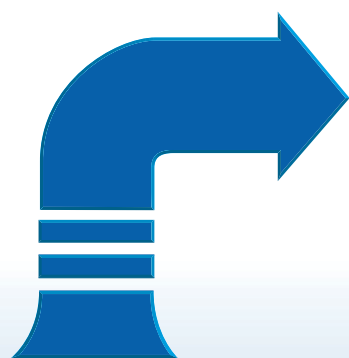
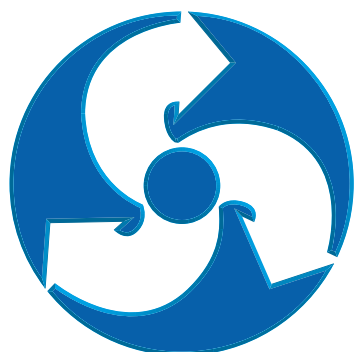




American National Standard for

Rotodynamic Pumps

for Assessment of Applied Nozzle
Loads

ANSI/HI 9.6.2-2011



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American National Standard for

Rotodynamic Pumps for Assessment of Applied Nozzle Loads

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Approved May 19, 2011
American National Standards Institute, Inc.

American National Standard

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Foreword (Not part of Standard)

Purpose and aims of the Hydraulic Institute

The purpose and aims of the Institute are to promote the continued growth and well-being of pump manufacturers and further the interests of the public in such matters as are involved in manufacturing, engineering, distribution, safety, transportation, and other problems of the industry, and to this end, among other things:

- a) To develop and publish standards for pumps;
- b) To collect and disseminate information of value to its members and to the public;
- c) To appear for its members before governmental departments and agencies and other bodies in regard to matters affecting the industry;
- d) To increase the amount and to improve the quality of pump service to the public;
- e) To support educational and research activities;
- f) To promote the business interests of its members but not to engage in business of the kind ordinarily carried on for profit or to perform particular services for its members or individual persons as distinguished from activities to improve the business conditions and lawful interests of all of its members.

Purpose of Standards

- 1) Hydraulic Institute Standards are adopted in the public interest and are designed to help eliminate misunderstandings between the manufacturer, the purchaser, and/or the user and to assist the purchaser in selecting and obtaining the proper product for a particular need.
- 2) Use of Hydraulic Institute Standards is completely voluntary. Existence of Hydraulic Institute Standards does not in any respect preclude a member from manufacturing or selling products not conforming to the Standards.

Definition of a Standard of the Hydraulic Institute

Quoting from Article XV, Standards, of the By-Laws of the Institute, Section B:

“An Institute Standard defines the product, material, process or procedure with reference to one or more of the following: nomenclature, composition, construction, dimensions, tolerances, safety, operating characteristics, performance, quality, rating, testing and service for which designed.”

Comments from users

Comments from users of this standard will be appreciated, to help the Hydraulic Institute prepare even more useful future editions. Questions arising from the content of this standard may be sent to the Technical Director of the Hydraulic Institute. The inquiry will then be directed to the appropriate technical committee for provision of a suitable answer.

If a dispute arises regarding contents of a Hydraulic Institute Standard or an answer provided by the Institute to a question such as indicated above, the point in question shall be sent in writing to the Technical Director of the Hydraulic Institute, who shall initiate the Appeals Process.

Revisions

The Standards of the Hydraulic Institute are subject to constant review, and revisions are undertaken whenever it is found necessary because of new developments and progress in the art. If no revisions are made for five years, the standards are reaffirmed using the ANSI canvass procedure.

Units of measurement

US customary units of measurement are predominantly used. Due to the reference to ANSI/ASME B73 standards for pump dimensions, conversion to metric units was inappropriate. Consistent units must be used in all calculations required by this standard.

Consensus for this standard was achieved by use of the Canvass Method

The following organizations, recognized as having an interest in the standardization of centrifugal pumps, were contacted prior to the approval of this revision of the standard. Inclusion in this list does not necessarily imply that the organization concurred with the submittal of the proposed standard to ANSI.

4B Engineering
Arcadis Malcolm Pirnie, Inc.
Bechtel Power Corporation
Beekman, William, Consultant
Black & Veatch (B & V)
Brown and Caldwell
ekwestrel corp
GIW Industries, Inc.
Healy Engineering, Inc.
ITT - Industrial Process
ITT - Residential & Commercial Water

J.A.S. Solutions Ltd.
Kemet Inc.
LVVWD
Mechanical Solutions, Inc.
MWH Americas, Inc.
Pentair Water - Engineered Flow GBU
Powell Kugler, Inc.
Pump Design, Development & Diagnostics, LLC
TACO, Inc.
Weir Floway, Inc.

Committee list

Although this standard was processed and approved for submittal to ANSI by the Canvass Method, a working committee met many times to facilitate its development. At the time it was developed, the committee had the following members:

Chair - Fred F. Walker, Weir Floway, Inc
Vice-chair - Lucian Dobrot, TACO, Inc.

Committee Members

Charles A. Cappellino
Jack Claxton
Michael Coussens
Paul J. Ruzicka
Roger Turley

Company

ITT Industrial Process
Patterson Pump Company
Peerless Pump Company
ITT Residential & Commercial Water
Flowserve Corporation

Alternate Members

James R. Roberts
Steve P. Schmitz

ITT Residential & Commercial Water
ITT Residential & Commercial Water

9.6.2 Rotodynamic pumps for assessment of applied nozzle loads

9.6.2.0 Scope

This standard includes recommendations for assessment of applied nozzle loads for the following pump types. When specified by the user, pumps supplied shall conform to these requirements.

- a) Horizontal end suction single stage (ANSI/ASME B73.1, B73.3, and B73.5M)
- b) Vertical in-line single stage (ANSI/ASME B73.2)
- c) Axial split case single and two stage
- d) Vertical turbine short set pumps

Many other pump types are not included because of the different designs that are unique to each manufacturer. For pump types outside the scope of this standard, allowable nozzle loads should be established by the pump manufacturer, applied nozzle loads predicted by the purchaser, and differences, if any, negotiated and resolved by the two parties.

For assessment of applied nozzle loads for slurry pumps, see ANSI/HI 12.1-12.6 *Rotodynamic (Centrifugal) Slurry Pumps for Nomenclature, Definitions, Applications, and Operation*.

9.6.2.1 Horizontal end suction pumps

9.6.2.1.1 Scope

This section covers assessment of applied nozzle loads for the following horizontal end suction pump types:

- a) Pumps designed and constructed in accordance with ASME B73.1, *Specification for Horizontal End Suction Centrifugal Pumps for Chemical Process*, with Class 150 and 300 flanges. To be applicable, the pump casing and seal chamber or stuffing box must be constructed of a material listed in Table 9.6.2.1.7.2.2a and subjected to temperatures between -20 and 700 °F unless otherwise specified.
- b) Magnetic drive pumps designed and constructed in accordance with ASME B73.3, *Specification for Sealless Horizontal End Suction Metallic Centrifugal Pumps for Chemical Process*, with Class 150 and 300 flanges. To be applicable, the pump casing must be constructed of a material listed in Table 9.6.2.1.7.2.2a and subjected to temperatures between -20 and 500 °F unless otherwise specified.
- c) Pumps designed and constructed in accordance with ASME B73.5M, *Specification for Thermoplastic and Thermoset Polymer Material Horizontal End Suction Centrifugal Pumps for Chemical Process*. To be applicable, the pump must be constructed of a material with a 68 °F modulus of elasticity greater than 1.0×10^6 psi and may be subjected to temperatures between -20 and 200 °F.

9.6.2.1.2 Nomenclature and definitions

9.6.2.1.2.1 Source

The nomenclature and definitions of pump components shall be in accordance with those promulgated by the Hydraulic Institute.

9.6.2.1.2.2 Definitions (refer to Figure 9.6.2.1.2.2)

F_{xs} = applied force on x-axis on suction nozzle, to be assessed using equation sets 1-5

F_{ys} = applied force on y-axis on suction nozzle, to be assessed using equation sets 1-5

F_{zs} = applied force on z-axis on suction nozzle, to be assessed using equation sets 1-5

M_{xs} = applied moment about x-axis on suction nozzle, to be assessed using equation sets 1-5

M_{ys} = applied moment about y-axis on suction nozzle, to be assessed using equation sets 1-5

M_{zs} = applied moment about z-axis on suction nozzle, to be assessed using equation sets 1-5

F_{xd} = applied force on x-axis on discharge nozzle, to be assessed using equation sets 1-5

F_{yd} = applied force on y-axis on discharge nozzle, to be assessed using equation sets 1-5

F_{zd} = applied force on z-axis on discharge nozzle, to be assessed using equation sets 1-5

M_{xd} = applied moment about x-axis on discharge nozzle, to be assessed using equation sets 1-5

M_{yd} = applied moment about y-axis on discharge nozzle, to be assessed using equation sets 1-5

M_{zd} = applied moment about z-axis on discharge nozzle, to be assessed using equation sets 1-5

$F_{xs \max}$ = maximum value of force on x-axis on suction nozzle, to be used with equation sets 1-5

$F_{ys \max}$ = maximum value of force on y-axis on suction nozzle, to be used with equation sets 1-5

$F_{zs \max}$ = maximum value of force on z-axis on suction nozzle, to be used with equation sets 1-5

$M_{xs \max}$ = maximum value of moment about x-axis on suction nozzle, to be used with equation sets 1-5

$M_{ys \max}$ = maximum value of moment about y-axis on suction nozzle, to be used with equation sets 1-5

$M_{zs \max}$ = maximum value of moment about z-axis on suction nozzle, to be used with equation sets 1-5

$F_{xd \max}$ = maximum value of force on x-axis on discharge nozzle, to be used with equation sets 1-5

$F_{yd \max}$ = maximum value of force on y-axis on discharge nozzle, to be used with equation sets 1-5

$F_{zd \max}$ = maximum value of force on z-axis on discharge nozzle, to be used with equation sets 1-5

$M_{xd \max}$ = maximum value of moment about x-axis on discharge nozzle, to be used with equation sets 1-5

$M_{yd \max}$ = maximum value of moment about y-axis on discharge nozzle, to be used with equation sets 1-5

$M_{zd \max}$ = maximum value of moment about z-axis on discharge nozzle, to be used with equation sets 1-5

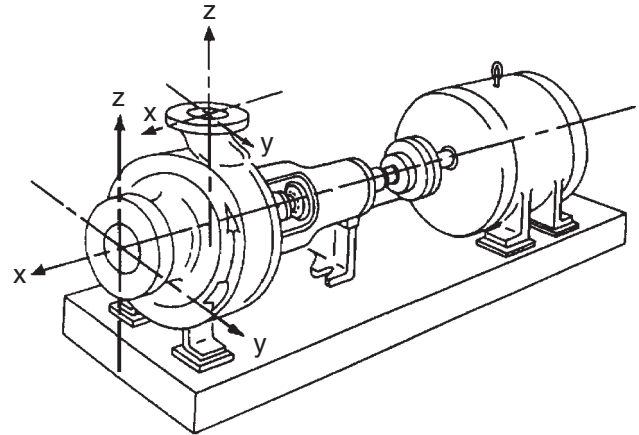


Figure 9.6.2.1.2.2 — Coordinate system for ASME B73.1, B73.3, and B73.5M horizontal end suction pumps

Group 1 is defined as ASME B73.1, B73.3, and B73.5M sizes AA and AB. Two-/four-pole, 60-cycle speed, and up to 20/10 hp, respectively.

Group 2 is defined as ASME B73.1, B73.3, and B73.5M sizes A05, A10, A20, A30, A50, A40, A60, A70, and A80. Two-/four-pole, 60-cycle speed, and up to 130/65 hp, respectively.

Group 3 is defined as ASME B73.1, B73.3, and B73.5M sizes A90, A100, A110, and A120. Four-/six-pole, 60-cycle speed, and up to 220/146 hp, respectively.

9.6.2.1.3 Criteria for loading allowances

9.6.2.1.3.1 Driver/pump coupling alignment

The radial movement of the pump shaft at the pump coupling hub due to nozzle loads shall not exceed 0.005 in. relative to initial alignment. Axial movement of the pump shaft at the pump coupling hub is not considered in this standard.

9.6.2.1.3.2 Internal pump distortion

No contact between casing and impeller is allowed.

The radial movement of the pump shaft with respect to the seal chamber due to nozzle loads shall not exceed 0.002 in. relative to initial position.

9.6.2.1.3.3 Pump hold-down bolts

Fasteners used for hold-down bolts should have yield strength of 36,000 psi or greater, i.e., greater than or equal to the yield strength of SAE J429 Grade 1 fasteners. The maximum allowable tensile stress in the pump hold-down bolts is 90% of fastener's material yield strength. The maximum allowable shear stress in the pump hold-down bolts is 25% of fastener's material yield strength.

The pump shall be bolted to the baseplate at both the casing feet and rear foot position(s) and sufficiently tightened to prevent slippage of the pump on the baseplate. Refer to API 686, Appendix E, for required torque values (use 0.5-in nominal bolt diameter torque value for Group 1 and 2 pumps, and 0.75-in nominal bolt diameter value for Group 3 pumps). It may be necessary to arrange for periodic tightening of the bolts to maintain required torque levels.

9.6.2.1.3.4 Pump mounting

The base for which the loads in Tables 9.6.2.1.4b through 9.6.2.1.4e are established must be a fully grouted metal baseplate with anchor bolts. The base as a minimum must withstand the applied nozzle loads combined with normal operating loads (e.g., driver weight and pump weight).

The base must be installed and grouted in accordance with ANSI/HI 1.4 *Rotodynamic (Centrifugal) Pumps for Manuals Describing Installation, Operation and Maintenance*.

9.6.2.1.3.5 Nozzle stress

The maximum stresses developed in the pump nozzles and flanges, constructed of a material listed in Table 9.6.2.1.7.2.2a, by the applied nozzle loads, combined with internal pressure, shall not exceed 26,250 psi tensile and 13,125 psi shear. By applying the temperature and material adjustment factors of Section 9.6.2.1.7.2.1, applied nozzle loads may be increased for stronger materials and must be decreased for weaker materials.

The allowable suction nozzle stress was based on three-dimensional stress analysis methods. The allowable discharge nozzle stress was based on the method contained in the ASME Boiler and Pressure Vessel Code, 1983 edition, Section III, NC 3653, due to its complex geometry.

9.6.2.1.3.6 Pressure/temperature

Any temperature referenced in Section 9.6.2.1 is the temperature of the pressure-containing components of the pump. In general, this temperature is the same as that of the contained liquid.

Use of a pressure rating as specified in ANSI/ASME B16.5 corresponding to a temperature other than that of the contained liquid is the responsibility of the user, subject to the requirements of the applicable code or regulation.

Low-temperature and high-temperature considerations addressed in ANSI/ASME B16.5 should be examined.

9.6.2.1.4 ANSI/ASME B73.1 pump assessment of applied nozzle loads

Loads given in Tables 9.6.2.1.4b through 9.6.2.1.4e are applicable for ASME B73.1 pumps constructed of ASTM A351/A351M - Grade CF8M (Type 316SS) operated between -20 and 100 °F and mounted on a grouted metal baseplate with anchor bolts.

For an individual force or moment, pumps must be capable of satisfactory operation when subjected to loads shown in Table 9.6.2.1.4b (adjusted if applicable) while meeting the criteria of equation set 1.

For a combination of more than one force and/or moment, pumps must be capable of satisfactory operation when subjected to the loads in Tables 9.6.2.1.4c through 9.6.2.1.4e (adjusted if applicable) while meeting the criteria of equation sets 2 – 5. When combining loads, the absolute value of any individual load must not exceed the value given in Table 9.6.2.1.4b.

Adjustment of the tabulated maximum forces and moments load values is required if any of the following occur:

- Temperature is above 100 °F.
- The pump material construction is not ASTM A351/A351M - Grade CF8M.
- The base is not a fully grouted metal baseplate with anchor bolts.

Table 9.6.2.1.4a — Equation sets 1 through 5 (Using the maximum forces and moments of the referenced tables, applied loads shall satisfy the criteria defined by these equations.)

Set	Equation	Reference	Remarks
1	$\frac{F_{xs}}{F_{xs \max}} \leq 1.0, \frac{F_{ys}}{F_{ys \max}} \leq 1.0, \frac{F_{zs}}{F_{zs \max}} \leq 1.0, \frac{M_{xs}}{M_{xs \max}} \leq 1.0, \frac{M_{ys}}{M_{ys \max}} \leq 1.0, \frac{M_{zs}}{M_{zs \max}} \leq 1.0,$ $\frac{F_{xd}}{F_{xd \max}} \leq 1.0, \frac{F_{yd}}{F_{yd \max}} \leq 1.0, \frac{F_{zd}}{F_{zd \max}} \leq 1.0, \frac{M_{xd}}{M_{xd \max}} \leq 1.0, \frac{M_{yd}}{M_{yd \max}} \leq 1.0, \frac{M_{zd}}{M_{zd \max}} \leq 1.0,$	Table 9.6.2.1.4b	Individual loading
2	$\frac{1}{2} \times \left[\frac{F_{xs}}{F_{xs \max}} + \frac{F_{ys}}{F_{ys \max}} + \frac{F_{zs}}{F_{zs \max}} + \frac{M_{xs}}{M_{xs \max}} + \frac{M_{ys}}{M_{ys \max}} + \frac{M_{zs}}{M_{zs \max}} + \frac{F_{xd}}{F_{xd \max}} + \frac{F_{yd}}{F_{yd \max}} + \frac{F_{zd}}{F_{zd \max}} + \frac{M_{xd}}{M_{xd \max}} + \frac{M_{yd}}{M_{yd \max}} + \frac{M_{zd}}{M_{zd \max}} \right] \leq 1.0$	Table 9.6.2.1.4c	Nozzle stress, hold-down bolt stress, pumps slippage
3	$-1.0 \leq a = \frac{F_{ys}}{F_{ys \max}} + \frac{M_{xs}}{M_{xs \max}} + \frac{M_{ys}}{M_{ys \max}} + \frac{M_{zs}}{M_{zs \max}} + \frac{F_{yd}}{F_{yd \max}} + \frac{M_{xd}}{M_{xd \max}} + \frac{M_{yd}}{M_{yd \max}} + \frac{M_{zd}}{M_{zd \max}} \leq 1.0$	Table 9.6.2.1.4d	y-axis movement
4	$-1.0 \leq b = \frac{F_{xs}}{F_{xs \max}} + \frac{F_{zs}}{F_{zs \max}} + \frac{M_{xs}}{M_{xs \max}} + \frac{M_{ys}}{M_{ys \max}} + \frac{M_{zs}}{M_{zs \max}} + \frac{F_{xd}}{F_{xd \max}} + \frac{F_{yd}}{F_{yd \max}} + \frac{F_{zd}}{F_{zd \max}} + \frac{M_{xd}}{M_{xd \max}} + \frac{M_{yd}}{M_{yd \max}} + \frac{M_{zd}}{M_{zd \max}} \leq 1.0$	Table 9.6.2.1.4e	z-axis movement
5	$\sqrt{a^2 + b^2} \leq 1.0$	Equation sets 4 and 5	Combined axis movement

Table 9.6.2.1.4b — Maximum forces and moments for use with equation set 1 to assess applied loads

ASME B73 Designation	Pump Size	Suction						Discharge					
		Forces (lb)			Moments (lb•ft)			Forces (lb)			Moments (lb•ft)		
		$F_{xs\ max}$	$F_{ys\ max}$	$F_{zs\ max}$	$M_{xs\ max}$	$M_{ys\ max}$	$M_{zs\ max}$	$F_{xd\ max}$	$F_{yd\ max}$	$F_{zd\ max}$	$M_{xd\ max}$	$M_{yd\ max}$	$M_{zd\ max}$
AA	1.5 × 1 × 6	1050	750	750	720	170	170	800	1350	3000	410	410	410
AB	3 × 1.5 × 6	1050	1240	1250	900	490	490	800	1350	3000	500	550	510
A10	3 × 2 × 6	1050	1050	1050	900	220	220	800	1350	3000	500	1000	510
AA	1.5 × 1 × 8	1050	1210	1210	720	190	190	800	1350	3000	360	360	360
---	3 × 1.5 × 8 ^a	1050	1240	1250	900	490	490	800	1350	3000	440	440	440
A50	3 × 1.5 × 8	2700	1350	1500	1300	370	370	1400	1350	3250	460	460	460
A60	3 × 2 × 8	2700	1350	1500	1300	600	600	1400	1350	3250	660	660	660
A70	4 × 3 × 8	2700	1350	1500	1300	350	350	1400	1350	3250	1200	1460	690
A05	2 × 1 × 10	2340	960	960	1270	220	220	1400	1350	3250	660	660	660
A50	3 × 1.5 × 10	2700	1350	1500	1300	420	420	1400	1350	3250	370	370	370
A60	3 × 2 × 10	2700	1350	1480	1300	310	310	1400	1350	3250	560	560	560
A70	4 × 3 × 10	2300	1350	1500	1300	310	310	1400	1350	3250	1200	1460	690
A80	6 × 4 × 10	2700	1350	1500	1300	1100	1100	1400	1350	3250	1200	1500	690
A20	3 × 1.5 × 13	2700	1350	1500	1300	670	670	1400	1350	3250	530	530	530
A30	3 × 2 × 13	1920	1230	1230	1300	350	350	1400	1350	3250	1200	1270	690
A40	4 × 3 × 13	2700	1350	1500	1300	400	400	1400	1350	3250	1200	1500	690
A80	6 × 4 × 13	2700	1350	1500	1300	1300	1100	1400	1350	3250	1200	1500	690
A90	8 × 6 × 13	3500	3180	2000	1500	1170	1170	1500	3000	3500	1250	2840	2840
A100	10 × 8 × 13	3500	3180	2000	1500	2000	2150	1500	3000	3500	1250	2840	2840
A110	8 × 6 × 15	3500	3180	2000	1500	1480	1480	1500	3000	3500	1250	2840	2840
A120	10 × 8 × 15	3500	3180	2000	1500	1130	1130	1500	3000	3500	1250	2840	2840

NOTE: Please note that certain sizes do not follow a trend of increased allowable nozzle loads with increased pump size. This is due to interaction of individual pump geometry (i.e., nozzle wall thickness, distance from flange face to nozzle connection with casing, etc.).

^a This is not an ASME size. It is included here as a special Group 1 size that is common among manufacturers.

Table 9.6.2.1.4c — Maximum forces and moments for use with equation set 2 to assess applied loads

ASME B73 Designation	Pump Size	Suction						Discharge					
		Forces (lb)			Moments (lb•ft)			Forces (lb)			Moments (lb•ft)		
		$F_{xs\ max}$	$F_{ys\ max}$	$F_{zs\ max}$	$M_{xs\ max}$	$M_{ys\ max}$	$M_{zs\ max}$	$F_{xd\ max}$	$F_{yd\ max}$	$F_{zd\ max}$	$M_{xd\ max}$	$M_{yd\ max}$	$M_{zd\ max}$
AA	1.5 × 1 × 6	2020	750	750	1830	170	170	2020	1350	6240	410	410	410
AB	3 × 1.5 × 6	2020	1240	2110	2290	490	490	2020	1350	6240	550	550	510
A10	3 × 2 × 6	2020	1050	1050	2290	220	220	2020	1350	6240	1030	1030	510
AA	1.5 × 1 × 8	2020	1210	1210	1830	190	190	2020	1350	6240	360	360	360
—	3 × 1.5 × 8 ^a	2020	1240	1640	2290	490	490	2020	1350	6240	440	440	440
A50	3 × 1.5 × 8	2700	1350	1820	3730	370	370	2020	1350	6240	460	460	460
A60	3 × 2 × 8	2700	1350	2490	3730	600	600	1970	1350	6240	660	660	660
A70	4 × 3 × 8	2700	1350	1840	3730	350	350	2020	1350	6240	1460	1460	690
A05	2 × 1 × 10	2340	960	960	3640	220	220	2020	1350	6240	660	660	660
A50	3 × 1.5 × 10	2700	1350	1910	3730	420	420	1940	1350	6240	370	370	370
A60	3 × 2 × 10	2700	1350	1480	3730	310	310	2020	1350	6240	560	560	560
A70	4 × 3 × 10	2300	1350	1640	3730	310	310	2020	1350	6240	1460	1460	690
A80	6 × 4 × 10	2700	1350	6240	3730	1100	1100	2020	1350	6240	3100	3100	690
A20	3 × 1.5 × 13	2700	1350	3060	3730	670	670	2020	1350	6240	530	530	530
A30	3 × 2 × 13	1920	1230	1230	3730	350	350	2020	1350	6240	1460	1460	690
A40	4 × 3 × 13	2700	1350	2390	3730	400	400	2020	1350	6240	1730	1730	690
A80	6 × 4 × 13	2700	1350	6240	3730	4980	1100	2020	1350	6240	2150	2150	690
A90	8 × 6 × 13	6360	3180	5080	8970	1170	1170	6360	3180	13,460	6780	3850	2840
A100	10 × 8 × 13	6360	3180	13,460	8970	2450	2150	6360	3180	13,460	8970	7220	2840
A110	8 × 6 × 15	6360	3180	6680	8970	1480	1480	6360	3180	13,460	6560	3720	2840
A120	10 × 8 × 15	6360	3180	5130	8970	1130	1130	6360	3180	13,460	8970	9060	2840

^a This is not an ASME size. It is included here as a special Group 1 size that is common among manufacturers.

Table 9.6.2.1.4d — Maximum forces and moments for use with equation set 3 to assess applied loads

Pump Group	Suction						Discharge					
	Forces (lb)			Moments (lb•ft)			Forces (lb)			Moments (lb•ft)		
		$F_{ys\ max}$		$M_{xs\ max}$	$M_{ys\ max}$	$M_{zs\ max}$		$F_{yd\ max}$		$M_{xd\ max}$	$M_{yd\ max}$	$M_{zd\ max}$
Group 1		−2000		900	1200	1250		1500		−500	1500	1250
Group 2		−3500		1300	1300	3000		2500		−1200	1500	3000
Group 3		−5000		1500	2000	4000		3000		−1250	5000	4000

Table 9.6.2.1.4e — Maximum forces and moments for use with equation set 4 to assess applied loads

Pump Group	Suction						Discharge					
	Forces (lb)			Moments (lb•ft)			Forces (lb)			Moments (lb•ft)		
	$F_{xs\ max}$		$F_{zs\ max}$	$M_{xs\ max}$	$M_{ys\ max}$	$M_{zs\ max}$	$F_{xd\ max}$	$F_{yd\ max}$	$F_{zd\ max}$	$M_{xd\ max}$	$M_{yd\ max}$	$M_{zd\ max}$
Group 1	1050		–1250	1500	1200	–2500	800	2000	–3000	–1500	1000	–2500
Group 2	3500		–1500	1500	1300	–3500	1400	2500	–3250	–1500	2150	–3500
Group 3	3500		–2000	1500	4100	–4000	1500	4000	–3500	–1500	5000	–4000

Refer to Section 9.6.2.1.7 for adjustment factors.

9.6.2.1.5 ANSI/ASME B73.3 sealless pump assessment of applied nozzle loads

Assessment of nozzle loads applied to pumps built to ASME B73.3, *Specification for Sealless Horizontal End Suction Centrifugal Pumps for Chemical Process* is identical to ASME B73.1 pumps. Refer to Section 9.6.2.1.4.

9.6.2.1.6 ANSI/ASME B73.5M composite pump assessment of applied nozzle loads

By reducing the values in Tables 9.6.2.1.4b through 9.6.2.1.4e to 90% of their original values, the values are applicable for ASME B73.5 pumps mounted on a grouted metal baseplate with anchor bolts. Use equation sets 1 – 5 with these adjusted values.

If mounting the pump on a base other than a fully grouted metal baseplate with anchor bolts, refer to Section 9.6.2.1.7 for adjustment factor.

9.6.2.1.7 Nozzle load adjustment factors

The loads in the tables must be multiplied by adjustment factors when applicable. The lowest correction factor should be applied when more than one adjustment factor is involved. For instance, if the pump is an ASME B73.5 pump (90% reduction factor) mounted on a fully grouted nonmetallic baseplate (80% reduction factor), then the reduction factor for Tables 9.6.2.1.4b through 9.6.2.1.4e would be 80%.

There may be cases where one adjustment factor is applied to Table 9.6.2.1.4c and another adjustment factor is applied to Tables 9.6.2.1.4d and 9.6.2.1.4e. These cases are denoted in the text.

Refer to Appendix A for further discussion of nozzle load reduction factors.

9.6.2.1.7.1 Alternate pump mounting

For alternate mounting conditions, the pump must be mounted on a base that can, as a minimum, withstand the applied nozzle loads combined with normal operating loads.

9.6.2.1.7.1.1 Stilt-mounted metal baseplate

Use 100% of the values in Table 9.6.2.1.4c and 90% of the values in Tables 9.6.2.1.4d and 9.6.2.1.4e. If after adjusting the value for a particular load in Tables 9.6.2.1.4d and 9.6.2.1.4e, the absolute value of any adjusted value is lower than the corresponding load in Table 9.6.2.1.4b, then substitute the lower value into Table 9.6.2.1.4b. All of the values in Tables 9.6.2.1.4b through 9.6.2.1.4e may be used if it can be demonstrated that the baseplate design (see Figure 9.6.2.1.7.1.1) meets the deflection criteria contained in ANSI/HI 1.3 *Rotodynamic (Centrifugal) Pumps for Design and Application*.