



Member of the FM Global Group

Approval Standard for Right Angle Gear Drives

Class Number 1338

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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 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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I INTRODUCTION

- 1.1 This standard covers right angle gear drives which are used as power transmission units for connecting prime movers such as internal-combustion engines, steam turbines, or solid shaft electric motors to vertical shaft, turbine-type pumps.
- 1.2 FM Approval is based on evaluation of the product and the manufacturer in three major areas:
 - Examinations and tests on production samples to evaluate 1) the suitability of the product, 2) the proper operation and performance of the product as specified by the manufacturer and required by FM Approvals and 3) the reasonable durability and reliability of the product.
 - An examination of the manufacturing facilities and quality control procedures to evaluate the manufacturer's ability to produce the product involved. This includes an evaluation of the production facilities and the procedures used to ensure proper quality control. A check of sufficient availability of parts and service is also performed. These examinations are repeated as part of FM Approvals' approved product follow-up program.
 - Satisfactory field experience is also a requirement for continued approval. Unsatisfactory field experience may result in withdrawal of FM Approval.
- 1.3 The requirements of this standard are intended as guidelines reflecting current FM Approval tests and practices. Items which do not precisely conform to these requirements may be approved. In the same way, items that do conform to these requirements may not be approved if they do not meet the intent of these requirements or if other considerations govern.

II PERFORMANCE REQUIREMENTS

- 2.1 **DRIVE** — The right angle gear drive shall reliably transmit power from the prime mover to a vertical shaft, turbine-type pump.
 - 2.1.1 **Bearings** — In order to obtain reliable performance throughout the useful life of the right angle gear drive, radial and thrust load bearings shall be designed for a minimum of 5,000 hours of continuous operation under maximum load (see Paragraph 3.1).
 - 2.1.2 **Gears and Shafts** — To provide adequate strength and durability, gears should be designed according to Standard AGMA 223.01 of the American Gear Manufacturer's Association; shafts should be designed according to ANSI-B58.1 (American National Standards Institute). Gears and shafts designed according to other national or international standards will be evaluated on a case-by-case basis.
 - 2.1.3 **Gear Adjustment** — In order to provide smooth gear operation through suitable tooth engagement, means for adjusting the vertical and horizontal shaft assemblies shall be provided.

- 2.1.4 Lubrication — In order to obtain maximum endurance of the gear drive at reasonable temperatures, adequate lubrication shall be provided. When forced lubrication is needed, an oil pump powered by the vertical shaft of the gear drive or a method of equivalent reliability shall be used. Lubricant cooling may be accomplished by heat exchangers where the cooling water is provided by the fire pump and the cooling air fan is powered by the gear drive. Regardless of what type of lubrication system is employed, it shall be possible to check the lubricant level readily.
 - 2.1.5 Hollow Shaft — To provide means for a direct drive for the line shaft and lateral adjustment of the pump impellers, a hollow shaft type gear drive shall be provided.
 - 2.1.6 Housing — The housing shall have adequate structural rigidity to maintain proper gear engagement during high torque conditions such as those encountered during starting or maximum pump load.
 - 2.1.7 Materials — To insure reliable operation of gear drive components, materials used shall be suitable for the intended application. For areas requiring high strength and dimensional stability, heat-treated and strain-relieved alloys may be required.
- 2.2 REVERSE ROTATION — The gear drive shall prevent rotation of the pump under all conditions.
- 2.2.1 Nonreverse Ratchet — In order to prevent fire pump damage due to reverse rotation, a nonreverse ratchet of adequate strength to withstand the full starting torque of the prime mover in reverse rotation shall be provided.

III EXAMINATION AND TESTS

- 3.1 STRENGTH CALCULATIONS — In order to determine the design strength of power transmitting components, a review of design calculation for each gear drive will be performed. The calculated fatigue load of the gears shall not exceed 50% of the actual fatigue strength of the material. Calculations shall be based on the maximum load.
- 3.2 APPROVAL TESTS — In order to verify adequate strength and proper alignment of the gear train and shafts, the gear drive shall be tested at designed speed and designed load (when possible) for a duration necessary to produce stabilization of surface and lubricant temperature. Under these conditions, the drive shall not experience undue noise, vibration, temperature rise or other indication of improper performance.
- 3.3 SHOP TESTS — In order to insure that the transmission of each gear drive is in proper alignment, each drive shall be tested at designed speed and designed load (when possible) for at least 10 minutes prior to leaving the factory. No undue noise, vibration or overheating shall occur.
- 3.4 OTHER — Other tests to verify adequate performance may be necessary. Such tests will be at the discretion of FM Approvals.

IV MARKING

4.1 A permanently marked, corrosion-resistant nameplate shall be securely attached to the drive where it will be easily visible. The nameplate shall include the following information:

- Manufacturer's name and address
- Model number
- Rated speed
- Rated power
- Gear ratio
- Serial number
- the FM Approval Mark

V APPROVAL PROCEDURES

5.1 The following information shall be provided by the manufacturer so that the construction and intended operation of the drive can be evaluated:

- Strength calculations for the drive shafts and gears
- Sample calculations for determining total pump thrust, shaft size and ball or taper bearing life
- Detailed drawings of each part used in the drive with materials lists and physical property specifications
- General assembly drawing
- Maintenance and installation instructions.

APPENDIX

APPROVAL MARKS

REPRODUCTION ART: FM Approval Marks

**For use on nameplates, in literature, advertisements,
packaging and other graphics.**



- 1) The Approvals diamond mark is acceptable to FM Approvals as an Approval mark when used with the word "Approved."
- 2) The FM Approval logomark has no minimum size requirement, but should always be large enough to be readily identifiable.
- 3) Color should be black on a light background or a reverse may be used on a dark background.

For Cast-On Marks



- 4) Where reproduction of the mark described above is impossible because of production restrictions, a modified version of the diamond is suggested. Minimum size specifications are the same as for printed marks. Use of the word "Approved" with this mark is optional.

NOTE: These Approval marks are to be used only in conjunction with products or services that have been FM Approved. The FM Approval marks should never be used in any manner (including advertising, sales or promotional purposes) that could suggest or imply FM Approval or endorsement of a specific manufacturer or distributor. Nor should it be implied that Approval extends to a product or service not covered by written agreement with FM Approvals. The Approval marks signify that products or services have met certain requirements as reported by FM Approvals.

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