Tentative Interim Amendment

NFPA® 654

Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids

2020 Edition

Reference: 1.4.2(new), A.1.4.2(new), 2.4, 3.3.7, A.3.3.7, Various new definitions in 3.3, 8.4.3.7 thru 8.4.3.9, 9.3.13.1.1.2(4)(e) and Annex, 9.4.2, A.9.4.2.2, Table A.9.4.2.2, A.3.3.8, A.9.3.12.2.1, A.9.4.3.6.6, A.9.4.8.2, G.1.2.6, and G.3
TIA 20-1
(SC 22-4-12 / TIA Log #1620)

Pursuant to Section 5 of the NFPA *Regulations Governing the Development of NFPA Standards*, the National Fire Protection Association has issued the following Tentative Interim Amendment to NFPA 654, *Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids*, 2020 edition. The TIA was processed by the Technical Committee on Handling and Conveying of Dusts, Vapors, and Gases, and the Correlating Committee on Combustible Dusts, and was issued by the Standards Council on April 12, 2022, with an effective date of May 2, 2022.

1. Add a new 1.4.2 and associated Annex material to read as follows; and renumber existing paragraphs accordingly:

1.4.2* This standard shall apply to the storage or use of ignitible fibers/flyings, specifically with regard to fire hazards.

A.1.4.2 Ignitible fibers/flyings, as defined in *NFPA 70* and NFPA 499, do not present a flash-fire-hazard or explosion hazard and are not included in the definition of *combustible dust* in this standard. Ignitible fibers/flyings present a fire hazard, so locations are classified differently and the electrical installation includes additional restrictions compared to combustible fibers/flyings.

2. Revise section 2.4 to read as follows:

2.4 References for Extracts in Mandatory Sections. …

NFPA 499, *Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas*, 2021 edition.

…

3. Revise 3.3.7, and associated Annex A.3.3.7 to read as follows:

3.3.7* Combustible Dust. A finely divided combustible particulate solid, including combustible fibers/flyings, that presents a flash-fire hazard or explosion hazard when suspended in air or the process-specific oxidizing medium over a range of concentrations. [**652,** 2019]

A.3.3.7 Combustible Dust. The term *combustible dust* when used in this standard includes powders, fines, fibers, flyings, etc. Combustible fibers/flyings are specifically mentioned because, while the hazard is the same, *NFPA 70* and NFPA 499 treat combustible dust and combustible fibers/flyings separately in regards to establishing hazardous (classified) locations and specifying the electrical installation. Ignitible fibers/flyings, as defined in *NFPA 70* and NFPA 499, do not present a flash-fire or explosion hazard and are not included in the definition of combustible dust in this standard. Ignitible fibers/flyings present a fire hazard, so locations are classified differently and the electrical installation includes additional restrictions compared to combustible fibers/flyings. [**652,** 2019]

This definition also includes consideration of a process-specific oxidizing medium other than air. A larger particle size material might not present a hazard in air, yet could present a hazard in an atmosphere with increased oxygen concentration. Similarly, a combustible metal might still present a hazard in an atmosphere typically considered inert, such as CO_2 or nitrogen. [**652,** 2019]

Dusts traditionally were defined as material 420 µm or smaller (i.e., capable of passing through a U.S. No. 40 standard sieve). For consistency with other standards, 500 µm (i.e., capable of passing through a U.S. No. 35 standard sieve) is now considered an appropriate size criterion. Particle surface area-to-volume ratio is a key factor in determining the rate of combustion. Combustible particulate solids with the smallest ~~a minimum~~ dimension more than 500 µm generally have a surface-to-volume ratio that is too small to pose a deflagration hazard. ~~Flat platelet-shaped particles, flakes, or fibers~~ Fibers/flyings with lengths that are large compared to their diameter or thickness usually do not pass through a 500 µm sieve, yet could still pose a deflagration hazard. Many particulates accumulate electrostatic charge in handling, causing them to attract each other, forming agglomerates. Often, agglomerates behave as if they were larger particles, yet when they are dispersed they present a significant hazard. Therefore, it can be inferred that any particulate that has the smallest ~~a minimum~~ dimension less than or equal to 500 µm could behave as a combustible dust if suspended in air or the process-specific oxidizer. If the smallest ~~minimum~~ dimension of the particulate is greater than 500 µm, it is unlikely that the material would be a combustible dust, as determined by test. The determination of whether a sample of combustible material presents a flash-fire or explosion hazard could be based on a screening test methodology such as provided in the ASTM E1226, *Standard Test Method for Explosibility of Dust Clouds*. Alternatively, ~~and~~ a standardized test method such as ASTM E1515, *Standard Test Method for Minimum Explosible Concentration of Combustible Dusts*, could be used to determine dust explosibility. Chapter 5 of NFPA 652 has additional information on testing requirements. [**652,** 2019]

…

4. In 3.3 add new definitions for Combustible Fibers/Flyings, Ignitible Fibers/Flyings, and their associated Annex material to read as follows:

3.3.x* Combustible Fibers/Flyings. Fibers/flyings, where any dimension is greater than 500 µm in nominal size, which can form an explosible mixture when suspended in air at standard atmospheric pressure and temperature. [**499,** 2021]

A.3.3.x Combustible Fibers/Flyings. Section 500.5 of *NFPA 70* defines a Class III location. Combustible fibers/flyings can be similar in physical form to ignitible fibers/flyings and protected using the same electrical equipment installation methods. Examples of fibers/flyings include flat platelet-shaped particulate, such as metal flake, and fibrous particulate, such as particle board core material. If the smallest dimension of a combustible material is greater than 500 µm, it is unlikely that the material would be combustible fibers/flyings, as determined by test. Finely divided solids with lengths that are large compared to their diameter or thickness usually do not pass through a 500 µm sieve, yet when tested could potentially be determined to be explosible. [**499,** 2021]

The typical test methods for evaluating an explosible mixture are ASTM E1226, *Standard Test Method for Explosibility of Dust Clouds*, ISO 6184-1, *Explosion protection systems — Part 1: Determination of explosion indices of combustible dusts in air*, or ISO/IEC/UL 80079-20-2, *Explosive atmospheres — Part 20-2: Material characteristics — Combustible dusts test methods*, for procedures for determining the explosibility of dusts. A material that is found to not present an explosible mixture could still be an ignitible fiber/flying, as defined in 3.3.y. Historically, the explosibility condition has been described as presenting a flash fire or explosion hazard. It could be understood that the potential hazard due to the formation of an explosible mixture when suspended in air at standard atmospheric pressure and temperature would include ignition. [**499,** 2021]

While this standard includes larger yet still hazardous materials as a subset of combustible dust, *NFPA 70* addresses them separately for purposes of defining the appropriate electrical classification. Although the hazard is the same when dispersed in a cloud, the electrical installation to prevent ingress of combustible fibers/flyings is different.

5. In 3.3 add new definition for Ignitible Fibers/Flyings, and associated Annex material to read as follows:

3.3.y* Ignitible Fibers/Flyings. Fibers/flyings where any dimension is greater than 500 µm in nominal size, which are not likely to be in suspension in quantities to produce an explosible mixture, but could produce an ignitible layer fire hazard. [**499,** 2021]

A.3.3.y Ignitible Fibers/Flyings. Section 500.5 of *NFPA 70* defines a Class III location as one where ignitible fibers/flyings are present, but not likely to be in suspension in the air in quantities sufficient to produce ignitible mixtures. This description addresses fibers/flyings that do not present a flash-fire hazard or explosion hazard by test. This could be because those fibers/flyings are too large or too agglomerated to be suspended in air in sufficient concentration, or at all, under typical test conditions. Alternatively, this could be because they burn so slowly that, when suspended in air, they do not propagate combustion at any concentration. [**499,** 2021]

In this document the zone classification system includes ignitible fibers/flyings as a fire hazard in a layer, which is not addressed in the IEC zone system (see IEC 60079-10-2, *Explosive atmospheres — Part 10-2: Classification of areas —*

Explosive dust atmospheres). Where these are present, the user could also consider installation in accordance with Article 503 of *NFPA 70*. [**499,** 2021]

6. Revise 8.4.3.7, 8.4.3.8, 8.4.3.9, and associated Annexes A.8.4.3.7 and A.8.4.3.8 to read as follows:

8.4.3.7* Portable vacuum cleaners that meet the following minimum requirements shall be permitted to be used to collect combustible particulate solids in unclassified ~~(general purpose) areas~~ locations:
(1) Materials of construction shall comply with 9.3.13.2 and 9.4.3.2.
(2) Hoses shall be conductive or static dissipative.
(3) All conductive components, including wands and attachments, shall be bonded and grounded.
(4) Dust-laden air shall not pass through the fan or blower.
(5) Electrical motors shall not be in the dust-laden air stream unless listed for Class II or Class III, Division 1, as appropriate, or Zone 20 or Zone 21 locations.
(6)* When liquids or wet material are picked up by the vacuum cleaner, paper filter elements shall not be used.
(7) Vacuum cleaners used for metal dusts shall meet the requirements of NFPA 484.
8.4.3.8* In combustible dust hazardous (classified) ~~Class II electrically classified (hazardous)~~ locations, vacuum cleaners shall be listed for the purpose and location or shall be a fixed-pipe suction system with remotely located exhauster and AMS installed in conformance with 9.3.13 and shall be suitable for the dust being collected.
8.4.3.9 Where flammable vapors or gases are present, vacuum cleaners shall be listed for both flammable vapors or gases and combustible dust ~~Class I and Class II~~ hazardous (classified) locations.

A.8.4.3.7 The intention of this requirement is to provide specifications for vacuum cleaners that could be used to remove incidental amounts of combustible dusts from unclassified areas in order to maintain the unclassified area designation.

If a large quantity of material is spilled in an unclassified area, the bulk material should be collected by sweeping, by shoveling, or with a portable vacuum cleaner listed as suitable for combustible dust hazardous (classified) ~~Class II~~ locations. Vacuum cleaners meeting the requirements in 8.4.3.2 can be used to clean up residual material after the bulk of the spill has been collected.

These requirements for portable vacuum cleaners also should be applied to the use of vacuum trucks for combustible dust. However, there can be other safety issues concerning vacuum truck applications that are not covered within this section. Given that this application might represent a change from normal procedures, operators should also consider the guidance found in conducting a management of change evaluation.

A.8.4.3.8 The Committee is not aware of vendors providing equipment listed for Class III hazardous (classified) ~~electrically classified (hazardous)~~ locations. A common practice is to use equipment listed for combustible dust hazardous (classified) locations ~~Class II~~ in areas classified as Class III.

7. Revise 9.3.13.1.1.2(4)(e) and associated Annex A.9.3.13.1.1.2(4)(e) to read as follows:

9.3.13.1.1.2* The requirement of 9.3.13.1.1.1 shall not apply to…
(4)* Enclosureless AMSs meeting all the following criteria shall be permitted to be used:
…
(e)* The fan motor is suitable for Class II or Class III, Division 2, as appropriate, or Zone 22~~, or Class III, as appropriate~~.
…
A.9.3.13.1.1.2(4)(e) *NFPA 70*, in 502.125(B), states: In Class II, Division 2, locations, motors, generators, and other rotating electrical equipment shall be totally enclosed non ventilated, totally enclosed pipe-ventilated, totally enclosed water-air-cooled, totally enclosed fan-cooled or dust-ignition proof for which maximum full-load external temperature shall be in accordance with 500.8(D)(2) of *NFPA 70* for normal operation when operating in free air (not dust blanketed) and shall have no external openings. *NFPA 70* does not include an equivalent description of suitable zone-rated equipment.

8. Revise Section 9.4.2 and associated Annex A.9.4.2.2 and Table A.9.4.2.2 to read as follows:

9.4.2 Electrical Equipment.
9.4.2.1 All electrical equipment and installations shall comply with the requirements of *NFPA 70*.
9.4.2.2* ~~In local areas of a plant where a hazardous quantity of dust accumulates or is suspended in air, the area shall be classified and all electrical equipment and installations in those local areas shall comply with Article 502 or Article 503 of *NFPA 70* , as applicable.~~ The identification of the possible presence and extent of hazardous (classified) locations shall be made based on the criteria in Article 500 or Article 506 of *NFPA 70*.
9.4.2.3 Hazardous (classified) ~~areas~~ locations that are identified in accordance with 9.4.2.2 shall be documented, and such documentation shall be permanently maintained on file for the life of the facility.
A.9.4.2.2 Refer to NFPA 499. See also Table A.9.4.2.2 ~~(Note: Table A.9.4.2.2 does not apply to Class III materials)~~.

Threshold dust accumulation that would require electrically classified equipment is tied to the likelihood of the accumulations and the housekeeping policy as shown in Table A.9.4.2.2 provided as guidance. Dust accumulations present hazards due to potential overheating and failure of the covered equipment or overheating of the dust layer resulting in a fire, as well as potential to be put into suspension as a cloud resulting in a flash fire or explosion. However, neither ~~the~~ *NFPA 70* nor NFPA 654 provides a mandatory prescription for the user to decide how much dust accumulation should trigger the use of classified equipment.

~~When evaluating how much dust is too much for electrical equipment, several factors need to be considered. *NFPA 70* provides Class II, Division 1 and Division 2 criteria in article 500. It states that a Division 2 location is one of the following:~~

~~(1) A location in which combustible dust due to abnormal operations might be present in the air in quantities sufficient to produce explosive or ignitible mixtures~~

~~(2) A location in which combustible dust accumulations are present but are normally insufficient to interfere with the normal operation of electrical equipment or other apparatus but could, as a result of infrequent malfunctioning of handling or processing equipment, become suspended in the air~~

~~(3) A location in which combustible dust accumulations on, in, or in the vicinity of the electrical equipment could be sufficient to interfere with the safe dissipation of heat from electrical equipment or could be ignitible by abnormal operation or failure of electrical equipment~~

~~The first two criteria deal with the potential for presence of a dust cloud in the location under abnormal conditions. The third criterion deals with the potential for ignition of a dust accumulation by unprotected hot surfaces, either internal or external to the electrical equipment under normal as well as abnormal conditions.~~

~~The first and second criteria are process related, and the third criterion is directly related to the layer thickness on the electrical equipment.~~

The likelihood of a dust to be heated to ignition temperature when accumulated on the outside of an electrical enclosure or a piece of electrical equipment is a function of the thickness, thermal conductivity, density, and combustion chemistry of the dust layer as well as the fractional coverage of the equipment's heat dissipation area and the time it remains on the heated equipment.

Both NFPA 654 and NFPA 499 recognize early ignition possibilities due to dehydration and carbonization phenomena but do not offer any methods to evaluate this potential. The appropriate electrical equipment for a given dust is that equipment designed with a maximum surface temperature, designated by the T-code, less than the lower of the layer or cloud ignition temperature of the specific dust. The layer ignition temperature can be determined according to ASTM E2021, *Standard Test Method for Hot-Surface Ignition of Dust Layers*, using at least a 1⁄2 in. (13 mm) layer thickness. This is greater than the 1⁄8 in. (~~3.2~~ 3.0 mm) nominal dust layer establishing a Division 1 or Zone 20 or 21 hazardous (classified) ~~area~~ location per NFPA 499, thus providing a safety factor. NFPA 499 also establishes that a Division 2 or Zone 22 hazardous (classified) ~~area~~ location would exist when the dust layer prevents clearly discerning the underlying floor color. Given that dust layers tend to be thicker on the upward-facing surfaces of equipment while heat dissipation area is more evenly distributed, it can be seen that this is a significantly conservative approach.

Table A.9.4.2.2 Guidance for Area Electrical Classification

Depth of Dust Accumulation (in.)	Frequency	Housekeeping Requirement	Area Electrical Classification
Negligible[a]	N/A	N/A	Unclassified (general purpose)
Negligible to <1/32[b]	Infrequent[c]	Clean up during same shift~~.~~	Unclassified (general purpose)
Negligible to <1/32[b]	Continuous/frequent[d]	Clean as necessary to maintain an average accumulation below 1/64 in.[e]	Unclassified; however, electrical enclosures should be dusttight[f,g]
1/32 to 1/8	Infrequent[c]	Clean up during same shift~~.~~	Unclassified; however, electrical enclosures should be dusttight[f,g]
1/32 to 1/8	Continuous/frequent[d]	Clean as necessary to maintain an average accumulation below 1/16 in.	Class II or Class III, Division 2 or Zone 22
>1/8	Infrequent[c]	Immediately shut down and clean~~.~~	Class II or Class III, Division 2 or Zone 22

>1/8	Continuous/frequent[d]	Clean at frequency appropriate to minimize accumulation.	Class II or Class III, Division 1 or Zone 20 or 21

~~Notes:~~
~~(1) Note:~~ For SI units, 1 in. = 25.4 mm.
~~(2) This table does not apply to Class III materials~~. Note: Where the combustible material is anticipated to be solely combustible fibers/flyings, installation in accordance with Class III or Zone Group IIIA is suitable. Where the combustible material is anticipated to be either combustible dust with particle size less than 500 µm or a mixture with combustible fibers/flyings, installation in accordance with Class II or Zone Group IIIB is appropriate.

[a]Surface color just discernible under the dust layer.
[b] 1⁄32 in. is approximately the thickness of a typical paper clip.
[c]Episodic release of dust occurring not more than about two or three times per year.
[d]Episodic release of dust occurring more than about three times per year or continuous release resulting in stated accumulation occurring in approximately a 24-hour period.
[e]It has been observed that a thickness of about 1⁄64 in. of a low-density dust is sufficient to yield a small puffy cloud with each footstep.
[f]For example, National Electrical Manufacturers Association (NEMA) 12 or better. Note~~:~~ ~~O~~ordinary equipment that is not heat producing, such as junction boxes, can be significantly sealed against dust penetration by the use of silicone-type caulking. This can be considered in areas where fugitive dust is released at a slow rate and tends to accumulate over a long period of time.
[g]Guidance to be applied for existing facilities. For new facilities, it is recommended that the electrical classification be at least Class II or Class III, depending on the material form, Division 2 or Zone 22.

9. Add new text to the end of Annex A.3.3.8 to read as follows:

A.3.3.8 Combustible Particulate Solid…

For purposes of determining appropriate electrical installation requirements for combustible particulate solids, NFPA 499 has defined three material subgroups that can warrant establishing hazardous (classified) locations. Combustible dusts, per NFPA 499, are materials with a particle size less than 500 µm that can propagate a deflagration when suspended in a cloud, as determined by test. Combustible fibers/flyings are larger than 500 µm in at least one dimension, yet can still propagate a deflagration in a cloud. Both of these first two subgroups present flash-fire or explosion hazards when suspended in a cloud, as well as fire hazards when in a layer. Ignitible fibers/flyings are larger than 500 µm in at least one dimension, but either are too large or too agglomerated to suspend in the typical test or do not propagate a deflagration in a cloud. Ignitible fibers/flyings do not present a flash-fire or explosion hazard, yet still present a fire hazard when in a layer. All three of these subgroups defined in NFPA 499 are included in the term *combustible particulate solid* as defined and used in NFPA 652. Combustible fibers/flyings as defined in NFPA 499 are included in the term *combustible dust* as used and defined in NFPA 652. [**652,** 2019]

NFPA 70 provides different installation requirements for each of these three material subgroups. Materials smaller than 500 µm require more stringent dust exclusion designs (i.e., Class II or Zone Group IIIB) than materials larger than 500 µm (i.e., Class III or Zone Group IIIA). The exception to this is combustible metals, where both combustible metal dust and combustible metal fibers/flyings require Class II or Zone Group IIIC installations. Ignitible fibers/flyings additionally require lower maximum surface temperatures than combustible fibers/flyings for certain electrical equipment subject to overload conditions. When a hazardous (classified) location is established to address the presence of more than one of the three subgroups, the more stringent electrical installation requirements should be applied. [**652,** 2019]

10. Revise Annex A.9.3.12.2.1 to read as follows:

A.9.3.12.2.1 The Committee is aware of installations of AMDs (electrical motor and impeller) inside the clean-air plenum of AMSs. Standard duty AMDs are not suitable for such service. Because of the potential for failure of the filter medium or other malfunction, the clean-air side of air-material separators should be considered as at least a Class II, Division 2 or Zone 22~~,~~ location with regard to proper installation of electrical equipment. NFPA 91 also addresses AMD materials of construction and clearances, including specific requirements where combustible materials could be present.

11. Revise Annex A.9.4.3.6.6 to read as follows:

A.9.4.3.6.6 Table A.9.4.3.6.6 and Figure A.9.4.3.6.6 provide guides for the selection and use of FIBCs based on the MIE of product contained in the FIBC and the nature of the atmosphere surrounding it. While Table A.9.4.3.6.6 indicates division locations, equivalent zone locations are also included. Class I, Division Group C/D is equivalent to Zone Group IIA/IIB. Class II, Division 1 and 2 is equivalent to Zone 20/21/22.

12. Revise Annex A.9.4.8.2 to read as follows:

A.9.4.8.2 Diesel-powered front-end loaders suitable for use in hazardous (classified) locations have not been commercially available. The following provisions can be used to reduce the fire hazard from diesel-powered front-end loaders used in ~~Class II~~ combustible dust ~~hazardous~~ areas, as defined in Articles 500 and 506 of *NFPA 70*:

(1) Only essential electrical equipment should be used, …

13. Revise section G.1.2.6 to read as follows:

G.1.2.6 IEC Publications. …

ISO/IEC 80079-20-2:2016, *Explosive atmospheres — Part 20-2: Material characteristics — Combustible dusts test methods*, 2016.

14. Revise section G.3 to read as follows:

G.3 References for Extract in Informational Sections.

…

NFPA 499, *Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas*, 2021 edition.

…

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