NFPA

18

STANDARD ON WETTING AGENTS 1979

NATIONAL FIRE PROTECTION ASSOCIATION, INC.
470 Atlantic Avenue, Boston, MA 02210

4M-12-79-FP
Printed in U.S.A.

NOTICE

All questions or other communications relating to this document should be sent only to NFPA Headquarters, addressed to the attention of the Committee responsible for the document.

For information on obtaining Formal Interpretations of the document, proposing Tentative Interim Amendments, proposing amendments for Committee consideration, and appeals on matters relating to the content of the document, write to the Assistant Vice President — Standards, National Fire Protection Association, 470 Atlantic Avenue, Boston, MA 02210.

Statement on NFPA Procedures

This material has been developed under the published procedures of the National Fire Protection Association, which are designed to assure the appointment of technically competent Committees having balanced representation. 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.

NFPA has no power or authority to police or enforce compliance with the contents of this document and any certification of products stating compliance with requirements of this document is made at the peril of the certifier.

See Official NFPA Definitions at the back of this pamphlet.

SC-FM-79

Standard on
Wetting Agents

NFPA 18 — 1979

1979 Edition of NFPA 18

This 1979 edition of NFPA 18, *Standard on Wetting Agents,* was prepared by the Committee on Foam and was adopted by the National Fire Protection Association, Inc. on November 14, 1979, at its Fall Meeting in Phoenix, Arizona. It was released by the Standards Council for publication on December 3, 1979.

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.

This edition of the standard is a revision of the 1972 edition. Changes other than editorial are denoted by a vertical line in the margin of the pages in which they appear.

Committee on Foam

Norman R. Lockwood, *Chairman*
Washington Crossing, PA

Herb Wolff, *Secretary*
Reliance Insurance Cos.
(Rep. American Insurance Assn.)

Lewis E. Allen, Jr., Starr Technical Risks Agency

Wayne E. Ault, Rolf Jensen & Associates

Charles F. Averill, Grinnell Fire Protection Systems Co. (Rep. National Auto Sprinkler & Fire Control Association)

Francis X. Bender, Warner-Lambert Co. (Rep. NFPA Industrial Fire Protection Section)

William G. Boyce, U.S. Coast Guard

R. R. Burford, 3M Company

William M. Carey, Underwriters Laboratories Inc.

J. R. Corcoran, Niagara Mohawk Power Corp. (Rep. Edison Electric Institute)

MacDonald Curless, The FPE Group

F. L. Deacon, Kemper Insurance Cos. (Rep. Alliance of American Insurers)

Victor G. Geihsler, Industrial Risk Insurers

John A. Krembs, M&M Protection Consultants

A. N. Lagadinos, Insurance Services Office

Jack P. McLaughlin, Union Carbide Corp.

D. N. Meldrum, National Foam System, Inc.

Robert C. Merritt, Factory Mutual Research Corp.

Richard F. Murphy, Esso Engineering Europe Ltd. (Rep. American Petroleum Institute)

Patrick J. O'Brien, Lorcon Foam

H. B. Peterson, U.S. Naval Research Laboratory

L. E. Rivkind, *Mearl Corp.*

Eugene Stauffer, Ansul Company (Rep. Fire Equipment Manufacturers Association)

Sturgis L. Stenz, Santa Cruz, CA

Dr. Richard L. Tuve, Johns Hopkins University

Chief H. Ray Vliet, Edison New Jersey Fire Department (Rep. NFPA Fire Service Section)

Laurence D. Watrous, Brown & Root, Inc.

Alternates

Layard E. Campbell, *Reliable Automatic* Sprinkler Co. (Alternate to C. F. Averill)

D. O. Crabtree, Lorcon Inc. (Alternate to S. L. Stentz)

George R. Herzog, National Foam System, Inc. (Alternate to D. N. Meldrum)

Edward J. O'Donoghue, Industrial Risk Insurers (Alternate to V. G. Geihsler)

C. E. Saunders, Kemper Insurance Cos. (Alternate to F. L. Deacon)

Orville M. Slye, Jr., *Mobil Research &* Development Center (Alternate to R. F. Murphy)

Miles Suchomel, Underwriters Laboratories Inc. (Alternate to W. M. Carey)

G. A. Toyek, Insurance Services Office (Alternate to A. Lagadinos)

Klaus Wahle, U.S. Coast Guard (Alternate to W. G. Boyce)

Kenneth A. Zuber, Kedde-Belleville (Alternate to Eugene Stauffer)

Nonvoting

Desmond Hird, Angus Fire Armour Corp.

This list represents the membership at the time the Committee was balloted on the text of this edition. Since that time, changes in the membership may have occurred.

Contents

Standard on

Wetting Agents

NFPA 18 — 1979

NOTICE

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

Information on referenced publications can be found in 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 because it is a liquid.

Experience, as well as tests, has indicated that the addition of a proper wetting agent to 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 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, which do not ordinarily respond to treatment with 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 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 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 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.

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 provides an efficient smothering action for the extinguishment of both Class A and Class B combustibles or provides 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 which fulfill the primary function of a wetting agent, which is to lower the surface tension of 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 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

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

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 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.

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 purpose.

1-2 Definitions.

1-2.1 Class A Fires are fires in ordinary combustible materials, such as wood, cloth, paper, rubber, and many plastics.

1-2.2 Class B Fires are fires in flammable or combustible liquids and in gases or greases.

Combustible Liquid shall mean a liquid having a flash point at or above 100°F (37.8°C).

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 shall mean a liquid having a flash point below 100°F (37.8°C) and having a vapor pressure not exceeding 40 lbs psi (276 kPa) 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).

1-2.3 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.)

1-2.4 Class D Fires are fires in combustible metals, such as magnesium, titanium, zirconium, sodium, and potassium.

1-2.5 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.

1-2.6* Wet Water may be defined as water to which a compatible wetting agent has been added.

1-2.7 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.

1-3 Uses.

1-3.1 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.

1-3.2 The addition of proper wetting agents to 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.

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, Limitations.*)

1-3.4* 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 water which may 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 which shall be recognized.

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 new 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 1-2.2 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.

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. Application as a straight stream is not recommended. Spray or fog application can be employed with usual caution.

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 is not recommended and shall be avoided. The mixing of these agents may 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 and/or recommended by the testing laboratory shall be avoided. High concentrations may 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 corrosive and/or deterioration effects upon materials and metals recommended by the manufacturer as being compatible with the wetting agent shall be determined by the listing laboratory and results contained in their listing report and in the manufacturer's directions for use.

1-4.8.2 Solutions containing wetting agents will remove galvanizing or similar coatings and therefore shall not be used where they may contact such coatings.

1-4.8.3 Concentrated or dilute solutions of wetting agents may 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 concentrated solutions in contact with the skin. Due to the cleansing properties similar to strong soaps, continued contact may 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 may be 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 by a testing laboratory and shall be approved by the authority having jurisdiction.

1-5.2 Special equipment, such as proportioners, shall be listed by a testing laboratory 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]

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 may 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.

[1] For additional conversions and information see ASTM E380, *Standard for Metric Practice.*

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, 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 (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, on 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 one 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.*

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 trade-mark or some other distinctive symbol agreed upon with the 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 (15.6°C) of the concentrated wetting agent.

(e) Indicate recommended storage conditions.

(f) Lot number and/or date of manufacture.

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

Chapter 3 Requirements for Supply of Wetting Agent

3-1 System Requirements.

3-1.1 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 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 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 shall be carried in a container which 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 used also to take suction from a hydrant supplied by potable water, extra care shall be exercised to prevent contamination of such potable water supplies with wetting agent.

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

3-3 Fixed Systems.

3-3.1 Existing standards covering all fixed systems shall be followed where the addition of a wetting agent to the system is contemplated.

(*See 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.*) Such installations shall be approved by the authority having jurisdiction with consideration being given primarily to limitations outlined in Section 1-4 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.

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 which 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. For this reason 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 may be arranged to suit other inspection or drill schedules.

4-1.3 **Points of Inspection.** All points which 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 concen-

trate 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, Limitations.*)

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 Wet water to be most efficiently utilized shall be applied directly to the surface of the combustible, since wetting agents do not increase the heat absorption capacity of water, but may 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/or 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).

Appendix A

This Appendix is not a part of this NFPA standard, but is included for information purposes only.

A-1-2.6 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 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) 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 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.

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., which normally protect metal from the corrosive attack of water, in which case accelerated water corrosion may be expected.

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 investigated and listed 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 (25 mm by 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:

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

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. 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 as well as steel, with the exception of the pickling and sodium hydroxide treatment.