Approved American National Standard

ANSI

American National Standard for

Rotodynamic (Centrifugal and Vertical) Pumps

– Guideline for Allowable Operating Region

ANSI/HI 9.6.3-2012

Hydraulic INSTITUTE

6 Campus Drive
First Floor North
Parsippany, New Jersey
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Sponsor
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American National Standard

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Contents

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 of the 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 and guidelines 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 and Guidelines

1) 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.

2) Use of Hydraulic Institute Standards and Guidelines is completely voluntary. Existence of Hydraulic Institute Standards or Guidelines does not in any respect preclude a member from manufacturing or selling products not conforming to these standards or guidelines.

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 guideline will be appreciated, to help the Hydraulic Institute prepare even more useful future editions. Questions arising from the content of this guideline 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 the contents of an Institute Standard or Guideline, or an answer provided by the Institute to a question such as indicated above, the point in question shall be referred to the Technical Director of the Hydraulic Institute, who shall initiate the Appeals Process.

Revisions

The Standards and Guidelines 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 or guidelines are reaffirmed using the ANSI canvass procedure.

Scope

This guideline applies to rotodynamic (centrifugal and vertical) pump types. It describes the effects of operating a rotodynamic pump at rates of flow that are greater or less than the rate of flow at the pump's best efficiency point (BEP).

Units of measurement

Metric units of measurement are used; corresponding US customary units appear in brackets. Charts, graphs, and sample calculations are also shown in both metric and US customary units.

Since 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 guideline. If no such statement is provided, metric units shall govern.

Consensus for this guideline 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 guideline. Inclusion in this list does not necessarily imply that the organization concurred with the submittal of the proposed guideline to ANSI.

4B Engineering
Bechtel Power Corporation
Black & Veatch (B & V)
Brown and Caldwell
DuPont Company
ekwestrel corp
GIW Industries, Inc.
Gorman-Rupp Company
Healy Engineering, Inc.
ITT - Industrial Process
J.A.S. Solutions Ltd.
LVVWD - Las Vegas Valley Water District
Patterson Pump Company
Pentair Water
Powell Kugler, Inc.
Pump Design, Development & Diagnostics, LLC
TACO, Inc.
The Conservation Fund
Wasserman, Horton
Weir Floway, Inc.
Weir Minerals North America
Xylem Inc - Residential & Commercial Water

Committee list

Although this guideline 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 – Arnie Sdano, Pentair Water
Vice-Chair – Charles Cappellino, ITT - Industrial Process

Committee Members	Company
Stefan Abelin	Xylem Inc - Water & Wastewater
Graeme Addie	GIW Industries, Inc.
John Anspach	John Anspach Consulting
Jack Claxton	Patterson Pump Company
Michael Cropper	Sulzer Pumps (US) Inc.
Randal Ferman	ekwestrel corp
Thomas Hendrey	Whitley Burchett & Associates
Allen Hobratschk	National Pump Company
Al Iseppon	Pentair Water
Garr Jones	Brown and Caldwell
Dimitar Kalchev	Peerless Pump Company
Yuri Khazanov	InCheck Technologies Inc
Rodney Mrkvicka	Smith & Loveless, Inc.
Michael Mueller	Flowserve Corporation
James Roberts	Xylem Inc - Residential & Commercial Water
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Michael Coussens	Peerless Pump Company
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Other Contributors	Company
Ed Allis	Peerless Pump Company
Tom Angle	Weir Spec. Pumps
Bill Beekman	Weir Floway, Inc.

9.6.3 Allowable operating region

This guideline discusses the effects of operating a rotodynamic pump at rates of flows greater than or less than the pump's best efficiency point (BEP). These effects influence the power consumption and life of pump components and, therefore, considering the operating rate of flow is essential to reliable, efficient pump operation.

Design characteristics for both performance and service life are optimized near a rate of flow designated as the BEP. At BEP the pump operates with maximum hydraulic efficiency. The pumped liquid passes through the impeller vanes, casing diffuser (discharge nozzle), or vaned diffuser with minimal losses. Flow through the impeller and diffuser vanes (if so equipped) is relatively uniform and matched to the pump hydraulic geometry.

When the operating rate of flow moves far enough away from BEP, the flow through the pump is no longer uniform. Areas of flow recirculation and separation develop increasing hydraulic losses. Nonuniform flow and uneven pressure distributions in the pump result in increased hydraulic loads and vibration.

Pumps operating in the presence of fibrous materials and at low speeds and flows can lead to pump clogging. The minimum rate of flow, used to define the allowable operating region (AOR), may need to be increased to reduce the risk of clogging for these types of applications.

9.6.3.1 Preferred operating region

The preferred operating region (POR) is a range of rates of flow to either side of BEP within which the hydraulic efficiency of the pump is not substantially degraded. Within this region, the design service life of the pump will not be affected by the internal hydraulic loads or flow-induced vibration. Operating a pump within the POR ensures higher reliability and lower energy consumption.

The POR for most rotodynamic pumps is between 70% and 120% of BEP. For smaller pumps, less than 4 kilowatts (kW) (5 horsepower [hp]), or pumps with low specific speeds, $n_s < 15$ ($N_s < 800$), the manufacturer may recommend an alternate POR that could be more expansive or more restrictive. For larger pumps, greater than 1.0 MW, or pumps with an unstable head curve, the manufacturer may recommend a more restrictive POR.

Well-matched flow in higher specific speed pumps occurs in a narrower flow range. The POR for such pumps is shown in Table 9.6.3.1.

Table 9.6.3.1 — Preferred operating region related to specific speed

Specific Speed		Preferred Operating Region (POR)
Metric	US customary	
≤ 87	≤ 4500	Between 70% & 120% of BEP
> 87	> 4500	Between 80% & 120% of BEP

For slurry pumps handling high concentrations of abrasive solids, the generally acceptable range of rates of flow is primarily determined by wear considerations of the wear components. Refer to ANSI/HI 12.1-12.6 *Rotodynamic (Centrifugal) Slurry Pumps for Nomenclature, Definitions, Applications, and Operation* for information.

9.6.3.2 Allowable operating region

A wider range of rates of flow, outside the POR, over which the service life of a pump is acceptable, is designated the allowable operating region (AOR). The limits of AOR are determined by requirements other than energy consumption, and should be defined with the help of the pump manufacturer. Operation in regions that are not fully defined by the pump curve (head, efficiency, and NPSH) should not be undertaken without consultation with the manufacturer.