ANSI/HI 9.6.2-2021

American National Standard for

Rotodynamic Pumps

for Assessment of Applied Nozzle Loads

HYDRAULIC INSTITUTE™

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Rotodynamic Pumps for Assessment of Applied Nozzle Loads

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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 Hydraulic Institute are to promote the advancement of the pump manufacturing industry and further the interests of the public and to this end, among other things:

a) Develop and publish standards.

b) Address pump systems.

c) Expand knowledge and resources.

d) Educate the marketplace.

e) Advocate for the industry.

Purpose of Standards and Guidelines

a)Hydraulic Institute Standards and Guidelines 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.

b)Use of Hydraulic Institute Standards and Guidelines 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.”

Definition of a Hydraulic Institute Guideline

A Hydraulic Institute Guideline is not normative. The guideline is tutorial in nature, to help the reader better understand the subject matter.

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 directed to the Technical Director of the Hydraulic Institute. If appropriate, the inquiry will then be directed to the appropriate technical committee for provision of a suitable answer.

Revisions

American National 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.

Disclaimer

This document was prepared by a committee of the Hydraulic Institute and approved by following ANSI essential requirements. Neither the Hydraulic Institute, Hydraulic Institute committees, nor any person acting on behalf of the Hydraulic Institute: 1) makes any warranty, expressed or implied, with respect to the use of any information, apparatus, method, or process disclosed in this document or guarantees that such may not infringe privately owned rights; 2) assumes any liabilities with respect to the use of, or for damages resulting from the use of, any information, apparatus, method, or process disclosed in this guideline. The Hydraulic Institute is in no way

responsible for any consequences to an owner, operator, user, or anyone else resulting from reference to the content of this document, its application, or use.

This document does not contain a complete statement of all requirements, analyses, and procedures necessary to ensure safe or appropriate selection, installation, testing, inspection, and operation of any pump or associated products. Each application, service, and selection is unique with process requirements that shall be determined by the owner, operator, or its designated representative.

Units of measurement

Metric units of measurement are used, and corresponding US customary units appear in parentheses. Charts, graphs, and sample calculations are also shown in both metric and US customary units. Because values given in metric units are not exact equivalents to values given in US customary units, it is important that the selected units of measure to be applied be stated in reference to this standard. If no such statement is provided, metric units shall govern.

Consensus

Consensus for this American National Standard was achieved by use of the canvass method. The following organizations, recognized as having an interest in the standardization of 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.

Hidrostal
4B Engineering & Consulting, LLC
Patterson Pump Company
SULZER
Moving Water Industries (MWI)
Summit Pump, Inc.
Black & Veatch (B & V)
TRWD - Tarrant Regional Water District
West Yost Associates
HRSD - Hampton Roads Sanitation District
WC Livoti Consulting
LVVWD- Las Vegas Valley Water District
Parametrix, Inc.
Kemet Inc.
Xylem Inc. - Applied Water Systems
Brown and Caldwell
Stantec
ITT Pumps
Peerless Pump Company

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 – Lucian Dobrot, Xylem Inc. - Applied Water Systems
Vice-chair – David Skinner, ITT - Industrial Process

Committee members	**Company**
Lloyd Aanonsen	General Rubber Corporation
Paul Boyadjis	Mechanical Solutions, Inc.
Eric Eylat	Flowserve Corporation
Aleksander Roudnev	Weir Minerals North America

9.6.2 Rotodynamic pumps for assessment of applied nozzle loads

9.6.2.1 Introduction

Excessive loads applied to pump nozzles can result in numerous issues that may inhibit safe and reliable operation of the pump. This standard describes the various sources that can cause nozzle loads, the effects these loads can have on a pump, as well as provide manufacturers with suggested techniques and considerations for determining allowable nozzle loads.

Common causes of casing nozzle loads are piping dimensional changes or bend curvature changes due to thermal growth, pressurization strain, Bourdon-tube action, unrestrained discharge lines, installation misalignment, and soft-foot problems.

There are a wide variety of methods to determine how much nozzle load a pump assembly can tolerate in order to function properly. Done properly, manual calculations can provide valid conclusions. More accurate calculations are generally done using the finite element analysis (FEA) method. However, either the manual or computer based methods are only as accurate as the assumptions used and information that is used as input. Lab testing of nozzle loads may be performed to verify actual loads.

9.6.2.1.1 Purpose

This standard induces recommendations for assessment of applied nozzle loads for the the pump types within scope.

9.6.2.1.2 Scope

When specified by the user, pumps within scope that are supplied shall conform to these requirements.

a) Horizontal end suction single stage (ANSI/ASME B73.1 *Specification for Horizontal End Suction Centrifugal Pumps for Chemical Process* and B73.3 *Specification for Sealless Horizontal End Suction Metallic Centrifugal Pumps for Chemical Process*).

b) Vertical in-line single stage (ANSI/ASME B73.2 *Specification for Vertical In-Line Centrifugal Pumps for Chemical Process*).

c) Axially split one and two stage (BB1).

d) Vertically suspended pump single casing discharge through column with diffuser and volute (VS1 and VS2).

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*.

9.6.2.2 Relevance of nozzle loading evaluations

Excessive pump nozzle loads sourced in the piping can induce excessive nozzle stress, casing internal misalignment that could lead to rubbing, and driver/pump misalignment that could lead to high vibration and bearing or seal premature failure. Various international standards specify minimum loading that should be supported by the pump's nozzles using certain acceptance criteria. Manufacturers could also quote maximum nozzle loads that they allow at each pump flange. The loads are in the form of direct forces (vertical, axial, or horizontal) at the flange face, and moments (torques) about those axes.