ANSI/HI 9.6.6-2009

Approved American National Standard

ANSI

American National Standard for

Rotodynamic Pumps

for Pump Piping

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Hydraulic Institute

6 Campus Drive
First Floor North
Parsippany, New Jersey
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www.Pumps.org

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Sponsor

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Approved July 28, 2009

American National Standards Institute, Inc.

American National Standard

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Foreword (Not part of Standard)

Scope

This standard applies to rotodynamic pump types, in all worldwide markets. It provides required and recommended practices for pump piping which, if followed, should reduce the risk of the pump failing to perform properly due to interaction with the system. Excluded is any piping integral to the pump unit, such as auxiliary or lubricant piping. This document is intended to complement ANSI/HI 9.8 *Pump Intake Design*. In order to eliminate the possibility of overlapping and possibly conflicting standards, this document is considered to be applicable as follows:

- All piping downstream and upstream from the pump
- Upstream from the pump this document ceases to be applicable when the pipe enters a tank, vessel, or other intake structure

Purpose and aims of the Hydraulic Institute

The purpose and aims of the Institute are to promote the continued growth of pump knowledge for the interest of pump users and manufacturers and to 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 directed to the Hydraulic Institute. It will direct all such questions to the appropriate technical committee for provision of a suitable answer.

If a dispute arises regarding contents of an 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. The inquiry will then be directed to the appropriate technical committee for provision of a suitable answer.

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.

Disclaimers

This document presents accepted best practices based on information available to the ISO/TC-115 SC-3 Work Group 4 and Hydraulic Institute as of the date of publication. Nothing presented herein is to be construed as a warranty of successful performance under any conditions for any application.

Units of measurement

Metric units of measurement are used and corresponding US customary units appear in brackets. 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 be stated in reference to this standard. If no such statement is provided, metric units shall govern. See Section 9.6.6.8, List of acronyms.

In the application of this standard, the pump rated flow shall be used as the design flow for the basis of the piping design.

In this document references to pipe diameter will be understood to mean the nominal pipe size, not the pipe inside diameter.

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

The following organizations, recognized as having an interest in the standardization of rotodynamic 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
Alden Research Laboratory, Inc.
Berryman & Henigar
Black & Veatch
Brown and Caldwell
Carollo Engineers
CDM
Cheng Fluid Systems
CTE
Diagnostic Solutions, LLC
E.I. duPont de Nemours & Co., Inc.
ENSR International
Fairbanks Morse Pump
Flowserve Pump Division
Fluid Sealing Association
Flygt - ITT Industries
GIW Industries, Inc.
Greeley-Hansen, LLC
Grundfos Pumps Corporation
Healy Engineering
ITT - Res. & Comm. Water Group
ITT Industrial & BioPharm Group
John Anspach Consulting
John Crane Inc.
MechTronix Engineering
Northwest Hydraulic Consultants
Patterson Pump Company
Peerless Pump Company
Pentair Water
Powell Kugler, Inc.
Pumping Machinery, LLC
Reddy-Buffaloes Pump, Inc.
Rockwell Automation
Shell Global Solutions International BV
Sulzer Process Pumps (US) Inc.
Sulzer Pumps (US) Inc.
Suncor Energy Inc.
TACO, Inc.
Tuthill Pump Group
Union Sanitary District
Weir Floway Pumps
Weir Minerals North America
Weir Specialty Pumps
Whitley Burchett & Associates

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:

Co-chairman: Pat Moyer - ITT Bell & Gossett

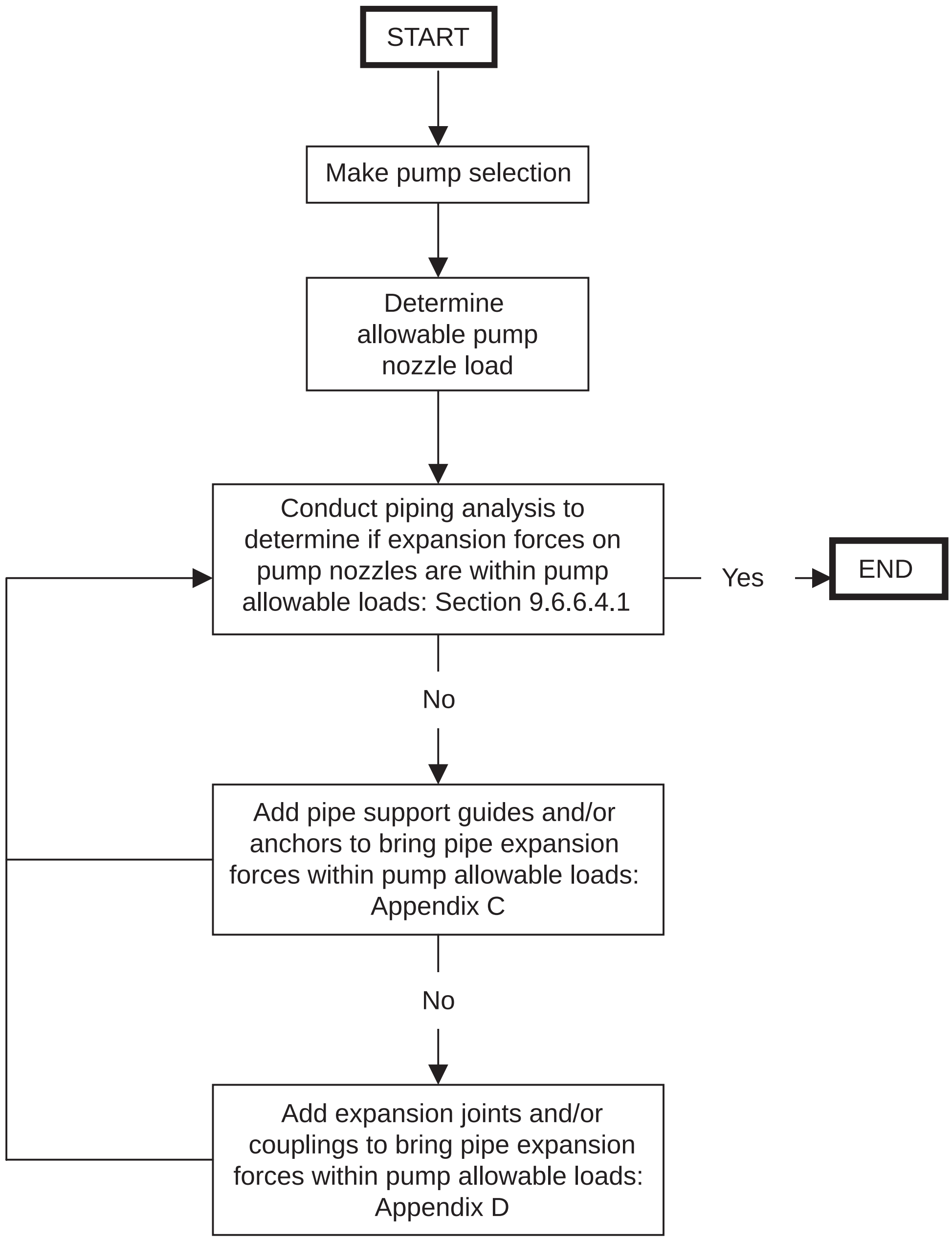
Co-chairman: Tom Angle, Weir Specialty Pumps

Other Members:

Stefan Abelin	ITT Flygt
Charles Allaben	CDM
Ed Allis	Peerless Pumps Co.
John Anspach	John Anspach Consulting
René Barbarulo	David Brown Guinard Pumps
Bill Beekman	Floway Pumps
Alan Budris	Formerly ITT Goulds
Fred Buse	Consultant, Flowserve
Jack Claxton	Patterson Pumps
Mike D'Ambrosia	King County
Tom Hendrey	Whitley Burchett & Associates
Al Iseppon	Pentair Water, Delevan
Garr Jones	Brown & Caldwell
Yuri Khazanov	Yeomans Chigago Corporation
Jim Osborne	A.R. Wilfley & Sons
Y.J. Reddy	Reddy-Buffaloes Pump, Inc.
Y.R. Reddy	Reddy-Buffaloes Pump, Inc.
Jim Roberts	Bell & Gossett – ITT Fluid Technology
Bob Rollings	DuPont
Aleks Roudnev	Weir Slurry North America
Steve Schmitz	ITT Bell & Gossett
Arnold Sdano	Fairbanks Morse Pump
Ernest Sturtz	CDM
Roger Turley	Flowserve

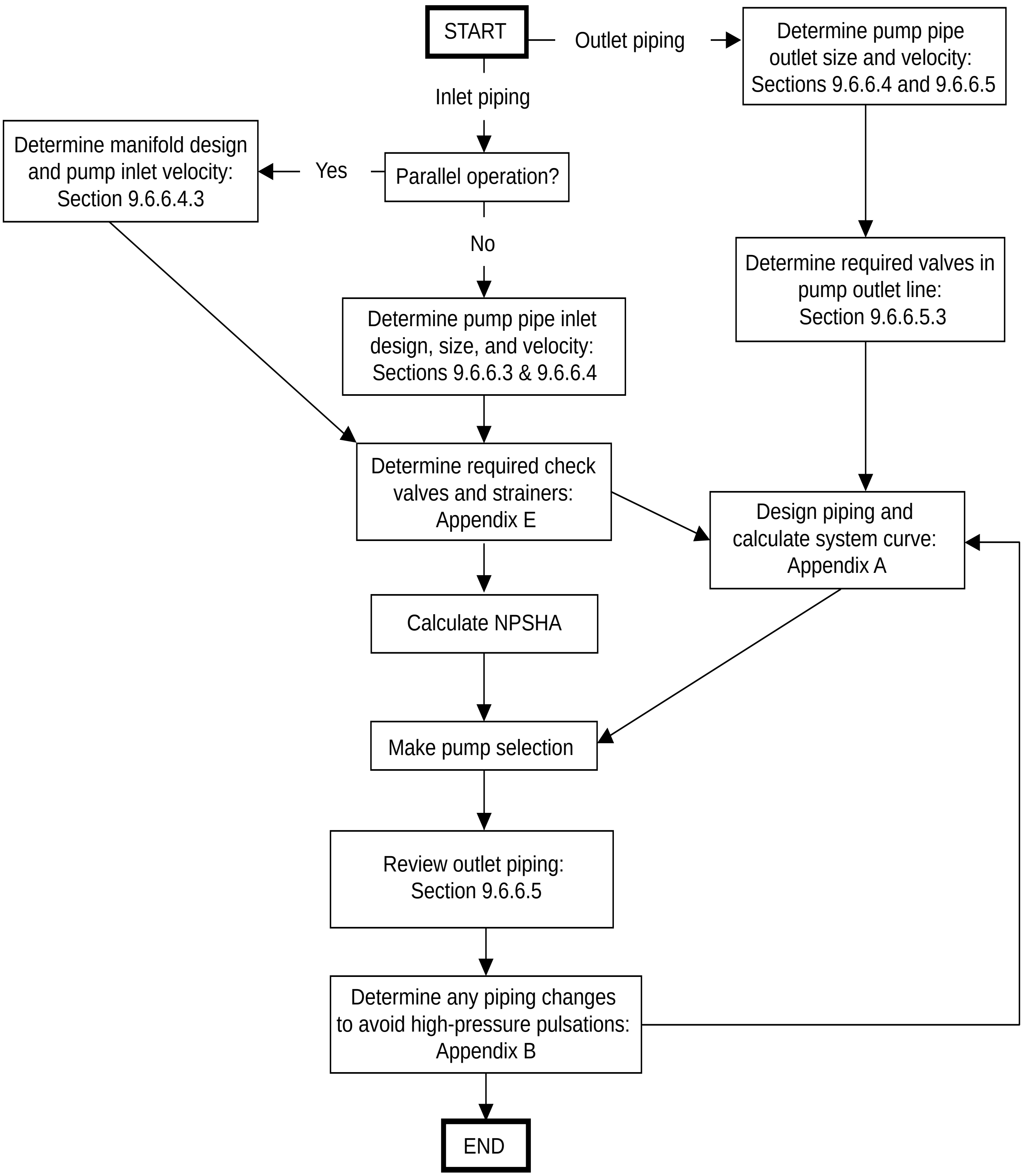
Flowchart for use of standard (mechanical considerations)

NOTE: This flowchart is intended as a guide to the use of this standard and can be used to locate the appropriate sections in this standard. The chart is not a substitute for comprehension of the complete standard.



Flowchart for use of standard (hydraulic considerations)

NOTE: This flowchart is intended as a guide to the use of this standard and can be used to locate the appropriate sections in this standard. The chart is not a substitute for comprehension of the complete standard.



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9.6.6 Pump piping for rotodynamic pumps

9.6.6.1 Objective

The objective of this standard is to provide piping requirements for rotodynamic pump piping, and to educate users about the effects and interactions of inlet (suction) and outlet (discharge) piping on rotodynamic pump performance. The standard covers pump suction liquid conditions, such as the effects of piping on the net positive suction head available (NPSHA) to the pump (which controls cavitation in the pump), the developed pressure of the pump, hydraulic and piping loads on the pump, pump noise, and pump vibration.

9.6.6.2 Introduction

The function of pump piping is to provide a conduit for the flow of liquid to and from a pump, while not adversely affecting the performance or reliability of the pump. In addition it should be noted that a well-designed piping system will usually be more energy efficient than a poorly designed system.

The function of suction piping is to provide a uniform velocity profile or symmetric approaching flow to the pump inlet (suction) connection with sufficient pressure to avoid damaging cavitation in the pump. An uneven distribution of flow is characterized by strong local currents and swirls. The ideal approach is a straight pipe, coming directly to the pump, with no turns or flow-disturbing fittings close to the pump. Failure of the inlet (suction) piping to deliver the liquid to the pump in this condition can lead to noisy operation, random axial load oscillations, premature bearing or seal failure, cavitation damage to the impeller and inlet portions of the casing, and occasionally damage due to liquid separation on the discharge side. See pump intake design standards [1, 2] and *Recommendations for Fitting of Inlet and Outlet on Piping* [3] for additional intake recommendations.

Outlet (discharge) piping flow characteristics normally will not affect the performance and reliability of a rotodynamic pump, with a few exceptions. Sudden valve closures can cause excessively high water-hammer-generated pressure spikes to be reflected back to the pump, possibly causing damage to the pump. Where there may be a sudden closure of a check valve or sudden stopping of the pump, a transient flow analysis may be required (see Section 9.6.6.5.4). Outlet (discharge) piping can affect the starting, stopping, and priming of the pump. The outlet (discharge) piping configuration can also alter any discharge flow recirculation that might extend into the outlet (discharge) piping at very low flow rates.

Three of the more common detrimental effects from poor pump piping details are the excessive loads that the piping can place on a pump because of pipe misalignment with the pump connections, failure to properly restrain the pump to the structure to transfer the unbalanced force generated by the pump, and the weight of unsupported or poorly supported valves and fittings or vertical in-line pumps can place on the piping. Excessive nozzle loads can be caused by thermal expansion of the pipe, unsupported piping and equipment weight, axially unrestricted couplings, and misaligned piping. Excessive pump nozzle loads lead to misalignment of the pump shaft with the driver shaft, mechanical seal failures, bearing failures, binding or rubbing of the pump rotor, and in extreme cases, failure of pump nozzles or feet.

9.6.6.3 Inlet (suction) piping requirements

Inlet flow disturbances, such as swirl, unbalance in the distribution of velocities and pressures, and sudden variations in velocity can be harmful to the hydraulic performance of a pump, its mechanical behavior, and its reliability. Usually the higher the energy level and specific speed of a pump, and the lower the NPSH margin, the more sensitive the pump's performance is to suction conditions.

All inlet (suction) fitting joints shall be tight, especially when the pressure in the piping is below atmospheric, to preclude air leaking into the fluid. Any valves in the inlet (suction) line should be installed with stems horizontal to eliminate the possibility of air accumulation. For pumps operating with a suction lift, the inlet (suction) line should slope constantly upwards toward the pump, with a minimum slope of 1% [11] (Figure 9.6.6.3). For most pumping systems, an inlet (suction) shut-off valve should be installed in the suction piping for system isolation.