



Member of the FM Global Group

Approval Standard for Fire Hose

Class Number 2111

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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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1. INTRODUCTION

1.1 Purpose

- 1.1.1 This standard states FM Approval criteria for 1½, 1¾, 2, and 2½ in. (38, 44, 51, and 65 mm) single-jacket occupant-use hose and single-jacket, double-jacket and covered lined fire hose; and 3 in. (76 mm) single-jacket, double-jacket and covered lined fire hose.
- 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 applicable to single-jacket occupant-use hose designed to be used by occupants of a building to fight incipient fires prior to the arrival of trained fire fighters or fire brigade members.
- 1.2.2 Single-jacket hose is designed for use on standpipes, fire hydrants and other such places where it will not be subject to chafing or being dragged over rough or sharp surfaces.
- 1.2.3 Double-jacket and covered hose is designed for use on pumpers or other areas where the extra protection afforded by the outer jacket or cover is desired.
- 1.2.4 While in service, fire hose tested and Approved to this Standard should be maintained and tested periodically to a nationally recognized standard, such as NFPA 1962, *Care, Use and Maintenance of Fire Hose Including Connections and Nozzles*.
- 1.2.5 In cases where metric sized fire hose is to be examined for Approval, test criteria comparable to the equivalent or nearest nominal inch size shall be used. Fire hose of unusual design may be subjected to special tests to determine their suitability.
- 1.2.6 FM Approvals 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 national and international 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 fire hose for the purpose of obtaining FM Approval. These requirements are intended primarily as guides, and strict conformity is not always mandatory. Fire hose 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, fire hose which does 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 facility(ies) and audit of quality control procedures shall be made to evaluate the manufacturer's ability to produce the product as 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 **July 31, 2000** 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 American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE)/American Society for Testing Materials (ASTM) SI 10-97, "*Standard for Use of the International System of Units (SI): The Modern Metric System.*"

1.8 Applicable Documents

The latest versions of the following standards, test methods, and practices are referenced in this standard:

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

National Fire Protection Association (NFPA) 1962, *Care, Use and Maintenance of Fire Hose Including Connections and Nozzles*

ASTM D 412, *Test Method for Rubber Properties in Tension, Method A*.

ASTM D 573, *Test Method for Rubber Deterioration in an Air Oven*.

1.9 Definitions

For purposes of this standard, the following terms apply:

Approval Mark

The FM Approval Mark is detailed in Appendix B. Its use is mandatory on all lengths of Approved hose. These registered marks cannot be used except as authorized by FM Approvals via the granting of Approval to a specific product.

Approved

This term refers to products FM Approved. Such products are listed in the Approval Guide. All products so listed have been successfully examined by FM Approvals, and their manufacturers have signed and returned an Approval Agreement to FM Approvals. This form obligates the manufacturer to allow re-examination of the product and audit of facilities and procedures at FM Approvals discretion. It further requires the manufacturer not to deviate from the as-Approved configuration of the product without review by, and agreement of, FM Approvals.

Degrees of Twist per Foot

The degrees per foot (degrees per meter) of twist shall be calculated by counting the number of turns of the free end as the hose is being pressurized to the proof pressure. The number of turns measured to the nearest one eighth turn shall be multiplied by 360° and the result divided by the initial length at 10 psi (70 kPa).

Percent Elongation

The percent elongation shall be calculated by dividing the initial length at 10 psi (70 kPa) by the length measured at the proof pressure. All measurements shall be taken to the nearest inch (centimeter). If the hose warps appreciably while the pressure is being increased, the length at proof pressure shall be determined by measuring along the contour of the hose.

Proof Pressure

The hydrostatic pressure to which a sample of new production hose is tested to indicate its acceptability for a specific normal maximum operating pressure. The proof pressure shall not be less than twice the service test pressure. Proof pressure tests shall only be conducted at the point of manufacture or by a laboratory qualified by FM Approvals.

Rise

As the hose is being pressurized from 10 psi (70 kPa) to the proof pressure it may rise off the test surface. The distance between the bottom of the hose and the test surface is the rise. If the hose rises in several places along its length the greatest measurement will be considered the rise. The rise shall be measured to the nearest inch (centimeter).

Service Test

A hydrostatic test conducted periodically by users on all in-service fire hose to determine suitability for continued service. The service test pressure shall be at least 10 percent greater than the normal highest operating pressure.

Warp

For hose having a nominal length of 50 ft (15 m), the warp is the maximum deviation between the centerline of the sample and a straight line drawn between the centerline of the couplings. For hose having a nominal length greater than 50 ft (15 m), but not exceeding 100 ft (30 m), the warp is the maximum deviation between the centerline of the sample and each of two straight lines. One line shall be drawn between the coupling or fitting at the fixed end to a point on the hose 50 ft (15 m) from that fitting. The other line shall be drawn from the coupling or fitting on the relief end to a point on the hose 50 ft (15 m) from that fitting. All measurements shall be taken along the centerline of the hose and couplings or fittings.

2. GENERAL INFORMATION

2.1 Product Information

2.1.1 Present standard nominal sizes of fire hose for fire protection service are: 1½, 1¾, 2, 2½, and 3 inches (38, 44, 51, 65 and 76 mm).

2.1.2 In order to meet the intent of this Standard, fire hose 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 hose, 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 trade names or designations, and sizes for the products or services being submitted for Approval consideration,
- jacket weave and lining specifications, anticipated marking format, brochures, sales literature, and installation, operation and maintenance procedures, and
- the number and location(s) of manufacturing facilities.

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 any special test fixtures that may be required to evaluate the fire hose.

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 Jackets shall be evenly and firmly woven, and as free from defects, dirt, knots, lumps, and irregularities as is consistent with good manufacturing practice and would not impair its intended use.
- 3.2.2 All knots in the filler yarn shall be tucked under the warp yarn.
- 3.2.3 Each jacket shall be seamless and shall have the filler woven around the hose throughout its length and the warps interwoven with and substantially covering the filler.
- 3.2.4 The lining and cover if provided, shall be of uniform thickness and free from pitting, blisters or other imperfections that may impair its intended use.
- 3.2.5 The internal diameter of the unpressurized hose shall not be less than the nominal size of the hose, except for 2½ in. (65 mm) hose which shall not be less than 2⁹/₁₆ in. (65 mm).
- 3.2.6 The manufacturer shall provide jacket weave specifications, detailing such areas as warp yarn, warp size, warp denier (decitex), number of warp ends, filler yarn, filler picks/in. (mm), and filler denier (decitex).

3.3 Materials

All materials used in these fire hoses shall be suitable for the intended application. Any materials used in these fire hoses shall have physical properties necessary to render them suitable for their intended use. When unusual materials are used, special tests may be necessary to verify their suitability.

3.4 Markings

- 3.4.1 The following information shall be stenciled on each length of hose in 1 in. (25 mm) high letters beginning approximately 3 ft (1 m) from each end:
 - manufacturer's name or identifying symbol;
 - trade name or designation;
 - month and year of manufacture;
 - Service Test Pressure in local and customary units; and
 - the FM Approval Mark (see Appendix B).
- 3.4.2 The trade name or designation 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 unless covered by a separate agreement.

3.4.3 The FM Approval Mark (see Appendix B) 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.

3.4.4 All markings shall be legible and durable.

3.5 Manufacturer's Installation and Operation Instructions

Instructions, including any special dimension requirements, shall be furnished by the manufacturer. Instructions shall be provided in each shipping container.

3.6 Calibration

All examinations and tests performed in evaluation to this Standard shall use calibrated measuring instruments traceable and certified to acceptable national standards.

4. PERFORMANCE REQUIREMENTS

4.1 Examination

4.1.1 Requirement

The fire hose shall conform to the manufacturer's specifications and to FM Approvals requirements.

4.1.2 Test/Verification

A sample shall be examined and compared to the specifications. It shall be verified that the sample conforms to the physical and structural requirements described in Section 3, General Requirements.

4.2 Hydrostatic Proof-Pressure Tests

4.2.1 Requirements

- A. The percent elongation shall not exceed the values shown in Table 4.2.1, when tested in accordance with Section 4.2.2.
- B. The number of degrees of twist per foot shall not exceed the values shown in Table 4.2.1, when tested in accordance with Section 4.2.2.
- C. The amount of warp per 50 ft (15 m) length shall not exceed the values shown in Table 4.2.1, when tested in accordance with Section 4.2.2.
- D. The hose shall not rise above the test surface more than the values specified in Table 4.2.1., when tested in accordance with Section 4.2.2.

Table 4.2.1 Proof Pressure Tests

Test	Number of Jackets	Nominal Size		Service Test Pressure		Maximum Allowable Requirements	
		in.	(mm)	psi	(kPa)		
Elongation	Single	1½ - 3	(38 - 76)	150 - 250	(1035 - 1725)	10 percent	
	Multiple	1½ - 2½	(38 - 65)	200 - 400	(1380 - 2760)	8 percent	
	Multiple	3	(76)	200 - 400	(1380 - 2760)	10 percent	
Twist	Single	1½ - 2	(38 - 51)	150	(1035)	54°/ft	(175°/m)
	Single	2½ - 3	(65 - 76)	150	(1035)	27°/ft	(90°/m)
	Single	1½ - 2	(38 - 51)	200	(1380)	72°/ft	(235°/m)
				250	(1725)		
	Single	2½ - 3	(65 - 76)	250	(1725)	36°/ft	(120°/m)
	Multiple	1½ - 2	(38 - 51)	200 - 400	(1380 - 2760)	32.4°/ft	(105°/m)
Multiple	2½ - 3	(65 - 76)	200 - 400	(1380 - 2760)	13.6°/ft	(45°/m)	
Warp	Single & Multiple	1½ - 3	(38 - 76)	150 - 400	(1035 - 2760)	20 in./50 ft (510 mm/15.2 m)	
Rise	Single	1½ - 2	(38 - 51)	150 - 250	(1035 - 1725)	7 in.	(180 mm)
	Single	2½ - 3	(65 - 76)	150 - 250	(1035 - 1725)	4 in.	(100 mm)
	Multiple	1½ - 3	(38 - 76)	200 - 400	(1380 - 2760)	0 in.	(0 mm)

4.2.2 Test/Verification

The minimum length sample shall be 50 ft (15 m). Samples shall not exceed 100 ft (30 m). When coupled hose is being tested, it shall be marked prior to the tests by suitable means at a point immediately adjacent to each coupling.

One end of the sample shall be connected to the source of water supply by means of couplings or temporary test fittings, and the other end shall be free to move and shall be closed by a fitting provided with a petcock for the escape of air while the sample is being filled with water. For hose having a nominal length of 50 ft (15 m), the connection between the end of the sample and the source of water supply is to be rigid. For hose having a nominal length greater than 50 ft (15 m), the connection between the end of the sample and the source of water supply may be flexible.

The sample shall be stretched out on the test surface so as to lie straight and without twist. To facilitate the complete removal of air from the sample, the surface on which the sample rests shall be inclined so that the supply end is lower than the relief end. With the petcock open, water shall be admitted through the sample gradually until all air has been expelled and the sample is completely filled with water. The petcock shall then be closed and the pressure raised to 10 psi (70 kPa) and held at that pressure while the initial length measurement is taken. While at this pressure, the sample shall be straightened out in order to obtain an accurate measurement. The jacket construction and workmanship in weaving, particularly knots, loose ends, and skips in warp threads shall be noted and recorded at this time.

The length of the sample between fittings shall be measured and recorded to the nearest inch (centimeter). The position of the sample with regard to twist shall be noted. From this point on, neither the sample nor the fittings shall be touched, moved, or interfered with in any way until all measurements and observations have been completed at the final test pressure.

Following measurement of the length at 10 psi (70 kPa), the pressure in the sample shall be increased at a rate of 300 - 1000 psi (2070 - 6900 kPa) per minute until the required proof pressure is reached. While the pressure is being increased, the sample shall be examined for leakage and other defects. The proof pressure shall be maintained for at least 15 seconds, but not more than 1 minute. During the time the test pressure is maintained, the observations and measurements for elongation, twist, warp, and rise shall be completed.

4.3 Kink Test

4.3.1 Requirement

Hose, while kinked, shall withstand a hydrostatic pressure of 1½ times the service test pressure without leakage, rupturing, or breaking any yarns in the jacket or reinforcement.

4.3.2 Tests/Verification

The sample shall be a minimum of 3 ft (0.9 m) long.

The sample shall be filled with water, 10 psi (70 kPa), in a manner such that all the air is allowed to bleed out. At 10 psi (70 kPa) the sample shall be kinked approximately 18 in. (455 mm) from the free end by tying the hose against itself as close to the free end as possible. The pressure shall be increased at a rate of 300 to 1000 psi (2070 to 6900 kPa) per minute until 1½ times the service test pressure is reached, and then immediately released.

4.4 Hydrostatic Minimum Burst-Pressure Test

4.4.1 Requirement

Two sample hoses shall withstand a hydrostatic test pressure of three times the marked service test pressure without rupturing or breaking of any yarn in the jacket or cover. One sample shall be tested while lying straight and the other while curved around a surface with a 27 in (0.7 m) radius.

4.4.2 Test/Verification

The length of the samples shall be between 3 and 4 ft (0.9 and 1.2 m).

The samples shall be filled with water and bled of air prior to testing. The pressure shall be increased at a rate of 300 to 1000 psi (2070 to 6900 kPa) per minute until the specified pressure is reached and immediately released.

4.5 Lining Adhesion

4.5.1 Requirements

- A. The rate of separation of a 1½ in. (38 mm) lining strip from the jacket shall not exceed 1 in. (25 mm) per minute when a weight of 12 lbs (5.5 kg) is applied.
- B. If a rubber backing is used between the liner and jacket or reinforcement, the adhesion between the lining and the jacket, and the lining and the backing, shall be such that the rate of separation of a 1½ in. (38 mm) strip is not greater than 1 in. (25 mm) per minute when a weight of 12 lbs (5.5 kg) is applied.
- C. The requirements of 4.5.1. A and B. are not intended to exclude a construction that provides no adhesion between the jacket and the lining along the fold, provided the surface over which there is no adhesion does not exceed 35 percent of the total surface.
- D. The adhesion between the cover and the woven jacket or reinforcement shall be such that the rate of separation of a 1½ in. (40 mm) strip of the cover from the jacket or reinforcement shall not be greater than 1 in. (25 mm) per minute with a weight of 10 lbs (4.5 kg).

4.5.2 Tests/Verification

- A. The apparatus required for this test shall consist of a supporting frame, clamps, weights, weight holders, and a timer. The supporting frame shall be of such design that specimens, with weights attached, may be suspended vertically and hang freely during the progress of the test.
- B. The specimen for the adhesion test shall be cut transversely to the length of the hose.
- C. The specimen shall be 2 in. (50 mm) wide and shall be cut through so as to give a rectangular sample 2 in. (50 mm) wide and the full circumference of the hose in length. A strip of lining, or cover if provided, 1½ in. (40 mm) wide shall be cut out accurately, the cut extending through the rubber but not entirely through the woven jacket. This strip shall be started at one end to the extent of about 1½ in. (40 mm), and a reference mark shall be placed on the jacket at the juncture of the jacket and lining. The free end of the woven jacket and the free end of the strip of rubber shall be secured in suitable clamps.
- D. With the separated jacket or liner gripped in a stationary clamp, the separated rubber backing shall be gripped in a freely suspended clamp hanging vertically, to which the prescribed weight shall be attached with suitable provision for supporting and releasing it slowly without jerking. The distance through which separation takes place shall be noted for a period of 10 minutes, or until complete separation occurs. The adhesion to the jacket shall be taken as the rate obtained by dividing the total distance separated by inches (millimeters), to the nearest 0.1 in. (2.5 mm), by the elapsed time in minutes.
- E. If a rubber backing is used between the lining and the jacket, the adhesion between the lining and the backing, and the adhesion between the backing and the jacket shall be determined using the methods specified in this section. If the adhesion between the lining and the backing or between the backing and the jacket cannot be determined because the backing has a tendency to tear during the test, the rate of separation between the separating members shall be considered the adhesion.

4.6 Tensile Strength and Ultimate Elongation

4.6.1 Requirements

The tensile strength and ultimate elongation of specimens taken from the lining and cover, if provided, shall not be less than as specified in Table 4.6.1 when tested as specified in Section 4.6.2.

Table 4.6.1 Tensile Strength and Ultimate Elongation

Material	Minimum Tensile Strength		Minimum Elongation, %
	psi	(kPa)	
Natural and Synthetic Rubber	1200	(8275)	400
Latex Rubber	1800	(12 410)	700
Thermoplastic	2000	(13 790)	400
All	1200	(8275)	400

The tensile strength and ultimate elongation values of specimens subjected to the oven aging test, as specified in Section 4.6.2. H, shall not be less than 75 percent of values of specimens not subjected to this test.

4.6.2 Tests/Verification

- A. Tensile strength and elongation shall be determined in accordance with the test methods specified in ASTM D 412, *Test Method for Rubber Properties in Tension, Method A*.
- B. Three dumbbell specimens shall be cut with a Type A or C die, as specified in ASTM D 412.
- C. The constricted portion of each specimen may be buffed to remove fabric impressions or other surface irregularities. Samples shall be buffed prior to cutting with the die. If the nature or thickness of the lining is such that buffing cannot be accomplished without damaging the lining, unbuffed specimens may be used for the tensile strength and elongation tests.
- D. The specimens shall be cut transversely from the sample.
- E. Three measurements for thickness shall be made in the constricted portion of each specimen. The minimum value obtained shall be used as the thickness of the specimen in calculating the tensile strength. The average tensile strength of the three specimens shall be considered the tensile strength of the rubber lining or cover.
- F. Two benchmarks 1 in. (25 mm) apart shall be stamped centrally on the constricted portion of each specimen.
- G. If a dumbbell test specimen breaks outside the benchmarks, or if the result of either tensile strength or elongation based on the average of three specimens is not acceptable, another set of three specimens shall be tested, and the results from this set shall be considered final. Results of tests of specimens that break in the curved portion just outside the benchmarks may be accepted if within the minimum requirements.
- H. Three specimens shall be prepared as described in items 4.6.2. B. through 4.6.2. E., above. The specimens shall be conditioned in an oven for 96 hours at 158°F±3.6°F (70°C±2°C) following the procedures described in ASTM D 573, *Test Method for Rubber Deterioration in an Air Oven*. Two benchmarks 1 in. (25 mm) apart shall be stamped centrally on the constricted portion of each specimen after the conditioning. The specimens shall then be tested in accordance with ASTM D 412, *Test Method for Rubber Properties in Tension, Method A*.

4.7 Cold Resistance (Not Required for Occupant-Use Hose)

4.7.1 Requirements

- A. A 3 ft (1 m) length of hose shall be conditioned as detailed in Section 4.7.2. A.; the hose shall then be subjected to a hydrostatic test to the proof pressure for 5 minutes without leakage or other damage.

- B. It shall be possible for one operator to uncoil and lay out a 50 ft (15 m) length of dry hose immediately upon removal from a -30°F (-34°C) conditioning chamber.

4.7.2. Tests/Verification

- A. A 3 ft (1 m) length of hose shall be immersed in a water bath at room temperature for 24 hours. The sample shall then be removed from the bath and conditioned at room temperature 15 minutes. The hose shall then be conditioned at -30°F (-34°C) for 24 hours. Immediately upon removal from the conditioning chamber the 3 ft (1 m) length of hose shall be bent double on itself, 180 degrees, first one way then the other. The sample shall then be allowed to thaw at room temperature for 24 hours, after which it shall be subjected to the proof pressure test described in Section 5.2.2. E.
- B. A 50 ft (15 m) length of dry hose shall be firmly coiled and conditioned at -30°F (-34°C) for 24 hours. Immediately upon removal from the conditioning chamber one operator shall uncoil and lay out the full length of hose.

4.8 Heat Resistance (Not Required for Occupant-Use Hose)

4.8.1 Requirements

An 18 in. (455 mm) length of coupled hose shall comply with the straight hydrostatic test requirements described in Section 5.4 after exposure to a heated steel block.

4.8.2 Tests/Verification

- A. The hose sample filled with water and capped at both ends shall be conditioned at room temperature of 24 hours.
- B. A 2½ × 1½ × 8 in. (65 × 40 × 205 mm) steel block shall be conditioned in an oven maintained at 500°F (260°C) for a minimum of 16 hours.
- C. Within 5 seconds of removal from the oven the steel block shall be placed on the hose so that the longitudinal axis of the block is perpendicular to the longitudinal axis of the hose. The contact area shall be the midpoint of the 2½ in. (65 mm) side of the block and the midpoint of the hose. A metal knife edge shall be used as a support near one end of the block to obtain maximum force on the hose. After 60 seconds the block shall be removed. The burst test shall be conducted after the hose has been allowed to cool.

4.9 Abrasion Test (Not Required for Occupant-Use Hose)

4.9.1 Requirement

The hose shall not leak or burst at the service test pressure after 3000 cycles by the abrasion wheel.

4.9.2 Tests/Verification

- A. The hose test sample shall have a minimum length of 3 ft (1 m). It shall be filled with water at a pressure of 125 psi (860 kPa) and firmly anchored horizontally.
- B. A Norton standard 5 × 2 × ½ in. (130 × 50 × 15 mm) nominal size abrasion wheel designation 37C36-KVK shall be moved to and fro for 3000 cycles along the crown of the hose. The wheel shall be prevented from rotating and shall exert on the hose its full weight plus half of the 1 lb (0.5 kg) weight of the moving arm.
- C. The frequency of cycles shall not exceed 30 per minute. The contact surface of the portion of the abrasion wheel utilized shall be unused at the start of the test.

4.10 Friction Loss (Not Required for Occupant-Use Hose)

4.10.1 Requirement

The friction loss per 50 ft (15 m) of coupled hose with swivel washers in place shall comply with the requirements shown in Table 4.10.1.

Table 4.10.1 Friction Loss Requirements

Nominal Size		Flow		Maximum Friction Loss		Nozzle	
in.	(mm)	gal/min	(L/min)	psi	(kPa)	in.	(mm)
1½	(38)	100	(380)	18	(125)	7/8	(20)
1¾	(44)	135	(510)	15	(105)	7/8	(20)
2	(51)	155	(585)	10	(70)	1	(25)
2½	(65)	250	(945)	8	(55)	1½	(30)
3	(76)	400	(1515)	8	(55)	1½	(30)

The above results were derived using the Hazen-Williams formula as follows:

$$f = \left(\frac{18.73 Q}{C} \right)^{1.85} \left(\frac{L}{D} \right)^{4.87}$$

Where:

- f* - friction loss in psi
- Q* - flow in gal/min
- D* - internal diameter of hose in inches
- C* - Hazen-Williams constant, 135

4.10.2 Tests/Verification

- A. A piezometer pipe of the proper length (minimum of 10 times the inside diameter of the pipe) shall be attached to both ends of the hose.
- B. The flow in gal/min (L/min), as per Table 4.10.1 shall be established.
- C. The pressure differential shall be determined with calibrated instrumentation.
- D. For hoses whose length is other than 50 ft (15 m), the friction loss requirement may be determined by dividing the value shown in Table 4.10.1 by 50 and multiplying the result by the length of the hose.

4.11 Additional Tests

Additional tests may be required, depending on design features, results of any tests, material application, or to verify the integrity and reliability of the fire hose, at the discretion of FM Approvals.

Unexplainable failures shall not be permitted. A re-test shall only be acceptable at the discretion of FM Approvals and with adequate technical justification of the conditions and reasons for failure.

5. OPERATIONS REQUIREMENTS

A quality control program is required to assure that subsequent fire hose produced by the manufacturer at an authorized location, shall present the same quality and reliability as the specific fire hose examined. Design quality, conformance to design, and performance are the areas of primary concern. Design quality is determined during the Approval examination and tests, and is covered in the Approval Report. Conformance to design is verified by control of quality and is covered in the Facilities and Procedures Audit (F&PA). Quality of performance is determined by field performances and 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 testing;
- in-process quality assurance, including testing;
- final inspection and tests;
- equipment calibration;
- drawing and change control;
- packaging and shipping;
- handling and disposition of non-conformance materials.

In order to assure adequate traceability of materials and products, the manufacturer shall maintain records of all quality control tests performed, and shall maintain these records for a minimum period of two years from the date of manufacture.

5.1.2 Documentation/Manual

There should be an authoritative collection of procedures and policies. Such documentation shall 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 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, 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 reporting proposed changes to Approved or Listed products 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 control program. Its purpose is to determine that the manufacturer's equipment, procedures, and quality program are maintained to insure a consistently uniform and reliable product. Initial inspections of facilities already producing similar Approved products may be waived at the discretion of FM Approvals.

- 5.2.2 Unannounced follow-up inspections shall be conducted at least annually by FM Approvals, or its designee, to determine continued compliance. More frequent audits may be required by FM Approvals.
- 5.2.3 The client shall manufacture the product or service only at 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 locations without prior written authorization by FM Approvals.

5.3 Manufacturer's Responsibilities

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

5.4 Manufacturing and Production Tests

5.4.1 *Test Requirement No. 1 — Internal Diameter*

The manufacturer shall perform measurements of the internal diameter every 1250 ft (380 m) or less to ensure the fire hose being produced is still within specifications.

5.4.2 *Test Requirement No. 2 — Thickness of Lining*

The manufacturer shall perform measurements of the lining thickness every 1250 ft (380 m) or less to ensure the fire hose being produced is still within specifications.

5.4.3 *Test Requirement No. 3 — Thickness of Cover*

The manufacturer shall perform measurements of the cover thickness every 1250 ft (380 m) or less to ensure the fire hose being produced is still within specifications.

5.4.4 *Test Requirement No. 4 — Adhesion Lining to Jacket*

The manufacturer shall perform testing of the adhesion of the lining to the jacket every 1250 ft (380 m) or less to ensure compliance with the requirements of this Standard.

5.4.5 *Test Requirement No. 5 — Adhesion Cover to Jacket*

The manufacturer shall perform testing of the adhesion of the cover to the jacket every 1250 ft (380 m) or less to ensure compliance with the requirements of this Standard.

5.4.6 *Test Requirement No. 6 — Physical Tests of Lining*

The manufacturer shall perform physical testing of the lining every 1250 ft (380 m) or less to ensure compliance with the requirements of this Standard.

5.4.7 *Test Requirement No. 7 — Physical Tests of Cover*

The manufacturer shall perform physical testing of the cover every 1250 ft (380 m) or less to ensure compliance with the requirements of this Standard.

5.4.8 *Test Requirement No. 8 — Kink Test*

The manufacturer shall kink test production fire hose every 2500 ft (760 m) or less, as per Section 4.3. Hose, while kinked, shall withstand a hydrostatic pressure of 1½ times the service test pressure without leakage, rupturing, or breaking any yarns in the jacket or reinforcement.

5.4.9 *Test Requirement No. 9 — Burst Test*

The manufacturer shall burst test production fire hose every 5000 ft (1525 m) or less, as per Section 4.4. Sample hose shall withstand a hydrostatic test pressure of three times the marked service test pressure without rupturing or breaking of any yarn in the jacket or cover.

5.4.10 *Test Requirement No. 10 — Proof Pressure Test*

The manufacturer shall proof pressure test every length of production fire hose, as per Section 4.2. The percent elongation, number of degrees of twist per foot, amount of warp per 50 ft (15 m) length, and rise above the test surface shall not exceed the values shown in Table 4.2.1.

APPENDIX A

UNITS OF MEASUREMENT

LENGTH:	in. - "inches"; (mm - "millimeters") mm = in. \times 25.4 ft - "feet" (m - "meters") m = ft \times 0.3048
WEIGHT:	lb - "pounds"; (kg - "kilograms") kg = lb \times 0.453
FLOW:	gal/min - "gallons per minute"; (L/min - "Liters per minute") L/min = gal/min \times 3.7854
PRESSURE:	psi - "pounds per square inch"; (kPa - "kilopascals") kPa = psi \times 6.895 bar - "bar"; (kPa - "kilopascals") bar = kPa \times 0.01 bar = psi \times 0.06895
AREA:	in ² - "square inches" (mm ² - "square millimeters") mm ² = in ² \times 6.4516 \times 10 ² ft ² - "square feet" (m ² - "square meters") m ² = ft ² \times 0.0929
TEMPERATURE:	°F - "degrees Fahrenheit" (°C - "degrees Celsius") °C = (°F - 32) \times 0.556

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
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