

## NFPA 654-2006

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

TIA Log No. 1002

Reference: 6.1, 6.2.3, 11.2.3, and A.6.1.1.1

Comment Closing Date: October 13, 2010

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1. Revise 6.1 to read as follows:

**6.1 General.** The provisions of this section shall apply to the overall design of systems that handle combustible particulate solids.

**6.1.1\*** Those portions of the process and facility where a dust deflagration hazard exists shall be protected from the effects of dust deflagrations in accordance with Sections 6.2, 6.3, and 6.4 and Chapter 7.

**6.1.1.1\*** A dust deflagration hazard shall be deemed to exist where dust clouds of a hazardous concentration exist or where the total dust accumulation on all surfaces exceeds the equivalent of the permissible layer depth of 1/32 in. (0.8 mm) over an area determined in accordance with one of the following options:

(1) For buildings or rooms with footprint areas smaller than 20,000 ft<sup>2</sup> (1860 m<sup>2</sup>), the permissible area is 5% of the building/room footprint area

(2) For buildings or rooms with footprint areas greater than or equal to 20,000 ft<sup>2</sup> (1860 m<sup>2</sup>), the permissible area is 1,000 ft<sup>2</sup> (93 m<sup>2</sup>).

**6.1.1.2** For materials with bulk density less than 75 lb/ft<sup>3</sup> (1200 kg/m<sup>3</sup>), the permissible layer depth can be increased according to equation 6.1.1.2.

$$\text{Permissible Layer Depth (in.)} = \frac{(1/32\text{in.})(75\text{ lb/ft}^3)}{\text{Bulk Density (lb/ft}^3)} \quad \text{Eqn 6.1.1.2}$$

**6.1.1.3** Dust accumulation amounts shall reflect the conditions that exist just prior to routinely scheduled cleaning in accordance with Chapter 8.

**6.1.1.4** An explosion hazard shall be deemed to exist in enclosed process equipment where both the following conditions are possible:

(1) combustible dust is present in sufficient quantity to cause enclosure rupture if the dust is suspended and ignited.

(2) A means of suspending the dust is present.

*No change to paragraphs 6.1.2, 6.1.3, 6.1.4, 6.1.5 and 6.1.6.*

**6.1.7** Personnel exposed to a dust deflagration hazard shall be protected in accordance with 11.2.3.

2. Revise 6.2.3 to read as follows:

### 6.2.3 Use of Separation.

**6.2.3.1\*** ~~When separation is used to limit the fire or dust explosion deflagration hazard area, the hazardous area shall include areas where dust accumulations exceed in. (0.8 mm) or areas where dust clouds of a hazardous concentration exist, unless otherwise permitted by 6.2.3.3.~~

**6.2.3.2** ~~The requirements of 6.2.3.1 shall not apply to dust accumulations with a bulk density less than 75 lb/ft<sup>3</sup> (1200 kg/m<sup>3</sup>), where the allowable thickness can be prorated upward by the following equation:~~

$$\text{Allowable thickness (in.)} = \frac{(1/32)(75)}{\text{bulk density (lb/ft}^3)}$$

### **6.2.3.3 Distance.**

**6.2.3.3.1** The required separation distance between the hazardous area identified in 6.2.3.1 6.1.1 and surrounding exposures shall be determined by the following:

- (1) Engineering evaluation that addresses the properties of the materials
- (2) Type of operation
- (3) Amount of material likely to be present outside the process equipment
- (4) Building design
- (5) Nature of surrounding exposures

**6.2.3.3.2 6.2.3.2** In no case shall the distance be less than 30 ft (9 m).

**6.2.3.4 6.2.3.3** When separation is used, housekeeping, fixed dust collection systems employed at points of release, and compartmentation shall be permitted to be used to limit the extent of the hazardous area.

3. Add a new subsection 11.2.3 to read as follows:

**11.2.3** Operating and maintenance procedures shall address personal protective equipment (PPE) for tasks involving processing or handling of combustible dust according to the following:

- a. PPE shall include flame-resistant garments in accordance with the workplace hazard assessment required by NFPA 2113; and
- b. Where a dust deflagration hazard exists, flame-resistant garments shall be required for all exposed personnel.

4. Add a new annex item to read as follows:

**A.6.1.1.1** The dust accumulation is a product of the actual layer depth and the total area of accumulation. The limitation in 6.1.1.1 is expressed as a product of the permissible layer depth and a percentage of the footprint area of the room or building. Within a single room or building, areas of significant dust accumulation could be contiguous or separated. When they are separated, the separate accumulations are combined and compared to the permissible dust accumulation. The permissible layer depth can be increased for a specific dust when the bulk density is known.

One way to determine if the actual dust accumulation is sufficient to result in a dust deflagration hazard is to ratio the actual dust accumulation to the permissible dust accumulation. In this ratio the permissible dust accumulation from paragraph 6.1.1.1 is the denominator. If the ratio exceeds 1, then a dust deflagration hazard exists in the subject building or room.

Surfaces where dust could settle include floors, beam flanges, piping, ductwork, equipment, suspended ceilings, light fixtures and walls. Particular attention should be given to dust adhering to walls and vertical surfaces as it can be easily dislodged.

Alternative dust layer thickness criteria can be determined from dust deflagration parameters in accordance with Chapter 5.

Example 1: A single floor accumulation area in a portion of a 25 ft by 40 ft room. The dust has a bulk density of 75 lb/ft<sup>3</sup>. For rooms less than 20,000 ft<sup>2</sup>, the limitation is based on a maximum of 5% of the footprint area.

Permissible Layer Depth = 1/32 inch

Room footprint area = 1000 ft<sup>2</sup>

Actual accumulation area = 100 ft<sup>2</sup>

Average layer depth in accumulation area = 1/32 inch

$$\text{Ratio} = \frac{100 \text{ ft}^2 \cdot \left(\frac{1}{32}\right) \text{ inch}}{0.05 \cdot 1000 \text{ ft}^2 \cdot \left(\frac{1}{32}\right) \text{ inch}} = \frac{3.1}{1.6} > 1$$


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Since the ratio is greater than 1, a dust deflagration hazard exists in the room.

Example 2: A single floor accumulation area in a small portion of a 25 ft. by 40 ft. room. The dust has a bulk density of 75 lb/ft<sup>3</sup>.

Permissible Layer Depth = 1/32 inch

Room footprint area = 1000 ft<sup>2</sup>

Actual accumulation area = 20 ft<sup>2</sup>

Average layer depth in accumulation area = 1/16 inch

$$\text{Ratio} = \frac{20 \text{ ft}^2 \cdot \left(\frac{1}{16}\right) \text{ inch}}{0.05 \cdot 1000 \text{ ft}^2 \cdot \left(\frac{1}{32}\right) \text{ inch}} = \frac{1.3}{1.6} \leq 1$$


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Since the ratio is less than or equal to 1, a dust deflagration hazard does not exist in the room. When the actual accumulation area is less than 5% of the room footprint, the layer thickness can be greater without resulting in a dust deflagration hazard.

Example 3: A single floor accumulation area in a portion of a 25 ft by 40 ft room. The dust has a bulk density of 30 lb/ft<sup>3</sup>. First adjust the Permissible Layer Depth for the reduced bulk density.

$$\text{Permissible Layer Depth} = \frac{\left(\frac{1}{32}\right) \text{ inch} \cdot 75 \text{ lb/ft}^3}{30 \text{ lb/ft}^3} = 0.078 \text{ inch} \cong \left(\frac{1}{16}\right) \text{ inch}$$


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Room footprint area = 1000 ft<sup>2</sup>

Actual accumulation area = 100 ft<sup>2</sup>

Average layer depth in accumulation area = 1/32 inch

$$\text{Ratio} = \frac{100 \text{ ft}^2 \cdot \left(\frac{1}{32}\right) \text{ inch}}{0.05 \cdot 1000 \text{ ft}^2 \cdot 0.078 \text{ inch}} = \frac{3.1}{3.9} \leq 1$$


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Since the ratio is less than or equal to 1, a dust deflagration hazard does not exist in the room. A dust with a bulk density less than the basis 75 lb/ft<sup>3</sup> can accumulate to 1/32 inch layer depth in more than 5% of the room footprint area and still not present a dust deflagration hazard.

Example 4: Multiple floor level and elevated accumulation areas with different layer depths for each area. The room is 100 ft by 100 ft. For rooms less than 20,000 ft<sup>2</sup>, the limitation is based on a maximum of 5% of the footprint area. The dust has a bulk density of 30 lb/ft<sup>3</sup>. First adjust the permissible layer depth for the reduced bulk density.

$$\text{Permissible Layer Depth} = \frac{\left(\frac{1}{32}\right) \text{ inch} \cdot 75 \text{ lb/ft}^3}{30 \text{ lb/ft}^3} = 0.078 \text{ inch} \cong \left(\frac{1}{16}\right) \text{ inch}$$


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Room footprint area = 10000 ft<sup>2</sup>

**Table A.6.1.1.1 Multiple Accumulation Areas for Example 4**

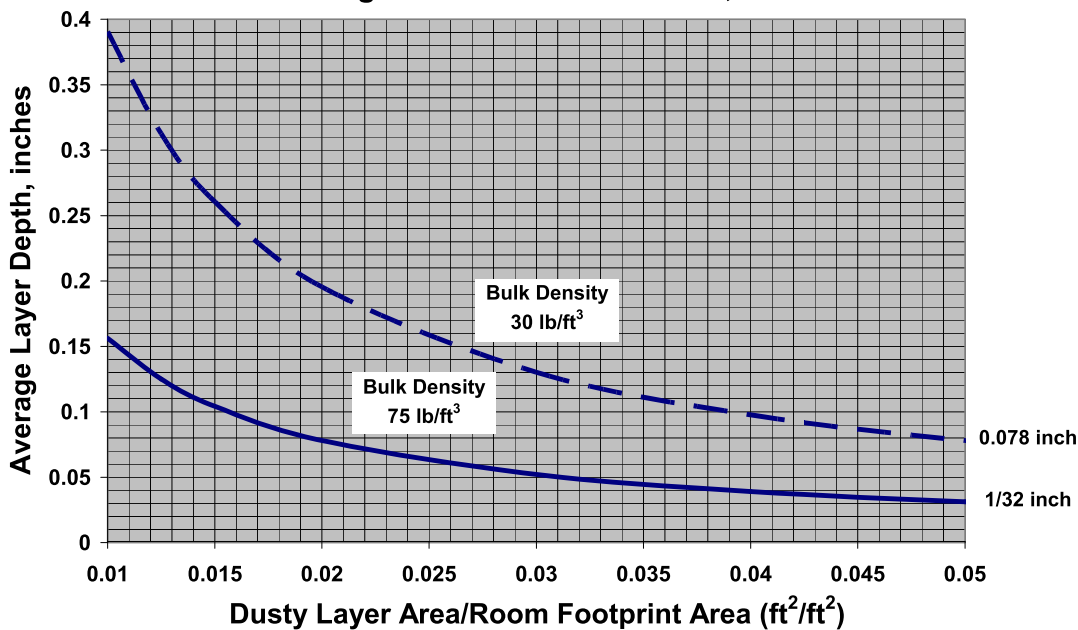
Accumulation Location	Accumulation Area	Average Layer Depth
Floor	50 ft <sup>2</sup>	1/16 inch
Beam Surfaces	500 ft <sup>2</sup>	1/32 inch
Equipment Surfaces	100 ft <sup>2</sup>	1/8 inch

$$\text{Ratio} = \frac{50 \text{ ft}^2 \cdot \left(\frac{1}{16}\right) \text{ inch} + 500 \text{ ft}^2 \cdot \left(\frac{1}{32}\right) \text{ inch} + 100 \text{ ft}^2 \cdot \left(\frac{1}{8}\right) \text{ inch}}{0.05 \cdot 10000 \text{ ft}^2 \cdot 0.078 \text{ inch}} = \frac{31}{39} \leq 1$$

Since the ratio is less than or equal to 1, a dust deflagration hazard does not exist in the room. There could be many more separated accumulation areas than listed in Table A.6.1.1.1 and all significant areas should be included.

When there is a single accumulation area or the actual layer depth is the same over all accumulation areas, Figure A.6.1.1.1 indicates the actual layer depth which results in a dust deflagration hazard for the dust densities assumed in the examples above.

**Figure A.6.1.1.1 Dust Deflagration Hazard Limitation - Average Layer Depth with Reduced Accumulation Area for Buildings or Rooms less than 20,000 ft<sup>2</sup>**



**Submitter’s Substantiation:** This TIA addresses three specific issues in the 2006 edition of NFPA 654: determination of where a deflagration hazard exists in a room or building, determination of where an explosion hazard exists in equipment, and thermal exposure protection for personnel exposed to a deflagration hazard

While many people use the 1/32 in. dust layer thickness criterion as a basis for determining the presence of a dust deflagration hazard, the existing text in the body of NFPA 654 does not provide sufficient guidance on the proper use of this criterion. In fact, the only reference to this layer thickness in the current body text is in a section that specifically addresses hazardous area separation distances.

The committee's intent for the application of the 1/32 in. criterion is presented in Annex D. This annex clearly describes how a 1/32 in. dust layer throughout an entire room could create an explosible cloud 10 ft high throughout the entire room. It also states that the dust layer should not be allowed to accumulate over more than 5% of the building floor area or 1000 ft<sup>2</sup>, whichever is less. However, this section is often overlooked when applying the 1/32 in. criterion. The result of this misapplication is that a user may fail to recognize a significant dust explosion hazard.

The proposed changes to 6.1.1 and 6.2.3 move the 1/32 in. threshold to a general section of the document to clearly establish where a deflagration hazard exists. These changes also incorporate the critical factors from Annex D into the body text so that they must be considered as part of the hazard analysis. Additional annex material has also been prepared to provide examples of the proper application of this requirement.

Dust deflagration events produce both pressure-related hazards and thermal exposure hazards. The existing text does not specifically address thermal exposure hazards to personnel from a dust flash fire or deflagration. Note that even with the proposed limitations on combustible dust (1/32 in. over 5% of the floor area), as much as 50% of the room volume could be filled with a burning dust cloud. The proposed addition of sections 6.1.7 and 11.2.3 require users to address flash fire personal protective equipment (PPE) as part of the operating and maintenance procedures, including the use of flame-resistant garments for all personnel exposed to a deflagration hazard.

The current edition also lacks a definitive statement establishing what constitutes an "explosion hazard" in enclosed equipment, which establishes the basis for numerous requirements in the document. A new section 6.1.1.4 has been added to remedy this omission. Without this new section there is no basis in the standard for the user to determine where many of the prescriptive criteria are applicable.

**Emergency Nature:** The proposed TIA addresses omissions in the 2006 edition of NFPA 654. The application of the 1/32 in. dust layer limit without regard to an area limitation presents a dangerous condition in which a secondary dust explosion could produce widespread damage and multiple injuries or fatalities. In addition, the thermal exposure hazard from a flash fire is a recognized hazard that is not addressed in the current edition. The proposed changes in this TIA will appropriately address these hazards.

*Anyone may submit a comment by the closing date indicated above. To submit a comment (on company letterhead), please identify the number of the TIA and forward to the [Secretary, Standards Council](#), 1 Batterymarch Park, Quincy, MA 02169-7471.*