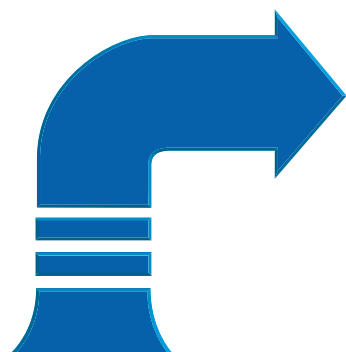




American National Standard for

Rotodynamic Vertical Pumps

for Manuals Describing Installation,
Operation, and Maintenance

ANSI/HI 2.4-2014



6 Campus Drive
First Floor North
Parsippany, New Jersey
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Rotodynamic Vertical Pumps

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Sponsor
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Approved May 16, 2014
American National Standards Institute, Inc.

American National Standard

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Foreword (Not part of Standard)

Scope

The purpose and aims of the Institute are to promote the continued growth of pump knowledge for the interest of pump 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 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 content 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 using the ANSI canvass procedure.

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. 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 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 vertical 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 & Consulting, LLC	Las Vegas Valley Water District
A.W. Chesterton Company	MWH Americas, Inc.
Black & Veatch Corp.	Peerless Pump Company
Brown and Caldwell	Pentair
DuPont Company	Sulzer Pumps (US) Inc.
ekwestrel corp	Summit Pump, Inc
Healy Engineering, Inc.	Weir Floway
John Anspach Consulting	Weir Minerals Hazleton, Inc.
Kemet Inc.	Weir Minerals North America
King County Wastewater Treatment Division	Zan Kugler P.E., LLC

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 - Mark Rosebraugh, Yeomans Chicago Corporation
Co-Chair - Paul Ruzicka, Xylem Inc. - Applied Water Systems

Committee Members

James Bonifas
Michael Coussens
Michael Cropper
Michael Cugal
Allen Hobradsch
Al Iseppon
Michael Mueller
Arnold Sdano
Bruce Ticknor, III (Alternate)
Fred Walker

Company

Nidec Motor Corporation
Peerless Pump Company
Sulzer Pumps (US) Inc.
Weir Hazleton, Inc.
National Pump Company
Pentair
Flowserve Corporation
Fairbanks Nijhuis
National Pump Company
Weir Floway, Inc.

2.4 Manuals describing installation, operation, and maintenance

2.4.1 Introduction

The normative portion of this standard is prescriptive in nature and thereby mandatory for compliance to this standard; it includes a standard outline for manufacturers' installation, operation, and maintenance (IOM) manuals.

Appendix A, a collection of IOM reference information arranged per the new standard outline, is informative and not mandatory for compliance to this standard. Pump users should refer to the manufacturers' IOM manuals for IOM information specific to their equipment.

The objective of this standard was to establish a standard outline for IOM manuals in order to help pump users locate IOM information.

2.4.2 Scope

This standard applies to IOM manuals for rotodynamic (vertical) pumps including the following:

- a) Vertical, axial flow, lineshaft (VS3).
- b) Vertical, diffuser, deep well (VS1).
- c) Vertical, diffuser, short set (VS1).
- d) Vertical, diffuser, can-mounted (VS6).
- e) Vertical, diffuser, submersible, deep well (VS0).
- f) Vertical, diffuser, submersible, short set (VS0).
- g) Vertical, diffuser, double casing, in-line, floor mounted (VS8).
- h) Vertical, volute, double suction, wet pit (VS2).
- i) Vertical, volute, double suction, can type (VS7).
- j) Vertical, volute, multistage axial split, can type (VS7a).
- k) Vertical, sump, lineshaft (VS4).
- l) Vertical, sump, cantilever (VS5).

The standard outline shall be used when writing IOM manuals. The subtopics within each section shall be addressed when appropriate for the specific pump.

Installation, operation, and maintenance manuals shall be comprised of nine sections. Each section must appear in the IOM manual and in the sequence shown. The topics that appear under each section may be combined and/or arranged to meet the specific needs of the product being addressed. Not all of the topics listed are applicable for all products and therefore, need not be included in every IOM manual for all products.

2.4.3 Standard outline for IOM manuals

A.1 Introduction and safety

- A.1.1 Marking and approvals
- A.1.2 Safety
 - A.1.2.1 Explanation of designations (safety terminology and symbols)

- A.1.2.2 General guidelines
- A.1.2.3 Safety labels
- A.1.2.4 Material safety data sheets (MSDSs)
- A.1.2.5 Noise level data
- A.1.2.6 Rigging and lifting

A.2 Transport and storage

- A.2.1 Transport and handling requirements (g-forces)
- A.2.2 Rigging and lifting
- A.2.3 Receipt, inspection, and damage reporting
- A.2.4 Unpacking
- A.2.5 Storage (short term and long term, inside and outside)
- A.2.6 Disposal of packaging materials

A.3 Product description

- A.3.1 Configuration
 - A.3.1.1 Pump, driver, baseplate or soleplate, coupling, etc.
- A.3.2 Nomenclature
 - A.3.2.1 Nameplate information
 - A.3.2.2 Pump
 - A.3.2.3 Parts
- A.3.3 Auxiliaries
- A.3.4 Support systems

A.4 Installation

- A.4.1 Factory support requirements (field engineer, technician)
- A.4.2 Location
- A.4.3 Foundation
 - A.4.3.1 Construction
- A.4.4 Rigging and lifting
- A.4.5 Baseplate (soleplate or pump)
 - A.4.5.1 Leveling
 - A.4.5.2 Grouting
- A.4.6 Piping and connections
 - A.4.6.1 Piping, general guidelines
 - A.4.6.2 Nozzle loads
 - A.4.6.3 Check valves
 - A.4.6.4 Strainers
- A.4.7 Clearance setting
- A.4.8 Alignment
 - A.4.8.1 Auxiliary (driver, coupling, etc.)
 - A.4.8.2 Hot alignment considerations (prealignment and realignment)
- A.4.9 Lubrication, priming, and cooling systems
- A.4.10 Electrical
- A.4.11 Control, monitoring, and alarm equipment (hardware)

A.5 Commissioning, start-up, operation, and shut-down

- A.5.1 Lubrication
- A.5.2 Rotation
- A.5.3 Guarding
- A.5.4 Checklist – start-up
 - A.5.4.1 System flushing
 - A.5.4.2 Priming by ejector or exhauster
 - A.5.4.3 Priming by vacuum pumps
 - A.5.4.4 Shaft sealing settings and adjustments (mechanical seals, packing, etc.)
- A.5.5 Start-up, operation, and shut-down
 - A.5.5.1 Minimum continuous flow

- A.5.5.2 Minimum thermal flow
- A.5.5.3 Lubrication system settings
- A.5.5.4 Drive system settings
- A.5.5.5 Valve settings and operation (timing)
- A.5.5.6 Condition monitoring
- A.5.5.7 Vibration (alarms and trip points)
- A.5.5.8 Performance testing/verification
- A.5.5.9 Bearing temperature

A.6 Maintenance

- A.6.1 Schedule
- A.6.2 Recommended spare parts
- A.6.3 Consumables
- A.6.4 Required tools and fixtures
- A.6.5 Fastener torques, rotation direction, and sequence
- A.6.6 Pump decontamination
- A.6.7 Disassembly
- A.6.8 Inspection
 - A.6.8.1 Acceptance criteria and dimensions
 - A.6.8.2 Shaft straightening
 - A.6.8.3 Wear-ring resurfacing
- A.6.9 Assembly
 - A.6.9.1 Clearances
- A.6.10 Auxiliary equipment – see separate documentation

A.7 Troubleshooting guide

- A.7.1 Hydraulic performance
 - A.7.1.1 Pressure
 - A.7.1.2 Flow
 - A.7.1.3 Power
- A.7.2 Mechanical
 - A.7.2.1 Vibration
 - A.7.2.2 Bearing temperature
 - A.7.2.3 Noise
- A.7.3 Electrical, instrumentation, and controls

A.8 Parts listing and cross-sectional drawings

A.9 Certification

Appendix A

Installation, operation, and maintenance manual reference information

This appendix is **not** part of this standard, but is presented as a guideline for the development of an installation, operation, and maintenance manual that complies with the requirements of the standard. The content is **not** intended to be copied verbatim, but should be thoroughly reviewed and properly tailored to the subject equipment.

A.1 Introduction and safety

Vertical pumps, when properly installed and operated, and when given reasonable care and maintenance, will operate satisfactorily for a long period of time. The following paragraphs outline the general principles that should be considered to ensure trouble-free pump operation.

Vertical pumps are built in a wide variety of designs and for many different services. The manufacturer's instruction book should be studied carefully and followed, as there may be specific requirements for a particular machine or application that cannot be covered in a general discussion.

The installation and service manual and/or special instructions included in the shipment should be read thoroughly before installing or operating the equipment. All instructions regarding maintenance should be retained for reference.

A.1.1 Marking and approvals (UL, CSA, NSF, CE, ATEX, etc.)

It is a legal requirement that machinery and equipment put into service within certain regions of the world shall conform to the applicable standards. Some examples are UL; CSA; NSF; CE marking directives, where applicable; low-voltage equipment; Electromagnetic Compatibility (EMC); Pressure Equipment Directive (PED); and equipment for potentially explosive atmospheres (ATEX).

Where applicable the directives and any additional approvals cover important safety aspects relating to machinery and equipment and the satisfactory provision of technical documents and safety instructions. To confirm that the product has required listings and meets required directives and approvals, check for markings on product nameplates, labels, and the certification (see Section A.9).

A.1.2 Safety

Legal requirements and local regulations may differ substantially with regard to particular safety requirements and may be regularly modified by relevant authorities without notice. As a consequence, applicable laws and regulations should be consulted to ensure compliance. The following cannot be guaranteed as to its completeness or continuing accuracy.

A.1.2.1 Explanation of designations (safety terminology and symbols)

These user instructions contain specific safety markings where nonobservance of an instruction would cause hazards. The specific safety markings are:



DANGER

This symbol indicates electrical safety instructions where noncompliance will involve a high risk to personal safety or the loss of life.



This symbol indicates safety instructions where noncompliance would affect personal safety and could result in loss of life.



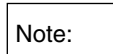
This symbol indicates “hazardous and toxic fluid” safety instructions where noncompliance would affect personal safety and could result in loss of life.



This symbol indicates safety instructions where noncompliance will involve some risk to safe operation and personal safety and/or would damage the equipment or property.



This symbol indicates explosive atmosphere zone marking according to ATEX. It is used in safety instructions where noncompliance in the hazardous area would cause the risk of an explosion.



This sign is not a safety symbol but indicates an important instruction in the assembly process.

A.1.2.2 General guidelines



These instructions must always be kept close to the product’s operating location or directly with the product.

These instructions are intended to facilitate familiarization with the product and its permitted use. Operating the product in compliance with these instructions is important to help ensure reliability in service and avoid risks. The instructions may not reflect all current legal requirements and local regulations; ensure that such requirements and regulations are observed by all, including those installing the product. Always coordinate repair activity with operations personnel, and follow all plant safety requirements and applicable safety and health laws/regulations.



These instructions should be read prior to installing, operating, using, and maintaining the equipment in any region worldwide. The equipment must not be put into service until all the conditions relating to safety noted in the instructions have been met.

Information in these user instructions is believed to be reliable. In spite of all the efforts to provide sound and necessary information, the content of this manual may appear insufficient and is not guaranteed as to its completeness or accuracy.

Products are manufactured to exacting international quality management system standards as certified and audited by external quality assurance organizations. Genuine parts and accessories have been designed, tested, and incorporated into the products to help ensure their continued product quality and performance in use. Incorrect incorporation of substitute parts from other suppliers and accessories may adversely affect the performance and safety features of the products. The failure to properly select, install, or use authorized parts and accessories is considered misuse. Damage or failure caused by misuse is not covered by the warranty. In addition, modification of products or removal of original components may impair the safety of these products in their use.



The product must not be operated beyond the parameters specified for the application. If there is any doubt as to the suitability of the product for the application intended, contact the manufacturer for advice, quoting the serial number.

If the agreed on conditions of service are going to be changed (for example, liquid pumped, temperature, or duty), it is recommended that the user seek the manufacturer’s written agreement before start-up.

A.1.2.3 Safety labels

A.1.2.3.1 Personnel qualification and training

All personnel involved in the operation, installation, inspection, and maintenance of the unit must be qualified to carry out the work involved. If the personnel in question do not already possess the necessary knowledge and skill, appropriate training and instruction must be provided.

If required, the operator may commission the manufacturer/supplier to provide applicable training.

Always coordinate repair activity with operations and health and safety personnel, and follow all plant safety requirements and applicable safety and health laws and regulations.

A.1.2.3.2 Safety action

This is a summary of conditions and actions to prevent injury to personnel and damage to the environment and to equipment.



DANGER

NEVER DO MAINTENANCE WORK WHEN THE UNIT IS CONNECTED TO POWER



GUARDS MUST NOT BE REMOVED WHILE THE PUMP IS OPERATIONAL



DRAIN THE PUMP AND ISOLATE PIPEWORK BEFORE DISMANTLING THE PUMP

The appropriate safety precautions should be taken where the pumped liquids are hazardous.



FLUORO-ELASTOMERS (When fitted.)

When a pump is subjected to temperatures over 250 °C (482 °F), partial decomposition of fluoro-elastomers (for example, Viton) will occur. In this condition, these are extremely dangerous and skin contact must be avoided.



HANDLING COMPONENTS

Many precision parts have sharp corners, thus wearing appropriate safety gloves and equipment is required when handling these components. To lift heavy pieces above 25 kg (55 lb), use a crane appropriate for the mass and in accordance with current local regulations.



THERMAL SHOCK

Rapid changes in the temperature of the liquid within the pump can cause thermal shock that can result in damage or breakage of components and should be avoided.



APPLYING HEAT TO DISASSEMBLE A PUMP

If heat is used to disassemble a pump, then it must be applied with great care. For example, there may be occasions when the impeller has either been shrunk to fit onto the pump shaft or has become difficult to remove due to corrosive products. Before applying heat to remove an impeller, ensure any residual hazardous liquid trapped between the impeller and pump shaft is thoroughly drained out through the impeller keyway to prevent an explosion or emission of toxic vapor.

Because impeller design varies, so does temperature, location, and duration of heat application. Contact the manufacturer for help.

UNDER NO CIRCUMSTANCE SHOULD HEAT BE USED TO EXPAND OR CUT A THREADED IMPELLER FROM THE SHAFT. Personal injury and damage to equipment could occur as a result of an explosion. A shaft wrench may be necessary to assist with impeller removal. Special tools may also be required to service the product and may be sourced from the manufacturer or need to be fabricated.



HOT (and COLD) PARTS

If hot or freezing components or auxiliary heating supplies can present a danger to operators and persons entering the immediate area, then action must be taken to avoid accidental contact. If complete protection is not possible, the machine access must be limited to maintenance staff only, with clear visual warnings and indicators to those entering the immediate area. Note: Bearing housings must not be insulated and drive motors and bearings may be hot.

If the temperature is greater than 54 °C (130 °F) or below 5 °C (41 °F) in a restricted zone, or exceeds local regulations, action as above shall be taken.



HAZARDOUS LIQUIDS

When the pump is handling hazardous liquids, care must be taken to avoid exposure to the liquid by appropriate setting of the pump, limiting personnel access, and by operator training. If the liquid is flammable and/or explosive, strict safety procedures must be applied.

Gland packing must not be used when pumping hazardous liquids.



CAUTION PREVENT EXCESSIVE EXTERNAL PIPE LOAD

Do not use pump as a support for piping. Do not mount expansion joints, unless allowed by the manufacturer in writing, so that their force, due to internal pressure, acts on the pump flange.



CAUTION ENSURE CORRECT LUBRICATION

(See Section A.5, Commissioning, start-up, operation, and shut-down.)



CAUTION START THE PUMP AT REDUCED SPEED OR WITH THE OUTLET VALVE PARTLY OPENED

(Unless otherwise instructed at a specific point in the user instructions.)

This is recommended to minimize the risk of overloading and damaging the pump motor at full or zero flow. Pumps may be started with the valve further open only on installations where this situation cannot occur. The pump outlet control valve may need to be adjusted to comply with the duty following the run-up process. (See Section A.5, Commissioning, start-up, operation, and shut-down.)



CAUTION NEVER RUN THE PUMP DRY



CAUTION SUCTION VALVES TO BE FULLY OPEN WHEN PUMP IS RUNNING

Running the pump at a flow rate below the manufacturer's recommended minimum flow rate will cause damage.



CAUTION DO NOT RUN THE PUMP CONTINUOUSLY OUTSIDE THE ALLOWABLE OPERATING REGION

Operating at a flow rate higher than normal or at a flow rate with no backpressure on the pump may overload the motor and cause cavitation. Low flow rates may cause a reduction in pump/bearing life, overheating of the pump, instability, and cavitation/vibration.

A.1.2.3.2.1 Products used in potentially explosive atmospheres



Measures are required to:

- Avoid excess temperature
- Prevent buildup of explosive mixtures
- Prevent the generation of sparks
- Prevent leakages
- Maintain the pump to avoid hazard

The following instructions for pumps and pump units, when installed in potentially explosive atmospheres, must be followed to help ensure explosion protection. Both electrical and nonelectrical equipment must meet the requirements of European Directive 94/9/EC.

A.1.2.3.2.2 Scope of compliance



Use equipment only in the zone for which it is appropriate. Always check that the driver, drive coupling assembly, seal, and pump equipment are suitably rated and/or certified for the classification of the specific atmosphere in which they are to be installed.

Where the manufacturer has supplied only the bare shaft pump, the Ex rating applies only to the pump. The party responsible for assembling the pump set shall select the coupling, driver, and any additional equipment, with the necessary CE Certificate/Declaration of Conformity establishing it is suitable for the area in which it is to be installed.

The output from a variable frequency drive (VFD) can cause additional heating effects in the motor, and the ATEX Certification for the motor must state that it covers the situation in which electrical supply is from the VFD. This particular requirement still applies even if the VFD is in a safe area.

A.1.2.3.2.3 Marking

An example of ATEX equipment marking is shown below. The actual classification of the pump will be engraved on the nameplate.



II 2 GD c IIC 135°T (T4)

Equipment Group

I = Mining

II = Nonmining

Category

2 or M2 = High level protection

3 = Normal level of protection

Gas and/or Dust

G = Gas

D = Dust

c = Constructional safety

(in accordance with EN 13463-5)

Gas Group (Equipment Category 2 only)

IIA – Propane (typical)

IIB – Ethylene (typical)

IIC – Hydrogen (typical)

A.1.2.3.2.4 Avoiding excessive surface temperatures**ENSURE THE EQUIPMENT TEMPERATURE CLASS IS SUITABLE FOR THE HAZARD ZONE**

Pumps have a temperature class as stated in the Ex rating on the nameplate. These are based on a maximum ambient temperature of 40 °C (104 °F). Refer to the manufacturer for higher ambient temperatures.

The surface temperature on the pump is influenced by the liquid handled. The maximum permissible liquid temperature depends on the temperature class and must not exceed the values in the table that follows. The temperature rise at the seals and bearings due to the minimum permitted flow rate is taken into account in the temperatures stated.

Surface temperatures above 54 °C (130 °F) can cause irreversible skin damage and, therefore, require insulation to protect personnel.

Temperature class (reference NEC ^a , CEC ^b , IEC ^c , CENELEC ^d)	Maximum surface temperature permitted	Temperature limit of liquid handled (depending on material and construction variant – check which is lower)
T6	85 °C (185 °F)	Consult manufacturer
T5	100 °C (212 °F)	Consult manufacturer
T4	135 °C (275 °F)	115 °C (239 °F)
T3	200 °C (392 °F)	180 °C (356 °F)
T2	300 °C (572 °F)	275 °C (527 °F)
T1	450 °C (842 °F)	400 °C (752 °F)

^a National Electrical Code.^b Commission of the European Communities.^c International Electrotechnical Commission.^d Comité Européen de Normalisation Électrotechnique (European Committee for Electrotechnical Standardization).

The responsibility for compliance with the specified maximum liquid temperature is with the plant operator.

Note:

Temperature classification Tx is used when the liquid temperature varies and the pump could be installed in different hazardous atmospheres. In this case the user is responsible for ensuring that the pump surface temperature does not exceed that permitted in the particular hazardous atmosphere.