



Member of the FM Global Group

Approval Standard

for

Centrifugal Fire Pumps

(Vertical Shaft, Turbine Type, Barrel)

Class Number 1370

December 2011

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Foreword

The FM Approvals certification mark is intended to verify that the products and services described will meet FM Approvals' 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 FM Approval of various types of products and services, as guidance for FM Approvals personnel, manufacturers, users and authorities having jurisdiction.

Products submitted for certification by FM Approvals 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 surveillance 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 FM Approval criteria for vertical shaft, turbine type, barrel centrifugal fire pumps which are intended supply water to fire protection systems. They are a critical component in a facility's fire protection system. They are expected to automatically start upon loss of fire protection system pressure or by other automatic fire detection means. They are required to supply the necessary water flow and pressure without interruption to a facility's fire protection system under fire conditions despite being idle for extended periods. They are required to provide a high degree of reliability.
- 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 surveillance audit program.

1.2 Scope

- 1.2.1 This standard encompasses the design and performance requirements for vertical shaft, turbine type, centrifugal fire pumps for use in fire protection systems. Approval is limited to vertical shaft, turbine type, centrifugal fire pumps that have a minimum rated discharge pressure of at least 40 psi (275 kPa). In cases where metric sized vertical shaft, turbine type, centrifugal fire pumps are to be examined for Approval, test criteria equal to or greater than the United States size or value shall be used.
- 1.2.2 Requirements for other types of centrifugal fire pumps are detailed in the following FM Approval Standards:

<i>Approval Standard</i>	<i>Centrifugal Fire Pump Type</i>
<i>Class Number</i>	
1311	Split-Case Type, (Axial or Radial)
1312	Vertical Shaft Turbine Type
1319	Horizontal, End-Suction Type
1371	In-Line Type

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

<i>Approval Standard</i>	<i>Equipment</i>
<i>Class Number</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

- 1.2.4 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 vertical shaft, turbine type, centrifugal fire pumps for the purpose of obtaining Approval. Vertical shaft, turbine type, centrifugal fire pumps having characteristics not anticipated by this standard may be Approved if performance equal, or superior, to that required by this standard is demonstrated, or if the intent of the standard is met. Alternatively, vertical shaft, turbine 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 FM 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, (as described in Section 1.1.1);
 - 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 A first 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 Approvals' Surveillance Audit program. (Refer to Section 5.2, Surveillance Audit Program.) A review of the documented quality program will be conducted. This quality program must demonstrate capacity for continuous improvement (i.e., incorporation of feedback from "lessons learned") and executive commitment/support.

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 Surveillance Audits 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 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 **December 31, 2012** for 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.” Two units of measurement (liter and bar), outside of but recognized by SI, are commonly used in international fire protection and are 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:

- American Bearing Manufacturers Association (ABMA) Standard 9, 1990, *Load Ratings and Fatigue Life for Ball Bearings*
- ABMA Standard 11, 1990, *Load Ratings and Fatigue Life for Roller Bearings*
- ANSI/AWWA E101, 1988, *AWWA Standard for Vertical Turbine Pumps - Line Shaft and Submersible Types*
- ANSI/Hydraulic Institute Standard (HI) 1.1 - 1.2-2000, *Centrifugal Pumps - Nomenclature, Definitions, Application and Operation*
- ANSI/HI 1.6, 1994, *Centrifugal Pump Tests*
- ANSI/IEEE/ASTM SI 10-97, *Standard for Use of the International System of Units (SI): The Modern Metric System*.
- FM Global Property Loss Prevention Data Sheets
- International Organization for Standardization, (ISO) 281, 2007 *Rolling bearings - Dynamic load ratings and rating life*
- ISO 1940-1, 2003, *Mechanical vibration - Balance quality requirements for rotors in a constant (rigid) state - Part 1: Specification and verification of balance tolerances*
- National Electrical Manufacturers Association (NEMA) Standard MG 1, 2006, *Motors and Generators*
- National Fire Protection Association (NFPA) 20, 1999, *Standard for the Installation of Stationary Pumps for Fire Protection*

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. It is installation specific. A product accepted for one installation may not be acceptable elsewhere. (Contrast with FM Approved.)

Bowl Assembly

The actual pumping component which develops the necessary pressure and flow rate. The pump assembly may consist of one or more stages, or bowl assemblies.

Cavitation

A reduction of pressure within a pump that causes water vaporization. Cavitation reduces a pump’s performance and can damage the pump impeller.

Characteristic Curve

Graphic representation of the variation of the pump's total head, efficiency and brake horsepower versus the pump's capacity at a constant speed.

Column Pipe

The pipe which suspends the pump bowl assembly from the head assembly and serves as a conductor for the water from the pump bowl assembly to the discharge head.

Corrosion Resistant

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

Datum

The elevation of the surface from which the pump head or baseplate is supported.

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, and at maximum speed plus the maximum suction pressure for the pump.

Discharge Head

A part of the pump assembly which supports the driver, pump, and column; aligns the driver and pump; seals the pumped water from atmosphere; and changes the vertical flow to a horizontal direction.

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. All impellers supplied in accordance with this Approval standard shall be of this type.

Flexible coupling

A device used to connect a driver to a pump; it can compensate for small misalignments and dampen vibration.

FM Approvals Certification Mark

The FM Approvals Certification Mark is detailed in Appendix B. Their use is mandatory on all units of FM Approved vertical shaft, turbine type, barrel centrifugal fire 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 surveillance audit 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.

Hollow Shaft

Pertains to the hollow drive shaft of electric motors or right angle gear drives. The hollow drive shaft is designed to accept the solid line shaft. This design facilitates impeller adjustment within the bowl assembly and the installation of a nonreverse ratchet into the motor or gear drive.

Line Shaft

A shaft which transmits the power from the driver to the pump shaft. Line shafts can be either of the open, water lubricated, or enclosed, oil lubricated, type.

Mass Elastic Torsional Analysis

An engineering analysis conducted for the purpose of identifying and eliminating damaging torsional forces and linear resonant frequencies from the operating speed range of rotating equipment.

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.

Minimum Submergence

The minimum depth of water required for proper pump operation, as specified by the manufacturer.

Multiple Stage Pumps

Vertical shaft, turbine type, centrifugal fire pumps with more than one impeller and bowl on the same shaft. The number of stages is determined by the number of impellers.

Non-reverse Ratchet

A mechanism installed as an integral part of the hollow shaft electric motor or hollow shaft right angle gear drive to prevent reverse rotation of the pump driver assembly.

Oil Lubricated Pump

A design in which the shaft is enclosed in a tube and the shaft bearings are lubricated by oil.

Overall Length

The length from the datum to the bottom of the strainer.

Rated Capacity

Rate at which water is delivered, in gal/min (L/min), at rated pressure and rated speed.

Rated Pressure

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

Setting

The nominal vertical distance in feet (meters) from the datum to the column pipe connection at the bowl assembly.

Service factor

A multiplier that, when applied to the rated horsepower of an ac motor, indicates a permissible horsepower loading that can be carried at the rated voltage, frequency, and temperature. The service factor multiplier (e.g., 1.15) indicates that the motor is permitted to be overloaded 1.15 times the rated horsepower without insulation breakdown or otherwise significantly reducing service life.

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.

Total Discharge Head

The gauge reading in psi (kPa) at the discharge of the pump, referred to the pump centerline, plus the velocity head at the point of gauge attachment, plus the elevation difference between the discharge gauge centerline and the sump water level.

Total Suction Head

The vertical distance in feet (meter) from the water surface to the datum.

Water Lubricated Pump

A design in which the shaft is open and the shaft bearings are lubricated by the pumped water.

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 discharge pressure, (total discharge head), of 40 psi (275 kPa).
- 2.1.3 In order to meet the intent of this standard, vertical shaft, turbine 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:

Fire Protection 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, including maximum and minimum characteristic curves for each rated speed;
- The pump manufacturer shall, for each model pump, conduct performance tests prior to the Approval program on minimum and maximum impeller diameters. Suction pressure shall be sufficient to determine maximum power requirements. The maximum horsepower measured shall be used to size the electric motor(s) for Approval tests and, ultimately, for site installation. Performance curves of the total head and power versus flow shall be drawn from the data from these tests and submitted to FM Approvals prior to scheduling the witnessed Approval tests.
- Motor specifications for each motor used, including power rating, speed, frame size, radial thrust capacity, shaft deflection versus radial thrust, minimum shaft fatigue lift, maximum shaft runout, and minimum "L-10" bearing life;
- Calculations to determine shaft size, shaft runout, stuffing box runout, shaft deflection, and casing bolt size;
- General assembly drawings (showing the pump and attachments), one complete set of manufacturing drawings, materials list(s) and physical property specifications (such as ASTM A48 CL 40 - Cast Iron), anticipated marking format, brochures, sales literature, specification sheets, installation, operation and maintenance procedures;