NFPA 704 Identification of the Fire Hazards of Materials 1990 Edition

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An International Standards-Making Organization

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Policy Adopted by NFPA Board of Directors on December 3, 1982

The Board of Directors reaffirms that the National Fire Protection Association recognizes that the toxicity of the products of combustion is an important factor in the loss of life from fire. NFPA has dealt with that subject in its technical committee documents for many years.

There is a concern that the growing use of synthetic materials may produce more or additional toxic products of combustion in a fire environment. The Board has, therefore, asked all NFPA technical committees to review the documents for which they are responsible to be sure that the documents respond to this current concern. To assist the committees in meeting this request, the Board has appointed an advisory committee to provide specific guidance to the technical committees on questions relating to assessing the hazards of the products of combustion.

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NFPA 704

Standard System for the

Identification of the Fire Hazards of Materials

1990 Edition

This edition of NFPA 704, *Standard System for the Identification of the Fire Hazards of Materials*, was prepared by the Technical Committee on Fire Hazards of Materials, and acted on by the National Fire Protection Association, Inc. at its Fall Meeting held November 13-15, 1989 in Seattle, WA. It was issued by the Standards Council on January 12, 1990, with an effective date of February 5, 1990, and supersedes all previous editions.

The 1990 edition of this document has been approved by the American National Standards Institute.

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 704

Work on this standard originated in 1957 with a great deal of the development work having been done by the NFPA Sectional Committee on Classification, Labeling and Properties of Flammable Liquids starting in 1952. Background data was published by the Association in its Quarterly magazine in July 1954, 1956, and 1958. The material in its present form was first Tentatively Adopted in 1960. Official Adoption was secured in 1961 and revisions adopted in 1964, 1966, 1969, 1975, 1980, and 1985. In 1987, the Committee on Fire Hazards of Materials began a major effort to develop quantitative guidelines for assigning the Health Hazard and Reactivity Hazard Ratings. This 1990 edition contains these new guidelines and amended definitions for the Hazard Ratings.

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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.

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.

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NFPA 704

Standard System for the

Identification of the Fire Hazards of Materials

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Information on referenced publications can be found in Appendix E.

Foreword

The Committee on Fire Hazards of Materials has been working on the material in this standard since early 1957. A great deal of preliminary work was developed as a manual by the Sectional Committee on Classification, Labeling and Properties of Flammable Liquids of the NFPA Committee on Flammable Liquids starting in 1952. Progress reports were given on this activity at NFPA Annual Meetings and reported in the NFPA *Quarterly* in July issues of 1954, 1956, and 1958. The material was tentatively adopted as a guide in 1960, adopted in 1961, and further amended in 1964, 1966, 1969, 1975, and 1980.

As originally conceived, the purpose of the standard is to safeguard the lives of those individuals who may be concerned with fires occurring in an industrial plant or storage location where the fire hazards of materials may not be readily apparent.

Chapter 1 General

1-1 Scope.

1-1.1 This standard shall address the health, flammability, reactivity, and related hazards that may be presented by short-term, acute exposure to a material during handling under conditions of fire, spill, or similar emergencies.

1-1.2 This standard provides a simple, readily recognized, easily understood system of markings that provides a general idea of the hazards of a material and the severity of these hazards as they relate to handling, fire prevention, exposure, and control. The objectives of the system are:

(a) to provide an appropriate signal or alert and on-the-spot information to safeguard the lives of both public and private emergency response personnel;

(b) to assist in planning for effective fire and emergency control operations, including clean-up;

(c) to assist all designated personnel, engineers, plant and safety personnel in evaluating hazards;

1-1.3 It is recognized that local conditions will have a bearing on evaluation of hazards; therefore, discussion must be kept in general terms.

1-2 Applicability.

1-2.1 This standard is applicable to industrial, commercial, and institutional facilities that manufacture, process, use, or store hazardous materials.

1-2.2 This standard is not applicable to transportation or to use by the general public.

1-2.3 This standard is not applicable to chronic exposure or to nonemergency occupational exposure.

1-3 Purpose. This system is intended to provide basic information to fire fighting, emergency, and other personnel, enabling them to more easily decide whether to evacuate the area or to commence emergency control procedures. It is also intended to provide them with information to assist in selecting fire fighting tactics and emergency procedures.

1-4 Description.

1-4.1 This system identifies the hazards of a material in terms of three principal categories: "health," "flammability," and "reactivity." It indicates the degree of severity by a numerical rating that ranges from four (4), indicating severe hazard, to zero (0), indicating no hazard.

1-4.2 The information is presented by a spatial arrangement of numerical ratings with the health rating always at the nine o'clock position; the flammability rating always at the twelve o'clock position; and the reactivity rating always at the three o'clock position. Each rating is located in a square-on-point field, each of which is assigned a color: blue for health hazard; red for flammability hazard; yellow for reactivity hazard. Alternately, the square-on-point field may be any convenient contrasting color and the numbers themselves may be colored. See pages 9-10 for examples of the spatial arrangements.

1-4.3 The fourth space, at the six o'clock position, is reserved for indicating any unusual reactivity with water. The standard symbol for indicating unusual reactivity with water is the letter "W" with a line through the center: ~~W~~. No special color is associated with this symbol.

1-4.3.1 This space may also be used to indicate other unusual hazards, but only if not needed to indicate reactivity with water. Approved symbols will be designated in Chapter 5 of this standard.

1-5 Assignment of Ratings.

1-5.1 While the system is basically simple in application, the hazard evaluation required to determine the correct numerical ratings for a specific material shall be performed by persons who are technically competent and experienced in the interpretation of the hazard criteria set forth in this Standard. Assignment of ratings shall be based on factors that encompass a knowledge of the inherent hazards of the material, including the extent of change in behavior to be anticipated under conditions of exposure to fire or fire control procedures. (For additional information, see NFPA 49, *Hazardous Chemicals Data*, and NFPA 325M, *Fire Hazard Properties of Flammable Liquids, Gases, and Volatile Solids*.)

1-5.2 The system is based on relative rather than absolute values. Therefore, it is anticipated that conditions of storage and use may result in different ratings being assigned to the same material by different persons. Furthermore, the guidance presented in the following chapters is necessarily limited. For example, flash point is the primary criterion for assigning the flammability rating, but other criteria may be of equal importance. For example, autoignition temperature, flammability limits, and susceptibility of a container to failure due to fire exposure also must be considered. For reactivity, emphasis has been placed on the ease by which an energy-releasing reaction is triggered. For health, consideration is given not only to inherent hazard but also to protective measures that must be taken to minimize effects of short-term exposure.

1-5.3 In some situations, such as warehouses, storage rooms or buildings, laboratory facilities, etc., a variety of materials may be present in one localized area. In such cases considerable judgement may be needed to properly assign ratings to the area.

Chapter 2 Health Hazards

2-1 General.

2-1.1 This chapter shall address the capability of a material to cause personal injury due to contact with or entry into the body via inhalation, ingestion, skin contact, or eye contact. Only the hazards that arise from an inherent toxic property of the material or its products of decomposition or combustion shall be considered. Injury resulting from the heat of a fire or from the force of an explosion shall not be considered.

2-1.2 In general, the health hazard that results from a fire or other emergency condition is one of acute (single) short-term exposure to a concentration of a hazardous material. This exposure may vary from a few seconds to as long as one hour. The physical exertion demanded by fire-fighting or other emergency activity may be expected to intensify the effects of any exposure. In addition, the hazard under ambient conditions will likely be exaggerated at elevated temperatures. Health hazards that may result from chronic or repeated long-term exposure to low concentrations of a hazardous material shall not be considered.

2-1.3 The oral route of exposure, i.e. ingestion, is highly unlikely under the conditions anticipated by this standard. If situations are encountered, however, where the oral toxicity values indicate a significantly different health hazard rating than from other, more likely routes of exposure or where the oral toxicity values would tend to either exaggerate or minimize the hazards likely to be encountered, then professional judgement shall be exercised in assigning the health hazard rating. In such cases, other routes of entry may be considered to be more appropriate to assessing the hazard. Also, based on professional judgement, it may be appropriate to either increase or decrease the health hazard rating to more accurately assess the likely degree of hazard that will be encountered under the conditions anticipated by this standard. Similarly, inhalation of dusts and mists is unlikely under the conditions anticipated by this standard. In such cases, the health hazard ratings should also be based on data for the more likely routes of exposure.

2-1.4 This chapter shall consider two major categories of health hazards in emergencies. One originates with the inherent physical and toxic properties of the material; the other arises from the generation of toxic products during decomposition or combustion of the material. For purposes of assigning the health hazard rating, only the inherent physical and toxic properties of the material shall be considered unless the combustion or decomposition products present a significantly greater degree of risk.

2-1.5 The degree of hazard shall indicate to fire fighting and emergency response personnel one of the following: that they can work safely only with specialized protective equipment; that they can work safely with suitable respiratory protective equipment; or that they can work safely in the area with ordinary clothing.

2-2 Definitions.

Health Hazard. The likelihood of a material to cause, either directly or indirectly, temporary or permanent injury or incapacitation due to an acute exposure by contact, inhalation, or ingestion.

2-3 Degrees of Hazard.

2-3.1 The degrees of health hazard shall be ranked according to the probable severity of the effects of exposure to personnel as follows:

4 Materials that, on very short exposure, could cause death or major residual injury, including those that are too dangerous to be approached without specialized protective equipment. This degree usually includes:

Materials that, under normal conditions or under fire conditions, are extremely hazardous (i.e., toxic or corrosive) through inhalation or through contact with or absorption by the skin;

Materials whose LD_{50} for acute oral toxicity is less than or equal to 5 milligrams per kilogram (mg/kg);

Materials whose LD_{50} for acute dermal toxicity is less than or equal to 40 milligrams per kilogram (mg/kg);

Dusts and mists whose LC_{50} for acute inhalation toxicity is less than or equal to 0.5 milligrams per liter (mg/L);

Any liquid whose saturated vapor concentration at 20 °C is equal to or greater than ten times its LC_{50} for acute inhalation toxicity, if its LC_{50} is less than or equal to 1000 parts per million (ppm);

Gases whose LC_{50} for acute inhalation toxicity is less than or equal to 1000 parts per million (ppm).

3 Materials that, on short exposure, could cause serious temporary or residual injury, including those requiring protection from all bodily contact. This degree usually includes:

Materials that give off highly toxic combustion products;

Materials whose LD_{50} for acute oral toxicity is greater than 5 milligrams per kilogram (mg/kg), but less than or equal to 50 milligrams per kilogram (mg/kg);

Materials whose LD_{50} for acute dermal toxicity is greater than 40 milligrams per kilogram (mg/kg), but less than or equal to 200 milligrams per kilogram (mg/kg);

Dusts and mist whose LC_{50} for acute inhalation toxicity is greater than 0.5 milligrams per liter (mg/L), but less than or equal to 2 milligrams per liter (mg/L);

Any liquid whose saturated vapor concentration at 20 °C is equal to or greater than its LC_{50} for acute inhalation toxicity, if its LC_{50} is less than or equal to 3000 parts per million (ppm) and that does not meet the criteria for degree of hazard 4;

Gases whose LC_{50} for acute inhalation toxicity is greater than 1000 parts per million (ppm), but less than or equal to 3000 parts per million (ppm);

Materials that either are severely corrosive to skin on single, short exposure or cause irreversible eye damage.

2 Materials that, on intense or short exposure, could cause temporary incapacitation or possible residual injury, including those requiring the use of respiratory protective equipment that has an independent air supply. This degree usually includes:

Materials that give off toxic or highly irritating combustion products;

Materials that, under normal conditions or fire conditions, give off toxic vapors that lack warning properties;

Materials whose LD_{50} for acute oral toxicity is greater than 50 milligrams per kilogram, but less than or equal to 500 milligrams per kilogram (mg/kg);

Materials whose LD_{50} for acute dermal toxicity is greater than 200 milligrams per kilogram (mg/kg), but less than or equal to 1000 milligrams per kilogram (mg/kg);

Dusts and mists whose LC_{50} for acute inhalation toxicity is greater than 2 milligrams per liter (mg/L), but less than or equal to 10 milligrams per liter (mg/L);

Any liquid whose saturated vapor concentration at 20 °C is equal to or greater than one-fifth (1/5) its LC_{50} for acute inhalation toxicity, if its LC_{50} is less than or equal to 5000 parts per million (ppm) and that does not meet the criteria for either degree of hazard 3 or degree of hazard 4;

Gases whose LC_{50} for acute inhalation toxicity is greater than 3000 parts per million (ppm), but less than or equal to 5000 parts per million (ppm);

Materials that cause severe but reversible respiratory, skin, or eye irritation.

1 Materials that, on short exposure, could cause irritation, but only minor residual injury, including those requiring the use of an approved air-purifying respirator. This degree usually includes:

Materials that, under fire conditions, give off irritating combustion products;

Materials that, under fire conditions, cause skin irritation, but not destruction of tissue;

Materials whose LD_{50} for acute oral toxicity is greater than 500 milligrams per kilogram (mg/kg), but less than or equal to 2000 milligrams per kilogram (mg/kg);

Materials whose LD_{50} for acute dermal toxicity is greater than 1000 milligrams per kilogram (mg/kg), but less than or equal to 2000 milligrams per kilogram (mg/kg);

Dusts and mists whose LC_{50} for acute inhalation toxicity is greater than 10 milligrams per liter (mg/L), but less than or equal to 200 milligrams per liter (mg/L);

Gases and vapors whose LC_{50} for acute inhalation toxicity is greater than 5000 parts per million (ppm), but less than or equal to 10,000 parts per million (ppm);

Materials that are moderate respiratory irritants or that cause slight to moderate eye irritation.

0 Materials that on short exposure under fire conditions, would offer no hazard beyond that of ordinary combustible materials. This degree usually includes:

Materials whose LD_{50} for acute oral toxicity is greater than 2000 milligrams per kilogram (mg/kg);

Materials whose LD_{50} for acute dermal toxicity is greater than 2000 milligrams per kilogram (mg/kg);

Dusts and mists whose LC_{50} for acute inhalation toxicity is greater than 200 milligrams per liter (mg/L);

Gases and vapors whose LC_{50} for acute inhalation toxicity is greater than 10,000 parts per million (ppm).

Chapter 3 Flammability Hazards

3-1 General.

3-1.1 This chapter shall address the degree of susceptibility of materials to burning. Since many materials will burn under one set of conditions but will not burn under others, the form or condition of the material shall be considered, along with its inherent properties.

3-2 Degrees of Hazard.

3-2.1 The degrees of hazard shall be ranked according to the susceptibility of materials to burning as follows:

4 Materials that will rapidly or completely vaporize at atmospheric pressure and normal ambient temperature or that are readily dispersed in air, and which will burn readily. This degree usually includes:

Flammable gases;

Flammable cryogenic materials;

Any liquid or gaseous material that is liquid while under pressure and has a flash point below 73 °F (22.8 °C) and a boiling point below 100 °F (37.8 °C) (i.e. Class IA flammable liquids);

Materials that ignite spontaneously when exposed to air.

3 Liquids and solids that can be ignited under almost all ambient temperature conditions. Materials in this degree produce hazardous atmospheres with air under almost all ambient temperatures or, though unaffected by ambient temperatures, are readily ignited under almost all conditions. This degree usually includes:

Liquids having a flash point below 73 °F (22.8 °C) and having a boiling point at or above 100 °F (37.8 °C) and those liquids having a flash point at or above 73 °F (22.8 °C) and below 100 °F (37.8 °C) (i.e. Class IB and Class IC flammable liquids);

Materials that on account of their physical form or environmental conditions can form explosive mixtures with air and that are readily dispersed in air, such as dusts of combustible solids and mists of flammable or combustible liquid droplets;

Materials that burn with extreme rapidity, usually by reason of self-contained oxygen (e.g., dry nitrocellulose *and many organic peroxides*).

2 Materials that must be moderately heated or exposed to relatively high ambient temperatures before ignition can occur. Materials in this degree would not under normal conditions form hazardous atmospheres with air, but under high ambient temperatures or under moderate heating may release vapor in sufficient quantities to produce hazardous atmospheres with air. This degree usually includes:

Liquids having a flash point above 100 °F (37.8 °C), but not exceeding 200 °F (93.4 °C) (i.e. Class II and Class IIIA combustible liquids);

Solid materials in the form of coarse dusts that may burn rapidly but that generally do not form explosive atmospheres with air;

Solid materials in a fibrous or shredded form that may burn rapidly and create flash fire hazards, such as cotton, sisal, and hemp;

Solids and semisolids that readily give off flammable vapors.

1 Materials that must be preheated before ignition can occur. Materials in this degree require considerable preheating, under all ambient temperature conditions, before ignition and combustion can occur. This degree usually includes:

Materials that will burn in air when exposed to a temperature of 1500 °F (815.5 °C) for a period of 5 minutes or less;

Liquids, solids, and semisolids having a flash point above 200 °F (93.4 °C) (i.e. Class IIIB combustible liquids);

Most ordinary combustible materials.

0 Materials that will not burn. This degree usually includes any material that will not burn in air when exposed to a temperature of 1500 °F (815.5 °C) for a period of 5 minutes.

Chapter 4 Reactivity (Instability) Hazards

4-1 General.

4-1.1 This chapter shall address the degree of susceptibility of materials to release energy. Some materials are capable of rapid release of energy by themselves, as by self-reaction or polymerization, or can undergo violent explosive reaction if contacted with water or other extinguishing agents or with certain other materials.

4-1.2 The violence of reaction or decomposition of materials may be increased by heat or pressure, by mixture with certain other materials to form fuel-oxidizer combinations, or by contact with incompatible substances, sensitizing contaminants, or catalysts.

4-1.3 Because of the wide variations of accidental combinations possible in fire or other emergencies, these extraneous hazard factors (except for the effect of water) cannot be applied in a general numerical scaling of hazards. Such extraneous factors must be considered individually in order to establish appropriate safety factors, such as separation or segregation. Such individual consideration is particularly important where significant amounts of materials are to be stored or handled. Guidance for this consideration is provided in NFPA 49, *Hazardous Chemicals Data*.

4-1.4 The degree of reactivity hazard shall indicate to fire fighting and emergency personnel that the area should be evacuated, that a fire must be fought from a protected location, that caution must be used in approaching a spill or fire to apply extinguishing agents, or that a fire may be fought using normal procedures.

4-2 Definitions.

4-2.1 For the purposes of this standard, a reactive material is one that can enter into a violent chemical reaction with water. Reactions with other materials may also result in violent release of energy but are beyond the scope of this standard.

4-2.2 For the purposes of this standard, an unstable material is one that, in the pure state or as commerially produced, will vigorously polymerize, decompose or condense, become self-reactive, or otherwise undergo a violent chemical change under conditions of shock, pressure, or temperature.

4-2.3 Stable materials are those that normally have the capacity to resist changes in their chemical composition, despite exposure to air, water, and heat as encountered in fire emergencies.

4-3 Degrees of Hazard.

4-3.1 The degrees of hazard shall be ranked according to ease, rate, and quantity of energy release as follows:

4 Materials that in themselves are readily capable of detonation or explosive decomposition or explosive reaction at normal temperatures and pressures. This degree usually includes materials that are sensitive to localized thermal or mechanical shock at normal temperatures and pressures.

3 Materials that in themselves are capable of detonation or explosive decomposition or explosive reaction, but that require a strong initiating source or that must be heated under confinement before initiation. This degree usually includes:

Materials that are sensitive to thermal or mechanical shock at elevated temperatures and pressures;

Materials that react explosively with water without requiring heat or confinement.

2 Materials that readily undergo violent chemical change at elevated temperatures and pressures. This degree usually includes:

Materials that exhibit an exotherm at temperatures less than or equal to 150 °C when tested by differential scanning calorimetry;

Materials that may react violently with water or form potentially explosive mixtures with water.

1 Materials that in themselves are normally stable, but that can become unstable at elevated temperatures and pressure. This degree usually includes:

Materials that change or decompose on exposure to air, light, or moisture;

Materials that exhibit an exotherm at temperatures greater than 150 °C, but less than or equal to 300 °C, when tested by differential scanning calorimetry.

0 Materials that in themselves are normally stable, even under fire conditions. This degree usually includes:

Materials that do not react with water;

Materials that exhibit an exotherm at temperatures greater than 300 °C but less than or equal to 500 °C when tested by differential scanning calorimetry;

Materials that do not exhibit an exotherm at temperature less than or equal to 500 °C when tested by differential scanning calorimetry.

Chapter 5 Special Hazards

5-1 General.

5-1.1 This chapter shall address the other properties of the material that may cause special problems or require special fire fighting techniques.

5-1.2 Special hazards symbols shall be shown in the fourth space of the diagram or immediately above or below the entire symbol.

5-2 Symbols.

5-2.1 Materials that demonstrate unusual reactivity with water shall be identified with the letter W with a horizontal line through the center (W̶).

5-2.2 Materials that possess oxidizing properties shall be identified by the letters OX.

Chapter 6 Identification of Materials by Hazard Signal System

6-1 One of the systems delineated in the following illustrations shall be used for the implementation of this standard.

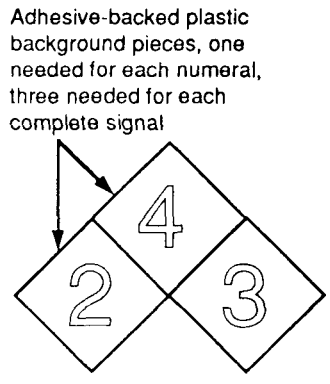


Figure 1 For use where specified color background is used with numerals of contrasting colors.

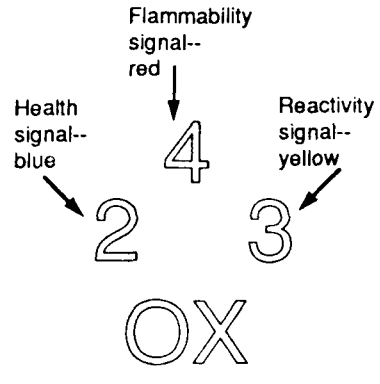


Figure 2 For use where white background is necessary.

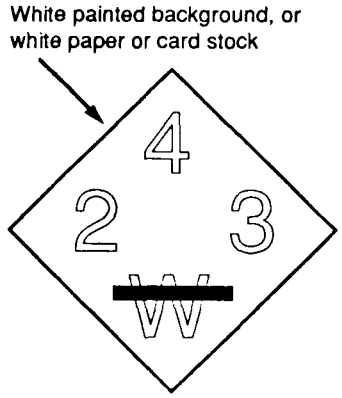
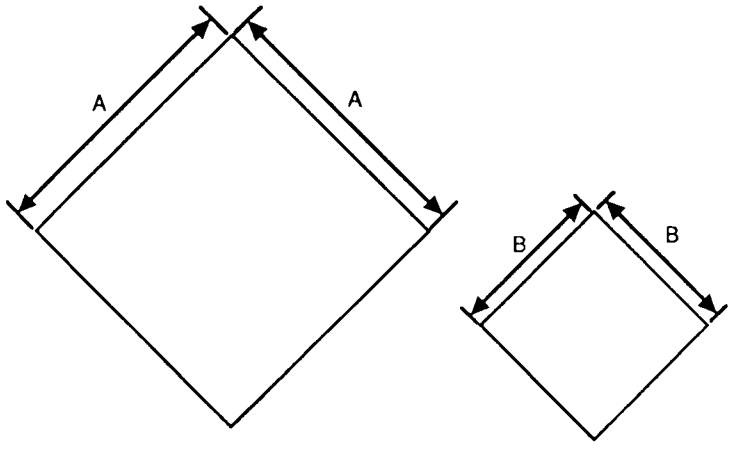


Figure 3 For use where white background is used with painted numerals, or for use when signal is in the form of sign or placard.

Figure 6-1 Alternate arrangements for display of NFPA 704 Hazard Identification System.



When painted (use same dimensions for sign or placard)

When made from adhesive-backed plastic (one for each numeral, three necessary for each complete signal)

Minimum Dimensions of White Background for Signals (White Background is Optional)

Size of Signals H	W	T	A	B
1	0.7	5/32	2 1/2	1 1/4
2	1.4	5/16	5	2 1/2
3	2.1	15/32	7 1/2	3 3/4
4	2.8	5/8	10	5
6	4.2	15/16	15	7 1/2

All dimensions given in inches

Exception: For containers with a capacity of one gallon or less, symbols may be reduced in size, provided:

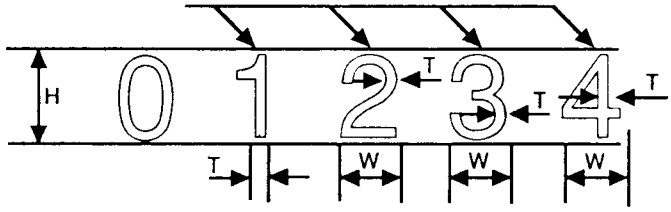
1. This reduction is proportionate.

2. The color coding is retained.

3. The vertical and horizontal dimensions of the diamond are not less than 1 in. (2.5 cm).

4. The individual numbers are no smaller than 1/8 in. tall.

Color of numerals 1,2,3,4 should be as indicated



Note: Style of numerals shown is optional.

Figure 6-2 Dimensions of NFPA 704 placard and numerals.

Arrangement and Order of Signals – Optional Form of Application

Distance at which signals must be legible	Minimum size of signals required
50 feet	1"
75 feet	2"
100 feet	3"
200 feet	4"
300 feet	6"

Note: This shows the correct spatial arrangement and order of signals used for identification of materials by hazard.

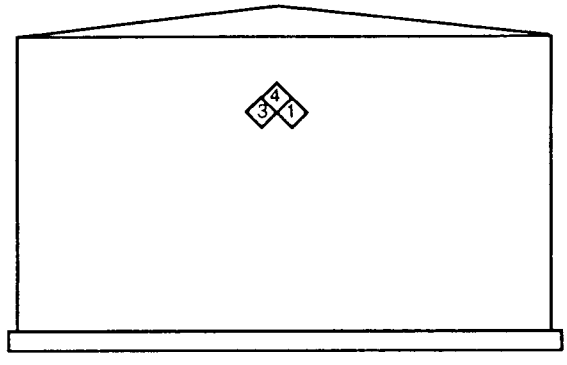


Figure 6-3 Minimum size of numerals for legibility at distance.

Appendix A

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

A-1 This is a system for the identification of hazards to life and health of people in the prevention and control of fires and explosions in the manufacture and storage of materials. The bases for identification are the physical properties and characteristics of materials that are known or can be determined by standard methods. Technical terms, expressions, trade names, etc., are purposely avoided as this system is concerned only with the identification of the involved hazard from a standpoint of safety.

The explanatory material in this Appendix is to assist users of this standard, particularly the person who assigns the degree of hazard in each category.

Identification of Health Hazard Color Code: BLUE		Identification of Flammability Color Code: RED		Identification of Reactivity (Stability) Color Code: YELLOW	
	Type of Possible Injury	Susceptibility of Materials to Burning		Susceptibility to Release of Energy	
Signal		Signal		Signal	
4	Materials that on very short exposure could cause death or major residual injury.	4	Materials that will rapidly or completely vaporize at atmospheric pressure and normal ambient temperature, or that are readily dispersed in air and that will burn readily.	4	Materials that in themselves are readily capable of detonation or of explosive decomposition or reaction at normal temperatures and pressures.
3	Materials that on short exposure could cause serious temporary or residual injury.	3	Liquids and solids that can be ignited under almost all ambient temperature conditions.	3	Materials that in themselves are capable of detonation or explosive decomposition or reaction but require a strong initiating source or which must be heated under confinement before initiation or which react explosively with water.
2	Materials that on intense or continued but not chronic exposure could cause temporary incapacitation or possible residual injury.	2	Materials that must be moderately heated or exposed to relatively high ambient temperatures before ignition can occur.	2	Materials that readily undergo violent chemical change at elevated temperatures and pressures or which react violently with water or which may form explosive mixtures with water.
1	Materials that on exposure would cause irritation but only minor residual injury.	1	Materials that must be preheated before ignition can occur.	1	Materials that in themselves are normally stable, but which can become unstable at elevated temperatures and pressures.
0	Materials that on exposure under fire conditions would offer no hazard beyond that of ordinary combustible material.	0	Materials that will not burn.	0	Materials that in themselves are normally stable, even under fire exposure conditions, and which are not reactive with water.

A-2 In developing this edition of NFPA 704, the Committee on Fire Hazards of Materials determined that the standard should provide quantitative guidelines for determining the numerical health hazard rating of a material. In addition, the Committee agreed that a "4" or a "3" health hazard rating should be assigned to any material classified as a "Poison - Inhalation Hazard" by the U.S. Department of Transportation (DOT). This classification, "Poison-Inhalation Hazard", was adopted by DOT from the United Nations (UN) criteria detailed in the UN publication, *Recommendations on the Transport of Dangerous Goods*, 4th Edition - Revised, 1986. (See also Notice of Proposed Rulemaking, *Federal Register*, Vol. 50, p 5270 et seq., February 7, 1985, and Notice of Final Rule, *Federal Register*, Vol. 50, p. 41092 et seq., October 8, 1985.)

The UN criteria for inhalation toxicity is based upon the LC_{50} and saturated vapor concentration of the material. Furthermore, in addition to inhalation toxicity, the UN has established criteria for oral and dermal toxicity, as well as corrosivity. Based upon these criteria, the UN assigns a given material to categories called Packing Groups I, II, or III.Packing Group I materials represent a severe hazard in transport, Group II materials a serious hazard, and Group III materials a low hazard.

The Committee decided to adopt the UN criteria for toxicity and corrosivity, and correlate Packing Groups I, II, and III with the health hazard ratings "4," "3," and "2," respectively. Adoption of the UN system has several advantages. First, it addresses hazards in transportation, which are similar to the type of emergencies likely to be encountered by fire fighting personnel and emergency responders. Most other hazard ranking systems have been developed for occupational exposures. Secondly, the UN system is well established, and it is presumed that a large number of chemical manufacturers have already classified (or can easily clasify) materials into the appropriate Packing Groups. Finally, users

of chemicals can assign "4," "3," or "2" health hazard ratings by establishing if chemicals have been assigned to UN Packing Groups due to toxicity or corrosivity.

In order to establish "1" and "0" health hazard rankings, the Committee utilized criteria for the "1" and "0" ratings contained in the Hazardous Materials Identification System (HMIS™) developed by the National Paint & Coatings Association (NPCA) (Hazardous Materials Identification System Revised, Implementation Manual, 1981). Although the NPCA criteria were developed for occupational exposure, the "1" and "0" criteria are on the low end of the hazard spectrum and are fairly consistent with, and complementary to, the "4," "3," and "2" ratings based upon the UN criteria. No UN criteria was established for eye irritation, and the Committee adopted NPCA "3," "2," and "1," and "0" criteria as health hazard ratings for eye irritation.

The Committee made a number of revisions to the proposed hazard rating system to provide conformity with existing industrial practice and to recognize limitations and availability of corrosivity and eye irritation into a single "skin/eye contact" category and utilize descriptive terms for the health hazard ratings. Minor changes were made to the "2," "1," and "0" criteria for oral toxicity and to the "1" and "0" criteria for dermal toxicity. Specifically, the distinction between solids and liquids in the oral toxicity criteria was eliminated, and the cutoff between "1" and "0" rankings for oral and dermal toxicity was lowered from 5000 to 2000 mg/kg.

In summary, the "4," "3," and "2" health hazard rankings for oral, dermal, and inhalation toxicity are based primarily on UN criteria. The "1" and "0" health hazard rankings for oral, dermal, and inhalation toxicity, and all of the "skin/eye contact" rankings are based primarily on NPCA criteria.

For the assistance of the user of this standard, the following definitions are quoted from Section 6.5 of Recommendations on the Transport of Dangerous Goods, Fourth Revised Edition, 1986, published by the United Nations, New York, NY.

"LD_{50} for acute oral toxicity:

"That dose of the substance administered which is most likely to cause death within 14 days in one half of both male and female young adult albino rats. The number of animals tested shall be sufficient to give a statistically significant result and be in conformity with good pharmacological practice. The result is expressed in milligrams per kilogram of body weight.

"LD_{50} for acute dermal toxicity:

"That dose of the substance which, administered by continuous contact for 24 hours with the bare skin of albino rabbits, is most likely to cause death within 14 days in one half of the animals tested. The number of animals tested shall be sufficient to give a statistically significant result and be in conformity with good pharmacological practice. The result is expressed in milligrams per kilogram of body weight.

"LC_{50} for acute toxicity on inhalation:

"That concentration of vapour, mist or dust which, administered by continuous inhalation to both male and female young adult albino rats for one hour, is most likely to cause death within 14 days in one half of the animals tested. If the substance is administered to the animals as dust or mist, more than 90 percent of the particles available for inhalation in the test must have a diameter of 10 microns or less, provided that it is reasonably forseeable that such concentrations could be encountered by man during transport. The result is expressed in milligrams per liter of air for dusts and mists or in millilitres per cubic meter of air (parts per million) for vapors."

The following information quoted from Section 6.4 of the above-cited Recommendations also applies:

"The criteria for inhalation toxicity of dusts and mists are based on LC_{50} data relating to 1 hour exposures and where such information is available it should be used. However, where only LC_{50} data relating to 4 hour exposures to dusts and mists are available, such figures can be multipled by four and the product substituted in the above criteria, i.e. LC_{50} (4 hour) × 4 is considered equivalent of LC_{50} (1 hour).

"The criteria for inhalation toxicity of vapors are based on LC_{50} data relating to 1 hour exposures, and where such information is available it should be used. However, where only LC_{50} data relating to 4 hour exposures to dusts and mists are available, such figures can be multiplied by two and the product substituted in the above criteria, i.e. LC_{50} (4 hour) × 2 is considered equivalent of LC_{50} (1 hour)."

Appendix B

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

The information contained within Appendix B is derived from introductory explanatory material on the 704 system contained within NFPA 49, *Hazardous Chemicals Data*; and NFPA 325M, *Fire Hazard Properties of Flammable Liquids, Gases, and Volatile Solids*. The following paragraphs summarize the meanings of the numbers in each hazard category and explain what a number should tell fire fighting personnel about protecting themselves and how to fight fires where the hazard exists.

Health.

In general, health hazard in fire fighting is that of a single exposure that may vary from a few seconds up to an hour. The physical exertion demanded in fire fighting or other emergency conditions may be expected to intensify the effects of any exposure. Only hazards arising out of an inherent property of the material are considered. The following explanation is based upon protective equipment normally used by fire fighters.

4 Materials too dangerous to health to expose fire fighters. A few whiffs of the vapor could cause death, or the vapor or liquid could be fatal on penetrating the fire fighter's normal full protective clothing. The normal full protective clothing and breathing apparatus available to the average fire department will not provide adequate protection against inhalation or skin contact with these materials.

3 Materials extremely hazardous to health but areas may be entered with extreme care. Full protective clothing, including self-contained breathing apparatus, coat, pants, gloves, boots, and bands around legs, arms, and waist should be provided. No skin surface should be exposed.

2 Materials hazardous to health, but areas may be entered freely with full-faced mask self-contained breathing apparatus that provides eye protection.

1 Materials only slightly hazardous to health. It may be desirable to wear self-contained breathing apparatus.

0 Materials that on exposure under fire conditions would offer no hazard beyond that of ordinary combustible material.

Flammability.

Susceptibility to burning is the basis for assigning degrees within this category. The method of attacking the fire is influenced by this susceptibility factor.

4 Very flammable gases or very volatile flammable liquids. Shut off flow and keep cooling water streams on exposed tanks or containers.

3 Materials that can be ignited under almost all normal temperature conditions. Water may be ineffective because of the low flash point.

2 Materials that must be moderately heated before ignition will occur. Water spray may be used to extinguish the fire because the material can be cooled below its flash point.

1 Materials that must be preheated before ignition can occur. Water may cause frothing if it gets below the surface of the liquid and turns to steam. However, water fog gently applied to the surface will cause a frothing that will extinguish the fire.

0 Materials that will not burn.

Reactivity (Stability).

The assignment of degrees in the reactivity category is based upon the susceptibility of materials to release energy either by themselves or in combination with water. Fire exposure is one of the factors considered along with conditions of shock and pressure.

4 Materials that (in themselves) are readily capable of detonation or of explosive decomposition or explosive reaction at normal temperatures and pressures. Includes materials that are sensitive to mechanical or localized thermal shock. If a chemical with this hazard rating is in an advanced or massive fire, the area should be evacuated.

3 Materials that (in themselves) are capable of detonation or of explosive decomposition or of explosive reaction but which require a strong initiating source or which must be heated under confinement before initiation. Includes materials that are sensitive to thermal or mechanical shock at elevated temperatures and pressures or that react explosively with water without requiring heat or confinement. Fire fighting should be done from a location protected from the effects of an explosion.

2 Materials that (in themselves) are normally unstable and readily undergo violent chemical change but do not detonate. Includes materials that can undergo chemical change with rapid release of energy at normal temperatures and pressures or that can undergo violent chemical change at elevated temperatures and pressures. Also includes those materials that may react violently with water or that may form potentially explosive mixtures with water. In advanced or massive fires, fire fighting should be done from a safe distance or from a protected location.

1 Materials that (in themselves) are normally stable but which may become unstable at elevated temperatures and pressures or which may react with water with some release of energy but not violently. Caution must be used in approaching the fire and applying water.

0 Materials that (in themselves) are normally stable even under fire exposure conditions and that are not reactive with water. Normal fire fighting procedures may be used.

Appendix C Flammability

This Appendix is not a part of the requirements (recommendations) of this NFPA document, but is included for information purposes only.

The selection of the flash point breaks for the assigning of degrees within the Flammability category has been based upon the recommendations of the Technical Committee on Classification and Properties of Flammable Liquids of the NFPA Committee on Flammable Liquids. This Technical Committee initiated the study that led to the development of this standard. Close cooperation between the Technical Committee and the Committee on Fire Hazards of Materials has continued.

Flash point tells several things. One, if the liquid has no flash point, it is not a flammable liquid. Two, if it has a flash point, it must be considered flammable or combustible. Three, the flash point is normally an indication of susceptibility to ignition.

The flash point test may give results that would indicate that the liquid is nonflammable or that it comes under degree 1 or 2 when it is a mixture containing, for example, carbon tetrachloride. As a specific example, sufficient carbon tetrachloride can be added to gasoline so that the mixture has no flash point. However, on standing in an open container, the carbon tetrachloride will evaporate more rapidly than the gasoline. Over a period of time, therefore, the residual liquid will first show a high flash point, then a progressively lower one until the flash point of the final 10 percent of the original sample will approximate that of the heavier fractions of the gasoline. In order to evaluate the fire hazard of such liquid mixtures, fractional evaporation tests can be conducted at room temperature in open vessels. After evaporation of appropriate fractions, such as 10, 20, 40, 60, and 90 percent of the original sample, flash point tests can be conducted on the residue. The results of such tests indicate the grouping into which the liquid should be placed if the conditions of use are such as to make it likely that appreciable evaporation will take place. For open system conditions, such as in

open dip tanks, the open-cup test method may give a more reliable indication of the flammability hazard.

In the interest of reproducibility of results, it is recommended that:

The flash point of liquids having a viscosity less than 45 SUS (Saybolt Universal Seconds) at 100 °F (37.8 °C) and a flash point below 200 °F (93.4 °C) may be determined in accordance with ASTM D-56-79, *Standard Method of Test for Flash Point by the Tag Closed Tester.* (In those countries that use the Abel or Abel-Pensky closed cup tests as an official standard, these tests will be equally acceptable to the Tag Closed Cup Method.)

The flash point of aviation turbine fuels may be determined in accordance with ASTM D3828-81, *Test Method for Flash Point by Setaflash Closed Tester.*

For liquids having flash points in the range of 32 °F (0 °C) to 230 °F (110 °C) the determination may be made in accordance with ASTM D3278-82, *Flash Point of Liquids by Setaflash Closed Tester.*

For viscous and solid chemicals the determination may be made in accordance with ASTM E502-74, *Flash Point of Chemicals by Closed Cup Methods.*

The flash point of liquids having a viscosity of 45 SUS (Saybolt Universal Seconds) or more at 100 °F (37.8 °C) or a flash point of 200 °F (93.4 °C) or higher may be determined in accordance with ASTM D-93-79, *Standard Method of Test for Flash Point by the Pensky-Martens Closed Tester.*

Appendix D Reactivity, Differential Scanning Calorimetry (DSC)

This Appendix is not a part of the requirements (recommendations) of this NFPA document, but is included for information purposes only.

Differential Scanning Calorimetry (DSC) is the primary screening test for assessing reactivity hazard. It indicates whether a material undergoes an exothermic or endothermic reaction, and a general temperature range in which the reaction occurs.

This test is routinely run before other more sophisticated tests are run, such as an Accelerating Rate Calorimetry (ARC) test or drop weight testing. Heats of reaction, heats of decomposition, and heats of fusion, as well as kinetic information, can be determined by DSC for homogenous solids and liquids, as well as heterogenous systems.

DSC data should be used with caution, avoiding any inference that the test conditions duplicate those that the material will experience in a foreign environment.

A DSC test consists of heating a small quanity of material (typically 1-10 milligrams) held in a sample container from room temperature to approximately 500 °C. Exotherms are usually detected by the DSC test at temperatures higher than that expected in systems that are more adiabatic (insulated tanks, large masses of material, etc.)

Small changes in the composition of a material can have a significant effect on its thermal behavior. For example, a material may not decompose in the container in which DSC is done, but it may be catalytically decomposed by the material of construction of the container used in service.

The DSC is a screening test that is used primarily to determine if further testing is required.

Appendix E Referenced Publications

E-1 The following documents or portions thereof are referenced within this standard for informational purposes only and thus are not 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.

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

NFPA 49-1975, *Hazardous Chemicals Data*

NFPA 325M-1984, *Fire Hazard Properties of Flammable Liquids, Gases, and Volatile Solids.*

E-1.2 ASTM Publications. American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM D-56-87, *Standard Method for Test for Flash Point by the Tag Closed Tester*

ASTM D-3828-87, *Test Method for Flash Point by Setaflash Closed Tester*

ASTM D-3278-82, *Flash Point of Liquids by Setaflash Closed Tester*

ASTM D-93-85, *Test Methods for Flash Point by the Pensky-Martens Closed Tester*

ASTM E-502-84, *Flash Point of Chemicals by Closed Cup Methods.*

E-1.3 Other Publications.

Tou, J.C. and Whiting, L.F.; "A Cradle-Glass Ampoule Sample Container for Differential Scanning Calorimetric Analysis"; Thermochimica Acta; Vol. 42; Elsevier Scientific Publishing Co.; Amsterdam; 1980.

Whiting, L.F., LaBean, M.S., and Eadie, S.S.; "Evaluation of a Capillary Tube Sample Container for Differential Scanning Calorimetry"; Thermochimica Acta; Vol. 136; Elsevier Scientific Publishing Co.; Amsterdam; 1988.

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The NFPA Codes and Standards Development Process

Since 1896, one of the primary purposes of the NFPA has been to develop and update the standards covering all areas of fire safety.

Calls for Proposals
The code adoption process takes place twice each year and begins with a call for proposals from the public to amend existing codes and standards or to develop the content of new fire safety documents.

Report on Proposals
Upon receipt of public proposals, the technical committee members meet to review, consider, and act on the proposals. The public proposals – together with the committee action on each proposal and committee-generated proposals – are published in the NFPA's Report on Proposals (ROP). The ROP is then subject to public review and comment.

Report on Comments
These public comments are considered and acted upon by the appropriate technical committees. All public comments – together with the committee action on each comment – are published as the Committee's supplementary report in the NFPA's Report on Comments (ROC).

The committee's report and supplementary report are then presented for adoption and open debate at either of NFPA's semi-annual meetings held throughout the United States and Canada.

Association Action
The Association meeting may, subject to review and issuance by the NFPA Standards Council, (a) adopt a report as published, (b) adopt a report as amended, contingent upon subsequent approval by the committee, (c) return a report to committee for further study, and (d) return a portion of a report to committee.

Standards Council Action
The Standards Council will make a judgement on whether or not to issue an NFPA document based upon the entire record before the Council, including the vote taken at the Association meeting on the technical committee's report.

Voting Procedures
Voting at an NFPA Annual or Fall Meeting is restricted to members of record for 180 days prior to the opening of the first general session of the meeting, except that individuals who join the Association at an Annual or Fall Meeting are entitled to vote at the next Fall or Annual Meeting.

"Members" are defined by Article 3.2 of the Bylaws as individuals, firms, corporations, trade or professional associations, institutes, fire departments, fire brigades, and other public or private agencies desiring to advance the purposes of the Association. Each member shall have one vote in the affairs of the Association. Under Article 4.5 of the Bylaws, the vote of such a member shall be cast by that member individually or by an employee designated in writing by the member of record who has registered for the meeting. Such a designated person shall not be eligible to represent more than one voting privilege on each issue, nor cast more than one vote on each issue.

Any member who wishes to designate an employee to cast that member's vote at an Association meeting in place of that member must provide that employee with written authorization to represent the member at the meeting. The authorization must be on company letterhead signed by the member of record, with the membership number indicated, and the authorization must be recorded with the President of NFPA or his designee before the start of the opening general session of the Meeting. That employee, irrespective of his or her own personal membership status, shall be privileged to cast only one vote on each issue before the Association.

Sequence of Events Leading to Publication of an NFPA Committee Document

Call for proposals to amend existing document or for recommendations on new document.

▼

Committee meets to act on proposals, to develop its own proposals, and to prepare its report.

▼

Committee votes on proposals by letter ballot. If two-thirds approve, report goes forward. Lacking two-thirds approval, report returns to committee.

▼

Report is published for public review and comment. (Report on Proposals - ROP)

▼

Committee meets to act on each public comment received.

▼

Committee votes on comments by letter ballot. If two-thirds approve, supplementary report goes forward. Lacking two-thirds approval, supplementary report returns to committee.

▼

Supplementary report is published for public review. (Report on Comments - ROC).

▼

NFPA membership meets (Annual or Fall Meeting) and acts on committee report (ROP and ROC).

▼

Committee votes on any amendments to report approved at NFPA Annual or Fall Meeting.

▼

Complaints to Standards Council on Association action must be filed within 20 days of the NFPA Annual or Fall Meeting.

▼

Standards Council decides, based on all evidence, whether or not to issue standard or to take other action, including hearing any complaints.

▼

Appeals to Board of Directors on Standards Council action must be filed within 20 days of Council action.

FORM FOR PROPOSALS ON NFPA TECHNICAL COMMITTEE DOCUMENTS

Mail to: Secretary, Standards Council
National Fire Protection Association, 1 Batterymarch Park, Quincy, Massachusetts 02269-9101
Fax No. 617-770-3500

Note: All proposals must be received by 5:00 p.m. EST/EDST on the published proposal-closing date.

If you need further information on the standards-making process, please contact the Standards Administration Department at 617-984-7249.

Date 9/18/93 **Name** John B. Smith **Tel. No.** 617-555-1212

Company _____

Street Address 9 Seattle St., Seattle, WA 02255

Please Indicate Organization Represented (if any) Fire Marshals Assn. of North America

1. a) NFPA Document Title National Fire Alarm Code **NFPA No. & Year** NFPA 72, 1993 ed.

b) Section/Paragraph 1-5.8.1 (Exception No.1)

2. Proposal recommends: (Check one)
- ☐ **new text**
- ☐ **revised text**
- ☒ **deleted text**

FOR OFFICE USE ONLY
Log # _____
Date Rec'd _____

3. Proposal (include proposed new or revised wording, or identification of wording to be deleted): (Note: Proposed text should be in legislative format: i.e., use underscore to denote wording to be inserted (inserted wording) and strike-through to denote wording to be deleted (~~deleted wording~~).

Delete exception.

4. Statement of Problem and Substantiation for Proposal: (Note: State the problem that will be resolved by your recommendation; give the specific reason for your proposal including copies of tests, research papers, fire experience, etc. If more than 200 words, it may be abstracted for publication.)

A properly installed and maintained system should be free of ground faults. The occurrence of one or more ground faults should be required to cause a "trouble" signal because it indicates a condition that could contribute to future malfunction of the system. Ground fault protection has been widely available on these systems for years and its cost is negligible. Requiring it on all systems will promote better installations, maintenance and reliability.

5. ☒ This Proposal is original material. (Note: Original material is considered to be the submitter's own idea based on or as a result of his/her own experience, thought, or research and, to the best of his/her knowledge, is not copied from another source.)

☐ **This Proposal is not original material; its source (if known) is as follows:** _____

Note 1: Type or print legibly in black ink.
Note 2: If supplementary material (photographs, diagrams, reports, etc.) is included, you may be required to submit sufficient copies for all members and alternates of the technical committee.

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John B. Smith
Signature (Required)

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