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18

STANDARD FOR
WETTING AGENTS 1972

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NATIONAL FIRE PROTECTION ASSOCIATION
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Official NFPA Definitions

Adopted Jan. 23, 1964: Revised Dec. 9, 1969. Where variances to these definitions are found, efforts to eliminate such conflicts are in process.

SHALL is intended to indicate requirements.

SHOULD is intended to indicate recommendations or that which is advised but not required.

APPROVED means acceptable to the authority having jurisdiction. 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 or 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 nationally recognized testing laboratories,* i.e., laboratories qualified and equipped to conduct the necessary tests, in a position to determine compliance with appropriate standards for the current production of listed items, and the satisfactory performance of such equipment or materials in actual usage.

*Among the laboratories nationally recognized by the authorities having jurisdiction in the United States and Canada are the Underwriters' Laboratories, Inc., the Factory Mutual Research Corp., the American Gas Association Laboratories, the Underwriters' Laboratories of Canada, the Canadian Standards Association Testing Laboratories, and the Canadian Gas Association Approvals Division.

LISTED: Equipment or materials included in a list published by a nationally recognized testing laboratory that maintains periodic inspection of production of listed equipment or materials, and whose listing states either that the equipment or material meets nationally recognized standards or has been tested and found suitable for use in a specified manner.

LABELED: Equipment or materials to which has been attached a label, symbol or other identifying mark of a nationally recognized testing laboratory that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling is indicated compliance with nationally recognized standards or tests to determine suitable usage in a specified manner.

AUTHORITY HAVING JURISDICTION: The organization, office or individual responsible for "approving" equipment, an installation, or a procedure.

Statement on NFPA Procedures

This material has been developed in the interest of safety to life and property under the published procedures of the National Fire Protection Association. These procedures are designed to assure the appointment of technically competent Committees having balanced representation from those vitally interested and active in the areas with which the Committees are concerned. These procedures provide that all Committee recommendations shall be published prior to action on them by the Association itself and that following this publication these recommendations shall be presented for adoption to the Annual Meeting of the Association where anyone in attendance, member or not, may present his views. While these procedures assure the highest degree of care, neither the National Fire Protection Association, its members, nor those participating in its activities accepts any liability resulting from compliance or noncompliance with the provisions given herein, for any restrictions imposed on materials or processes, or for the completeness of the text.

Standard on

Wetting Agents

NFPA No. 18 — 1972

1972 Edition of No. 18

This edition of NFPA No. 18, with revisions recommended by the Committee on Foam and adopted by the Association at the Annual Meeting in Philadelphia, Pa., May 15-19, 1972, supersedes the 1966 edition.

Origin and Development of No. 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) responsiblity for this Standard was transferred to the Committee on Foam through which the present text was processed.

Committee on Foam

SCOPE: The installation, maintenance and use of foam systems for fire protection, including foam hose streams.

Standard on Wetting Agents

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Foreword

1. 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 because it is a liquid.

2. The increasing use of wetting agents by the fire services has become quite pronounced in the past few years, and gives indication of becoming a permanent and important factor in the field of fire control. Experience, as well as tests, has indicated that the addition of a proper wetting agent to plain water will, when properly applied, increase the extinguishing efficiency of that water with respect to quantity used as well as time saved. The value of such a factor may well become of considerable importance, especially in rural areas where the amount of water available for fire fighting is often inadequate. This is due to the fact that 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 must be transported manually in portable equipment.

Certain types of fires, such as those in baled cotton, stacked hay, some rubber compounds and some flammable liquids, which do not ordinarily respond to treatment with plain water may be extinguished when a proper wetting agent is used. This property may be attributed to an increase in the penetrating, spreading and emulsifying powers of plain water due to such factors as lowering the surface tension. This decreased surface tension can be described as a disruption of the forces holding the surface film of plain 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 which plain 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 increased absorptive speed and superior adhesion to solid surfaces.

3. Wetting agents having foaming characteristics as referred to in this Standard, when mixed with water and air, produce a foam which retains the wetting and penetrating characteristics of the wetting agent and provide an efficient smothering action for the extinguishment of both Class A and Class B combustions, 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. 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.

4. There are numerous chemicals which fulfill the primary function of a wetting agent, which is to lower the surface tension of plain water. However, very few of these chemicals are suited to fire control work because application to this purpose is complicated by 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 a wetting agent as an aid for fire extinguishment. The requirements are intended to insure 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

11. Introduction

111. 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 purpose.

112. 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.

1121. The method whereby the wetting agent is added to water is not herein specifically set forth. The solution may be premixed in tanks or may 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.

12. Definitions

121. CLASS A FIRES are fires in ordinary combustible materials, such as wood, cloth, paper, rubber, and many plastics.

122. CLASS B FIRES are fires in flammable liquids, gases, and greases.

NOTE: Flammable liquid shall mean any liquid having a flash point below 140°F (60°C) and having a vapor pressure not exceeding 40 pounds per square inch absolute (2068.6 mm) at 100°F (37.8°C).

Combustible liquid shall mean any liquid having a flash point at or above 140°F (60°C).

Liquids shall be divided into three classes based upon flash point determinations as defined below:

Class I shall include those having flash points below 100°F (37.8°C) and may 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)

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

Class III shall include those having flash points at or above 140°F (60°C).

123. CLASS C FIRES are fires which involve energized electrical equipment. (When electrical equipment is de-energized, the fire may continue to burn as a Class A, B, or D fire.)

124. CLASS D FIRES are fires in combustible metals, such as magnesium, titanium, zirconium, sodium, and potassium.

125. A WETTING AGENT may be defined as a chemical compound which, when added to water in proper quantities, materially reduces its surface tension, increases its penetrating and spreading abilities and may also provide emulsification and foaming characteristics.

***126.** WET WATER may be defined as any water to which a compatible wetting agent has been added.

127. WET WATER FOAM may be defined as an admixture of wet water with air to form a cellular structure foam which breaks down rapidly into its original liquid state at temperatures below the boiling point of water, at a rate directly related to the heat to which it is exposed, in order to cool the combustible on which it is applied.

128. LISTED refers to devices and materials which have been tested by nationally recognized laboratories for compliance with the standards of construction and performance of such laboratories with regard to their suitability for installation in accordance with this Standard.

13. Uses

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

***132.** The addition of proper wetting agents to plain water will increase its penetrating and emulsifying abilities and may provide foaming characteristics as to extend the efficiency of water for the protection against fire exposure and the extinguishment of Class A and Class B fires in ordinary combustibles and combustible liquids which are insoluble in water and ordinarily stored at atmospheric temperatures and pressures.

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*See Appendix.

133. In general, wetting agents can be effectively applied and used with all types of standard fire protection equipment where plain 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 Article 14, Limitations)

***134.** When water containing *listed* wetting agents is applied to a fire, some of the wetting agent may be expected to remain after extinguishment. This residual wetting agent may be effective in reducing the surface tension of plain water which may subsequently be applied.

135. The range and discharge capacity of solid stream or spray nozzles discharging water containing a wetting agent in concentration recommended by the manufacturer should not be appreciably changed from that when used with plain water. The discharge angle of spray nozzles should not be changed appreciably from that realized when plain water is used.

136. 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 plain water systems should apply.

137. 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.

1371. The addition of wetting agents to plain water will increase the efficiency due to the spreading characteristics of the wetting agent, thus affording greater protection than plain water.

14. Limitations

NOTE: The addition of wetting agents to plain water, which changes its physical characteristics, creates certain limitations for use which must be recognized.

141. Class A Fires. Wet water has the same limitations as plain water with respect to extinguishing fires involving chemicals that react with water to create new hazards.

*See Appendix.

142. Class B Fires. The effective use of wet water for the extinguishment of fires involving Class B combustible liquids as defined in Section 122 is limited to those materials not soluble in water, such as petroleum products. In water soluble materials of the alcohol type, some control may be realized, but extinguishment is questionable.

***143. Class C Fires.** Wet Water solutions have the same limitations as plain water in fighting fires involving electrical equipment so far as safety to fire fighting personnel is concerned. Application as a straight stream is not recommended. Spray or fog application can be employed with usual caution.

144. Wet Water should not be used on Class D fires.

145. Use of Wetting Agents with Other Than Plain Water. Admixing of wetting agents with other wetting agents or with mechanical or chemical foam liquids is not recommended and shall be avoided. The mixing of these agents may have adverse results and thus render them ineffective for fire extinguishment.

146. The use of wetting agents in concentrations greater than that specified by the manufacturer and/or specified by the testing laboratory should be avoided. High concentrations may cause adverse effects.

***147. Corrosion.** The corrosive effects of wetting agents should be specified by the manufacturer and included in the listing report of the testing laboratory. Generally, listed wetting agents have a definite cleaning action and will remove from metal surfaces grease, oil, mill scale, protective coatings, etc., which normally protect metal from the corrosive attack of water, in which case accelerated water corrosion may be expected.

*1471. The corrosive and/or deterioration effects upon materials and metals should be determined by the listing laboratory and results contained in their listing report and in the manufacturer's directions for use.

1472. As an example, solutions containing wetting agents will remove galvanizing or similar coatings and therefore should not be used where they may contact such coatings.

1473. Concentrated or dilute solutions of wetting agents may cause mild pit-type corrosion of some metal surfaces at

*See Appendix.

the liquid level and in the vapor space. Therefore, storage of wetting agents in any concentration over long periods of time in open containers should be avoided, unless corrosive-resistant materials or suitable protective coatings are provided.

*148. **Toxicity.** In general, listed wetting agents are nontoxic. However, reasonable care should be exercised to avoid concentrated solutions in contact with the skin. Due to the cleansing properties similar to strong soaps, continued contact may cause mild dermatitis.

1481. Contamination of foods and eating of contaminated food should be avoided.

1482. The degree of toxicity should be determined by the manufacturer and contained in the listing laboratory's report and in the manufacturer's directions for use.

149. The use of listed wetting agents in existing water-type portable extinguishers is limited to special formulations as may be specified by the manufacturer and determined by the testing laboratories. As an example, there are some wetting agents which will tolerate high concentrations of sodium salts and become more efficient in the presence of such concentrations. Other types may precipitate under similar conditions.

15. Basic Requirements

151. The use of wetting agents for fire extinguishment should be based on the requirements outlined in Chapter 3.

152. Wetting agents for fire fighting shall be listed by a nationally recognized testing laboratory and shall be approved by the authority having jurisdiction.

153. Special equipment, such as proportioners, shall be listed by a nationally recognized testing laboratory and shall be approved by the authority having jurisdiction.

154. Equipment and/or wetting agents offered for use on which approval is pending, shall be submitted to the authority having jurisdiction.

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*See Appendix.

CHAPTER 2.
WETTING AGENT SPECIFICATIONS AND TESTS

21. General

211. 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 approvals shall be based on such specifications.

*2111. Wetting agents when added to plain water in concentration specified for use shall appreciably reduce the surface tension of the plain water.

2112. The addition of the wetting agent, in concentrations specified for use by the manufacturer, shall not appreciably change the characteristics of plain water with regard to boiling or freezing temperature.

2113. A wetting agent to be used for fire extinguishing puposes shall be readily soluble in plain water and easily and uniformly mixed.

a. **Solubility.** At 32°F. to 120°F. the wetting agent should form a true solution with water, which 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. Any increase in haziness, cloudiness or precipitation occurring during the course of the test should be checked as an indication of 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, on standing for 30 days at any temperature between 32°F. and 120°F. The formation of two or more distinct layers or precipitation occurring during the course of the test should 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 and then warmed to 60°F., shall return to normal condition after reasonable agitation.

*See Appendix.

2114. Listings shall indicate the use for which the material is effective, as on Class A or Class B materials or as a defoaming agent.

*2115. **pH.** The pH of aqueous solutions of the wetting agents in concentrations recommended for use by the manufacturer should be between 7 and 12 at 60°F.

2116. **Nozzle Discharge.** No appreciable reduction in range, pattern or discharge rate shall be permitted as compared to plain water discharge at the same temperature and pressure.

2117. **Viscosity.** Viscosity determinations at several temperatures by any of the standard laboratory methods are satisfactory. The results should be reported in terms of absolute viscosity (centipoise) for easy comparison with established data.

212. Fire Extinguishment Tests. 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 and/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 plain water discharged through the same nozzle. Evaluation tests for Classes A and B of fires are discussed in Paragraphs 2121 and 2122.

2121. **Class A Fires.** Acceptable evaluation tests of the effectiveness of water or solutions containing large percentages of water, in control and/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 in this group of extinguishing agents which 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 are capable of physical measurement and evaluations of effectiveness may be made.

*See Appendix.

2122. **Class B Fires.** Evaluation tests by a nationally recognized testing laboratory shall be followed for acceptance of a wetting agent for application to Class B fires.

213. Field Evaluation Tests. Some method of field evaluation is deemed necessary whereby the probable performance of a wetting agent can be estimated before it is put into actual use after standing for a period of time. The following tests have been selected as being most indicative of probable performance.

*2131. **Wetting Action on Class A Combustibles.** At a minimum solution temperature of 60°F., the wetting time of one-inch squares of canvas should be less than 15 sec. The tests should be made with aqueous solutions of the wetting agent in such concentrations as are specified for use by the manufacturer.

*2132. **Absorption Action on Class A Combustibles.** A wick test to determine extinguishment efficiency, based on rate of absorption, should be made on aqueous solutions of the wetting agent in concentrations specified for use by the manufacturer. Using quick fire starters, this test should indicate an efficiency of at least 200 per cent compared to plain water.

214. Container Marking. The submitter shall include the following information on the container label:

a. The manufacturer's name or trade-mark or some other distinctive symbol agreed upon with the nationally recognized testing laboratory to clearly identify the wetting agent as a listed chemical.

b. Concentration for use with various types of combustibles.

c. Surface tension of solutions of recommended concentration in distilled water.

d. Viscosity at 60°F. of the concentrated wetting agent.

e. Indicate recommended storage conditions.

f. Lot number and/or date of manufacture.

*See Appendix.

22. Toxicity

(See Sections 147 and A147)

CHAPTER 3. REQUIREMENTS

31. System Requirements

311. Equipment. Wetting agents which comply with the specifications herein set forth, may 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 Sections 133 and 136. Permissible use with new types of equipment shall be determined by the authority having jurisdiction.

312. Calculations. The manufacturer shall provide such information and data as may be required to indicate the amount of wetting agent which is to be added to plain water to make up the necessary concentration.

32. Fire Department Supply Requirements

321. The wetting agent may be premixed in a booster tank in such concentration as may 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 should be carried in a container which can readily be emptied into such tanks.

322. 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 should be carried in a suitable tank connected to appropriate proportioning equipment on the apparatus. Where such equipment is used also to take suction from hydrant supplied by potable water, extra care should be exercised to prevent contamination of such potable water supplies with wetting agent.

323. Additional Supplies. Additional supply of wetting agent will be needed to insure continuity of operation and this should be carried on the apparatus. Further supply should be stocked in fire department houses to recharge the apparatus.

33. Fixed Systems

331. Existing standards covering all fixed systems shall be followed where the addition of a wetting agent to the system is contemplated. Such installations shall be approved by the authority having jurisdiction with consideration being given primarily to limitations outlined in Article 14 and to:

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.

NOTE: More specific specifications will depend on field experience and the application of wetting agents to fire protection problems.

CHAPTER 4. SERVICE REGULATIONS

41. Inspection

411. Due to its greater penetrating power, wet water is capable of passing through small openings which would be impassable to plain 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. For this reason all old packings should be renewed when the switch is made to wet water, and regular inspections should be held thereafter in order to minimize losses, as well as to ascertain that the equipment is in good operating condition.

412. Schedule. The inspection schedule should be arranged by the authority having jurisdiction. It is herein recommended that for the first month after the initial addition of a wetting agent, inspections should be made at frequent intervals. After the first leaks have been detected and repaired only routine inspections will be necessary, and these may be arranged to suit other inspection or drill schedules.

413. Points of Inspection. All points which might conceivably be subject to leakage should be carefully examined. These would include valve packings, retainers, bushings, threaded joints, screw unions, etc.

42. Testing

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

422. Schedule. It is recommended that pre-mixed solutions of the wetting agent be tested once every 30 days in accordance with the following test procedure, and that this same test 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 should be used to make up a small test sample. This sample should then be subjected to the wetting test as detailed in Chapter 2, pars.

2131 and A2131. Failure to meet the test will be an indication that the wetting agent has deteriorated, in which case the authority having jurisdiction should be notified, and steps taken to correct the situation.

43. Maintenance

431. General Rules. Rules and regulations as set forth in applicable standards should be observed in the maintenance of systems in which wet water is being used. Special care should be taken to replace worn packings and to eliminate other potential sources of leakage.

CHAPTER 5. INSTRUCTIONS FOR USE

51. Precautions

NOTE: See Article 14, Limitations.

52. Applications

521. In general, recognized application techniques can be followed where wetting agents are used. Primary consideration should 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.

522. Wetting agents do not increase the heat absorption capacity of plain water, but may increase the heat absorption efficiency of such water due to its greater spreading and penetrating ability. It is for that reason that wet water, to be most efficiently utilized, must be applied directly to the surface of the combustible.

53. Storage

531. Proper facilities for storing the concentrate and/or premix solutions in accordance with the recommendations of the manufacturer shall be provided. In general, no wetting agent should be stored at a temperature below 32°F.

532. Anti-freeze Solutions. In cases where pre-mixed solutions of the wetting agent are exposed to possible freezing temperatures, it must be determined that the wetting agent can be used in conjunction with anti-freeze materials before such is permitted. The manufacturer should specify which anti-freeze materials, if any, are suitable for use with his product.

APPENDIX

The following appendices are intended to furnish clarification, explanation and examples for the rules contained in the main text of this standard. Therefore, the provisions of the appendix are not mandatory but indicate recommended practice and procedure.

A126. 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.

A132. The expression "stored at atmospheric temperature and pressure" is intended to include those combustibles having a vapor pressure up to 300 mm. of mercury at 20°C.

A134. Field observations indicate that in the use of wetting agents for fire extinguishment the water present is expended due to its conversion into steam which gives cooling effect; whereas, the wetting agent itself is not expended (except for runoff) up to an undetermined temperature which is much higher than the boiling point of water. It is also indicated that when sufficient (the quantity being undetermined as yet) non-expendable wetting agent has been applied to a fire, it continues to be effective with the addition of plain water. Additional fire tests or field experience will be necessary to determine these indicated items.

A143. Should wet water come in contact with electrical equipment, the wetting agent may remain behind after the water has dried off, and may constitute a hazard when the equipment is put back in operation.

Wet Water, due to its penetrating characteristics, may 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 in service again. Use on fires involving grouped electrical cables is not recommended.

A147. Corrosion of Metals. Samples of mild steel (also brass, bronze, and copper — see last paragraph, page 18–17) are to be tested for corrosion in prepared solutions of the wetting agent in all concentrations specified for use by the manufacturer.

For continuous storage the use of such materials 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 the manufacturer guarantees the product for such use. This is due to the fact that wetting agents, although noncorrosive, exhibit a tendency to accelerate corrosion due to the cleaning and penetrating action and will penetrate and loosen unbonded coatings which are not of the "baked on" type.

Specimens approximately 1 in. wide by 5 in. long are cut from $\frac{1}{16}$ in. 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 desiccator and weighed.

The samples are then suspended in wide-mouth one quart 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. 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 per cent 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 desiccator, and reweighed. The corrosion rates are calculated as inches per year from the weight loss during exposure using the formula:

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

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, and the presence of more than two pits deeper than 1/5 the thickness of the specimen should be cause for rejection.

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

A1471. 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 shall include samples of fire hose, natural rubber, synthetic rubber, asphalt, etc.

Cut 1 in. (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 cotton yarn and fifty of linen yarn of the types used in fire hose are cut in 12-in. lengths. For a period of 24 hr., 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 hr., dry them between towels and condition for 48 hr. at 100° F. Tensile strength tests are then conducted according to A.S.T.M. Standard D 2256-64T.*

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

A148. The most widely accepted definition of toxicity for man given in terms of the response of laboratory animals appears in the *Regulations for the Enforcement of the Federal Insecticide, Fungicide & Rodenticide Act* of 1947 (Amended August 29, 1964).†

A2111. Surface Tension. Solutions in such concentration 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.

A2113b. and **A2113c.** Both concentrated and dilute solutions shall be tested. Place a 100 cc. sample in a clean beaker

*Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, Penna. 19103.

†Published in the Code of Federal Regulations, Title 7, Chapter III, Part 362 available from the United States Government Printing Office, Washington, D. C.

or flask and raise the temperature to 120°F. Observe any evidence of precipitation or separation. Then gradually lower the temperature to 32°F., observing any evidence of separation over the entire range. Any increase in haziness, cloudiness or precipitation during the course of the test should be checked as an indication of separation.

A2113d. 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 50°F. without agitation. As soon as this temperature has been reached, remove the source of heat and stir the sample for one 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.

A2115. 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.$\pm$1°. Any municipal water works laboratory can perform these tests.

A2131. Wetting Action Efficiency Standard: CLASS A COMBUSTIBLES, CANVAS WETTING TESTS. The following outlines the test procedure for determining efficiency of wetting action, on Class A combustibles, of wet water solutions.

(1) Cut a supply of 1 in. squares from a standard sample of Mt. Vernon No. 6 Canvas, made by Mt. Vernon Woodbury Mills, Columbia, South Carolina. (Two 1 in. squares of canvas and a stop watch are required for each test.) Prepare samples of wet water and plain water in suitable containers, adjust the temperature to a minimum of 60° F., and remove any foam from the surface.

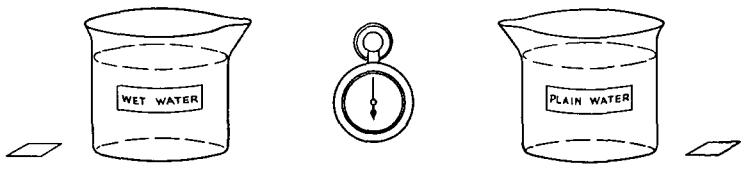

FIG. 1(a)

(2) Place squares of the canvas flat on the surface of the solutions simultaneously by dropping from a height of approximately 1 in. above the liquid surface. (The holding medium should not come in contact with the wet water.)

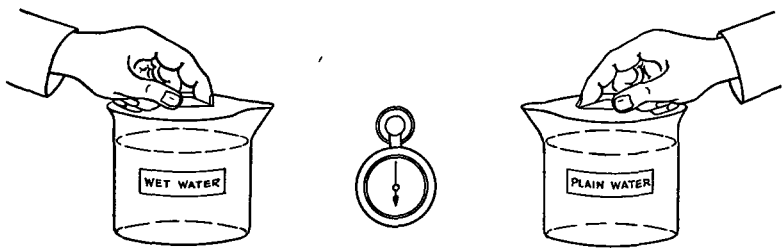

FIG. 1(b)

(3) Record the time required for the top surface of the canvas to become completely wet, at which instant it will start to sink.

FIG. 1(c)

NOTES

Repeat the above test at a solution temperature of 140° F.

Three tests should be made on each sample, taking the average of the three as the final result.

New canvas squares are required for each test.

CAUTION. In making plain water tests, extreme care must be exercised to use equipment which has not been exposed to wet water.