

NFPA 499

Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas

2004 Edition



NFPA, 1 Batterymarch Park, Quincy, MA 02169-7471
An International Codes and Standards Organization

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This edition of NFPA 499, *Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas*, was prepared by the Technical Committee on Electrical Equipment in Chemical Atmospheres and acted on by NFPA at its November Association Technical Meeting held November 15–19, 2003, in Reno, NV. It was issued by the Standards Council on January 16, 2004, with an effective date of February 5, 2004, and supersedes all previous editions.

This edition of NFPA 499 was approved as an American National Standard on January 16, 2004.

Origin and Development of NFPA 499

The Technical Committee on Electrical Equipment in Chemical Atmospheres began the development of NFPA 497B in 1989. The Technical Committee based the diagrams in this document on various NFPA codes and standards and on the accepted practices of the chemical process industries. This was the first edition of this recommended practice, and it was adopted by the NFPA membership at the 1990 November Technical Meeting.

In 1993, the Technical Committee on Electrical Equipment in Chemical Atmospheres combined the information on group classifications of dusts located in NFPA 497M, *Classification of Gases, Vapors, and Dusts for Electrical Equipment in Hazardous (Classified) Locations*, and the information in NFPA 497B into an expanded version and renamed the document. The table information on dusts was expanded to include CAS numbers for clarity and user-friendliness.

In 2001 the Technical Committee on Electrical Equipment in Chemical Atmospheres entered NFPA 499 into the November 2003 revisions cycle. The 2004 edition has been significantly revised and reorganized for conformance with the 2003 NFPA *Manual of Style*. These organizational and editorial changes enhance the usability of this recommended practice. In addition, editorial changes have been made to the text to harmonize with the requirements of NFPA 70, *National Electrical Code*®.

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

Committee Scope: This Committee shall have primary responsibility for documents on (1) developing data on the properties of chemicals enabling proper selection of electrical equipment for use in atmospheres containing flammable gases, vapors or dusts; (2) making recommendations for the prevention of fires and explosions through the use of continuously purged, pressurized, explosion-proof, or dust-ignition-proof electrical equipment where installed in such chemical atmospheres.

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

Changes other than editorial are indicated by a vertical rule beside the paragraph, table, or figure in which the change occurred. These rules are included as an aid to the user in identifying changes from the previous edition. Where one or more complete paragraphs have been deleted, the deletion is indicated by a bullet (•) between the paragraphs that remain.

A reference in brackets [] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, Annex B lists the complete title and edition of the source documents for both mandatory and nonmandatory extracts. Editorial changes to extracted material consist of revising references to an appropriate division in this document or the inclusion of the document number with the division number when the reference is to the original document. Requests for interpretations or revisions of extracted text should be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex B.

Chapter 1 Administration

1.1 Scope.

1.1.1 This recommended practice applies to those locations where combustible dusts are produced, processed, or handled, and where dust released into the atmosphere or accumulated on surfaces could be ignited by electrical systems or equipment.

1.1.2 This recommended practice provides information on specific combustible dusts whose relevant combustion properties have been sufficiently identified to allow their classification into the groups established by NFPA 70, *National Electrical Code (NEC®)*, for proper selection of electrical equipment in hazardous (classified) locations. The tables of selected combustible materials contained in this document are not intended to be all-inclusive.

1.1.3 This recommended practice also applies to chemical process areas. As used in this document, a chemical process area could be a chemical process plant, or it could be a part of such a plant. A chemical process area could be a part of a manufacturing facility where combustible dusts are produced or used in chemical reactions, or are handled or used in operations such as mixing, coating, extrusion, conveying, drying, and/or grinding.

1.1.4 This recommended practice does not apply to agricultural grain-handling facilities except where powdered grain is used in a chemical reaction or mixture.

1.1.5 This recommended practice does not apply to situations that could involve catastrophic failure of, or catastrophic discharge from, silos, process vessels, pipelines, tanks, hoppers, or conveying or elevating systems.

1.1.6 This recommended practice does not apply to oxygen-enriched atmospheres or pyrophoric materials.

1.2 Purpose.

1.2.1 The purpose of this recommended practice is to provide the user with a basic understanding of the parameters that determine the degree and the extent of the hazardous (classified) location. This recommended practice also provides the user with examples of the applications of these parameters.

1.2.2 Information is provided on specific combustible dusts whose relevant properties determine their classification into groups. This will assist in the selection of special electrical equipment for hazardous (classified) locations where such electrical equipment is required.

1.2.3 This recommended practice is intended as a guide and should be applied with sound engineering judgment. Where all factors are properly evaluated, a consistent area classification scheme can be developed.

1.2.4 This recommended practice is based on the criteria established by Articles 500 and 502 of the *NEC*. Once an area is properly classified, the *NEC* specifies the type of equipment and the wiring methods that shall be permitted to be used.

1.3 Relationship to NFPA Codes and Standards. This recommended practice is not intended to supersede or conflict with the following NFPA standards:

- (1) NFPA 36, *Standard for Solvent Extraction Plants*, 2004 edition.
- (2) NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities*, 2002 edition.
- (3) NFPA 68, *Guide for Venting of Deflagrations*, 2002 edition.
- (4) NFPA 69, *Standard on Explosion Prevention Systems*, 2002 edition.
- (5) NFPA 484, *Standard for Combustible Metals, Metal Powders, and Metal Dusts*, 2002 edition.
- (6) NFPA 654, *Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids*, 2000 edition.
- (7) NFPA 655, *Standard for Prevention of Sulfur Fires and Explosions*, 2001 edition.
- (8) NFPA 664, *Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities*, 2002 edition.

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this recommended practice and should be considered part of the recommendations of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 36, *Standard for Solvent Extraction Plants*, 2004 edition.

NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities*, 2002 edition.

NFPA 68, *Guide for Venting of Deflagrations*, 2002 edition.

NFPA 69, *Standard on Explosion Prevention Systems*, 2002 edition.

NFPA 70, *National Electrical Code*®, 2002 edition.

NFPA 484, *Standard for Combustible Metals, Metal Powders, and Metal Dusts*, 2002 edition.

NFPA 654, *Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids*, 2000 edition.

NFPA 655, *Standard for Prevention of Sulfur Fires and Explosions*, 2001 edition.

NFPA 664, *Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities*, 2002 edition.

2.3 Other Publication.

2.3.1 ASTM Publication. American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM D 3175, *Standard Test Method for Volatile Matter in the Analysis Sample of Coal and Coke*, 1989.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter apply to the terms used in this recommended practice. Where terms are not included, common usage of the terms applies.

3.2 NFPA Official Definitions.

3.2.1 Recommended Practice. A document that is similar in content and structure to a code or standard but that contains only nonmandatory provisions using the word “should” to indicate recommendations in the body of the text.

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

3.3 General Definitions.

3.3.1* Autoignition Temperature (AIT). The minimum temperature required to initiate or cause self-sustained combustion of a solid, liquid, or gas independently of the heating or heated element.

3.3.2 CAS. Chemical Abstract Service.

3.3.3* Combustible Dust. Any finely divided solid material 420 microns or less in diameter (i.e., material passing through a U.S. No. 40 Standard Sieve) that presents a fire or explosion hazard when dispersed.

3.3.4 Combustible Dust, Class II. Class II combustible dusts are divided into Groups E, F, and G.

3.3.4.1 Group E. Atmospheres containing combustible metal dusts, including aluminum, magnesium, and their commercial alloys, or other combustible dusts whose particle size, abrasiveness, and conductivity present similar hazards in the use of electrical equipment.

3.3.4.2 Group F. Atmospheres containing combustible carbonaceous dusts that have more than 8 percent total entrapped volatiles (see ASTM D 3175, *Standard Test Method for Volatile Matter in the Analysis Sample of Coal and Coke*, for coal and coke dusts) or that have been sensitized by other materials so that they present an explosion hazard. Coal, carbon black, charcoal, and coke dusts are examples of carbonaceous dusts.

3.3.4.3 Group G. Atmospheres containing other combustible dusts, including flour, grain, wood flour, plastic, and chemicals.

3.3.5 Combustible Material. A generic term used to describe either a mixture of dust in air, or a hybrid mixture, that may burn, flame, or explode.

3.3.6* Explosion Severity. A measure of the damage potential of the energy released by a dust explosion.

3.3.7 Hybrid Mixture. A mixture of a dust with one or more flammable gases or vapors.

3.3.8 Ignitable Mixture. A combustible material that is within its flammable range.

3.3.9* Ignition Sensitivity. A measure of the ease by which a cloud of combustible dust could be ignited.

Chapter 4 Combustible Dusts

4.1 National Electrical Code® Criteria.

4.1.1 Article 500 of the *NEC* classifies any location in which a combustible material is or can be present in the atmosphere in sufficient concentrations to produce an ignitable mixture.

4.1.2* In a Class II hazardous (classified) location, the combustible material present is a combustible dust.

4.1.3 Class II is further subdivided into either Class II, Division 1 or Class II, Division 2 as follows.

4.1.3.1 Class II, Division 1. A Class II, Division 1 location is a location

- (1) In which combustible dust is in the air under normal operating conditions in quantities sufficient to produce explosive or ignitable mixtures, or
- (2) Where mechanical failure or abnormal operation of machinery or equipment might cause such explosive or ignitable mixtures to be produced, and might also provide a source of ignition through simultaneous failure of electric equipment, through operation of protection devices, or from other causes, or
- (3) In which combustible dusts of an electrically conductive nature may be present in hazardous quantities. [70:500.5(C)(1)]

4.1.3.2 Class II, Division 2. A Class II, Division 2 location is a location

- (1) Where combustible dust is not normally in the air in quantities sufficient to produce explosive or ignitable mixtures, and dust accumulations are normally insufficient to

interfere with the normal operation of electrical equipment or other apparatus, but combustible dust may be in suspension in the air as a result of infrequent malfunctioning of handling or processing equipment and

- (2) Where combustible dust accumulations on, in, or in the vicinity of the electrical equipment may be sufficient to interfere with the safe dissipation of heat from electrical equipment or may be ignitable by abnormal operation or failure of electrical equipment. [70:500.5(C)(2)]

4.1.4 The intent of Article 500 of the *NEC* is to prevent the use of electrical equipment and systems in hazardous (classified) locations that would ignite an ignitable dust cloud or layer.

4.1.5 Electrical installations within hazardous (classified) locations can use various protection techniques. No single protection technique is best in all respects for all types of equipment used in a chemical plant.

4.1.5.1 Dust-ignitionproof electrical equipment, electrical equipment protected by pressurizing, and intrinsically safe electrical equipment are applicable to both Division 1 and Division 2 locations.

4.1.5.2 Other dusttight equipment enclosures, as specified in Article 502 of the *NEC*, are permitted in Division 2 locations.

4.1.5.3 Electrical equipment protected by pressurizing and intrinsically safe electrical equipment are applicable to both Division 1 and Division 2 locations.

4.1.5.4 Equipment and wiring suitable for Class I, Division 1 locations are not required and might not be acceptable in Class II locations.

4.1.6 Electrical equipment in Division 1 locations is enclosed in a manner that will exclude ignitable amounts of dusts or will not permit arcs, sparks, or heat generated or liberated inside the enclosures to cause ignition of dust accumulations or of atmospheric dust suspensions in the vicinity of the equipment.

4.1.7 Electrical equipment in Division 2 locations is designed so that normal operation of the electrical equipment does not provide a source of ignition.

4.1.7.1 Protection against ignition during electrical breakdown is not provided. However, electrical breakdowns are sufficiently rare that the chances of one occurring simultaneously with accidental release of an ignitable mixture are extremely remote.

4.1.7.2 Arcing and sparking devices are permitted only if suitably enclosed or if the sparks are of insufficient energy to ignite the mixture.

4.1.7.3 Electrical installations in Division 2 locations could be designed with dusttight enclosures or other equipment enclosures as specified in Article 502 of the *NEC*.

4.1.8 Where flammable gases or flammable vapors, and combustible dusts are present, electrical equipment and wiring suitable for simultaneous exposure to both Class I and Class II conditions are required.

4.1.9 Where Group E dusts are present in hazardous quantities, there are only Division 1 locations. The *NEC* does not recognize any Division 2 locations for such dusts.

4.1.10 Factors such as corrosion, weather, maintenance, equipment standardization and interchangeability, and possible process changes or expansion frequently dictate the use

of special enclosures or installations for electrical systems. However, such factors are outside the scope of this recommended practice.

4.1.11 For the purpose of this recommended practice, locations not classified as Division 1 or Division 2 are “unclassified” locations.

4.2 Behavior of Combustible Dusts.

4.2.1 Dispersion and Explosion.

4.2.1.1 Dust discharged or leaking from equipment into the atmosphere is acted on by gravity and will settle relatively quickly, depending on the size of particles, the internal pressure propelling the particles out of the equipment, and any air currents in the vicinity.

4.2.1.1.1 The result is a layer of dust that settles on horizontal surfaces below the leak opening in a radial or elliptical manner, depending on the location of the opening on the equipment.

4.2.1.1.2 The depth of the layer will be greatest under and close to the source and will taper off to the outside of the circle or ellipse.

4.2.1.1.3 The greater the height of the dust source above the surface, the greater the area covered.

4.2.1.1.4 The internal pressure in the equipment will likewise increase the area covered.

4.2.1.1.5 The size of the leak opening and the elapsed time of emission also affect the quantity of dust on the surface.

4.2.1.1.6 Some dusts have particles that are extremely fine and light (i.e., have a low specific particle density). Such particles could behave more like vapors than like dusts and could remain in suspension for long periods. These particles could travel far from the emitting source and collect on surfaces above the source.

4.2.1.1.7 Although horizontal surfaces accumulate the largest quantities of dust, vertical surfaces could in some instances also accumulate significant quantities.

4.2.1.2 Although a dust cloud will ignite and explode readily in the presence of an open ignition source, dust layers, if undisturbed and not in direct contact with the ignition source, will not explode. However, if a small amount of dust is dispersed in the air at the ignition source, a small explosion will occur. The pressure wave from this explosion blows the dust layer into the air, and a larger explosion then takes place. It is often this secondary explosion that does the most damage.

4.2.2* Hybrid Mixtures. The presence of the flammable gas or vapor, even at concentrations less than their lower flammable limit (LFL), will not only add to the violence of the dust-air combustion but will drastically reduce the ignition energy. This situation is encountered in certain industrial operations, such as fluidized bed dryers and pneumatic conveying systems for plastic dusts from polymerization processes where volatile solvents are used. In such cases, electrical equipment should be specified that is suitable for simultaneous exposure to both the Class I (flammable gas) and the Class II (combustible dust).

4.3* Conditions Necessary for Ignition of a Combustible Dust.

4.3.1 In a Class II location, one of the following sets of conditions must be satisfied for ignition by the electrical installation.