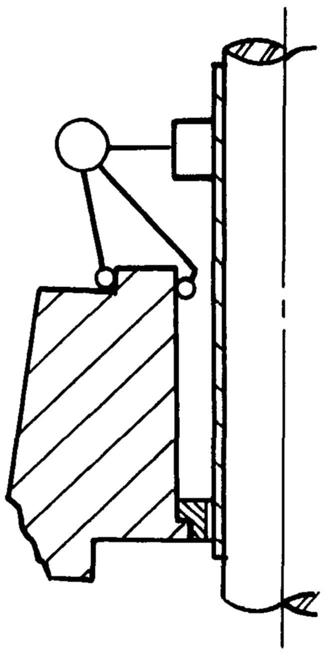


FIG. 5 REGISTER CONCENTRICITY

pump shaft, shaft seal, and impeller without disturbing the motor (see Table 1).

(a) Drive motor for VC pumps shall be NEMA P-base In-Line Pump Motor, available in all standard enclosures. These P-base motors shall have mounting and shaft extension dimensions per NEMA Standard MG 1-18.620 (see Table 2).

(b) Tolerance for mounting and shaft dimensions for P-base motors shall also be per NEMA Standard MG 1-18.620.

4.7.2 Motorshaft Design VM (Vertical Motor Shaft). Pumps that have the impeller mounted on an extended motor shaft (see Table 1).

(a) Motors for VM pumps shall be NEMA JM or JP solid shaft designed for vertical operation (JMV, JPV) with mounting and shaft dimensions per NEMA MG 1-18.614. Alternative shaft extension dimensions may be offered.

(b) Tolerances for mounting and shaft dimensions for the JMV/JPV motors shall be per NEMA MG 1-18.614.

4.7.3 Bearing Housing Design VB (Vertical Bearing Housing). Pumps that have their own bearing housings and bearings designed to handle the pump loads (see Table 1).

Max. *AK* fit runout with respect to shaft

Fig. I

0.004 TIR

Max. face runout

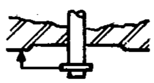


Fig. II

0.004 TIR

Max. shaft runout

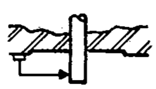


Fig. III

0.001 TIR

Shaft End Play

Not to exceed 0.002 in.

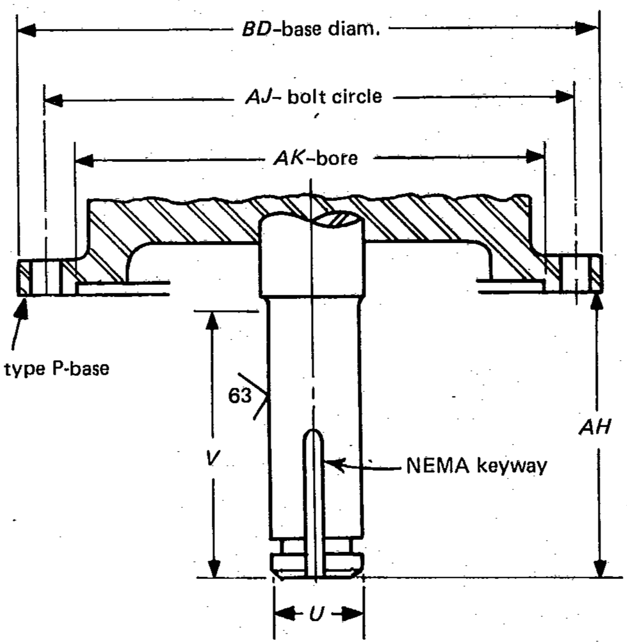


TABLE 2 NOMINAL SHAFT EXTENSION AND MOUNTING DIMENSIONS FOR VERTICAL SOLID SHAFT P-BASE IN-LINE PUMP MOTORS

NEMA Frames	Shaft Diameter *U*	*V* Length Shaft of *U* Diameter	Shaft Protrusion Below Base *AH*	Rabbet Diameter *AK*	Bolt Circle *AJ*	Base Diameter *BD*
143 & 145-LP	$1\frac{1}{8}$	$2\frac{3}{4}$	$2\frac{3}{4}$	$8\frac{1}{4}$	$9\frac{1}{8}$	10
182 & 184-LP	$1\frac{1}{8}$	$2\frac{3}{4}$	$2\frac{3}{4}$	$8\frac{1}{4}$	$9\frac{1}{8}$	10
213 & 215-LP	$1\frac{5}{8}$	$2\frac{3}{4}$	$2\frac{3}{4}$	$8\frac{1}{4}$	$9\frac{1}{8}$	10
254 & 256-LP	$1\frac{5}{8}$	$2\frac{3}{4}$	$2\frac{3}{4}$	$8\frac{1}{4}$	$9\frac{1}{8}$	10
284 & 286-LPH	$2\frac{1}{8}$	4	$4\frac{1}{2}$	$13\frac{1}{2}$	$14\frac{3}{4}$	$16\frac{1}{2}$
324 & 326-LP	$2\frac{1}{8}$	4	$4\frac{1}{2}$	$13\frac{1}{2}$	$14\frac{3}{4}$	$16\frac{1}{2}$
364 & 365-LP	$2\frac{1}{8}$	4	$4\frac{1}{2}$	$13\frac{1}{2}$	$14\frac{3}{4}$	$16\frac{1}{2}$
404 & 405-LP	$2\frac{1}{8}$	4	$4\frac{1}{2}$	$13\frac{1}{2}$	$14\frac{3}{4}$	$16\frac{1}{2}$
444 & 445-LP	$2\frac{1}{8}$	4	$4\frac{1}{2}$	$13\frac{1}{2}$	$14\frac{3}{4}$	$16\frac{1}{2}$

GENERAL NOTE:
All dimensions in inches (1 in. = 25.4 mm). See NEMA MG 1-18.620 for complete dimensions.

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

(b) Tolerance for mounting and shaft dimensions shall be per NEMA MG 1-11.35.

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

4.7.4 Motor Horsepower Selection. Motors shall be selected having nameplate horsepower ratings at least as high as in Table 3, based on the pump rated bhp in the Table. Where it appears that using this Table leads to unnecessary oversizing of the motor, an alternative size may be offered in addition to the Table selection.

4.7.5 Bearings — VC and VM Pumps

(a) Duty. The motor bearings shall carry the hydraulic radial and thrust loads imposed by the pump, in addition to the weight of all rotating parts.

(b) Life. After tentative selection of the motor size and manufacturer, the pump manufacturer shall be responsible for assuring that the bearing lives when calculated in accordance with ANSI/AFBMA 9, Load Ratings and Fatigue Life for Ball Bearings, and ANSI/AFBMA 11, Load Ratings and Fatigue Life for Roller Bearings, will provide for a minimum L'_{10} life of 26,000 hr continuous duty at the rated condition, or 17,500 hr continuous duty at maximum load.[2]

If the calculated bearing life fails to meet this specification, the pump manufacturer shall determine whether to use a larger or different motor whose bearings will meet the specification, or to reduce the loads sufficiently in order to comply.

(c) End Play. End play in the shaft from the motor thrust bearing shall be at a minimum, the definition of which depends upon internal clearances and mechanical seal requirements.

4.7.6 Bearings — VB Pumps

(a) Duty. Pump bearing housing and bearings shall be designed specifically to handle radial and thrust loads imposed by the pump, in addition to the weight of all rotating parts. Motor bearings are not subjected to the additional pump loads.

(b) Life. Pump bearings will provide an L'_{10} life of 17,500 hr continuous duty at maximum load.[2]

[2]*Maximum load* (for use in bearing life calculation) is defined as the maximum equivalent radial load on the bearings, with contract impeller at any point on its curve based on contract specific gravity or 1.0, whichever is higher. Maximum load includes the weight of the complete rotating element in addition to all hydraulic loads.

(c) End Play. End play in the shaft from the pump thrust bearing shall be at a minimum, the definition of which depends upon internal clearances and mechanical seal requirements.

4.8 Materials of Construction

The identifying material of a pump shall be that of which the major pumpage-wetted parts are constructed. Pumps should be available with the following materials of construction:

Material	Material Specification
Cast iron (not to be used for hazardous liquids)	ASTM A 278M (or A 48 for nonpressure containing parts)
Cast ductile iron	ASTM A 395 (or A 536 for structural parts)
Cast carbon steel	ASTM A 216 / A 216M
Cast high alloy steel (similar to 316 stainless steel)	ASTM A 744 / A 744M
Other	Optional

No repair by plugging, peening, or impregnation shall be allowed on any pressure containing, wetted metal parts.

4.9 Corrosion Allowance

The casing, cover, and gland shall have a corrosion allowance of at least 3.2 mm ($\frac{1}{8}$ in.).

4.10 Direction of Rotation

Direction of rotation shall be clockwise, looking down from top of motor. An arrow showing the direction of rotation shall be cast or welded on the motor adapter.

4.11 Dimensions

Pump dimensions shall conform to Table 1.

4.12 Miscellaneous Design Features

4.12.1 Safety Guards

(a) For VB and VC pumps, vented coupling guards that comply with ANSI/ASME B15.1 shall be supplied.

(b) For VM pumps, no guards are required unless there are hazardous attachments on the shaft.

(c) An auxiliary guard to control spray from seal or packing leakage shall be supplied when specified.

4.12.2 Threads. All threaded parts, such as bolts, nuts, and plugs, shall conform to ANSI standards.

TABLE 3 MOTOR HORSEPOWER SELECTION

For Pump Rated bhp up to [Note (1)]	Select Motor With Nameplate hp Rating		Maximum Allowable Motor Load [Note (2)]	Percent of Margin Motor hp	For Pump Rated bhp up to [Note (1)]	Select Motor With Nameplate hp Rating		Maximum Allowable Motor Load [Note (2)]	Percent of Margin Motor hp
...	SF 1.0	SF 1.15	(hp)	...	...	SF 1.0	SF 1.15	(hp)	...
0.70	1	...	1.00	43	21.00	25	...	25.00	19
0.82	...	1	1.15	41	24.40	...	25	28.75	18
1.08	1½	...	1.50	39	25.50	30	...	30.00	17½
1.25	...	1½	1.72	38	29.50	...	30	34.50	17
1.46	2	...	2.00	37	34.50	40	...	40.00	16
1.70	...	2	2.30	35	40.00	...	40	46.00	15
2.25	3	...	3.00	33½	43.80	50	...	50.00	14
2.62	...	3	3.45	31½	50.90	...	50	57.50	13
3.85	5	...	5.00	29½	53.30	60	...	60.00	12½
4.49	...	5	5.75	28	62.00	...	60	69.00	11½
5.93	7½	...	7.50	26½	67.50	75	...	75.00	11
6.90	...	7½	8.62	25	78.00	...	75	86.25	10½
8.10	10	...	10.00	23½	91.00	100	...	100.00	10
9.36	...	10	11.50	23	104.50	...	100	115.00	10
12.30	15	...	15.00	22	113.50	125	...	125.00	10
14.25	...	15	17.25	21	131.00	...	125	144.00	10
16.60	20	...	20.00	20½	136.50	150	...	150.00	10
19.20	...	20	23.00	20	156.50	...	150	172.50	10

GENERAL NOTE: 1 hp = 0.746 kW.

NOTES:
(1) bhp at the specified operating condition.
(2) Motor nameplate hp times service factor.

4.12.3 Lifting Rings. A lifting ring or other equivalent device shall be provided to facilitate handling the frame and associated assembly if its mass exceeds 27 kg (60 lb).

Eyebolts on motors are not suitable for lifting the entire pump motor assembly. See the pump manufacturer's manual for proper lifting instructions.

4.12.4 Tapped Openings. All tapped openings, including those in the mechanical seal gland which may be exposed to the pumped fluid under pressure, shall be plugged with threaded metal plugs. Plugs normally in contact with the pumped fluid shall be of the same material as the case, except that carbon steel plugs may be used in cast iron or ductile iron pumps. Threaded plugs shall not be used in the heating or cooling jackets, including glands with heating or cooling passages; instead, snap-in plugs or waterproof tape shall be used to relieve possible pressure accumulation until piping is installed.

All tapped openings in the mechanical seal gland shall be identified to designate their purpose. This designation should be cast or stamped immediately adjacent to the opening. Designations are F for flush, D for drain, Q for quench, and V for vent.

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

4.12.6 Adapter. The bearing frame adapter on VB type and the driver pedestal on all three types shall be designed to resist a torque at least as high as the ultimate torque strength of the pump shaft at its weakest point. The frame or adapter ring, when it clamps the rear cover plate to the pump casing, shall be made of a suitable ductile material such as cast ductile iron or cast carbon steel.

4.12.7 Drainage. A threaded drain connection(s) (1/2 in. NPT preferred) shall be provided so that liquid will drain from the motor adapter and stuffing box cover.

5 GENERAL INFORMATION

5.1 Application

5.1.1 Terminology. Pump application and application terminology shall be in accordance with the Hydraulic Institute Standards.

5.1.2 Flange Loading. Allowable flange loading imposed by the piping shall be available from the pump manufacturer.

5.1.3 Noise. The maximum overall sound pressure level produced by the pump–driver unit shall comply with the limit specified. Tests, if specified, shall be conducted in accordance with the Hydraulic Institute Standards.

5.1.4 Vibration. The unfiltered vibration level measured on the motor upper bearing housing on VC and VM pumps and on the pump's upper bearing housing on VB pumps at the manufacturer's test facility at rated speeds +5% and rated flow ±5% shall not exceed 6.4 mm/sec (0.25 in./sec) peak velocity or 0.064 mm (2.5 mils) peak-to-peak displacement.

5.2 Tests

5.2.1 Hydrostatic. After machining, casings, covers, and jackets shall be hydrostatically tested for 10 min minimum with water at 1.5 times the maximum design pressure corresponding to 38°C (100°F) for the material of construction used. The test water temperature shall be 15°C (60°F) minimum when testing carbon steel.

5.2.2 Performance. When performance tests are required, they shall be conducted in accordance with the Hydraulic Institute Standards, except that the contract motor, rather than a calibrated motor, may be used unless specifically excluded. The published efficiency of the contract motor may be used in determining brake horsepower.

5.2.3 Performance Curves. Published performance curves shall be based on tests conducted in accordance with the Hydraulic Institute Standards.

5.3 Nameplates

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

6 REFERENCES

6.1 American National Standards

The following American National Standards are referenced in this document and are available from the American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036. ASME standards are also available from The American Society of Mechanical Engineers, 22 Law Drive, Box 2300, Fairfield, NJ 07007-2300. AFBMA standards are also available from the Anti-Friction Bearing Manufacturers Association, Inc., 1101 Connecticut Avenue, N.W., Suite 700, Washington, DC 20036. NEMA standards are also available from the National Electrical Manufacturers Association, 2101 L St., N.W., Washington, DC 20037.

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

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

ASME B1.1, Unified Inch Screw Threads

ANSI/ASME B1.20.1, Pipe Threads, General Purpose (Inch)

ANSI/ASME B15.1, Safety Standard for Mechanical Power Transmission Apparatus

ASME/ANSI B16.1, Cast Iron Pipe Flanges and Flanged Fittings

ASME/ANSI B16.5, Pipe Flanges and Flanged Fittings

ANSI/NEMA MG 1, Motors and Generators

6.2 Other Publications

6.2.1 ASTM Publications. The following is published by the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM A 48, Standard Specification for Gray Iron Castings

ASTM A 216 / A 216M, Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service

ASTM A 278M, Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures Up to 345°C

ASTM A 395, Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures

ASTM A 536, Standard Specification for Ductile Iron Castings

ASTM A 744, Standard Specification for Castings, Iron–Chromium–Nickel, Corrosion Resistant, for Severe Service

6.2.2 Hydraulic Institute Publications. The following are published by the Hydraulic Institute, 30200 Detroit Road, Cleveland, OH 44145-1967.

Hydraulic Institute Standards for Centrifugal, Vertical, Rotary and Reciprocating Pumps

HI 1.6, Testing for Centrifugal Pumps

APPENDIX A
DOCUMENTATION

(This Appendix is not part of ASME B73.2M-1991, and is included here for information purposes only.)

A1 SCOPE

The documentation specified within this Appendix covers the minimum required to provide clear communication between the pump user and pump manufacturer, and to facilitate the safe design, installation, and operation of the pump. Additional data, as required for specific purposes, shall be available, if requested. It is the intent of ASME B73.2M-1991 that information be furnished in a similar form from all sources to improve clarity and foster efficient utilization of the documentation.

A2 DOCUMENTATION

A2.1 Requirements

The following documents shall be supplied for each item furnished:

(a) pump and driver outline drawing;
(b) vertical in-line pump data sheet;
(c) mechanical seal drawing (if applicable);
(d) mechanical seal piping drawing (if applicable);
(e) manufacturer's cooling/heating piping drawing (if applicable);
(f) performance curve with rating point;
(g) cross section drawing with parts list;
(h) instruction manual.

A2.2 Size

Each document shall be in a size that is a multiple of 8½ in. × 11 in.

A2.3 Information

A description for each document is as follows.

A2.3.1 Pump and Driver Outline Drawing

(a) The pump and driver outline drawing shall contain all information shown on and should be arranged as the sample outline drawing included herein and identified as Fig. A1.

(b) All tapped openings shall be uniformly identified on the drawing with the Roman numerals as shown in Fig. A1.

A2.3.2 Vertical In-Line Pump Data Sheet

(a) The vertical in-line pump data sheet may contain all information shown on and may be arranged as the sample data sheet included herein and identified as Form A1.

(b) This document may be used for inquiry, proposal, and as-built.

A2.3.3 Mechanical Seal Drawing

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

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

(c) It shall include dimensions complete with seal setting dimension with the gland bolted in-place.

(d) The drawing shall have a title block duplicating that on the pump data sheet, Form A1, and have a blank space for the user's identification stamp 1½ in. × 3 in., minimum.

A2.3.4 Mechanical Seal Piping Drawing

(a) A mechanical seal piping drawing shall be included if the pump is fitted with a mechanical seal piping system supplied by the pump manufacturer.

(b) The mechanical seal piping drawing may contain all information and uniform nomenclature shown on and may be arranged as the sample drawings included herein and identified as Fig. A2.

A2.3.5 Manufacturer's Cooling/Heating Piping Drawing

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

(b) The cooling/heating piping drawing may contain all information and uniform nomenclature shown on and may be arranged as the sample drawings included herein and identified as Fig. A3.

A2.3.6 Performance Curve

(a) The type of curve shall be a composite (family) curve for full impeller diameter range, plotting head against capacity and including efficiency, NPSH, power consumption, and speed. The design impeller diameter shall be stated with the rating point identified.

(b) If the pump fluid viscosity or specific gravity affects the pump performance, it shall be so noted on the performance curve.

A2.3.7 Cross Section Drawing. The cross section drawing shall show all assembled parts of the pump. It shall be complete with a parts list referenced to the drawing.

A2.3.8 Instruction Manual

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

(b) Any limitations or warnings on the installation, operation, etc., of the unit should be clearly defined.

(c) The instruction manual shall be an $8\frac{1}{2}$ in. × 11 in. booklet.

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

(e) Recommended tolerances for coupling alignment and pump part fits would be beneficial to the user.

(f) Instruction manuals for the pump driver, mechanical seal, coupling, etc., shall be supplied by the pump manufacturer if included as part of their supply.

A3 SPECIALLY REQUESTED DOCUMENTATION

Documentation in addition to that listed under para. A2 is sometimes required by some users. This additional documentation shall be made available to those users upon specific request.

A3.1 Master Document List

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

(b) This list shall be submitted along with the first document in order for the user to be aware of the documents which will follow.

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

A3.2 External Forces and Moments on Nozzles

(a) The allowable external forces and moments on pump suction and discharge nozzles shall be presented at the specified operating temperature of the pump.

(b) Values shall be given through the coordinate system; i.e., x, y, and z directions.

A3.3 Parts List

(a) A list of all pump parts with pump identification number shall be supplied by the manufacturer.

(b) A list of recommended spare parts shall be supplied by the manufacturer and shall be subdivided into two categories:

(1) for start-up;

(2) for 1 year's operation.

(c) The pump manufacturer should also furnish a spare parts list for equipment supplied with the pump, but not of his manufacture, as recommended by the manufacturer of that particular equipment. This would include, as applicable, mechanical seal, coupling, driver, gear boxes, etc.

(d) These lists shall be presented to the user before the equipment is shipped, in order to permit obtaining the necessary parts prior to equipment start-up.

A3.4 Special Operating or Design Data

Special operating and design data required by the user shall be supplied. This may include the following:

(a) minimum mechanical seal flush flow;

(b) stuffing box pressure;

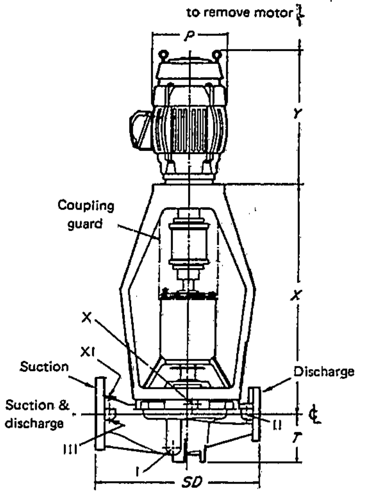
(c) maximum allowable casing pressure and temperature;

(d) maximum allowable jacket pressure and temperature.

A3.5 Special Testing, Painting, and Preparation

Any special testing, painting, and preparation furnished shall be specified on the vertical in-line pump data sheet.

Minimum headroom required to remove motor



Dimensions Determined By Motor				
NEMA Frame	X	Y	P	Wt.

Flange Holes

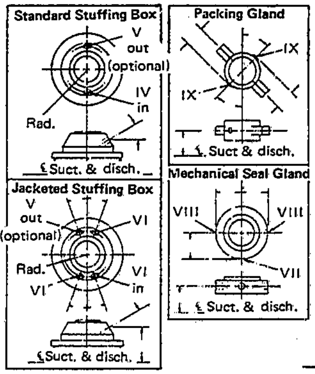
Thru ☐
Tapped ☐

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

Pump Type

☐ VC ☐ VM ☐ VB

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



Motor Specifications

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

Weight (lb)

Pump ______
Driver ______

Mechanical Seal Specifications

Mfr. ______
Type ______
Code ______
Dwg. No. ______
For Piping B/M, See drawing
No. ______
No. rings ______ Size ______

Coupling Specifications

Mfr. ______
Type ______ Size ______
Coupling Bores } Pump- ______ Driver ______

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

Lubrication of Bearings	Casing	Shaft Type
☐ Oil mist	☐ Plain	☐ Sleeved
☐ Grease	☐ Jacketed	☐ Nonsleeved
☐ Grease — lubed for life	☐ Traced	

Type of oil lubrication

Tapped Openings						
No.	Size	Qty.	Purpose	Furnished Yes	Furnished No	Usage
I			Casing drain			
II			Seal bypass connection			
III			Suction flush connection			
IV			Lantern ring or mechanical, seal flush			
V			Flush connection for mechanical seal			
VI			Stuffing box jacket connection			
VII			Flush connection mechanical seal gland			
VIII			Vent and drain for mechanical seal			
IX			Quench connection for packed box			
X			Motor support drain			
XI			Suction gage connection			
XII						

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 (millimeters). Weights are in lb (kg) approximate.

Dwg. No. ______

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

FIG. A1 PUMP AND DRIVER OUTLINE DRAWING

FORM A1 CENTRIFUGAL PUMP DATA SHEET

PUMP SIZE AND MODEL ______ BRG. FRAME ______ SERVICE ______
NO. PUMPS REQ'D. ______ NO. MOTORS REQ'D. ______ ITEM NO. ______ NO. TURBINES REQ'D. ______ ITEM NO. ______

OPERATING CONDITIONS – EACH PUMP

LIQUID/SLURRY ______
PT. °F NORM ______ MAX. ______ US GPM AT NORM ______ RATED ______
SP. GR. AT NORM PT. ______ TOTAL HEAD, FT RATED ______
VAP. PRESS. AT NORM PT. PSIA ______ SUCT. PRESS. PSIG MAX. ______ RATED ______
VIS. AT NORM PT SSU ______ NPSHA, FT ______
CORR./EROS. CAUSED BY ______ PH ______ HYD. HP ______
DRIVER HP TO BE SELECTED FOR MAX. S.G. ______ & MAX. VISCOSITY ______

CONSTRUCTION – ☐ ASME B73.1M ☐ ASME B73.2M ☐ OTHER ______

PUMP TYPE: ☐ HORIZ. ☐ VERT. IN-LINE ☐ COUPLED MOTOR SHAFT ☐ CRADLED MNT.
CASE HORIZONTAL MOUNT: ☐ FOOT ☐ CENTERLINE
VERTICAL MOUNT: ☐ MOTOR SHAFT ☐ RIGID COUPLING ☐ OTHER ______
SPLIT: ☐ RADIAL ☐ AXIAL TYPE VOLUTE: ☐ SINGLE ☐ DOUBLE
PRESS: ☐ MAX. ALLOW. ______ PSIG ______ °F ______ HYDRO TEST ______ PSIG
CONNECT: ☐ DRAIN ☐ GAGE SUCTION ☐ GAGE DISCHARGE
IMPELLER DIA. RATED ______ MAX. ______ IMPELLER TYPE ______
BEARINGS TYPE: RADIAL ______ THRUST ______
LUBE: ☐ OIL ☐ OIL MIST ☐ GREASE ☐ GREASE FOR LIFE
COUPLING: MFR. ______ MODEL ______ GUARD ______ OILER ______
DRIVER HALF MTD. BY: ☐ PUMP MFR. ☐ DRIVER MFR. ☐ PURCHASER
STUFFING BOX COVER: ☐ STANDARD ☐ JACKETED ☐ SEAL ONLY
PACKING: ☐ MFR. & TYPE ______ SIZE/NO. OF RINGS ______
LANTERN RINGS: ☐ YES ☐ NO
MECH. SEAL: ☐ MFR. & MODEL ______ MATERIAL CODE ______
☐ BALANCED ☐ UNBALANCED ☐ SINGLE ☐ INSIDE ☐ OUTSIDE
☐ DOUBLE ☐ BACK TO BACK ☐ TANDEM ☐ FACE TO FACE ☐ CARTRIDGE

AUXILIARY PIPING (SEE FIGS. A2 AND A3 FOR CODE)

☐ STUF. BOX PLAN NO. ______ ☐ C. W. PIPING PLAN NO. ______
TOTAL COOLING WATER REQ'D., GPM ______ ☐ SIGHT F. I. REQ'D.
☐ PACKING COOLING INJECTION REQ'D., TOTAL GPM ______ PSIG ______
EXTERNAL SEAL FLUSH FLUID ______ GPM ______ PSIG ______
SEAL QUENCH PLAN ______ SEAL QUENCH FLUID ______

DRIVER: ☐ MOTOR ☐ TURBINE ☐ OTHER PROVIDED BY ______

HP ______ RPM ______ FRAME ______ VOLTS/PHASE/HERTZ ______
MFR. ______ BEARINGS ______ SERVICE FACTOR ______
TYPE ______ INSULATION ______ AMPS: FL ______ LR ______
LUBE ______ TEMP. RISE °C ______ ENCL. ______
INLET PRESS. ______ EXHAUST PRESS. ______ STEAM TEMP. ______ WATER RATE ______
OTHER

PERFORMANCE

PERFORMANCE CURVE NO. ______
RPM ______ NPSH (WATER) ______
EFF. ______ % BHP RATED ______
MAX. BHP RATED IMPELLER ______
MAX. HEAD RATED ______
MAX. DISCH. PRESS. PSIG ______
MIN. CONTINUOUS GPM ______

SHOP TESTS

☐ NONWIT. PERF. ☐ WIT. PERF.
☐ NONWIT. HYDRO. ☐ WIT. HYDRO.
☐ NONWIT. NPSH ☐ WIT. NPSH
☐ NONWIT. VIBRATION ☐ WIT. VIBR.
☐ DISMANTLE & INSPECT AFTER TEST
☐ OTHER: ______

PUMP MATERIALS

CASING ______
IMPELLER ______
WEAR RINGS ______
SHAFT/SLEEVE ______
GLAND ______
GASKETS ______
BASEPLATE ______
COUPLING GUARD ______
OTHER: ______

INSPECTION – ☐ NOT REQUIRED

☐ IN PROCESS ☐ FINAL
______ DAYS NOTIFICATION REQUIRED

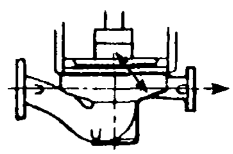
SOUND SPECIFICATION REQUIREMENTS

ADDITIONAL REQUIREMENTS/ COMMENTS

CUSTOMER/USER ______
LOCATION ______
CUSTOMER P.O. NO. ______
ITEM NO(S). ______ EQUIP. NO(S). ______
FACTORY ORDER NO(S). ______ PUMP SERIAL NO(S). ______
ISSUED BY ______ DATE ______
REV. ______ DATE ______

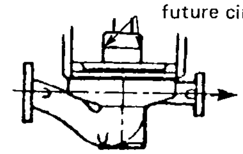
Figure A2 begins on the following page.

Recirculation of Pump Fluid

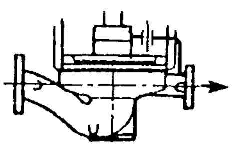


Plan No. 7301
Internal recirculation from pump discharge to seal

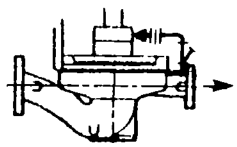
Plugged connections for possible future circulating fluid



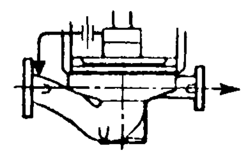
Plan No. 7302
Dead-ended seal box with no circulation of flush fluid.
Water cooled box jacket and throat bushing required unless otherwise specified.



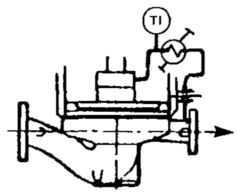
Plan No. 7311
Recirculation from pump case through orifice to seal



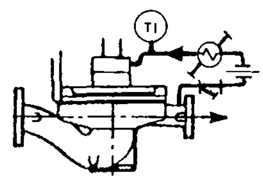
Plan No. 7312
Recirculation from pump case through strainer and orifice to seal



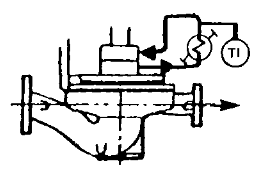
Plan No. 7313
Recirculation from seal chamber through orifice and back to pump suction



Plan No. 7321
Recirculation from pump case through orifice and cooler to seal

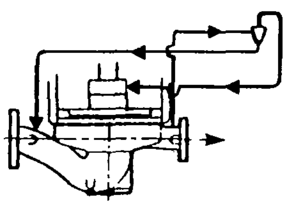


Plan No. 7322
Recirculation from pump case through strainer, orifice, and cooler to seal

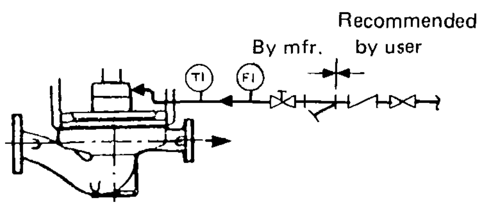


Plan No. 7323
Recirculation from seal with pumping ring through cooler and back to seal

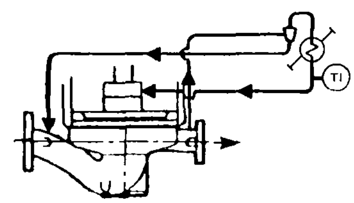
External Flushing



Plan No. 7331
Recirculation from pump case through cyclone separator delivering clean fluid to seal and fluid with solids back to pump suction



Plan No. 7332
Injection to seal from external source of clean cool fluid
[See Note (1)]



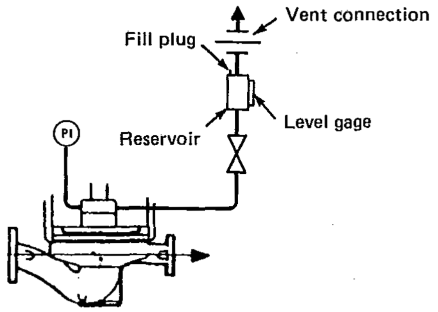
Plan No. 7341
Recirculation from pump case through cyclone separator delivering clean fluid through cooler to seal and fluid with solids back to pump suction

LEGEND

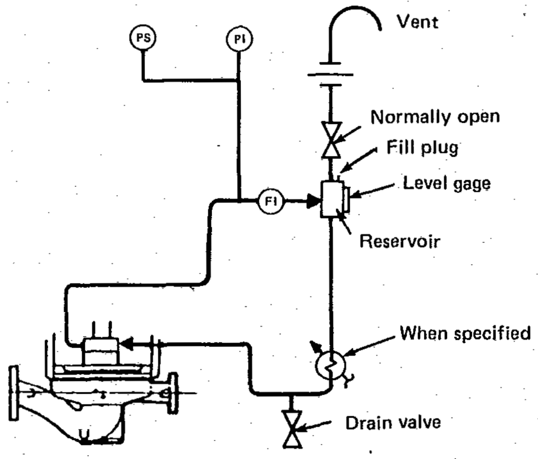
	heat exchanger
(PI)	pressure gage with block valve
(TI)	dial thermometer when specified
(PS)	pressure switch, when specified, including block valve
	cyclone separator
(FI)	flow indicator when specified
	Y-type strainer
	flow regulating valve
	block valve
	check valve
	orifice (removable orifice or an integral pressure breakdown arrangement)

FIG. A2 MECHANICAL SEAL PIPING PLANS

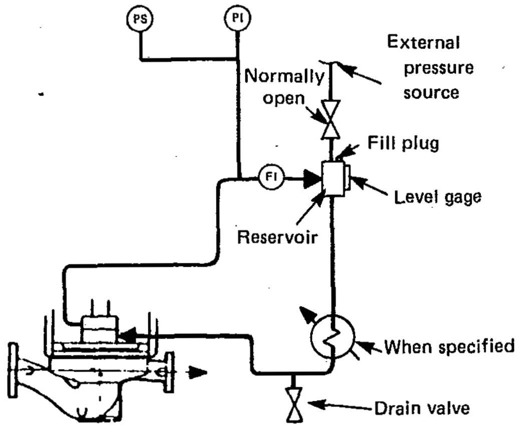
Auxiliary Seal Devices



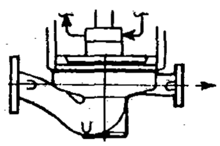
Plan No. 7351
Dead-ended blanket



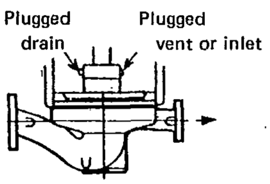
Plan No. 7352
External fluid reservoir for tandem seals.
Thermosyphon or forced circulation, as required.
[See Note (1)]



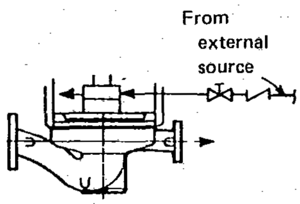
Plan No. 7353
External fluid reservoir for double seals. Thermosyphon or forced circulation, as required. [See Note (1)]



Plan No. 7354
Circulation of clean buffer fluid from an external source
[See Note (1)]



Plan No. 7361
Tapped connections for user's use. Note (1) shall apply when user is to supply fluid (steam, gas, water, other) to auxiliary sealing device.



Plan No. 7362
External fluid quench (steam, gas, water, other)
[See Note (1)]

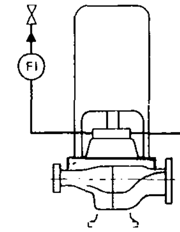
MATERIALS OF CONSTRUCTION

Code A (a) Tubing: carbon steel, 3/8 in. O.D. x 0.035 in. wall, ASTM A 519;
(b) Tube Fittings: carbon steel, bite type.
Code B (a) Tubing: 316 stainless steel, 3/8 in. O.D. x 0.035 in. wall, ASTM A 269;
(b) Tube Fittings: 316 stainless steel, bite type.
Code C (a) Pipe: carbon steel, 3/8 in. nominal Schedule 40, ASTM A 106;
(b) Pipe Fittings: carbon steel, 150 #, ASTM A 105.
Code D (a) Pipe: 316 stainless steel, 3/8 in. nominal Schedule 40, ASTM A 312;
(b) Pipe Fittings: 316 stainless steel, 150 #, ASTM A 182.
Code E Tubing: armored TFE resin with suitable alloy fittings, design pressure of 350 psi at 500°F.
Code F Other (specify).

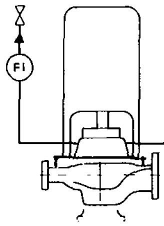
GENERAL NOTE: These plans represent commonly used systems. Other variations are available and should be specified in detail.

NOTE:
(1) User shall specify fluid characteristics when supplemental seal fluid is provided. Manufacturer shall specify the required flow rate and pressure where these are factors.

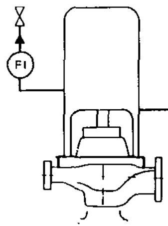
FIG. A2 MECHANICAL SEAL PIPING PLANS (CONT'D)



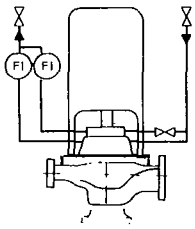
Plan N
Cooling or heating to seal gland



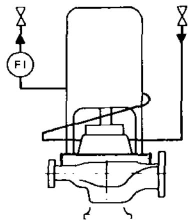
Plan C
Cooling or heating to stuffing box jacket



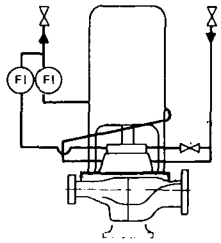
Plan A
Cooling to bearing housing



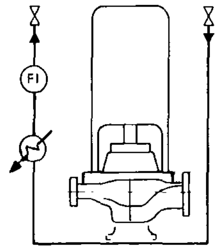
Plan D
Cooling or heating to stuffing box jacket with parallel flow to seal gland



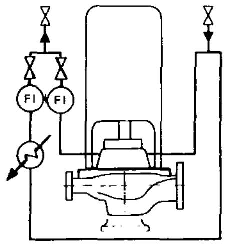
Plan E
Cooling to stuffing box jacket and bearing housing in series



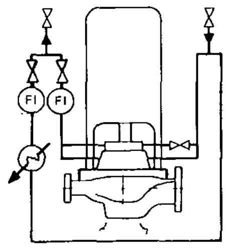
Plan F
Cooling to stuffing box jacket and bearing housing in series with parallel flow to seal gland



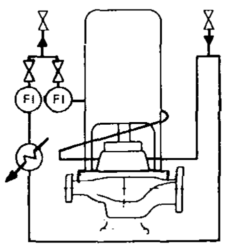
Plan P
Cooling to cooler



Plan J
Cooling to stuffing box jacket with parallel flow to cooler



Plan M
Cooling to stuffing box jacket. Seal gland and cooler in parallel.



Plan K
Cooling to stuffing box jacket and bearing housing in series with parallel flow to cooler

GENERAL NOTE: Flow indicators are optional, furnished only when specified.

FIG. A3 COOLING AND HEATING PIPING PLANS

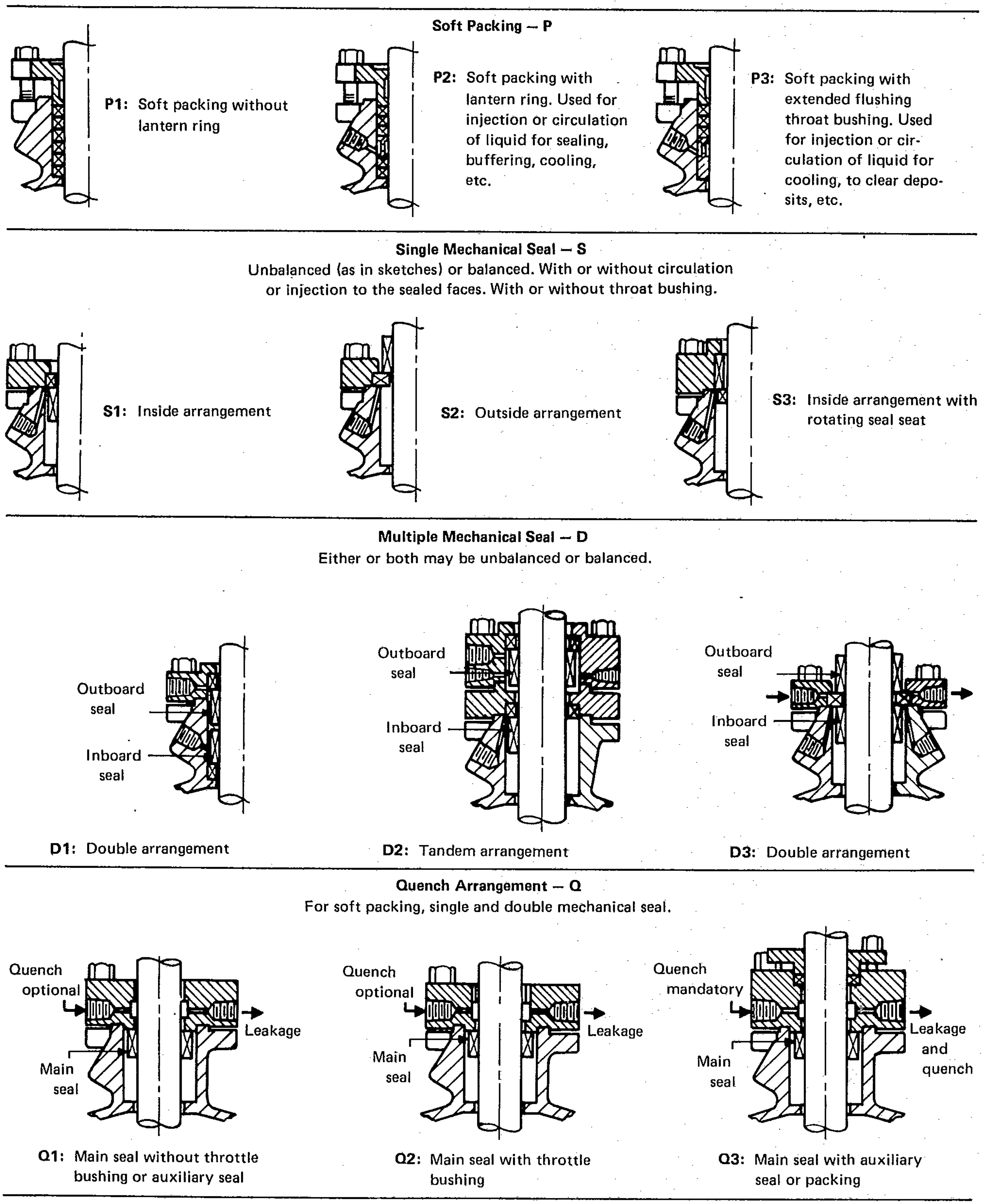


FIG. A4 TYPICAL SEAL ARRANGEMENTS

This document is printed
on 50% recycled paper.

50% RECOVERED PAPER MATERIAL means paper waste generated after the completion of the papermaking process, such as postconsumer materials, text books, envelopes, bindery waste, printing waste, cutting and converting waste, butt rolls, obsolete inventories, and rejected unused stock.

ISBN # 0-7918-2127-7

J04991