



American National Standard for

Rotodynamic Centrifugal Pumps

for Nomenclature and Definitions

ANSI/HI 1.1-1.2-2014



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

This page intentionally blank.

American National Standard for

Rotodynamic Centrifugal Pumps

for Nomenclature and Definitions

Sponsor
Hydraulic Institute
www.Pumps.org

Approved October 30, 2014
American National Standards Institute, Inc.

American National Standard

Approval of an American National Standard requires verification by ANSI that the requirements for due process, consensus and other criteria for approval have been met by the standards developer.

Consensus is established when, in the judgement of the ANSI Board of Standards Review, substantial agreement has been reached by directly and materially affected interests. Substantial agreement means much more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered, and that a concerted effort be made toward their resolution.

The use of American National Standards is completely voluntary; their existence does not in any respect preclude anyone, whether he has approved the standards or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not conforming to the standards.

The American National Standards Institute does not develop standards and will in no circumstances give an interpretation of any American National Standard. Moreover, no person shall have the right or authority to issue an interpretation of an American National Standard in the name of the American National Standards Institute. Requests for interpretations should be addressed to the secretariat or sponsor whose name appears on the title page of this standard.

CAUTION NOTICE: This American National Standard may be revised or withdrawn at any time. The procedures of the American National Standards Institute require that action be taken periodically to reaffirm, revise, or withdraw this standard. Purchasers of American National Standards may receive current information on all standards by calling or writing the American National Standards Institute.

Published By

Hydraulic Institute
6 Campus Drive, First Floor North
Parsippany, NJ 07054-4406

www.Pumps.org

Copyright © 2014 Hydraulic Institute
All rights reserved.

No part of this publication may be reproduced in any form,
in an electronic retrieval system or otherwise, without prior
written permission of the publisher.

Printed in the United States of America

ISBN 978-1-935762-19-5



Recycled
paper

Contents

Page

Foreword	vii
Preface	1
1 Rotodynamic centrifugal pumps	1
1.1 Types and nomenclature	1
1.1.1 Scope	1
1.1.2 Definition of rotodynamic centrifugal pumps	1
1.1.3 Types of rotodynamic pumps	1
1.1.4 Impeller designs	8
1.1.5 Construction drawings	11
1.1.6 General information	11
1.1.7 Centrifugal pumps nomenclature	47
1.2 Definitions	65
1.2.1 Rate of flow $[Q]$	68
1.2.2 Speed (n)	68
1.2.3 Head (h) $[H]$	68
1.2.4 Condition points	70
1.2.5 Suction conditions	71
1.2.6 Power	72
1.2.7 Pump pressures	72
1.2.8 Impeller balancing	73
1.2.9 Rotodynamic pump icons	73
Appendix A References	83
Appendix B Standard dimension for HI – NEMA type C face-mounted motors	84
Appendix C Index	91
Figures	
1.1.3a — Rotodynamic pump types - overhung impeller	2
1.1.3b — Rotodynamic pump types - between bearings	3
1.1.3c — Rotodynamic pump types - vertically suspended	4
1.1.3d — Rotodynamic pump types - regenerative turbine	4
1.1.3e — Rotodynamic pump types - circulator pumps	5
1.1.4.1 — General impeller types	10
1.1.4.2 — Double suction radial flow impeller	10
1.1.4.3 — Mixed flow impeller	10
1.1.4.4 — Axial flow impeller	11
1.1.5a — Overhung impeller – flexibly coupled – frame mounted – single stage	12
1.1.5b — Overhung impeller – flexibly coupled – horizontal – frame mounted – single stage – lined pump	13
1.1.5c — Overhung impeller – flexibly coupled – horizontal – foot mounted – single stage – stock pump	14
1.1.5d — Overhung impeller – flexibly coupled – horizontal – foot mounted – single stage	15
1.1.5e — Overhung impeller – flexibly coupled – horizontal – foot mounted – single stage – ASME B73.1	16
1.1.5f — Overhung impeller – flexibly coupled – horizontal – foot mounted – self-priming – single stage	17
1.1.5g — Overhung impeller – flexibly coupled – horizontal – centerline mounted – single stage – API 610	18

1.1.5h — Overhung impeller — flexibly coupled — vertical — in-line — integral bearing frame — single stage	19
1.1.5i — Overhung impeller — flexibly coupled — vertical — end suction — single stage — OH3A	20
1.1.5j — Overhung impeller — rigidly coupled — vertical — in-line — single stage	21
1.1.5k — Overhung impeller — close coupled — vertical — in-line — single stage (showing seal and packing)	22
1.1.5l — Overhung impeller — close coupled — vertical — end suction — single stage — vertically mounted — OH5A.	23
1.1.5m — Overhung impeller — close coupled — high-speed integral gear — single stage	24
1.1.5n — Overhung impeller — close coupled — horizontal — single stage — end suction	25
1.1.5o — Overhung impeller — close coupled — submersible — diffuser — single stage — end suction	26
1.1.5p — Overhung impeller — close coupled — submersible — volute — single stage — end suction	27
1.1.5q — Overhung impeller — flexibly coupled — horizontal — axial flow — single stage	28
1.1.5r — Between bearings — single stage — axially split pump	29
1.1.5s — Between bearings — single stage — radially split pump	30
1.1.5t — Between bearings — multistage — axially split pump	31
1.1.5u — Between bearings — multistage — radially split — single casing pump	32
1.1.5v — Between bearings — multistage — radially split — double casing pump	33
1.1.5w — Regenerative turbine — overhung side channel	34
1.1.5x — Regenerative turbine — overhung peripheral	35
1.1.5y — Regenerative turbine — between bearings — peripheral	36
1.1.5z — Pitot tube pump	37
1.1.5aa — Close-coupled sealless with canned motor	38
1.1.5bb — Close-coupled horizontal in-line	39
1.1.5cc — Flexibly coupled horizontal in-line	40
1.1.6.5.1.1 — Liquid end (or wet end) assembly	41
1.1.6.5.1.2 — Power end (or frame assembly)	42
1.1.6.5.1.3 — Back pull-out assembly	43
1.1.6.6 — Position of casing and shaft rotation	44
1.1.6.7a — Horizontal pump — shaft rotation (CW rotation)	45
1.1.6.7b — Vertical pump — shaft rotation (CW rotation)	45
1.1.6.8 — Pump with C-frame motor adapter, short coupled	46
1.1.7.2a — Overhung impeller — flexibly coupled — single stage — frame mounted	59
1.1.7.2b — Overhung impeller — flexibly coupled — single stage — frame mounted — pump on baseplate.	59
1.1.7.2c — Overhung impeller — flexibly coupled — single stage — centerline mounted	60
1.1.7.2d — Overhung impeller — flexibly coupled — single stage — centerline mounted — pump on baseplate	60
1.1.7.2e — Overhung impeller — flexibly coupled — single stage — centerline mounted (top suction)	61
1.1.7.2f — Overhung impeller — flexibly coupled — single stage — centerline mounted — pump on baseplate (top suction)	61
1.1.7.2g — Impeller between bearings — flexibly coupled — single stage — axial (horizontal) split case — pump on baseplate	62
1.1.7.2h — Impeller between bearings — flexibly coupled — single stage — axial (horizontal) split case	62
1.1.7.2i — Overhung impeller — close coupled — single stage — end suction	63
1.1.7.2j — Overhung impeller — flexibly coupled — vertical — end suction — single stage — separate driver support	63
1.1.7.2k — Overhung impeller — flexibly coupled — vertical — end suction — single stage — integral driver support	64
1.1.7.2l — Overhung impeller — close coupled — single stage — vertical end suction	64
1.2.3.4 — Datum elevation for various pump designs at eye of first-stage impeller	69
1.2.9.1.1 — Pump type OH00: Horizontal, flexibly coupled, axial flow, single stage, overhung design	74

1.2.9.1.2 — Pump type OH0: Horizontal, frame mounted, flexibly coupled, single stage, overhung design	74
1.2.9.1.3 — Pump type OH1: Horizontal, foot mounted, single stage, overhung design	74
1.2.9.1.4 — Pump type OH2: Horizontal, centerline mounted, single stage, overhung design.	75
1.2.9.1.5 — Pump type OH3: Vertical, in-line mounted, single stage, with integral bearing bracket	75
1.2.9.1.6 — Pump type OH4: Vertical, in-line mounted, single stage, rigidly coupled to the driver shaft	76
1.2.9.1.7 — Pump type OH5: Vertical, in-line mounted, single stage, close coupled to the driver shaft.	76
1.2.9.1.8 — Pump type OH6: High-speed, integral gear driven, single stage, overhung design	77
1.2.9.1.9 — Pump types OH8A and OH8B	77
1.2.9.1.10 — Pump types OH9, OH10, OH11, and OH12.	78
1.2.9.2.1 — Pump type BB1: Horizontal, axial split, single and two stage, between-bearings design	78
1.2.9.2.2 — Pump type BB2: Horizontal, radial split, single and two stage, between-bearings design	78
1.2.9.2.3 — Pump type BB3: Horizontal, axial split, multistage, between-bearings design.	79
1.2.9.2.4 — Pump type BB4: Horizontal, radially split, multistage, between-bearings design	79
1.2.9.2.5 — Pump type BB5: Horizontal, radially split, multistage, double casing, between-bearings design . . .	79
1.2.9.4.1 — Pump type RT1: Overhung, close-coupled, side channel design	80
1.2.9.4.2 — Pump type RT2: Overhung, close-coupled, peripheral design	80
1.2.9.4.3 — Pump type RT3: Between-bearing, flexibly coupled, side channel design	80
1.2.9.4.4 — Pump type RT4: Between-bearing, flexibly coupled, peripheral design	81
1.2.9.5.1 — Pitot tube (rotating casing) pump	81
1.2.9.6.1 — Pump type CP1: Close-coupled sealless with canned motor.	81
1.2.9.6.2 — Pump type CP2: Close-coupled horizontal in-line	82
1.2.9.6.3 — Pump type CP3: Flexibly coupled horizontal in-line	82
1.2.9.1.10 — Pump types OH9, OH10, OH11, and OH12.	83
B.1 — Dimensions for types JM and JP, alternating current, face-mounting, close-coupled pump motors having rolling element contact bearings.	86
B.2 — Standard dimensions for HI – NEMA type HP and HPH vertical, solid-shaft motors	90
Tables	
1.1.3.1 — Overhung impeller pump attributes	6
1.1.7.1a — Centrifugal pump nomenclature – alphabetical listing.	47
1.1.7.1b — Centrifugal pump nomenclature – numerical listing.	56
1.2a — Principal symbols	65
1.2b — Subscripts	67
B.1 — Dimensions for type JM, alternating current, face-mounting, close-coupled pump motors (US customary units).	85
B.2 — Dimensions for type JP, alternating current, face-mounting, close-coupled pump motors (US customary units).	87
B.3 — Open drip-proof frame selections	88
B.4 — Standard dimensions for HI – NEMA type HP and HPH vertical solid-shaft motors (US customary units).	89

This page intentionally blank.

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 users and 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 directed 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 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, 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 in accordance with the *ANSI Essential Requirements*.

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 to be applied be stated in reference to this standard. If no such statement is provided, metric units shall govern.

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.

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:

Co-Chair – Michael L. Mueller, Flowserve Corporation
Co-Chair – Bruce Ticknor, III, National Pump Company

Committee Members

Michael Coussens
Michael S. Cropper
Lucian Dobrot
Al Iseppon
Christopher P. Rackham
Aleksander S. Roudnev
Joseph M. Salah

Company

Peerless Pump Company
Sulzer Pumps (US) Inc.
TACO, Inc.
Pentair - Berkeley
John Crane Inc.
Weir Minerals North America
Sulzer Pumps Solutions Inc.

Alternates

Christopher S. Johnson, Xylem Inc.

Company

Applied Water Systems

Preface

This document has been created to provide a standard for nomenclature and definitions for centrifugal pumps for various pumps configurations and services.

Symbols are used throughout this standard to identify the pump types. When originally introduced, the convention is to define the term in text, followed by the HI symbol in parenthesis (xx) and, when different, the ISO symbol is in brackets [xx].

Standard ANSI/HI 1.3 *Rotodynamic Centrifugal Pumps for Design and Applications* complements the nomenclature and definitions content in this document with detailed information about the design and application of rotodynamic centrifugal pumps.

1 Rotodynamic centrifugal pumps

1.1 Types and nomenclature

Rotodynamic pumps may be classified by such methods as impeller or casing configuration, end application of the pump, specific speed, or mechanical configuration. The method used in Figure 1.1.3a is based primarily on mechanical configuration.

1.1.1 Scope

This standard covers rotodynamic pumps with centrifugal (radial), mixed flow, and axial flow impellers, as well as regenerative turbine and Pitot tube type pumps, of all industrial/commercial types except vertically suspended diffuser turbine pumps. It contains description of types, nomenclature, and definitions.

1.1.2 Definition of rotodynamic centrifugal pumps

Rotodynamic pumps are kinetic machines in which energy is continuously imparted to the pumped fluid by means of a rotating impeller, propeller, or rotor. The most common types of rotodynamic pumps are centrifugal (radial), mixed flow, and axial flow pumps.

Centrifugal pumps use bladed impellers with essentially radial outlet to transfer rotational mechanical energy to the fluid primarily by increasing the fluid kinetic energy (angular momentum). Kinetic energy is then converted into pressure energy in the discharge collector.

1.1.3 Types of rotodynamic pumps

Rotodynamic pumps are commonly typed by their general mechanical configuration (see Figures 1.1.3a, b, c, d, and e). The broadest characteristics are discussed in the following paragraphs:

1.1.3.1 Overhung impeller type (OH)

In this group, the impeller(s) is mounted on the end of a shaft that is cantilevered or “overhung” from its bearing supports.

These pumps are either close coupled, where the impeller is mounted directly on the driver shaft; or separately coupled, where the impeller is mounted on a separate pump shaft supported by its own bearings. See Table 1.1.3.1 for a listing of OH pump types and their attributes.

1.1.3.1.1 Close coupled (OH5, OH5A, OH6, OH7, OH8A, OH8B, OH9, and OH10)

Close-coupled pumps are commonly characterized by the following attributes:

The pump and driver share one common shaft; the driver bearings absorb all pump thrust loads (axial and radial). The driver is aligned and assembled directly to the pump unit with machined fits.