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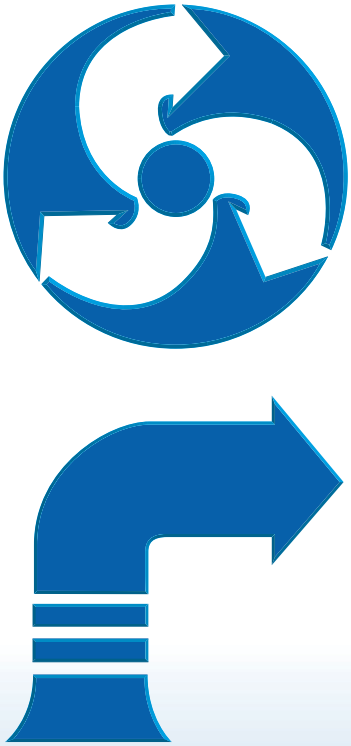

American National Standard for

Rotodynamic Pumps

for Pump Piping

ANSI/HI 9.6.6-2016

Hydraulic INSTITUTE

6 Campus Drive
First Floor North
Parsippany, New Jersey
07054-4406
www.Pumps.org

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Sponsor
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Approved March 23, 2016
American National Standards Institute, Inc.

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Contents

Figures

Tables

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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.

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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.

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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.

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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 his 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.

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Weir Minerals North America
Weir Specialty Pumps
WHEE
Whitley Burchett & Associates
Xylem Inc. - Applied Water Systems
Xylem Inc. - Water Solutions

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:

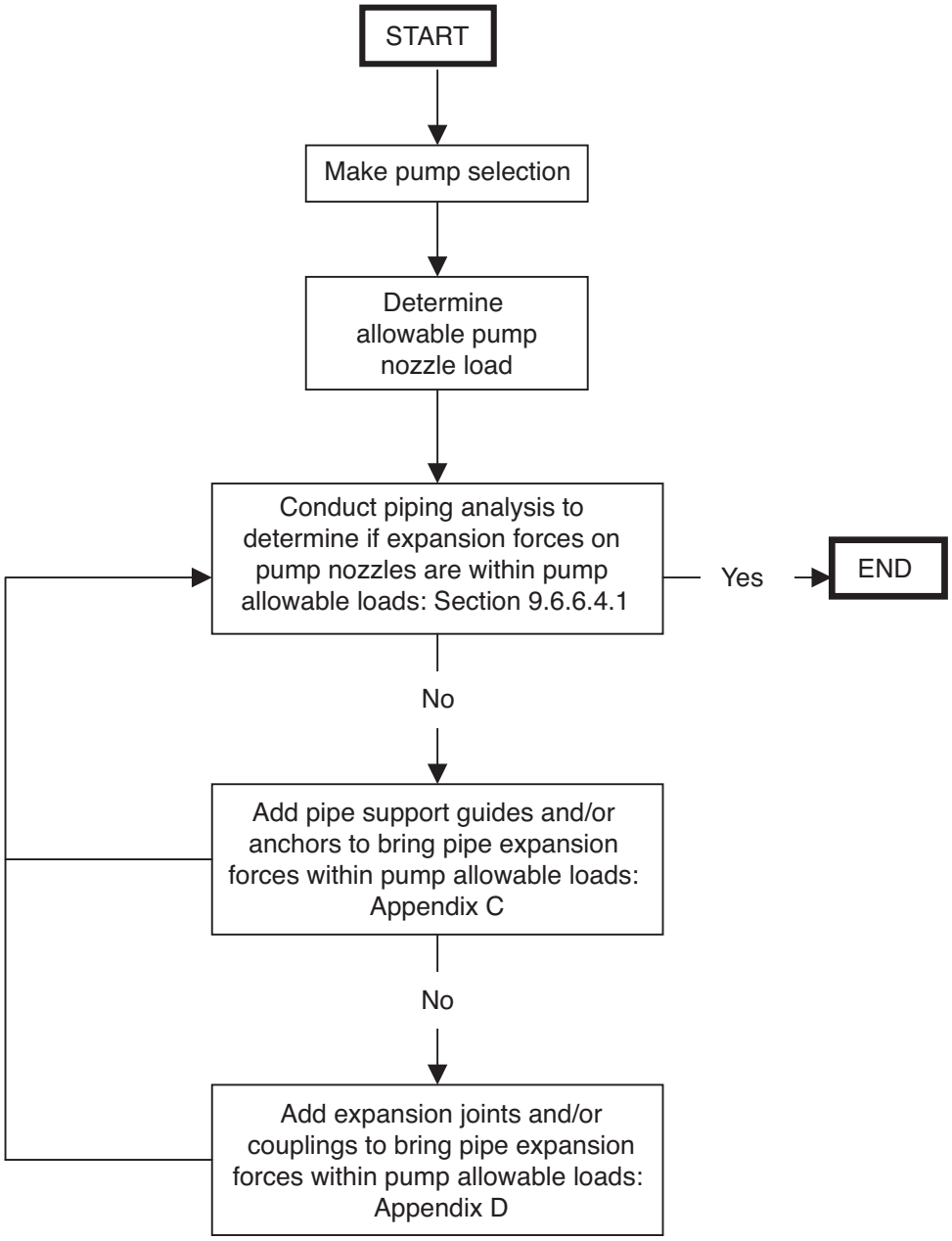
Chair – Patrick Moyer, Weir Minerals North America
Vice-chair – Daniel Boldt, Weir Floway, Inc.

Committee Members	Company
Tom Demlow	Northwest Hydraulic Consultants Inc.
Randy Ferman	ekwestrel corp
Greg Highfill	Flowserve Corporation
Andrew Johansson	Alden Research Laboratory, Inc.
Patricia McCarthy	Xylem Inc. - Water Solutions
Jim Roberts	Xylem, Inc. - Applied Water Systems
Arnie Sdano	Pentair - Fairbanks Nijhuis
Tino Senon	MWH Americas, Inc.
Ernie Sturtz	CDM Smith
Dave Werth	Clemson Engineering Hydraulics, LLC

Alternates	Company
Mark Allen	CDM Smith
Zbigniew Czarnota	Xylem Inc. - Water Solutions
Steve Fehniger	CDM Smith
Carl Frizzell	CDM Smith
Kara Hurtig	Northwest Hydraulic Consultants Inc.
Randy Kosmicki	Weir Minerals North America
Michael Mueller	Flowserve Corporation
Joe Orlins	Alden Research Laboratory, Inc.
George Tey	MWH Americas, Inc.
Fred Walker	Weir Floway, Inc.

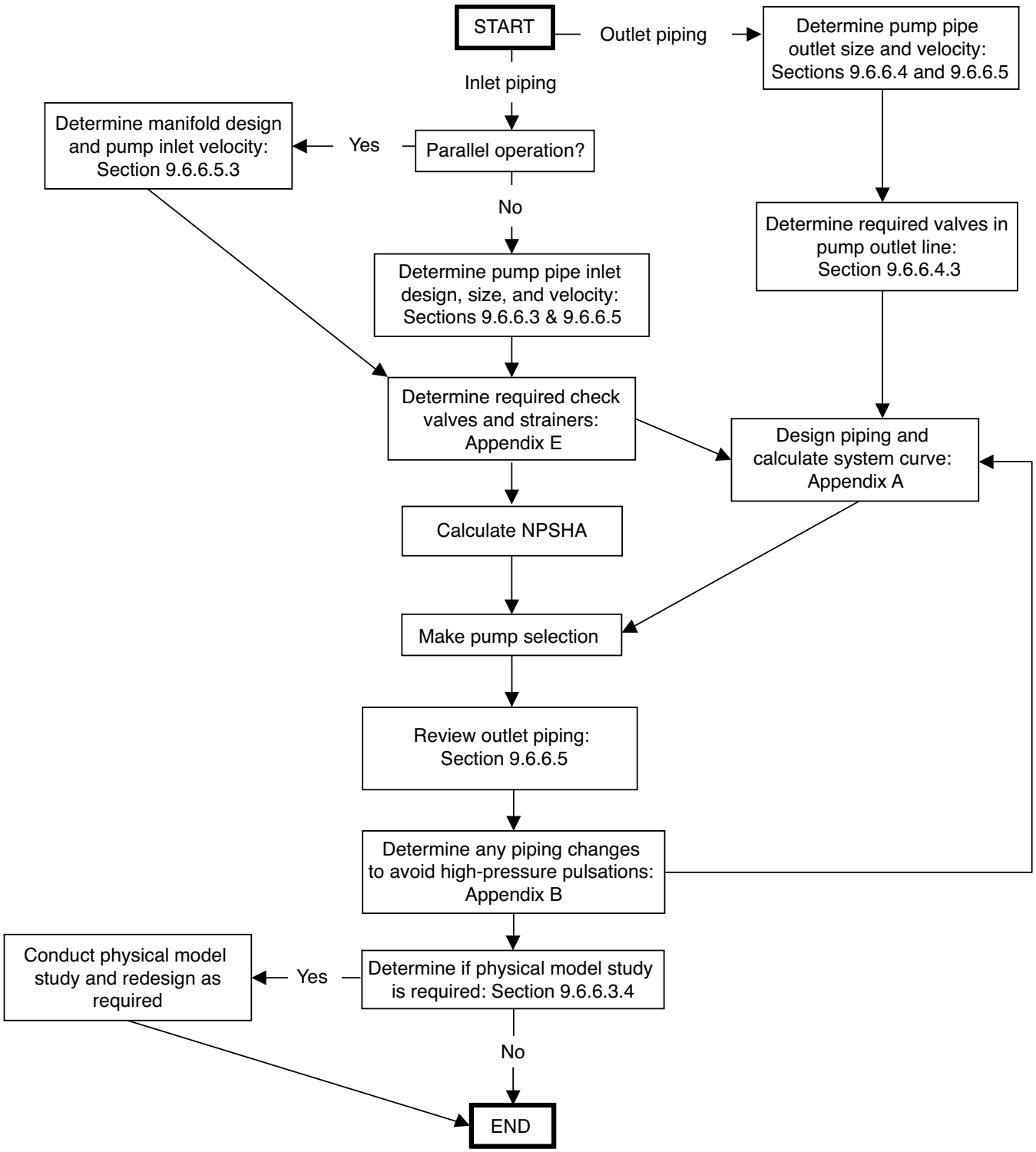
Flowchart for use of standard (mechanical considerations)

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 Rotodynamic pumps for pump piping

9.6.6.1 Scope

This standard applies to rotodynamic pump types, in all worldwide markets. It provides required and recommended practices for pump piping that, 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 *Intake Design for Rotodynamic Pumps*. 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

The objectives of this standard are 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 the following topics as they relate to pump suction and discharge piping: piping effects on fluid suction conditions (such as the effect on net positive suction head available [NPSHA] at pump inlet, which influences cavitation), effects on pressure development of the pump, hydraulic and piping loads on the pump, piping system considerations (water hammer, parallel pump operation, valving, and pipe supports), 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, early onset of suction recirculation, 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 9.6.6.4.4). 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 caused by poor pump piping designs include: 1) excessive loads that the piping can place on a pump because of pipe misalignment with the pump connections, 2) failure to properly restrain the pump to the foundation support structure, and 3) excessive loads on piping resulting from unsupported or poorly supported valves, fittings, or vertical in-line pumps. 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 mounting feet.