NFPA 18
Standard on Wetting Agents

1995 Edition

National Fire Protection Association, 1 Batterymarch Park, PO Box 9101, Quincy, MA 02269-9101
An International Codes and Standards Organization

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Standard on

Wetting Agents

1995 Edition

This edition of NFPA 18, *Standard on Wetting Agents*, was prepared by the Technical Committee on Foam and acted on by the National Fire Protection Association, Inc., at its Annual Meeting held May 22-25, 1995, in Denver, CO. It was issued by the Standards Council on July 21, 1995, with an effective date of August 11, 1995, and supersedes all previous editions.

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Changes other than editorial are indicated by a vertical rule in the margin of the pages on which they appear. These lines are included as an aid to the user in identifying changes from the previous edition.

Origin and Development of NFPA 18

This standard was originally sponsored by the NFPA General Committee on Special Extinguishing Methods and prepared by the NFPA Committee on Wetting Agents. It was initiated in 1949, tentatively adopted in 1949, and officially adopted first in 1951. Extensive revisions, most of which were concerned with the use of wetting agent foam, were adopted in 1955. Subsequently (1959) responsibility for this standard was transferred to the Committee on Foam, and the standard was amended in 1972 and 1979.

The 1986 and 1990 editions of the standard were reconfirmations of the 1979 edition.

The 1995 edition of the document is a reconfirmation. However, some editorial changes were incorporated in an effort to make the document more user friendly.

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NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on the installation, maintenance, and use of foam systems for fire protection, including foam hose streams.

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Appendix A.

Information on referenced publications can be found in Chapter 6 and Appendix B.

FOREWORD

Water has been accepted for many years as the most practical fire-fighting agent because of its almost universal availability, its great heat absorption capacity, and the fact that it is a liquid.

Both experience and tests have indicated that the addition of a proper wetting agent to water will, when properly applied, increase the extinguishing efficiency of that water by reducing the quantity of water needed and the amount of time needed to effectively fight the fire. The value of such a property might well become of considerable importance, especially in rural areas where the amount of water available for fire fighting is often inadequate. This is because the addition of a proper wetting agent to the charge in a booster tank will increase the extinguishing efficiency of the water. In other cases, such as forest fires, the increased efficiency becomes an important consideration since most of the water is transported manually in portable equipment.

Certain types of fires, such as those in baled cotton, stacked hay, some rubber compounds, and some flammable liquids, that do not ordinarily respond to treatment with water might be extinguished when a proper wetting agent is used. This property can be attributed to an increase in the penetrating, spreading, and emulsifying powers of water due to factors such as a lowering of the surface tension. This decreased surface tension can be described as a disruption of the forces holding the surface film of water together, thereby permitting it to flow and spread uniformly over solid surfaces. As a result, the treated water acquires the ability to penetrate into small openings and recesses that water would flow over by the simple bridging action of the surface film. It is to be noted that such solutions exhibit not only penetrating and spreading qualities, but also exhibit increased absorptive speed and superior adhesion to solid surfaces.

Wetting agents having foaming characteristics when mixed with water and air, as referred to in this standard, produce a foam that retains the wetting and penetrating characteristics of the wetting agent and provides an efficient smothering action for the extinguishment of both Class A and Class B combustibles, or a fluid insulation for protection against fire exposure. The foam produced in this manner has the additional advantage of breakdown at approximately 175°F (79.4°C) and returns to its original liquid state retaining the penetrating and wetting qualities. The breakdown of this foam when applied on Class A combustibles automatically provides an efficient and adequate application rate for efficient extinguishment.

There are numerous chemicals that fulfill the primary function of a wetting agent, that of lowering the surface tension of water. However, very few of these chemicals are suited to fire control work because of such considerations as toxicity, corrosive action on equipment, and stability in naturally occurring waters. In view of this fact, therefore, these standards set forth certain basic requirements and limitations for the use of a wetting agent as an aid for fire extinguishment. The requirements are intended to ensure that the addition of a wetting agent to any natural water shall not affect that water adversely with respect to fire-fighting properties, nor render it harmful to personnel, property, or equipment. It is further intended to establish standards for the evaluation of wetting agents as fire extinguishing mediums.

Chapter 1 General Information

1-1 Introduction.

1-1.1 Scope. This standard is limited to qualification tests, methods of evaluation, general rules for application, and limitations for use of wetting agents as related to fire control and extinguishment.

1-1.1.1 The method whereby the wetting agent is added to water is not herein specifically set forth. The solution can be premixed in tanks or can result from bringing the wetting agent into contact with water by any suitable proportioning device, providing, however, said device shall be approved in accordance with applicable standards.

1-1.2 Purpose. This standard gives, in general, the requirements for the performance and use of wetting agents as related to fire control and extinguishment and is prepared for the guidance of the fire services, authorities having jurisdiction, and others concerned with judging the acceptability and use of any chemical offered for such a purpose.

1-2* Definitions.

Approved.* Acceptable to the authority having jurisdiction.

Authority Having Jurisdiction.* The organization, office, or individual responsible for approving equipment, an installation, or a procedure.

Class A Fires. Fires in ordinary combustible materials, such as wood, cloth, paper, rubber, and many plastics.

Class B Fires. Fires in flammable liquids, oils, greases, tars, oil-base paints, lacquers, and flammable gases.

Class C Fires. Fires that involve energized electrical equipment. (When electrical equipment is de-energized, the fire might continue to burn as a Class A, Class B, or Class D fire.)

Class D Fires. Fires in combustible metals, such as magnesium, titanium, zirconium, sodium, lithium, and potassium.

Combustible Liquids shall be subdivided as follows:

Class II liquids shall include those having flash points at or above 100°F (37.8°C) and below 140°F (60°C).

Class IIIA liquids shall include those having flash points at or above 140°F (60°C) and below 200°F (93.4°C).

Class IIIB liquids shall include those having flash points at or above 200°F (93.4°C).

Flammable Liquid. A liquid having a flash point below 100°F (37.8°C) and having a vapor pressure not exceeding 40 lbs psi (276kPa) absolute at 100°F (37.8°C) and shall be known as a Class I liquid.

Class I liquids shall be subdivided as follows:

Class IA shall include those having flash points below 73°F (22.8°C) and having a boiling point below 100°F (37.8°C).

Class IB shall include those having flash points below 73°F (22.8°C) and having a boiling point at or above 100°F (37.8°C).

Class IC shall include those having flash points at or above 73°F (22.8°C) and below 100°F (37.8°C).

Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

Listed.* Equipment or materials included in a list published by an organization acceptable to the authority having jurisdictions and concerned with product evaluation, that maintains periodic inspection of production of listed equipment or materials and whose listing states either that the equipment or material meets appropriate standards or has been tested and found suitable for use in a specified manner.

Shall. Indicates a mandatory requirement.

Should. Indicates a recommendation or that which is advised but not required.

Wet Water.* Water to which a compatible wetting agent has been added.

Wet Water Foam. An admixture of wet water with air to form a cellular structure foam that breaks down rapidly into its original liquid state at temperatures below the boiling point of water, at a rate directly related to the exposure to heat, in order to cool the combustible where it is applied.

Wetting Agent. A chemical compound that, when added to water in proper quantities, materially reduces its surface tension, increases its penetrating and spreading abilities, and might also provide emulsification and foaming characteristics.

1-3 Uses.

1-3.1 In general, this standard is intended to signify that a wetting agent that successfully meets the requirements herein set forth shall not be limited in use or application except as herein specified.

1-3.2 The addition of proper wetting agents to water will increase its penetrating and emulsifying abilities and might also provide foaming characteristics that extend the efficiency of water for use in the protection against fire exposure and the extinguishment of Class A and Class B fires in ordinary combustibles and combustible liquids that are insoluble in water and ordinarily stored at atmospheric temperatures and pressures.

1-3.3 In general, wetting agents can be effectively applied and used with all types of standard fire protection equipment where water is normally used. The degree of efficiency obtained will depend on utilizing the most efficient application methods, techniques, and devices for the hazard involved. (*See Section 1-4.*)

1-3.4* When water containing listed wetting agents is applied to a fire, some of the wetting agent can be expected to remain after extinguishment. This residual wetting agent can be effective in reducing the surface tension of water that might subsequently be applied.

1-3.5 The authority having jurisdiction shall be consulted in all cases where the use of wet water is considered for application through fixed equipment, such as water spray, sprinkler, or foam systems. The volume of extinguishing medium required will vary with each type of system and hazard. If applied as a liquid solution, the standard applicable to water systems shall apply.

1-3.6 Effective exposure protection can be accomplished by the application of wet water foam directly to the exposed structure or equipment to reduce the heat transferred from the exposure fire. This protection is afforded whether applied from portable or fixed equipment. Due to the cellular structure and reflective characteristics of wet water foam, the water requirements can be appreciably reduced.

1-3.6.1 The addition of wetting agents to water will increase the efficiency due to the spreading characteristics of the wetting agent, thus affording greater protection than water.

1-4 Limitations.

1-4.1 The addition of wetting agents to water, which changes its physical characteristics, creates certain limitations for use that shall be considered.

1-4.2 Class A Fires. Wet water has the same limitations as water with respect to extinguishing fires involving chemicals that react with water to create additional hazards.

1-4.3 Class B Fires. The effective use of wet water for the extinguishment of fires involving Class B flammable or combustible liquids, as defined in Section 1-2, is limited to those materials not soluble in water, such as petroleum products. In water soluble materials of the alcohol type, some control might be possible, but extinguishment is questionable.

1-4.4* Class C Fires. Wet water solutions can conduct electricity and have limitations similar to water in fighting fires involving energized electrical equipment so far as safety to fire-fighting personnel is concerned. Spray or fog application shall be permitted, but only while adhering to the usual precautions. Application as a straight stream shall be prohibited.

1-4.5 Wet water shall not be used on Class D fires.

1-4.6 Use of Wetting Agents with Other Than Water. Admixing of wetting agents with other wetting agents or with mechanical or chemical foam liquids shall be avoided. The mixing of these agents can have adverse results and thus render them ineffective for fire extinguishment.

1-4.7 The use of wetting agents in concentrations greater than those specified by the manufacturer or recommended by the testing laboratory shall be avoided. High concentrations can cause adverse effects.

1-4.8* Corrosion. The corrosive effects of wetting agents shall be specified by the manufacturer and included in the listing report of the testing laboratory.

1-4.8.1* The level of corrosion and deterioration of materials and metals that are recommended by the manufacturer as being compatible with the wetting agent shall be determined by the listing laboratory and the results contained in their listing report and in the manufacturer's directions for use.

1-4.8.2 Solutions containing wetting agents shall not be used where they might contact galvanizing or similar coatings, since the coatings can be removed by the wetting agent.

1-4.8.3 Concentrated or diluted solutions of wetting agents can cause mild pit-type corrosion of some metal surfaces at the liquid level and in the vapor space. Therefore, storage of wetting agents in any concentration over long periods of time shall be avoided, unless the container is fabricated of corrosive-resistant materials or suitable protective coatings are provided.

1-4.9 Toxicity. Reasonable care shall be exercised to avoid skin contact with concentrated solutions. Due to cleansing properties similar to strong soaps, continued contact can cause mild dermatitis.

NOTE: In general, listed wetting agents are nontoxic.

1-4.9.1 Contamination of foods and eating of contaminated food shall be avoided.

1-4.10 The use of listed wetting agents in portable extinguishers is limited to special formulations as specified by the manufacturer and determined by the listing laboratories.

1-5 Basic Requirements.

1-5.1 Wetting agents for fire fighting shall be listed and shall be approved by the authority having jurisdiction.

1-5.2 Special equipment, such as proportioners, shall be listed and shall be approved by the authority having jurisdiction.

1-6* Units. Metric units of measurement in this standard are in accordance with the modernized metric system known as the International System of Units (SI).

1-6.1 If a value for measurement as given in this standard is followed by an equivalent value in other units, the first stated is to be regarded as the requirement. A given equivalent value might be approximate.

1-6.2 The conversion procedure for the SI units has been to multiply the quantity by the conversion factor and then round the result to the appropriate number of significant digits.

Chapter 2 Wetting Agent Specifications and Tests

2-1 General.

2-1.1* Evaluation Tests. The concentration for use of the active ingredient or ingredients of a wetting agent shall be specified by each manufacturer, and acceptance tests and approval shall be based on such specifications.

2-1.1.1* Wetting agents when added to water in concentrations specified for use shall reduce the surface tension to less than 33 dynes/cm^2.

2-1.1.2 The addition of the wetting agent, in concentrations specified for use by the manufacturer, shall not lower the boiling point or raise the freezing point temperatures of water.

2-1.1.3 A wetting agent to be used for fire extinguishing purposes shall be readily soluble in water and easily and uniformly mixed.

(a) *Solubility.* Throughout the listed storage and use temperature range, the wetting agent shall form a true solution with water that is stable up to the maximum concentration recommended for use by the manufacturer.

(b) **Separation Temperature.* Aqueous solutions of the wetting agent in concentrations recommended for use by the manufacturer shall not separate at any temperature between 32°F and 120°F (0°C and 48.9°C). Any increase in haziness, cloudiness, or precipitation occurring during the course of the test indicates a separation.

(c) **Separation on Standing.* The wetting agent, in concentrations specified for use by the manufacturer, shall display no tendency to "layer out" or otherwise separate when standing for 30 days at the minimum and maximum storage and use temperatures and at 60°F (15.6°C). The formation of two or more distinct layers or precipitation occurring during the course of the test shall be considered as an indication of separation.

(d) **Action after Freezing.* Aqueous solutions of the wetting agent in concentrations recommended for use by the manufacturer, after being frozen for 1 hour and then warmed to 60°F (15.6°C), shall return to normal condition after reasonable agitation.

2-1.1.4 Listings shall indicate the use for which the material is effective, as on Class A or Class B materials.

2-1.1.5* pH. The pH of aqueous solutions of the wetting agents in concentrations recommended for use by the manufacturer shall be between 7 and 12 at 60°F (15.6°C).

2-1.1.6 Nozzle Discharge. No appreciable reduction in range, pattern, or discharge rate shall be permitted as compared to water discharge at the same temperature and pressure.

2-1.1.7 Viscosity. Viscosity determinations at 60°F (15.6°C) by any of the standard laboratory methods are satisfactory. The results shall be reported in terms of absolute viscosity (centipoise) for easy comparison with established data.

2-1.2* Fire Extinguishment Tests.

2-1.2.1* Class A Fires. (*See A-2-1.2.1.*)

2-1.2.2 Class B Fires. Evaluation tests by a testing laboratory shall be followed for acceptance of a wetting agent for application to Class B fires.

2-1.3 Container Marking. The manufacturer shall include the following information on the container label:

(a) The manufacturer's name or trademark, or some other distinctive symbol agreed upon with the testing laboratory to clearly identify the wetting agent as a listed chemical.

(b) The concentration for use with various types of combustibles.

(c) The surface tension of solutions of recommended concentration in distilled water.

(d) The viscosity at 60°F (15.6°C) of the concentrated wetting agent.

(e) The recommended storage conditions.

(f) The lot number or date of manufacture, or both.

2-2 Toxicity. (*See 1-4.9 and 1-4.9.1.*)

Chapter 3 Requirements for Supply of Wetting Agent

3-1 System Requirements.

3-1.1 Equipment. Wetting agents that comply with the specifications herein set forth shall be allowed for use with standard equipment provided said equipment is primarily designed to utilize water or foam as a medium of fire control and extinguishment in accordance with 1-3.3 and 1-3.5. Permissible use with new types of equipment shall be determined by the authority having jurisdiction.

3-2 Fire Department Supply Requirements.

3-2.1 The wetting agent shall be permitted to be premixed in a booster tank in such concentration as might be specified by the manufacturer. Where such premixing is considered undesirable, an amount of wetting agent determined to be sufficient for the water contained in the portable tanks on the apparatus shall be carried in a container that can readily be emptied into such tanks.

3-2.2 Where portable tanks are not a part of the apparatus, or where it is desired to carry the wetting agent separately for use either with water from portable tanks or with water from other sources of supply, the amount considered necessary shall be carried in a suitable tank connected to appropriate proportioning equipment on the apparatus. Where such equipment is also used to take suction from a hydrant supplied by potable water, extra care shall be exercised to prevent contamination of such potable water supplies with the wetting agent.

3-2.3 Additional Supplies. Additional supplies of wetting agent will be needed to ensure continuity of operation and shall be carried on the apparatus. Further supplies shall be stocked in suitable storage facilities to recharge the apparatus.

3-3 Fixed Systems.

3-3.1 Where the addition of a wetting agent to the system is contemplated, the requirements of NFPA 13, *Standard for the Installation of Sprinkler Systems;* NFPA 14, *Standard for the Installation of Standpipe and Hose Systems;* and NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection,* shall be followed. Such installations shall be approved by the authority having jurisdiction with consideration being given primarily to limitations outlined in Section 1-4 and to the following:

(a) The possibility of increased water damage due to the high absorption ability of wet water.

(b) The possibility of increased floor loads due to the retention of large volumes of wet water.

Chapter 4 Service Regulations

4-1 Inspection.

4-1.1 Due to its greater penetrating power, wet water is capable of passing through small openings that would be impassable to water. For this reason it will often be found that old, but apparently sound, equipment will have a tendency to spring leaks when charged with wet water, especially at worn packing glands. As a result, all old packings shall be renewed when the switch is made to wet water, and regular inspections shall be held thereafter in order to minimize losses, as well as to ascertain that the equipment is in good operating condition.

4-1.2 Schedule. The inspection schedule shall be arranged by the authority having jurisdiction. Weekly inspections shall be made for the first month. After the first leaks have been detected and repaired only routine inspections will be necessary, and these can be arranged to suit other inspection or drill schedules.

4-1.3 Points of Inspection. All points that might conceivably be subject to leakage shall be carefully examined. These would include valve packings, retainers, bushings, threaded joints, screw unions, etc.

4-2 Testing.

4-2.1 The functional parts of a system in which wet water is being used shall be tested periodically in accordance with the standard applying to that system. In addition to this functional testing, which shall be a part of the regular drill program, samples of the wet water shall be tested periodically in accordance with the following schedule and test procedure.

4-2.2 Schedule. Pre-mixed solutions of the wetting agent shall be tested once every 30 days in accordance with the following test procedure, and this same test shall be applied immediately following the preparation of a new charge of wet water. In cases where the solution is never pre-mixed, but is to be made up at the fire scene, the concentrate shall be used to make up a small test sample. This sample shall then be subjected to the wetting test as detailed in Chapter 2. Failure to meet the test will be an indication that the wetting agent has deteriorated, in which case the authority having jurisdiction shall be notified, and steps taken to correct the situation by replacement of the wetting agent.

4-3 Maintenance.

4-3.1 General Rules. Rules and regulations as set forth in NFPA 13, *Standard for the Installation of Sprinkler Systems*; NFPA 14, *Standard for the Installation of Standpipe and Hose Systems;* and NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection,* shall be observed in the maintenance of systems in which wet water is being used. Special care shall be taken to replace worn packings and to eliminate other potential sources of leakage.

Chapter 5 Instructions for Use

5-1 Precautions. (*See Section 1-4.*)

5-2 Applications.

5-2.1 In general, recognized application techniques for water shall be followed where wetting agents are used. Primary consideration shall be given, however, to the characteristics of wet water in that a wetting agent is active only when it comes in contact with the combustible involved.

5-2.2 To be most efficiently utilized, wet water shall be applied directly to the surface of the combustible since wetting agents do not increase the heat absorption capacity of water but might increase the heat absorption efficiency of such water due to its greater spreading and penetrating abilities.

5-3 Storage. Proper facilities for storing the concentrate and premix solutions in accordance with the recommendations of the manufacturer shall be provided. In general, no wetting agent shall be stored at a temperature below 32°F (0°C).

Chapter 6 Referenced Publications

6-1 The following documents or portions thereof are referenced within this standard and shall be considered part of the requirements of this document. The edition indicated for each reference is the current edition as of the date of the NFPA issuance of this document.

6-1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 1994 edition.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, 1993 edition.

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, 1990 edition.

Appendix A Explanatory Material

This Appendix is not a part of the requirements of this NFPA document but is included for informational purposes only.

A-1-2 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization concerned with product evaluations that is in a position to determine compliance with appropriate standards for the current production of listed items.

A-1-2 Authority Having Jurisdiction. The phrase "authority having jurisdiction" is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A-1-2 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation, some of which do not recognize equipment as listed unless it is also labeled. The "authority having jurisdiction" should utilize the system employed by the listing organization to identify a listed product.

A-1-2 Wet Water. The term "water" as used in the standard includes all potable supplies. However, water from other sources may be used provided tests indicate the satisfactory performance of the specific wetting agent under consideration.

A-1-3.4 Field observations indicate that in the use of wetting agents for fire extinguishment the water present is expended due to its conversion into steam resulting in a cooling effect, whereas the wetting agent itself is not expended (except for runoff) up to an undetermined temperature that is much higher than the boiling point of water. It is also indicated that when sufficient (the quantity being undetermined as yet) nonexpendable wetting agent has been applied to a fire, it continues to be effective with the addition of water. Additional fire tests or field experience will be necessary to determine these indicated items.

A-1-4.4 Should wet water come in contact with electrical equipment, the wetting agent can remain behind after the water has dried off and can constitute a hazard when the equipment is put back in operation.

Wet water, due to its penetrating characteristics, can have harmful effects on electrical equipment involving use of fabric-covered wire, such as motors, transformers, etc. Electrical equipment of this nature should be thoroughly flushed and cleaned after exposure to wet water solutions and before placing back in service. Use on fires involving grouped electrical cables is not recommended.

A-1-4.8 Corrosion of Metals. Samples of mild steel (also brass, bronze, and copper — see the last paragraph of this section) are to be tested for corrosion in prepared solutions of the wetting agent in all concentrations specified for use by the manufacturer.

Generally, listed wetting agents have a definite cleaning action and will remove from metal surfaces grease, oil, mill scale, protective coatings, etc., that normally protect metal from the corrosive attack of water, in which case accelerated water corrosion can be expected.

For continuous storage, the use of materials such as cast iron, aluminum, zinc, galvanized iron, lead or lead-coated iron, die cast alloys (such as white metal, zinc, etc.), or "air-dried" types of coatings (which may include plastics, oil paint, lacquers, and asphalt) should be avoided unless investigated and listed for such use. This is because wetting agents, although noncorrosive, exhibit a tendency to accelerate corrosion due to the cleaning and penetrating action and will penetrate and loosen unbonded coatings that are not of the "baked on" type.

Specimens approximately 1 in. wide × 5 in. long (25 mm × 125 mm) are cut from $^1/_{16}$-in. (1.6-mm) thick hot rolled sheet steel. The mill scale is removed by pickling in warm hydrochloric acid containing Rodine inhibitor, and the specimens are then cleaned by scrubbing with soap and water, rinsed in acetone, dried in a desicator, and weighed.

The samples are then suspended in wide-mouth, 1-qt (0.95-L) bottles containing 800 cc of the solution to be tested. The specimens are hung from glass thread in such a manner that approximately 1 in. (25 mm) of metal extends above the surface of the liquid. For comparison, metal samples are similarly exposed to distilled water. The test containers are then stored at room temperature for one month. At the end of this time, they are carefully removed from the containers and cleaned by immersion in hot 20 percent sodium hydroxide solution containing zinc dust. The alkali is removed by rinsing in hot water and the specimens further cleaned by scrubbing with soap and water. They are then rinsed in acetone, dried in the desicator, and reweighed. The corrosion rates are calculated as inches per year from the weight loss during exposure using the formula:

$$\text{Inch per year} = \frac{43.9 \times \text{weight loss (g)}}{12 \times \text{density of metal (g/cc)} \times \text{area (in.}^2\text{)} \times \text{hours exposed}}$$

A minimum of two tests per solution to be evaluated are to be conducted and the average corrosion rate used.

A corrosion rate substantially greater than that of the distilled water control should be cause for rejection.

Examine the specimens for signs of pitting. The presence of any pits deeper than $^1/_5$ the thickness of the specimen should be cause for rejection.

This procedure is also used for other metals including steel, with the exception of the pickling and sodium hydroxide treatment.

A-1-4.8.1 Action on Fire Hose. This test is to consist essentially of a visual determination of the effects of wet water on nonmetallic materials used in the manufacture of fire-fighting equipment and should include samples of fire hose, natural rubber, synthetic rubber, asphalt, etc.

Cut 1-in. (25-mm) (approximately) squares of the materials; weigh and place them separately in 100 cc of the prepared solution. Similar control samples are to be placed in distilled water. Allow to stand for at least 30 days, and at the end of this time examine the samples visually for signs of swelling, softening, or disintegration. Dry the samples by wiping with a soft cloth and weigh.

The samples should exhibit no more attack than the control samples in distilled water, nor any greater increase in weight.

Fifty samples of the approved natural or synthetic thread of the types used in fire hose are cut in 12-in. (305-mm) lengths. For a period of 24 hours, 25 of each of these are immersed in distilled water and 25 of each in the prepared solution of the wetting agent. Remove the samples after 24 hours, dry them between towels and condition for 48 hours at 100°F (37.8°C). Tensile strength tests are then conducted according to ASTM D2256, *Test for Breaking Load (Strength) and Elongation of Yarn by the Single-Strand Method.*

The average strength of the 25 samples of yarn immersed in the wet water shall not be less than 90 percent of the 25 samples of the same yarn from the distilled water.

A-1-6 For additional conversions and information, see ASTM E380, *Standard for Metric Practice.*

A-2-1.1.1 Surface Tension. Solutions in such concentrations as are specified for use by the manufacturer are to be used, and an average of three determinations should be the reported value. Measurements are carried out on any standard instrument, such as the du Nuoy Tensiometer, and the proper correction factor applied to the determined values.

A-2-1.1.3(b) and (c) Both concentrated and diluted solutions should be tested. Place a 100 cc sample in a clean breaker or flask and raise the temperature to 120°F (48.9°C). Observe any evidence of precipitation or separation. Then gradually lower the temperature to 32°F (0°C), observing any evidence of separation over the entire range.

A-2-1.1.3(d) Action after Freezing. Place 100 cc of the prepared solution in a clean beaker or flask and immerse it in a suitable bath, or place it in the freezing section of a refrigerator, until the sample has completely solidified. Record the freezing temperature. After complete solidification has taken place, remove the sample and gently warm it to 60°F (15.6°C) without agitation. As soon as this temperature has been reached, remove the source of heat and stir the sample for 1 minute. At the end of this time make visual observation to ascertain whether or not the wetting agent has gone back into solution. The solution should become completely homogeneous upon completion of this test.

A-2-1.1.5 The pH of aqueous solutions of wetting agents is a measure of the acidity and alkalinity of the solution. Variations substantially below 7 or above 12 may result in serious increase in corrosion rate or may have material effect on its value in fire protection and fire extinguishment.

pH should be measured in accordance with standard practice procedures on a standard-type pH meter at water temperatures of 60°F ± 1° (15.6°C ± 0.6°). Any municipal water works laboratory can perform these tests.

A-2-1.2 Field experience and large-scale fire tests indicate: (1) that wet water foam, produced by discharging wetted water through a suitable nozzle, is more effective in control or extinguishment of fire than the same quantity of wetted water discharged through ordinary nozzles as a liquid and (2) the wetted water discharged through a nozzle as a liquid is more effective than the same quantity of water discharged through the same nozzle. Evaluation tests for Class A and Class B fires are discussed in A-2-1.2.1 and 2-1.2.2.

A-2-1.2.1 Acceptable evaluation tests of the effectiveness of water or solutions containing large percentages of water in control or extinguishment of fire in Class A combustibles have not been developed due primarily to the fact that the results have had to be based on observers' judgment rather than on measurable items such as temperature, volume, and time. Wetted waters applied as liquids to burning Class A combustibles fall into this group of extinguishing agents that are difficult to evaluate. Wetted waters discharged through suitable nozzles and applied to burning Class A combustibles as wet water foam may be evaluated in measurable terms of volume and time. Wet water foam breaks down into a liquid at a rate proportional to the heat to which it is exposed and thus when applied on burning Class A combustibles its breakdown rate is dependent on the temperature of the combustibles and the necessary application rate is thus automatically determined. These factors can be physically measured, and evaluations of effectiveness may be made.