



Member of the FM Global Group

**Approval Standard
for
Fire Service
Water Control Valves
(OS&Y and NRS Type
Gate Valves)**

Class Number 1120 and 1130

April 1997

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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1. INTRODUCTION

1.1 Purpose

- 1.1.1 This standard states FM Approval criteria for manually operated fire service water control valves which control the water supply to a fire protection system.
- 1.1.2 FM 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 is used to evaluate resilient-seated and metal-seated gate valves for their intended application of long term water flow control, above or below ground, indoors or outdoors.
- 1.2.2 This standard includes Outside Screw and Yoke (OS&Y) and Inside Screw type (NRS) gate valves.
Note: Non-rising Stem (NRS) type gate valves are a common substitution for Inside Screw type gate valves.
- 1.2.3 This standard is used to evaluate valves up to and including 14 inches nominal pipe size (NPS). Other sizes shall be evaluated on a case-by-case basis.
- 1.2.4 This standard is used to evaluate valves having the following types of end connections. Other types of end connections shall be evaluated on a case-by-case basis.
- Screwed
 - Flanged
 - Hub
 - Mechanical Joint
 - Grooved

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 gate valves for the purpose of obtaining FM Approval. Gate valves 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, gate valves which meet all of the requirements identified in this Standard may not be 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

FM 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 examination of the manufacturing facilities and audit of quality control procedures is made to evaluate the manufacturer's ability to produce the product which is examined and tested, and the marking procedures used to identify the product. These examinations are repeated as part of FM Approvals' product follow-up program.

1.5 Basis for Continued Approval

Continued Approval is based upon:

- production or availability of the product as currently Approved;
- the continued use of acceptable quality assurance procedures;
- satisfactory field experience;
- compliance with the terms stipulated in the Approval 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.

Also, as a condition of retaining Approval, manufacturers may not change a product or service without prior authorization by FM Approvals.

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 April 1997 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 ASTM E 380, "*Standard Practice for Use of the International System of Units (SI)*." Two units (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 latest versions of the following standards, test methods, and practices are referenced in this standard:

ASTM D 471 — “Standard Test Method for Rubber Property — Effect of Liquids.”

ASTM D 572 — “Test Method for Rubber Deterioration by Heat and Oxygen.”

2. GENERAL INFORMATION

2.1 Product Information

2.1.1 OS&Y gate valves are used indoors or in outdoor pits and NRS valves are used with wall indicator posts or underground with tee-handle wrenches or indicator posts attached or as roadway box valves (curb box installation).

2.1.2 NRS gate valves are available either with or without a base flange. Valves with base flanges are used to support upright indicator posts. Valves without base flanges are used with wall indicator posts or tee-handle wrenches in buried service.

2.2 Approval Application Requirements

To apply for an Approval examination the manufacturer, or its authorized representative, shall submit a letter of request to the Hydraulics Group Manager at the FM Approvals Hydraulics Laboratory, 743A Reynolds Road, West Glocester, Rhode Island (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 valves being submitted for Approval consideration.
- General assembly drawings, a complete set of manufacturing drawings, materials list, anticipated marking format, sales literature, specification sheets, installation, operation and maintenance procedures.
- Number and location of manufacturing facilities.

Note: All documents shall identify the manufacturer’s name, document number or other form of reference, title, date of last revision, and revision level. All documents shall be provided with English translation.

2.3 Sample Requirements for an Approval Examination

2.3.1 Following set-up and authorization of an Approval examination, the manufacturer shall submit samples for examination and testing as follows:

- One sample of each size and type of gate valve
- Six test specimens of valve rubber facings approximately 1 × 3 inches (25 × 76 mm) by 1/8 in. (3 mm) thick.
- Corrosion test coupons per Section 4.8.2.

Note: NRS type gate valves submitted for Approval with indicator posts shall include representative samples of the indicator post assembly when requested.

- 2.3.2 Sample requirements may vary depending on product design features, or results of prior or similar product testing.
- 2.3.3 It is the manufacturer's responsibility to submit samples representative of production. Any decision to use data generated using prototypes is at the discretion of FM Approvals.

3. GENERAL REQUIREMENTS

3.1 Review of Documentation

During the initial investigation and prior to physical testing, the manufacturer's specifications and detail drawings 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 **RATED WORKING PRESSURE** — Gate valves shall be designed for a minimum rated working pressure of 175 psi (12 bar).
- 3.2.2 **MATERIALS** — All materials used in these valves shall be suitable for the intended application. Valve parts exposed to water shall be constructed of corrosion resistant materials. Particular consideration will be given to the gate face, stem, seat rings, bushings, and packing glands.
- 3.2.3 **VALVE LOCKING** — It shall be possible to lock the OS&Y type gate valve so that the valve gate cannot be moved through more than five percent of its fully open to fully closed travel. A chain or cable and padlock is an acceptable locking method.
- 3.2.4 **PARTS REMOVAL** — The valve shall be designed so that all interior parts are accessible and replaceable while the valve is installed in the line.
- 3.2.5 **STEM SEAL AND PACKING REPLACEMENT** — The valve shall have a stem seal designed to prevent water within the body from leaking to the environment at the point where the stem passes through the bonnet. If packing is used, it shall be arranged so that the packing can be replaced by one person with the valve in the wide open position and under the rated working pressure.
- 3.2.6 **VALVE OPERATION**
- OS&Y gate valves shall be designed so that the operating handwheel or crank is turned counterclockwise to open. The operating handwheel or crank shall have sufficient mechanical strength to endure normal, expected abuse during shipment and after installation.
 - NRS gate valves shall be designed so that the operating nut is turned counterclockwise to open. The operating nut shall have the following dimensions: 1-¹⁵/₁₆ inches (49 mm) square at the top, 2 inches (51 mm) square at the base and 1-³/₄ inches (44 mm) high.

- c. NRS gate valves 4 inches nominal size and larger supplied for use with indicator posts, shall have a suitable flange to hold an indicator post. The flange shall contain holes for four bolts (minimum bolt size $\frac{5}{8}$ inch [16 mm]) 90° apart on a circle of 10- $\frac{1}{2}$ inches (267 mm). At least two $\frac{1}{2}$ inch (13 mm) diameter holes shall be provided in the flange for post drainage. Standardized operating nut dimensions and base flange dimensions permit Approved indicator posts to be installed on all Approved NRS gate valves 4 inches nominal size up to 14 inches nominal size.

3.2.7 Gate valves shall be free of sharp edges, burrs, or other imperfections liable to injure the installer or interfere with proper assembly of the unit.

3.3 Markings

3.3.1 Markings cast in raised letters on the valve cover, or body, or both, shall contain the following information:

- Manufacturer's Name or Trademark
- Date of manufacture or code traceable to date of manufacture or lot identification;
- Model designation, size and rated working pressure

A corrosion resistant nameplate bearing the same information shall be considered acceptable if permanently fastened to the valve cover, or body, or both.

3.3.2 The model or type identification shall correspond with the manufacturer's catalog designation and shall uniquely identify the product as Approved. The manufacturer shall not place this model or type identification on any other product.

3.3.3 The FM Approval Mark (see Appendix C) shall be displayed visibly and permanently on the product. The manufacturer shall not use this Mark on any other product unless such product is covered by separate agreement with FM Approvals.

3.3.4 OS&Y Valves Only — The operating handwheel or crank of an OS&Y valve shall be marked with an arrow showing the direction to open and the word "open".

3.3.5 NRS Valves Only — The base flange beneath the operating nut of a NRS valve shall be marked with an arrow showing the direction to open and the word "open". Alternatively, the marking may be on the operating nut.

3.3.6 All markings shall be legible and durable.

3.4 Installation Instructions

The manufacturer shall provide the user with

- adequate instructions for the proper installation, maintenance, and operation of the product, including any special dimension requirements, and
- adequate facilities for repair of the product and supply of replacement parts.

4. PERFORMANCE REQUIREMENTS

4.1 Hydrostatic Strength

4.1.1 Requirement

Valve bodies, covers, and bonnets shall withstand hydrostatic strength testing without sustaining cracking or permanent distortion.

4.1.2 Test/Verification

Valve bodies, covers, and bonnets shall be subjected to a hydrostatic test of 700 psi (48 bar) or four times the rated working pressure, whichever is greater, for five minutes.

4.2 Stem Seal

4.2.1 Requirement

Stem seals shall be free from leakage.

4.2.2 Test/Verification

A sample valve with the gate in a partially open position shall be subjected to its rated working pressure for five minutes with no visible stem leakage.

4.3 Packing Replacement

4.3.1 Requirement

One person shall be able to repack the valve under the rated working conditions.

4.3.2 Test/Verification

With a sample valve wide open and under rated working pressure, one person shall remove the packing rings and repack the valve.

4.4 Friction Loss Determination

4.4.1 Requirement

The construction of the valve shall be such that obstruction to the passage of water through the valve body is minimal. With the gate in the full open position, the loss in pressure through the valve shall not exceed 5.0 psi (34 kPa) at a flow producing a velocity of 20 ft/sec (6 m/s) in schedule 40 steel pipe of the same nominal diameter as the valve.

4.4.2 Test/Verification

Tests shall be conducted to show that the friction loss through the valve does not exceed that stated above. These tests may be waived at the examining project leader's opinion if a drawing and calculation review are satisfactory.

4.5 Bonding Adequacy

4.5.1 Requirement

For resilient seated valves, rubber facings shall remain securely bonded or fastened to the disc base material.

4.5.2 Test/Verification

A representative size valve in the approximately half open position shall be subjected to a flow rate of approximately 30 ft/sec (9 m/sec) as calculated using Schedule 40 steel pipe of the same diameter as the valve for 90 minutes. Following this test, there shall be no apparent separation of the rubber from the base material or substrate or any other type of failure, such as blistering, peeling, flaking, delaminating, or evidence of loosening from the base material.

4.6 Water Absorption

4.6.1 Requirement

For resilient seated valves, rubber facings shall not exceed water absorption limits specified in Section 4.6.2.

4.6.2 Test/Verification

A specimen of the valve rubber facing supplied by the manufacturer shall be maintained in water at a temperature of 212°F (100°C) for 6 hours to measure the comparative ability of rubber to withstand the effect of water in accordance with ASTM D 471 “Standard Test Method for Rubber Property — Effect of Liquids.” At the end of this period, any change in the sample shall not exceed 1.5 percent of the original thickness or weight.

4.7 Aging

4.7.1 Requirement

For resilient seated valves, aging shall not promote cracking of rubber facings.

4.7.2 Test/Verification

A specimen of the valve rubber facing as described in Section 2.3.1, supplied by the valve manufacturer shall be subjected to an accelerated aging test in accordance with ASTM D 572 — Test Method for Rubber Deterioration by Heat and Oxygen. The test duration shall be 96 hours. After the test the specimen shall be examined for resilience. No cracking shall occur when the sample is bent double.

4.8 Corrosion Protection Coating

4.8.1 Requirement

A corrosion protective coating on the interior of resilient seated valve bodies is required. All materials used as corrosion resistant coatings shall resist separation from the corrosion protected material. No evidence of separation of the coating material from the base material, such as blistering, peeling, flaking, or delaminating shall result.

4.8.2 Test/Verification

Four test coupons, of the same material as the valve body, supplied by the valve manufacturer, prepared from cylindrical tubes measuring 6 inches (152 mm) in diameter by 4 inches (102 mm) long and split lengthwise shall be coated. On each sample an "X" of at least 2 in. (51 mm) length on each leg shall be scribed with a sharp instrument through the coating material to the metal substrate on both the inside and outside surfaces. The scribed test coupons shall then be immersed in tap water at a temperature of 38°F (3°C) for 30 days. Following this test, the water temperature shall be raised to 150°F (66°C) and the same test coupons shall remain immersed for an additional 30 days.

4.9 Resilient Seat Leakage

4.9.1 Requirement

Resilient seated valves shall be leak tight when closed. When the valve is tested at its rated working pressure, there shall be no leakage past the seat. After the seat leakage test, valves shall be opened through their full travel range with no evidence of sticking or binding.

4.9.2 Test/Verification

The valve shall be closed. The input torque to close the valve shall not exceed the requirements listed in Table 1. With one side open to atmosphere, the other side shall be hydrostatically pressurized to the rated working pressure and held for five minutes. This shall be repeated for both directions of flow.

Table 1. Input Torque

Nominal Valve Size in.	Applied Torque		Nominal Valve Size in.	Applied Torque	
	lb•ft	(N•m)		lb•ft	(N•m)
1	25	(34)	4	75	(104)
1¼	30	(41)	5	90	(122)
1½	35	(48)	6	110	(149)
2	45	(61)	8	150	(203)
2½	50	(68)	10	185	(251)
3	55	(75)	12	225	(305)
3½	65	(88)	14	250	(340)

4.10 Metal Seat Leakage Test

4.10.1 Requirement

Metal seated valves shall be leak tight when closed. When the valve is tested at its rated working pressure, leakage shall not exceed one fluid ounce (30 cm³) per hour. At two times the rated working pressure, leakage shall not exceed one fluid ounce (30 cm³) per hour per inch (per 25 mm) of nominal valve size. After the seat leakage test, all valves shall be opened through their full travel range with no evidence of sticking or binding.

4.10.2 Test/Verification

The valve shall be closed (the input torque to close the valve shall not exceed the requirements in 4.9.2). With one side open to atmosphere, the other side shall be hydrostatically pressurized to the rated working pressure and held for five minutes. This shall be repeated for both directions of flow. This test shall then be repeated at two times the rated working pressure.

4.11 Operating Mechanism

4.11.1 *Requirement*

The valve operating mechanism shall be designed to withstand specified torques without impairment of operation. The tests detailed in 4.11.2 shall be conducted to determine adequate physical strength of the operating mechanism. No failure or permanent distortion of parts shall result from this test.

4.11.2 *Test/Verification*

- a. The torques indicated in Table 2 shall be applied in the direction to close the valve. After removal of the torque, the valve shall be capable of being opened and closed smoothly throughout its full travel range.

Table 2. Torque to Close

<i>Nominal Valve Size</i> <i>in.</i>	<i>Applied Torque</i>		<i>Nominal Valve Size</i> <i>in.</i>	<i>Applied Torque</i>	
	<i>lb•ft</i>	<i>(N•m)</i>		<i>lb•ft</i>	<i>(N•m)</i>
1	40	(54)	4	200	(271)
¼	50	(68)	5	250	(340)
1½	60	(81)	6	300	(407)
2	75	(102)	8	400	(542)
2½	125	(170)	10	600	(814)
3	150	(203)	12	800	(1085)
3½	175	(237)	14	900	(1220)

- b. After applying the above torque value, releasing it, and then operating the valve through its full range of travel, the above torque shall be reapplied to the valve stem in the direction to close. The torque shall be increased gradually from 101 to 150 percent of the tabulated value, carefully looking for any signs of permanent deformation or component failure. If any component fails, it shall be capable of being replaced without removing the valve from the line. The component which failed and the torque at which it failed shall be noted. If 150 percent of torque is reached, the test shall be stopped and the torque released.

It shall not be necessary for the valve to operate smoothly throughout its full range of travel after the application of the overtorque.

4.12 Indicator Post Flange

4.12.1 *Requirement*

Indicator post flanges shall demonstrate physical strength without permanent damage or deformation.

4.12.2 *Test/Verification*

NRS gate valves 4 inches nominal size and larger having indicator post flanges shall be subjected to the following test. With the flange and bonnet assembly securely fastened, an eccentric load of 6500 pounds (2950 kg) shall be applied normal to the surface of the flange between two of the bolt holes and at a distance of 5½ inches (140 mm) from the center of the flange. A steel bar between 1¼ and 2½ inches in diameter is a satisfactory loading device. If bolts are used for fastening the flange to the bonnet, they shall be secured with the torque specified for factory assembly.

4.13 Handle Strength (OS&Y Gate Valves Only)

4.13.1 Requirement

The operating handwheel or crank shall not fracture when subjected to loads at various points. No fracture or permanent deformation which would affect operation of the valve shall result.

4.13.2 Test/Verification

With an assembled valve supported in the upright position, a dead weight load of 200 pounds (91 kg) shall be applied to the handle at various points and maintained for 1 minute at each position.

4.14 Gate Strength

4.14.1 Requirement

The gate or disc shall not crack or deform when subjected to twice the rated working pressure. Afterward, the valve shall be fully operable and shall comply with the leakage requirements in Section 4.9 or 4.10 as appropriate.

4.14.2 Test/Verification

The valve shall be closed. With one side open to atmosphere, the other side shall be hydrostatically pressurized to two times its rated working pressure and held for 5 minutes. For this strength test, special provisions may be made to prevent leakage past the seat. This test shall be repeated for both directions of flow.

4.15 Additional Tests

Additional tests may be required, at the discretion of FM Approvals, depending on design features and results of any foregoing tests. A re-test shall only be acceptable at the discretion of FM Approvals and with an adequate technical justification of the conditions or reasons for failure, otherwise, a design change will be required.

5. OPERATIONS REQUIREMENTS

A quality assurance program is required to assure that subsequent gate valves produced by the manufacturer shall present the same quality and reliability as the specific gate valves examined. Design quality, conformance to design, and performance are the areas of primary concern.

- Design quality is determined during the examination and tests, and is documented in the Approval Report.
- Continued conformance to this Standard is verified by the Facilities and Procedures Audits (F&PA).
- Quality of performance is determined by field performance and as necessary by periodic re-examination and testing.

5.1 Demonstrated Quality Control Program

5.1.1 The manufacturer shall demonstrate a quality assurance program which specifies controls for at least the following areas:

- existence of corporate quality assurance guidelines
- incoming quality assurance, including inspection and testing
- in-process quality assurance, including inspection and testing
- final inspection and tests
- equipment calibration
- drawing and change control
- packaging and shipping
- handling and disposition of discrepant materials.

5.1.2 Documentation/Manual

There should be an authoritative collection of procedures/policies. It should provide an accurate description of the quality management system while serving as a permanent reference for implementation and maintenance of that system. The system should require that sufficient records are maintained to demonstrate achievement of the required quality and verify operation of the quality system.

5.1.3 Records

To assure adequate traceability of materials and products, the manufacturer shall maintain a record of all quality assurance tests performed, and shall maintain this record for a minimum period of two years from the date of manufacture.

5.1.4 Drawing and Change Control

- The manufacturer shall establish a system of product configuration control that shall allow no unauthorized changes to the product. Changes to critical documents, identified in the Approval Report "Primary Materials List," must be reported to, and authorized by, FM Approvals prior to implementation for production.
- The manufacturer shall assign an appropriate person or group to be responsible for, and require that, proposed changes to Approved or Listed products be reported to FM Approvals before implementation. The manufacturer shall notify FM Approvals of changes in the product or of persons responsible for keeping FM Approvals advised by means of FM Approvals Form 797, Approved Product Revision Report or Address/Contact Change Notice.
- Records of all revisions to all Approved products shall be maintained.

5.2 Facilities and Procedures Audit (F&PA)

5.2.1 An audit of the manufacturing facility is part of the Approval investigation to verify implementation of the quality assurance program. Its purpose is to determine that the manufacturer's equipment, procedures, and quality program are maintained to insure a uniform product consistent with that which was tested and Approved.

5.2.2 These audits shall be conducted periodically but at least annually by FM Approvals or its representatives or more frequently dependent on jurisdictional requirements. At issue of this standard the Occupational and Safety Health Administration of the U.S. Department of Labor, requires audits of manufacturing sites producing products for use in hazardous locations during each quarter that the product is manufactured.

5.2.3 FM Approved products or services shall be produced or provided at or from the location(s) audited by FM Approvals and as specified in the Approval Report. Manufacture of products bearing the FM Approval Mark is not permitted at any other location without prior written authorization by FM Approvals.

5.3 Manufacturer's Responsibilities

The manufacturer shall notify FM Approvals of changes in product construction, components, raw materials, physical characteristics, coatings, component formulation or quality assurance procedures prior to implementation.

5.4 Manufacturing and Production Tests

5.4.1 Seat Leakage

The manufacturer shall test 100 percent of production valves for seat leakage to the rated working pressure. Seating torque shall not exceed the requirements of Section 4.9, "Resilient Seat Leakage." The pressure shall be held for a minimum of 15 seconds with seat leakage not to exceed 0.075 in³ (1.25 cm³) for metal-seated valves and zero leakage for resilient-seated valves.

Following the seat leakage test, all valves shall be opened through their full travel range with no evidence of sticking or binding

5.4.2 Body Leakage

The manufacturer shall test 100 percent of production valves for body leakage to twice the rated working pressure. The pressure shall be held for a minimum of 1 minute with no evidence of body leakage or distortion.

APPENDIX A

UNITS OF MEASUREMENT

LENGTH:	<p>in. – “inches” (mm – “millimeters”) $\text{mm} = \text{in.} \times 25.4$</p> <p>ft – “feet” (m – “meters”) $\text{m} = \text{ft} \times 0.3048$</p>
AREA	<p>in.^2 – “square inches;” (mm^2 – square millimeters”) $\text{mm}^2 = \text{in.}^2 \times 6.4516 \times 10^2$</p> <p>$\text{ft}^2$ – “square feet;” (m^2 – square meters”) $\text{m}^2 = \text{ft}^2 \times 0.0929^2$</p>
MASS:	<p>lb – “pounds”; (kg – “kilograms”) $\text{kg} = \text{lb} \times 0.454$</p>
PRESSURE:	<p>psi – “pounds per square inch”; (bar – “bar”) $\text{kPa} = \text{psi} \times 0.0689$ bar – “bar”; (kPa – “kilopascals”) $\text{bar} = \text{kPa} \times 0.01$</p>
TEMPERATURE:	<p>$^{\circ}\text{F}$ – “degrees Fahrenheit” ($^{\circ}\text{C}$ – “degrees Celsius”) $^{\circ}\text{C} = (^{\circ}\text{F} - 32) \times 0.556$</p>
LIQUID VOLUME:	<p>gal – “gallons”; (L – “liter”) $\text{L} = \text{gal} \times 3.785$ L – “liter”; (dm^3 – “cubic decimeters”) $\text{L} = \text{dm}^3$</p>
FLOW RATE:	<p>gal/min – “gallon per minute”; (L/min – “liters per minute”) $\text{L/min} = \text{gal/min} \times 3.785$</p>

APPENDIX B

APPROVAL MARKS

REPRODUCTION ART: FM Approval Marks

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



- 1) The FM 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.

Additional reproduction art is available through

FM Approvals
P.O. Box 9102,
Norwood, Massachusetts 02062
U.S.A.