

Approval Standard

For

Centrifugal Fire Pumps Split-Case Type (Axial or Radial)

Class Number 1311

August 2007

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Foreword

Approvals are intended to verify that the products and services described will meet stated conditions of performance, safety and quality useful to the ends of property conservation. The purpose of Approval Standards is to present the criteria for Approval of various types of products and services, as guidance for FM Approvals personnel, manufacturers, users and authorities having jurisdiction.

Products submitted for Approval shall demonstrate that they meet the intent of the Approval Standard, and that quality control in manufacturing shall ensure a consistently uniform and reliable product. Approval Standards strive to be performance-oriented. They are intended to facilitate technological development.

For examining equipment, materials and services, Approval Standards:

- a) must be useful to the ends of property conservation by preventing, limiting or not causing damage under the conditions stated by the Approval listing; and
- b) must be readily identifiable.

Continuance of Approval and listing depends on compliance with the Approval Agreement, satisfactory performance in the field, on successful re-examinations of equipment, materials, and services as appropriate, and on periodic follow-up audits of the manufacturing facility.

FM Approvals LLC reserves the right in its sole judgment to change or revise its standards, criteria, methods, or procedures.

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1. INTRODUCTION

1.1 Purpose

- 1.1.1 This standard states Approval criteria for horizontal (axial) or vertical (radial), split-case type, centrifugal fire pumps that supply water to fire protection systems. These pumps must be available for many years to operate reliably at rated capacities and pressures during emergency fire incidents, despite being idle for extended periods.
- 1.1.2 Approval criteria may include, but are not limited to, performance requirements, marking requirements, examination of manufacturing facility(ies), audit of quality assurance procedures, and a follow-up program.

1.2 Scope

- 1.2.1 This standard encompasses the design and performance requirements for horizontal (axial) or vertical (radial), split-case type, centrifugal fire pumps for use in fire protection systems. Approval is limited to horizontal (axial) or vertical (radial), split-case type, centrifugal pumps which have a rated pressure of at least 40 psi (275 kPa). In cases where metric sized centrifugal fire pumps are to be examined for Approval, test criteria comparable to the United States equivalent size shall be used.
- 1.2.2 This standard encompasses the requirements for single and multistage split-case fire pumps.
- 1.2.3 Requirements for other types of centrifugal fire pumps are detailed in the following Approval Standards:

<i>Class</i>	<i>Pump Type</i>
1312	Vertical Shaft Turbine Type
1319	Horizontal End-Suction Type
1370	Vertical Turbine Barrel Type
1371	In-Line Type

- 1.2.4 Requirements for other major components in the pump package are detailed in the following Approval Standards:

<i>Class</i>	<i>Equipment</i>
1046	Fire Pump Flowmeter Systems
1321/1323	Controllers for Electric Motor Driven and Diesel Engine Driven Fire Pumps
1333	Diesel Engine Fire Pump Drivers
1359	Trim Water Pressure Relief Valves
2311	Pressure Gauges for Fire Protection Systems

- 1.2.5 Approval Standards are intended to verify that the product described will meet stated conditions of performance, safety, and quality useful to the ends of property conservation.

1.3 Basis for Requirements

- 1.3.1 The requirements of this Standard are based on experience, research and testing, and/or the standards of other organizations. The advice of manufacturers, users, trade associations, jurisdictions and/or loss control specialists was also considered.

- 1.3.2 The requirements of this Standard reflect tests and practices used to examine characteristics of horizontal (axial) or vertical (radial), split-case type, centrifugal fire pumps for the purpose of obtaining Approval. Horizontal (axial) or vertical (radial), split-case type, centrifugal fire pumps having characteristics not anticipated by this Standard may be FM Approved if performance equal, or superior, to that required by this Standard is demonstrated, or if the intent of the Standard is met. Alternatively, horizontal (axial) or vertical (radial), split-case type, centrifugal fire pumps which meet all of the requirements identified in this Standard may not be FM Approved if other conditions which adversely affect performance exist or if the intent of this Standard is not met.

1.4 Basis for Approval

Approval is based upon satisfactory evaluation of the product and the manufacturer in the following major areas:

- 1.4.1 Examination and tests on production samples shall be performed to evaluate
- The suitability of the product
 - The performance of the product as specified by the manufacturer and required by FM Approvals; and as far as practical,
 - The durability and reliability of the product.
- 1.4.2 An initial Facilities and Procedures Audit shall be conducted to evaluate the manufacturer's ability to consistently produce the product that was examined and tested as part of the Approval examination. The audit shall review the facility and in-place quality control procedures used in the manufacture of the product. Typically, areas of review are incoming inspection, work in progress, production testing, final quality control, marking, calibration of equipment, shipping procedures, and document and drawing control. These examinations are repeated as part of FM Approval's product follow-up program. (Refer to Section 5.2, Facility and Procedures Audit.)

1.5 Basis for Continued Approval

- 1.5.1 Continued Approval is based upon:
- Production or availability of the product as currently FM Approved;
 - The continued use of acceptable quality assurance procedures;
 - Satisfactory field experience;
 - Compliance with the terms stipulated in the Master Agreement;
 - Satisfactory re-examination of production samples for continued conformity to requirements; and
 - Satisfactory Facilities and Procedures Audits (F&PAs) conducted as part of FM Approvals' product follow-up program.
- 1.5.2 Also, as a condition of retaining Approval, manufacturers may not change an FM Approved product or service without prior authorization by FM Approvals. (Refer to Section 5.1.3 for further details regarding changes.)

1.6 Effective Date

The effective date of an Approval standard mandates that all products tested for Approval after the effective date shall satisfy the requirements of that standard. Products FM Approved under a previous edition shall comply with the new version by the effective date or forfeit Approval.

The effective date of this Standard is **(August 31, 2008)** for full compliance with all requirements.

1.7 System of Units

Units of measurement used in this Standard are United States (U.S.) customary units. These are followed by their arithmetic equivalents in International System (SI) units, enclosed in parentheses. The first value stated shall be regarded as the requirement. The converted equivalent value may be approximate. Appendix A lists the selected units and conversions to SI units for measures appearing in this standard. Conversion of U.S. customary units is in accordance with the Institute of Electrical and Electronics Engineers (IEEE)/American Society for Testing Materials (ASTM) SI 10-2002, *American National Standard for Use of the International System of Units (SI): The Modern Metric System*. One unit of measurement (Liter), outside of, but recognized by SI, is commonly used in international fire protection and is used in this standard.

1.8 Applicable Documents

The following standards, test methods, and practices are referenced in this standard or beneficial in understanding this standard.

ANSI/Hydraulics Institute (HI), ANSI/HI 1.1-1.2 (M101) - 2000, *Centrifugal Nomenclature*
ANSI/HI 1.3 (M102) - 2000, *Centrifugal Applications*
ANSI/HI 1.4 (M103) - 2000, *Centrifugal Operations*
ANSI/HI 1.6 (M104) - 2000, *Centrifugal Tests*
ANSI/HI 3.1-3.5 (M109) - 2000, *American National Standard for Rotary Pumps for Nomenclature, Definitions, Applications, and Operation*
ANSI/HI 3.6 (M110) - 2000, *American National Standard for Rotary Pump Tests*
ANSI/HI 4.1-4.6 (M111) - 2000, *American National Standard for Sealless Rotary Pumps for Nomenclature, Definitions, Applications, and Operations*
American Petroleum Institute (API) Standard 682/ISO 21049 - *Pumps—Shaft Sealing Systems for Centrifugal and Rotary Pumps*
FM Approvals' Approval Standards
FM Global Property Loss Prevention Data Sheet 2-81, January 2006, *Fire Safety Inspections and Sprinkler System Maintenance*
FM Global Property Loss Prevention Data Sheet 3-7N, September 2001, *Stationary Pumps for Fire Protection*
IEEE/ASTM SI 10-2002, *American National Standard for Use of the International System of Units (SI): The Modern Metric System*
National Fire Protection Association (NFPA) NFPA 20, 2007, *Standard for the Installation of Stationary Pumps for Fire Protection*
NFPA 25, 2002, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*

1.9 Definitions

For purposes of this standard, the following terms apply:

Accepted

This term refers to installations acceptable to the authority enforcing the applicable installation rules. When the authority is FM Global, such locations are termed "FM Global Accepted." Acceptance is based upon an overall evaluation of the installation. Factors other than the use of FM Approved equipment impact upon the decision to accept, or not to accept. Acceptance is not a characteristic of a product. A product accepted for one installation may not be acceptable elsewhere. (Contrast with FM Approved.)

Axial Split-Case Centrifugal Fire Pump

A pump with the shaft in a horizontal position, with a housing which is split in a horizontal plane through the shaft centerline for easy maintenance and in which the pressure is developed by the action of centrifugal force. The term horizontal split-case is also used.

Corrosion Resistant

Having resistance to corrosion equal to or exceeding that of bronze alloy having a minimum copper content of 80 percent, or is of Series 300 Stainless Steel construction.

Design Working Pressure

The maximum pressure for which a pump component is designed. This pressure is equal to or greater than the maximum pressure developed by the pump at shut off or churn conditions with the largest impeller available, plus the maximum suction pressure for the pump.

Efficiency

The ratio of the energy delivered by the pump to the energy supplied to the pump shaft (liquid power divided by applied power).

Enclosed Impeller

An impeller in which the pumped liquid is confined by the sidewalls (shrouds) and vanes of the impeller.

FM Approvals Certification Mark

The FM Approvals Certification Mark is detailed in Appendix B. Their use is mandatory on all units of FM Approved split-case pumps. These registered marks cannot be used except as authorized by FM Approvals via the granting of Approval to a specific product.

FM Approved

This term refers to products FM Approved by FM Approvals. Such products are listed in the Approval Guide, a publication of FM Approvals, issued three times per year. All products so listed have been successfully examined by FM Approvals, and their manufacturers have signed and returned a Master Agreement to FM Approvals. These forms obligate the manufacturer to allow re-examination of the product and audit of facilities and procedures at FM Approval's discretion. It further requires the manufacturer not to deviate from the FM Approved configuration of the product without review by and agreement of FM Approvals.

Maximum Power

The greatest speed-corrected power required to drive the pump at rated speed and at any point along its characteristic curve, and through the pumps total run out condition. This is determined under conditions of increasing positive suction head.

Mechanical Seals

A sealing device which forms a running seal between the rotating and stationary components. They may be used in place of compression (soft) packing. All mechanical seals are constructed of three basic sets of parts:

- A set of primary seal faces: one rotary and one stationary
- A set of secondary seals known as shaft packings and insert mountings such as O-rings, wedges and V-rings
- Mechanical seal hardware including gland rings, collars, compression rings, pins, springs and bellows

The primary seal is achieved by two very flat, lapped faces perpendicular to the shaft. The rubbing contact between these two flat mating surfaces minimizes leakage. One face is held stationary in a housing and the other face is fixed to, and rotates with, the shaft. Dissimilar materials are usually used for the stationary insert and the rotating seal ring face in order to prevent adhesion of the two faces.

Cartridge Seal Type

This type of mechanical seal is a completely self-contained unit (including stationary and rotating seal faces, gland sleeve, mating ring, etc.) which is pre-assembled and preset before installation. The cartridge mechanical seal is a complete seal assembly which is manufactured, assembled and calibrated by the mechanical seal manufacturer.

Component Type

This type of mechanical seal is assembled from the individual components directly onto the shaft. The components usually consist of a rotating unit with a mating face which is in contact with a stationary unit. The rotating unit seals in two places, at the interface between the rotating face and stationary and between the shaft and the seal body. The stationary unit seals against the pump body.

Split Seal Type

This type of mechanical seal has its primary sealing elements and other components split. The seal can be mounted on a pump with out removing the impeller.

Multiple Stage Pumps

Horizontal split-case, centrifugal fire pumps with more than one impeller on the same shaft. The number of stages is determined by the number of impellers.

Radial Split-Case Centrifugal Fire Pumps

Radial split-case centrifugal fire pumps are pumps with the shaft in a horizontal position, with a housing which is split in a plane perpendicular to the axis of rotation. The term vertically split is also used.

Rated Capacity

Capacity in gallons per minute - gal/min (liter/min - L/min), at rated pressure and speed.

Rated Pressure

Pressure in pounds per square inch - psi (kilopascals -kPa) developed by the pump when operating at rated capacity and speed.

Shutoff or Churn Pressure

The net pressure in psi (kPa) developed by the pump at rated speed with zero flow.

Single Stage Pump

A pump in which the total head is developed by one impeller.

Stuffing Box Packing

Typically an arrangement consisting of rings of packing, a lantern ring for the injection of a lubricating and/or flushing liquid, and a gland to hold the packing and maintain the desired compression for a proper seal. The function of packing is to control leakage it is not intended to eliminate it completely. The packing is lubricated by the pumped liquid. The lantern ring is supplied for situations where the stuffing box pressure is below atmospheric pressure, to inject lubrication into the stuffing box by the use of a bypass line from the pump discharge to the lantern ring connection.

Total Discharge Head

The gauge reading in psi (kPa) at the discharge flange of the pump, referred to the pump centerline, plus the velocity head at the point of gauge attachment.

Total Suction Head

The condition when the suction pressure is above atmospheric. The total suction head is the algebraic sum of the gauge reading in psi (kPa) at the pump suction flange, referred to the pump centerline, and the velocity head at the point of gauge attachment. Also called "positive suction pressure."

Total Suction Lift

The condition when suction pressure is below atmospheric. The total suction lift is the algebraic sum of the gauge reading in psi (kPa) at the suction flange of the pump, referred to the pump centerline, and the velocity head at the point of gauge attachment.

Total Head

The algebraic difference between the total discharge head and the total suction head. Where suction head exists, total head equals total discharge head minus total suction head. Where suction lift exists, total head equals total discharge head plus total suction lift.

Vertical Mounted Split-Case Centrifugal Fire Pump

A pump with the shaft in a vertical position, with a housing which is split parallel to the shaft for easy maintenance and in which the pressure is developed by the action of centrifugal force.

2. GENERAL INFORMATION

2.1 Product Information

- 2.1.1 Pumps covered by this standard include those designed for one of the following capacities: 25, 50, 100, 150, 200, 250, 300, 400, 450, 500, 750, 1000, 1250, 1500, 2000, 2500, 3000, 3500, 4000, 4500, 5000 gal/min (95, 190, 380, 570, 755, 945, 1135, 1515, 1705, 1895, 2840, 3785, 4730, 5680, 7570, 9465, 11 355, 13 250, 15 140, 17 035, 18 925 L/min) or larger. Pumps designed for other rated capacities shall be evaluated on a case-by-case basis.
- 2.1.2 Pumps shall have a minimum rated pressure of at least 40 psi (275 kPa).
- 2.1.3 In order to meet the intent of this Standard, split-case type, centrifugal fire pumps must be examined on a model-by-model, type-by-type, manufacturer-by-manufacturer, and plant-by-plant basis. This is predicated on the basis that identical designs, fabricated in identical materials by different manufacturers or, even by different plants of the same manufacturer, have been seen to perform differently in testing. Sample fire pumps, selected in conformance to this criterion, shall satisfy all of the requirements of this Standard.

2.2 Approval Application Requirements

To apply for an Approval examination the manufacturer, or its authorized representative, should submit a request to:

Hydraulics Group Manager
FM Approvals Hydraulics Laboratory
743A Reynolds Road
West Glocester, RI 02814 U.S.A.

The manufacturer shall provide the following preliminary information with any request for Approval consideration:

- A complete list of all models, types, sizes, and options for the products or services being submitted for Approval consideration;
- Anticipated pump performance, including total head, power requirements, and efficiency versus flow characteristics. If different impellers or a range of impellers are used to obtain the rated head range for the pump being examined, complete details shall be provided concerning the range of performance specifications to be evaluated;
- Calculations to determine shaft size, casing bolt size, and anti-friction bearing life;

- If mechanical seals are provided, all sizing and design information shall be submitted for evaluation, (See Section 3.2.7)
- General assembly drawings (showing the pump and attachments), one complete set of manufacturing drawings, materials list(s) and physical property specifications, anticipated marking format, brochures, sales literature, specification sheets, installation, operation and maintenance procedures;
- The number and location of manufacturing facilities and,
- All documents shall identify the manufacturer's name, document number or other form of reference, title, date of last revision, and revision level. All foreign language documents shall be provided with English translation.

2.3 Requirements for Samples for Examination

Following set-up and authorization of an Approval examination, the manufacturer shall submit samples for examination and testing. Sample requirements are to be determined by FM Approvals following review of the preliminary information. Sample requirements may vary depending on design features, results of prior testing, and results of the foregoing tests. It is the manufacturer's responsibility to submit samples representative of production. Any decision to use data generated utilizing prototypes is at the discretion of FM Approvals. The manufacturer shall provide the test facilities, which are required to evaluate the split-case type, centrifugal fire pumps.

3. GENERAL REQUIREMENTS

3.1 Review of Documentation

During the initial investigation and prior to physical testing, the manufacturer's specifications, technical data sheets, and design details shall be reviewed to assess the ease and practicality of installation and use. The product shall be capable of being used within the limits of the Approval investigation.

3.2 Physical or Structural Features

3.2.1 Pump

Pumps shall be designed for rated capacities equal to or greater than 25 gal/min (95 L/min). Rated pump pressures shall be at least 40 psi (275 kPa). Castings shall be free of defects which could make them unfit for their intended use. Flange dimensions, bolt layouts, and threaded openings used in pipe connections shall conform to a recognized national or international standard. Two or more pump ratings may be assigned to a single characteristic curve; however, the maximum power requirements used in selecting a driver shall be based on the highest power requirement, regardless of where it occurs on the entire characteristic curve.

3.2.2 Pump Package

The manufacturer of the pump shall be able to supply the necessary pump accessories (See Appendix D) to provide a complete pump installation, as detailed in FM Global Property Loss Prevention Data Sheets. The pump manufacturer shall be held accountable for the complete pump package (as detailed in Appendix D), and satisfactory performance of the "Field Acceptance Test" for any pump bearing the FM Approvals Certification Mark. This accountability only includes proper operation and sizing of the pump and the accessories listed in Appendix D, the pump manufacturer shall not be held

accountable for items supplied by others that affect the pump performance, (i.e. wrong piping, insufficient air intake for the pump room, etc.).

This responsibility may be delegated to an authorized agent of the pump manufacturer. This delegation does not relieve the pump manufacturer of their accountability and responsibility for the satisfactory performance of the complete pump package. Delegation to an authorized agent shall be accompanied by a set of assembly construction details from the pump manufacturer and a FM Approvals facilities and procedures audit shall be periodically conducted at the authorized agent's facility to ensure that the manufacturer's instructions are being followed. The authorized agent shall assemble the complete pump package; they shall not sell or release a bare-shafted pump. If the assembly construction details are provided by the authorized agent they shall be signed off (stamped, etc.) by the pump manufacturer.

3.2.3 Pump Casing

The pump casing shall be designed to permit examination and removal of impellers and other interior parts without disturbing suction or discharge piping. A drain opening(s) shall be provided so that all parts of the pump casing can be drained. The opening shall be threaded to receive a corrosion resistant pipe plug at least 1/2 in. nominal size. Renewable casing wearing rings shall be provided. Impeller wear rings may be provided, as an option.

3.2.4 Water Passages

All water passages shall be designed to minimize the possibility of foreign materials becoming lodged in them. The minimum width of these passages at the periphery or at any point within the impeller shall be at least 1/2 in. (12.7 mm) for pumps rated 500 gal/min (1895 L/min) and larger. Passages in pumps having rated capacities of 100 to less than 500 gal/min (380 to less than 1895 L/min) shall be at least 3/8 in. (9.5 mm). Passages in pumps having rated capacities less than 100 gal/min (380 L/min) shall be at least 1/4 in. (6.3 mm).

3.2.5 Impeller

Impellers shall be securely attached in a radial direction to the pump shaft. No impeller shall contact the casing under normal operating conditions. Impellers shall be the closed type. All impellers shall be dynamically balanced. Calculations shall be provided to show that the impeller will not come into contact with the casing at any point on the characteristic curve, including shut-off.

3.2.6 Shaft

Shafts shall be of adequate size and strength to successfully transmit the torques encountered in starting and during operation while supporting the impeller and other rotating parts.

In order to safeguard against shaft failure, the maximum torsional shearing stress, as calculated by the formula below, shall not exceed 30 percent of the elastic limit in tension and 18 percent of the ultimate tensile strength of the shaft material. For shafts with keyways, a further 25 percent reduction is required.

Renewable shaft sleeves shall be provided to adequately safeguard the shaft against wear, erosion, and corrosion. Shaft sleeves shall be of a hard bronze or other corrosion resistant material.