



National Fire Protection Association

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**COMMITTEE ON HANDLING AND CONVEYING OF DUSTS,
VAPORS, AND GASES**

**September 27 – 29, 2011
Four Points by Sheraton Manchester Airport
55 John East Devine Drive
Manchester, NH
8:00 a.m.**

AGENDA

1. Meeting opening, welcome members and guests, and introductions
2. Chair's remarks, Walt Frank
3. Review and approve minutes from March 29 – 30, 2011 meeting (NFPA 655 ROC meeting – Baltimore, MD and April 15 conference call and web meeting)
4. Staff Liaison update (Committee Roster, schedule, advisory service)
5. Task Group reports (see minutes for assignments)
 - a. Layer thickness and separation criteria (S. Rodgers)
 - b. FIBC (B. Stevenson)
 - c. Enclosureless dust collectors (J. Osborn)
6. NFPA 654 Report on Comments (ROC)
 - a. Review and act on Public Comments (35 Public Comments submitted)
 - b. Develop Committee Comments (as appropriate)
7. Other business
 - a. Fire Protection Research Foundation code fund projects discussion
8. Next meeting – None planned. Next revision cycle for NFPA 91, F2014 (proposal closing date, January 2013).
9. Adjournment

654- Log #76 CMD-HAP
(3.3.x.2 Dust Flash Fire Hazard Area)

Final Action:

Submitter: George Petino, Jr., Hazards Research Corporation, Inc.

Comment on Proposal No: 654-17

Recommendation: Revise to read as follows:

"An area where combustible dust accumulation on exposed or concealed surfaces, outside of equipment or containers, can result in personnel injury from thermal dose during a dust deflagration, as well as any areas, *outside of equipment or containers*, where dust clouds of a hazardous *at a* concentration *equal to or greater than the MEC* exist during normal operation. A propagating deflagration yields a flash fire through the hazard area. In the alternative, define the term "hazardous concentration to mean a concentration equal to or greater than the MEC.

Substantiation: The undefined term "hazardous concentration" is ambiguous and needs to be defined or replaced to avoid unnecessary confusion. Given the conservative approach inherent in the combustible dust testing protocols, and the properties of combustible dust (as distinguished from a flammable gas), we do not believe any airborne combustible dust concentration below the minimum explosive concentration (MEC) should be considered hazardous. The reference to "dust clouds" appears to be adequate to ensure the determination will not be based on an insignificant volume. Otherwise, one can, by applying a small enough boundary or perimeter, create a situation in which the presence of a small quantity of particles can exceed the MEC. While the minimum concentration for an explosion can be determined in the laboratory, there is no reliable instrument for measuring the instantaneous fugitive dust cloud concentration for explosion in the workplace with an acceptable degree of accuracy. This leaves one to use the general rule of thumb "if you can't see your hand at arm's length while standing in a dust cloud, it is a combustible cloud."

654- Log #85 CMD-HAP
(3.3.x Enclosureless Dust Collector and A.3.3.x)

Final Action:

Submitter: Marcelo M. Hirschler, GBH International

Comment on Proposal No: 654-15

Recommendation: Revise text to read as follows:

3.3.x Enclosureless Dust Collector. An air-material separator designed and used to remove dust from the transport air ~~which is not enclosed or in a container, possessing ALL of the following: (1) The filtration is accomplished by passing dust-laden air through filter media, collecting the dust on the inside of the filter media, and allowing cleaned air to exit to the surrounding area. (2) The filter medium is not enclosed or in a container. (3) The filter medium is not mechanically shaken or pressure-pulsed. (4) The filter medium is under positive pressure. (5) Removal of the collected dust is not continuous or mechanical.~~

A.3.3.x Enclosureless dust collectors should have the following features: (1) the filtration should be accomplished by passing dust laden air through filter media and collecting the dust on the inside of the filter media, and allowing cleaned air to exit to the surrounding area; (2) the filter medium should not be enclosed or in a container; (3) the filter medium should not be mechanically shaken or pressure-pulsed; (4) the filter medium should be under positive pressure and (5) removal of the collected dust should not be continuous or mechanical.

Substantiation: The proposed revision to the definition is problematic since definitions need to be in single sentences and it contains multiple requirements. The proposed revision would fix this by eliminating requirements and placing them into the annex. An even better approach would be to incorporate all of the requirements somewhere in the body of the standard.

I am the chair of the Glossary committee on terminology, set up by NFPA Standards Council to obtain uniformity of definitions within NFPA.

654- Log #64 CMD-HAP
(3.3.4)

Final Action:

Submitter: Brice Grinstead, Master Brand Cabinets

Comment on Proposal No: 654-6

Recommendation: None given.

Substantiation: Recommend removal of the addition of 420 micron diameter to 3.3.4. This requirement was removed in NFPA 664 ROP 3.3.24.1 and 3.3.24.2 - Deflagerable and Nondeflagerable wood dust. These definitions should be somewhat consistent.

654- Log #80 CMD-HAP
(3.3.4 Combustible Dust)

Final Action:

Submitter: John M. Cholin, Oakland, NJ

Comment on Proposal No: 654-9

Recommendation: Revise text to read as follows:

3.3.4* **Combustible Dust.** A finely divided combustible particulate solid that presents a flash fire or explosion hazard when suspended in air or the process specific oxidizing medium over a range of concentrations that has a mass-median particle size less than 1000 micron (1.0 mm).

Substantiation: The ROP language creates an obligation to test every particulate regardless of the particle size. There is ample industry experience that shows that particulates that are larger than a nominal 500 microns in mass median diameter are unlikely to pose a deflagration hazard. This comment doubles that number to err on the side of safety.

Without a size criterion if a facility operator had a silo full of golf balls she/he would be required to submit a sample for explosibility testing per ASTM E 1226. This example might seem ludicrous but it illustrates the point that most professionals knowledgeable in this segment of the fire protection industry recognize that many particulates are too large to pose a deflagration hazard in and of themselves. Consequently, there is no justification for testing them. The annex material covers the potentiality of particle attrition that produces a smaller, more hazardous particulate. The TC should address the economic burden the ROP language places on the operator and the fact that it establishes a requirement that is, in many cases, impossible to meet. This erodes the credibility of the entire standard.

654- Log #75 CMD-HAP
(3.3.5 Combustible Dust)

Final Action:

Submitter: George Petino, Jr., Hazards Research Corporation, Inc.

Comment on Proposal No: 654-9

Recommendation: Replace the proposed definition with the following taken from Section 3.3.3 of NFPA 449:

“**Combustible Dust.** Any finely divided solid material that is 420 microns or smaller in diameter (material passing a U.S. No. 40 Standard Sieve) and presents a fire or explosion hazard when dispersed and ignited in air.”

Substantiation: While we recognize this issue was discussed, we believe the absence of a reference to a particle size in this definition is inappropriate and leaves the user with no meaningful or practical guidance other than to test everything. The inclusion of the undefined phrase “finely divided” is not helpful.” The possibility that a user may misinterpret the definition suggests that the standard provide some additional guidance rather than removing practical guidance.

654- Log #84 CMD-HAP
(3.3.5 Combustible Particulate Solid)

Final Action:

Submitter: Marcelo M. Hirschler, GBH International

Comment on Proposal No: 654-9

Recommendation: Revise text to read as follows:

3.3.5* Combustible Particulate Solid. Any combustible solid material, composed of distinct particles or pieces, regardless of size, shape, or chemical composition ~~that presents a fire hazard~~ .

Substantiation: The revision to the definition causes a problem because a combustible solid material may well exist and be at such a low concentration so as not present a fire hazard and then be believed not to be a combustible particulate solid.

Note also that the term “combustible particulate solid” has as the preferred NFPA definition the following one: “A combustible solid material comprised of distinct particles or pieces, regardless of size, shape, or chemical composition, that is capable of being pneumatically conveyed.” from NFPA 1 and NFPA 69.

The technical committee might want to consider either adopting the preferred definition or adding a qualifier, such as “in terms of dust explosions” so that it becomes a unique definition. The definition would then read:

“3.3.5* Combustible Particulate Solid (in terms of dust explosions). Any combustible solid material, composed of distinct particles or pieces, regardless of size, shape, or chemical composition.

I am the chair of the Glossary committee on terminology, set up by NFPA Standards Council to obtain uniformity of definitions within NFPA.

654- Log #65 CMD-HAP Final Action:
 (3.3.11 Dust Collector, 7.3.2.x, 1.1.1, 10.2.2, 10.2.3.1, 9.1.2.1, 6.1.6, 7.3.3.x, 7.4.1, and 7.8.3.1, A.3.3.x, and A.7.3.2.x)

Submitter: Jack E. Osborn, Airdusco, Inc.

Comment on Proposal No: 654-12

Recommendation: Add new text to read as follows:

3.3.11* ~~Dust Collector~~ Dust Collection System: ~~See 3.3.2, Air-Material Separator (AMS).~~ A combination of equipment designed to contain, capture, pneumatically convey, collect, and filter airborne dusts.

(New) A.3.3.11 Dust Collection System. A typical dust collection system consists of the following:

(1) Hoods – devices designed to contain, capture, and control the airborne dusts by directing the induced air flow through the fugitive airborne dusts.

(2) Ducting – piping, tubing, fabricated duct, etc., used to provide the controlled pathway from the hoods to the dust collector (AMS). Maintaining adequate duct velocity (usually 4,000 fpm or higher) is a key factor in the proper functioning of the system.

(3) Dust collector – an AMS designed to typically filter the conveyed dusts from the conveying air stream. Usually these devices have automatic methods for cleaning the filters to allow extended use without blinding. In some systems a scrubber of similar device is used in place of the filter unit.

(4) Fan package – an AMD designed to induce the air flow through the entire system.

The system is design to only collect aerated dusts and not dusts at rest on surfaces. The system is also not designed to convey large amounts of dusts as the system design is based solely on the air friction losses. Thus, material loading must be minimal compared to the volume or mass of air flow.

3.3.19* Pneumatic Conveying System. An equipment system comprised of a material feeding device, an air-material separator, an enclosed ductwork, piping, or tubing system, and an air-moving device in which a combustible particulate solid is conveyed from one point to another with a stream of air or other gases used to transfer a controlled flow of solid particulate material from one location to another using air or other gases as the conveying medium.

3.3.19.1* Negative-Pressure Pneumatic Conveying System. A pneumatic conveying system that transports material by utilizing gas at less than atmospheric pressure (retained as before).

3.3.19.2* Positive-Pressure Pneumatic Conveying System. A pneumatic conveying system that transports material by utilizing gas at greater than atmospheric pressure (retained as before).

A.3.3.19 Pneumatic Conveying System. (Delete existing and revise with the following text): Generically, pneumatic conveying systems include a wide range of equipment systems utilizing air or other gases to transport solid particles from one point to another. A typical (there are variations) system is comprised of:

(1) A device used to meter the material into the conveying air stream.

(2) Piping, tubing, hose, etc., used to provide the closed pathway from the metering device to the AMS.

(3) AMS designed for the separation of comparatively large amounts of material from the conveying air/gas stream.

(4) An additional metering device (typically a rotary airlock valve or similar device) to allow discharge of the separated material from The conveying air stream without affecting the differential pressure of the system.

(5) AMD designed to produce the necessary pressure differential and air/gas flow in the system (positive or negative). This type of system requires the amount of material conveyed by the system to be considered as a major factor in the system calculations.

3.3.x * (New item) Centralized Vacuum Cleaning System. A fixed pipe system utilizing variable-volume induced air flows from remotely located hose connection stations to allow the vacuuming of dust accumulations from surfaces and conveying those dusts to an AMS.

A.3.3.x (new) Centralized Vacuum Cleaning System. This system normally consists of multiple locations, known as hose connection stations, hard-piped to an AMS located out of the hazardous area, using an AMD to provide the vacuum induced, variable volume, air flow. The hoses and vacuum cleaning tools utilized with the system are designed to be static dissipative in order to minimize any risk of generating an ignition source. Low MIE (minimum ignition energy) materials will require special consideration in the system design and use. A primary separator can be used if large quantities of materials are involved. However, most secondary AMS units (commonly called filter receivers) are capable of handling the high material loadings without the addition of the primary AMS (typically a cyclone).

7.3.2 ~~Pneumatic Conveying Systems.~~ Pneumatic Conveying, Dust Collection, and Centralized Vacuum Cleaning Systems.

7.3.2.1 No existing system shall be changed without considering the effects of those changes on the system performance. This requires a re-design of the system to incorporate the proposed changes. Such changes shall be fully

documented. The addition of branch lines shall not be made to an existing system without redesigning the entire system.

7.3.2.2 Branch lines shall not be disconnected and unused portions of the system shall not be blanked off without providing a means to maintain required and balanced airflow.

Delete the existing 7.3.2.3.

7.3.2.3 (new): The system shall be designed and maintained to assure that the air/gas velocity used shall at all times meet or exceed the minimum required to keep the interior surfaces of all duct free of accumulations.

Delete the existing 7.3.2.4.

7.3.2.4 (new): The system shall be equipped with adequate monitoring devices to allow continuous monitoring of the system performance.

7.3.2.5 (new – the existing will be renumbered) Specific Requirements for Dust Collection Systems

7.3.2.5.1 Each dust collection source or hood shall have a documented minimum air volume required for proper dust collection performance.

7.3.2.5.2 The minimum acceptable duct air/gas velocity for the transport of combustible dusts in a ducting system for a dust collection system is 4000 fpm. The system shall be designed to maintain this conveying air/gas velocity at all times in all branch lines.

7.3.2.5.3 No system shall include manually adjustable control devices (e.g. slide gates, butterfly valves, etc.), except for exclusively maintenance purposes, or on/off purposes, that allow personnel to adjust the air flow into the system.

7.3.2.5.4 The rate of airflow at each hood or other pickup point shall be designed so as to convey and control the material.

7.3.2.5.5* All ductwork shall be sized to provide the air volume and air velocity necessary to keep the duct interior clean and free of residual material.

A.7.3.2.5.5. The typical minimum accepted velocity is 4,000 fpm. Some tacky, adhesive, and/or cohesive materials may require significantly higher duct velocities.

7.3.2.5.6. (retain as written) The design of the pneumatic conveyance system shall be documented, including the following information:

(1) Data on the range of particulate size

(2) Concentration in conveyance air stream

(3) Potential for reaction between the transported particulate and the extinguishing media used to protect process equipment

(4) Conductivity of the particulate

(5) Other physical and chemical properties that affect the fire protection of the Process

7.3.2.7 (new) Specific Requirements for Centralized Vacuum Cleaning Systems:

7.3.2.7.1. The system design shall be designed to assure proper conveying velocities at all times whether the system is used with a single or multiple simultaneous operators.

7.3.2.7.2. The hose length and diameter shall be sized for the application and operator.

7.3.2.7.3. Use only metal or conducting materials for vacuum tools.

7.3.2.7.4. The AMS shall be designed for continuous material discharge into a suitable enclosed container.

7.3.2.6.8.(retain as written) Pneumatic conveying systems that remove material from operations that generate flames, sparks, or hot material shall not be interconnected with pneumatic conveying systems that transport combustible particulate solids or hybrid mixtures.

7.12 Air-Moving Devices (Fans and Blowers).

7.12.1 Air-moving devices shall conform to the requirements of NFPA 91, Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids, except as amended by the requirements of this chapter.

7.12.2* (new) Air moving devices shall not be inside the clean air plenum of the dust collector.

A.7.12.2: Installing the air moving device (fan package) for an air-material separator (commonly called a dust collector or bin vent) inside the clean air plenum enclosure creates a significant and unnecessary explosion hazard. Filter failure is a common upset condition which will result in the accumulation of combustible dusts in the clean air plenum. If the air moving device (fan package) is located in the clean air plenum the combustible dust passing through the failed filter or filters is directly exposed to the drive and other ignition generating components of the air moving device (fan package). This combination produces an unnecessary explosion hazard that is avoided by not locating the device in the clean air plenum. This does not void the use of sound enclosures or similar enclosures which do not produce such hazards (not an integral part of the clean air plenum).

NOTE – the following items are included to “clean-up” the use of “pneumatic conveying” to include all three(3) types of systems.

1.1.1 This standard shall apply to all phases of the manufacturing, processing, blending, pneumatic conveying, dust collection, and centralized vacuum cleaning systems, repackaging, and handling of combustible particulate solids or hybrid mixtures, regardless of concentration or particle size, where the materials present a fire or explosion hazard.

4.4* Pneumatic Conveying, Dust Collection, and Centralized Vacuum System Design. (retain rest of text).

A.4.4 The design of the pneumatic conveying, dust collection, or centralized vacuum cleaning system should be coordinated with the architectural and structural designs. (Retain the rest).

6.1.6 All components of pneumatic conveying, dust collection and centralized vacuum cleaning systems that handle combustible particulate solids shall be designed to be dusttight, except for openings designed for intake and discharge of air and material.

7.3.3.1 Sequence of Operation. Pneumatic conveying, dust collection and Centralized vacuum cleaning systems shall be designed with the operating logic, sequencing, and timing outlined in 7.3.3.2 and 7.3.3.3.

7.3.3.2* Startup. Pneumatic conveying, dust collection and centralized vacuum cleaning systems shall be designed such that, on startup, the system achieves and maintains design air velocity prior to the admission of material to the system.

7.3.3.3 Shutdown. Pneumatic conveying, dust collection and centralized vacuum cleaning systems shall be designed such that, on shutdown of the process, the system maintains design air velocity until material is purged from the system.

7.4.1 General. This section shall apply to facilities that operate pneumatic conveying, dust collection and centralized vacuum cleaning systems for metal particulates.

7.8.3.1 Airflow control valves that are installed in pneumatic conveying, dust collection and centralized vacuum cleaning systems shall be of both airtight and dusttight construction.

9.1.2.1 Where the process is configured such that the pneumatic conveying, dust collection or centralized vacuum cleaning system conveys materials that can act as an ignition source, means shall be provided to minimize the hazard.

10.2.2 Where fire detection systems are incorporated into pneumatic conveying, dust collection or centralized vacuum cleaning systems, an analysis shall be conducted to identify safe interlocking requirements for air-moving devices and process operations.

10.2.3.1 Where fire detection systems are incorporated into the pneumatic conveying, dust collection or centralized vacuum cleaning system design, the fire detection systems shall be interlocked to shut down any active device feeding materials to the pneumatic conveying system on actuation of the detection system.

9.1.2.1 Where the process is configured such that the pneumatic conveying, dust collection or centralized vacuum cleaning system conveys materials that can act as an ignition source, means shall be provided to minimize the hazard.

Substantiation: Substantiation: 3.3.11. Dust Collection System. There are major operational and dust explosion hazard differences between “dust collection systems”, pneumatic conveying systems, and centralized vacuum cleaning systems. Also, there is substantial confusion created in the 654 document by the use of the term “pneumatic conveying” in a generic for these three(3) quite different systems since the industry accepted terminology for a Pneumatic Conveying System” refers to a system designed to convey comparatively large amounts of material (ranging from dusts to large particles) in comparatively small diameter pipes, using negative or positive pressure. The design parameters for the three(3) systems are quite different and require significantly different expertise to create a successful system design. In general a system that pneumatically conveys a combustible dust, when compared to a dust collection system handling the same dust, represents a **significantly reduced hazard**.

Substantiation: 3.3.19. Pneumatic Conveying System. Due to the method of conveying and the inherent design characteristics of a pneumatic conveying system (compared to a dust collection system or centralized vacuum system) this type of material transfer method is normally of less risk than either of the other types of “pneumatic-conveying” systems. Protecting this system against explosion hazards is inherently different than that of the other types (centralized vacuum system is similar, however). Separating this definition from that of the dust collection system and centralized vacuum cleaning system will eliminate the significant confusion created by “lumping” them together. They do not inherently share the same dust explosion hazard risks.

Substantiation: 3.3.x. Centralized Vacuum Cleaning System. This definition is included to provide clarification of the difference between a “dust collection system” and a “pneumatic conveying system” as used commonly in the industrial environment. This system presents a significantly greater risk than a typical pneumatic conveying system due to the inclusion of human operators and the reality that “trash” (e.g. welding rods, bolts, nuts, etc.) are often included in the material vacuumed off the floors, etc. Unique deflagration hazards exist with this type of system verses the typical pneumatic transfer and dust collection system.

Substantiation. 7.3.2.x... Multiple. These changes are to allow for the differentiation between the dust collection system, pneumatic conveying system and centralized vacuum cleaning system and the various specific items that relate

to them for this section.

Substantiation: Specific to 7.12.2. There is no functional reason for locating the fan package (air material separator) inside the clean air plenum. It is purely done for aesthetics and sales promotional reasons. When the fan is located in the clean air plenum it requires a larger-than-necessary enclosure resulting in additional, not less, construction costs for the unit. Most major dust collector (air-material separator) manufacturers do not locate the fan in this position for both cost and safety reasons. This situation is found almost exclusively in the “lower-end” cost, package units, which provide the enclosure strictly for aesthetics and sales reasons as it offers no known advantage over installing the relatively small fan package on top of the enclosure around the dirty air plenum or, if a clean air plenum is desired/required, on top of that enclosure. Thus, since there is no functional advantage to locating the fan package in the clean air plenum (over outside the same), it is logical to eliminate an explosion hazard by requiring the fan to be located external to the clean air plenum.

Substantiation for remainder (1.1.1., 4.4., 6.1.6, 7.3.3.1, & 2, & 3, 7.8.3.1, 9.1.2.1, 10.2.2, 10.2.3.1) is to “clean-up” or include the reference to the three(3) types of systems where only “pneumatic conveying systems” is located/used in the text.

654- Log #82 CMD-HAP
(3.3.14.1.1 Type A FIBC)

Final Action:

Submitter: Marcelo M. Hirschler, GBH International
Comment on Proposal No: 654-14

Recommendation: Revise text to read as follows:

3.3.14.1.1 Type A FIBC. ~~A standard insulating flexible intermediate bulk container (FIBC): A flexible intermediate bulk container (FIBC) made from fabric or plastic sheet without any measures against the build up of static electricity. Any FIBC that does not meet the requirements specified in IEC/FDIS 61340-4-4:2005(E), or which has not been tested against the requirements is classified as Type A.~~

Substantiation: The proposed revision to the definition (as rejected) is problematic since definitions need to be in single sentences, cannot contain requirements and cannot refer to standards (and even less to proposed standards).

The proposed revision is a way forward for the technical committee, and it would read as follows:

3.3.14.1.1 Type A FIBC. A flexible intermediate bulk container (FIBC) made from fabric or plastic sheet without any measures against the build up of static electricity or which has not been tested against the requirements is classified as Type A.

Note that an FDIS is not a published standard.

I am the chair of the Glossary committee on terminology, set up by NFPA Standards Council to obtain uniformity of definitions within NFPA.

654- Log #87 CMD-HAP
(3.3.14.1.3 Type C FIBC and A.3.14.1.3)

Final Action:

Submitter: Marcelo M. Hirschler, GBH International

Comment on Proposal No: 654-14

Recommendation: Revise text to read as follows:

3.3.14.1.3* Type C FIBC. A flexible intermediate bulk container (FIBC) ~~where the fabric is interwoven with an electrically interconnected conductive fiber and provided with a tab for connection to grounding systems. made from conductive fabric or plastic sheet, or interwoven with conductive threads or filaments and designed to prevent the occurrence of incendiary sparks, brush discharges and propagating brush discharges.~~

A.3.14.1.3 Type C FIBC are designed to be connected to earth during filling and emptying operations.

Substantiation: The proposed revision to the definition (as rejected) is problematic since definitions need to be in single sentences.

The proposed revision is a way forward for the technical committee, and it would read as follows:

3.3.14.1.1 Type A FIBC. A flexible intermediate bulk container (FIBC) made from conductive fabric or plastic sheet, or interwoven with conductive threads or filaments and designed to prevent the occurrence of incendiary sparks, brush discharges and propagating brush discharges.

The second sentence can be made into an Annex note, as proposed here, or placed somewhere in the body of the standard.

I am the chair of the Glossary committee on terminology, set up by NFPA Standards Council to obtain uniformity of definitions within NFPA.

654- Log #77 CMD-HAP
(4.2.3)

Final Action:

Submitter: George Petino, Jr., Hazards Research Corporation, Inc.

Comment on Proposal No: 654-18

Recommendation: This provision should be deleted.

Substantiation: Scope: The scope and intent of this provision is unclear. On its face, it appears that this provision would apply to both areas inside process equipment and areas external to process equipment.

Application: As written, this requirement is neither appropriate nor practical. As a general principle, manufacturing plants are not designed with the expectation that they will generate significant dust deposits. Rather our experience is that the generation of dust deposits results from changes such as the evolution of a process (e.g., moving from granular to powdered materials) and the aging of equipment that still has a remaining useful life. This proposed provision does not have any apparent limitations. It appears to impose an unnecessary and impractical burden, requiring the ability to see into the future, for the person performing a PHA to specify, in advance, the allowable layer thickness and deposit surface area for each exposed or concealed surface in a facility. The reality is that one designs a facility to avoid the generation of fugitive dust and then re-assesses the situation after the plant is up and running. At that point, one then determines whether any process or equipment modifications are appropriate and what cleaning frequency and methods are required or appropriate to avoid or eliminate any dust explosion hazard areas that may exist. Any attempt to do this in advance is wholly impractical. As a general principle, any suggestion that one would design a plant with residual dust explosion hazard areas and then plan for the use of PPE is fundamentally wrong.

654- Log #78 CMD-HAP
(4.4.1)

Final Action:

Submitter: George Petino, Jr., Hazards Research Corporation, Inc.

Comment on Proposal No: 654-19

Recommendation: Revise this provision to read as follows:

"4.4.1* Incidents that result in a fire or explosion of a magnitude that causes *significant* property damage, *significant* production shutdown time, or *serious* injury shall be investigated."

Substantiation: The scope of Section 4.4.1 is unnecessarily broad and burdensome, and would result in excessive micromanagement of the user. Clearly, it is important not to overburden operators by having to conduct an incident investigation of every event regardless of its character. This is a point on which we believe it is preferable to narrow the scope to what is practical rather than being over-inclusive and expecting the user to discount the requirement to an appropriate degree.

654- Log #90 CMD-HAP
(4.6.2)

Final Action:

Submitter: George Petino, Jr., Hazards Research Corporation, Inc.

Comment on Proposal No: N/A

Recommendation: Delete Section 4.6.2.

Substantiation: We believe it is important to comment on this provision, although it was not part of a proposed change, because it relates to our comment on Section 4.2.3. This section provides:

The facility shall be designed, constructed, and equipped to maintain its structural integrity in spite of the effects of fire or explosion for the time necessary to evacuate, relocate, or defend in place occupants not in the immediate proximity of the ignition. As a general principle, a new manufacturing plant is not designed with the expectation that it will have unprotected AMS and generate significant fugitive dust deposits that present fire and explosion hazards. Rather our experience is that the generation of dust deposits results from changes such as the evolution of a process (e.g., moving from granular to powdered materials) and the aging of equipment that still has a remaining useful life. This proposed provision does not have any apparent limitations. It appears to impose an unnecessary and impractical burden, requiring the designer to have the ability to see into the future and specify, in advance, the design criteria that will ensure that the facility complies with this provision for events that could not have been foreseen or planned for at the time of the initial design of the facility. The reality is that one generally designs a facility to avoid the generation of fugitive dust and then re-assesses the situation after the plant is up and running. At that point, one then determines whether any process or equipment modifications are appropriate and what cleaning frequency and methods are required or appropriate to avoid or eliminate any dust explosion hazard areas that may exist. Any attempt to do this in advance is wholly impractical.

654- Log #91 CMD-HAP
(5.1.1)

Final Action:

Submitter: George Petino, Jr., Hazards Research Corporation, Inc.

Comment on Proposal No: N/A

Recommendation: This provision should be deleted or amended in a way that provides some meaningful, objective criteria for evaluating the qualifications of the person preparing the performance-based design.

Substantiation: This provision currently reads as follows:

"The performance-based design shall be prepared by a person with qualifications acceptable to the owner/operator." This provision lacks credibility, reflects negatively on the organization and should be amended so as to provide a credible definition of a qualified person that is based on reasonable, objective criteria that would not inappropriately exclude qualified individuals from this role, or it should be dropped."

654- Log #92 CMD-HAP
(5.3.2.1 and 5.3.2.2)

Final Action:

Submitter: George Petino, Jr., Hazards Research Corporation, Inc.

Comment on Proposal No: 654-2

Recommendation: Revise these provisions to read as follows:

5.3.2.1 Each duct, enclosed conveyor, silo, bunker, ~~cyclone, air-material separator dust collector~~, or other vessel containing a combustible dust in sufficient quantity ~~or and under conditions to that would~~ support the propagation of a flame front during startup, normal operating conditions, or shutdown shall be included as an explosion scenario.

5.3.2.2 Each duct, enclosed conveyor, silo, bunker, ~~cyclone, air-material separator dust collector~~, or other vessel containing a combustible dust in sufficient quantity ~~or and under conditions to that would~~ support the propagation of a flame front under credible conditions of production upset or single equipment failure shall be included as an explosion scenario.

Substantiation: A cyclone is one type of AMS; to use both terms suggests that a cyclone is not an AMS. The original language “or conditions” was unclear and would lead to misunderstandings and confusion. We inserted the word “credible” because the risk evaluation needs to be based on credible conditions rather than any theoretically possible conditions.

654- Log #81 CMD-HAP
(6.1 and 6.2)

Final Action:

Submitter: Samuel A. Rodgers, Honeywell International

Comment on Proposal No: 654-22, 654-25

Recommendation: Revise text to read as follows:

6.1.6.2* A dust explosion hazard and dust flash fire hazard shall be deemed to exist in any building or room where dust clouds of a hazardous concentration exist or where any of the following conditions exist:

~~(1) For any buildings or rooms with footprint areas smaller than 20,000 ft² either~~

~~(1) (a) the total area of non-separated dust accumulations exceeding the layer depth criterion is greater than 5% of the footprint area, or~~

~~(2) (a) the area of any single non-separated dust accumulations exceeding the layer depth criterion is greater than 1000 ft², or~~

~~(2) For buildings or rooms with footprint areas greater than or equal to 20,000 ft² either~~

~~(3) (b) the total volume of non-separated dust accumulations is greater than the layer depth criterion multiplied by 5% of the footprint area, or~~

~~(4) (b) the total volume of any single non-separated dust accumulations is greater than the layer depth criterion multiplied by 1000 ft².~~

6.1.6.2.1 Dust accumulations are deemed non-separated unless segregation, separation, or detachment is used to limit the hazard area in accordance with section 6.2.

6.2.3 Use of Separation.

6.2.3.1* Separation shall be permitted to be used to limit the dust explosion hazard or dust flash fire hazard area where supported by a documented risk evaluation acceptable to the authority having jurisdiction.

6.2.3.1.1 The required separation distance between the dust explosion hazard or flash fire hazard area identified in 6.1 and surrounding exposures shall be determined by a risk evaluation that addresses the following:

~~(1) Engineering evaluation that addresses the p~~ Properties of the materials

(2) Type of operation

(3) Amount of material likely to be present outside the process equipment

(4) Building and equipment design

(5) Nature of surrounding exposures

~~6.2.3.1.2 Within the separation area shall be free of dust or where dust accumulations on any surfaces do not exceed 1/64" or such that surface colors are shall be readily discernible.~~

6.2.3.1.3 When separation is used to limit the dust flash fire hazard area determined in 6.1, the minimum separation distance shall not be less than 30 ft (9 m).

6.2.3.2 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 dust explosion hazard or flash fire hazard area.

~~6.2.3.3* Where separation is used to limit a dust explosion hazard or dust flash fire hazard area, Equation 6.1.3.2 or 6.1.5 dust thresholds determined in Section 6.1 shall be applied to based on this limited area such that the parameter, A_{floor} , in the equations is consistent with the limited area under consideration.~~

~~6.2.3.4 Separation shall not be permitted to be used to limit the dust explosion hazard area.~~

Substantiation: Section 6.1.6.2 of CP#4 is currently not clear as to whether separation can be used to limit the dust accumulations that are included in the 5% criterion. Separation by distance should be permitted for explosion hazard if the dust accumulations are far enough separated to prevent propagation from one accumulation to the next. Currently Section 6.2.3 on Use of Separation prohibits the use of separation for explosion hazard.

654- Log #79 CMD-HAP
(6.1.2)

Final Action:

Submitter: John M. Cholin, Oakland, NJ

Comment on Proposal No: 654-22

Recommendation: Revise text to read as follows:

Include 654_L79_Include_REC here

Substantiation: While there is considerable potential in the computational method that has been proposed it does not have sufficient foundation to be mandatory text at this time.

The calculations rely on a parameter η_D , the entrainment factor, for which there is currently no test method for determining its numerical value nor is there sufficient research supporting the notion that a single value is applicable to all facilities under all scenarios. Until this supporting material is available this method should not be in the mandatory portion of the document.

By placing it in the Annex, it is available for use by practioners who can justify their selection of the numerical values for the parameters upon which the calculations rely, under the criteria established for performance-based design in Chapter 5.

The limits on applying the simple layer criteria were returned to the Annex by including the old Annex D test because there is simply no loss history suggesting that the simpler layer depth criteria without these limits are inadequate. The removed language in the ROP draft 6.1.6.2 was initially derived from the old Annex D text. The Annex D calculations were developed as a bounding value hypothetical case. It was written to inform users of the hypothetical worst-case scenario so the users would take the layer depth criteria in the body of the standard seriously. The conclusions drawn from the hypothetical case should not be made mandatory text unless there is some form of substantiation. The hypothetical case does not consider flame quenching be the building and the equipment, heat losses to non-combustible impingement surfaces, losses due to compression of the air ahead of the dust cloud, etc. It assumes a uniform dust suspension, something that is unlikely, at best. It is inappropriate to take a bounding value hypothetical case and use it as the basis for mandatory criteria.

The TC has made great strides in establishing a section that now effectively defines what constitutes an explosion hazard and what constitutes a flash-fire hazard. This was desperately needed. But there is simply no evidence that the simple, easy to enforce layer depth criterion has led to problems or has allowed personnel injuries in facilities that complied with it.

There is a cost associated with excessively restrictive criteria. We know that dust layers measured in inches are sufficient to put the occupants at serious risk. We have experience data that suggests that deflagrations were unable to propagate in facilities where the layer depth criteria were essentially compliant with the 1/32nd inch criterion that has been in this document for the past decade. What we don't know is at what layer depth the building compartment transitions from acceptable to unacceptable. This is an area for research but not hypotheation. Excessively restrictive criteria increase operating costs for facility operators with no demonstable benefit. That is NOT "good engineering". Who would buy a car fabricated from 1/4" steel plate? Sure, it would be safe but the mileage might be disappointing.

6.1.2 Hazard Assessment. The provisions of this section shall apply to the assessment of the hazards associated with the overall design of systems that handle combustible dusts.

6.1.2.1 Those portions of the process and facility where dust accumulations exist outside of equipment shall be evaluated to determine if a dust explosion hazard or flash fire hazard exists, unless the dust layer depth is $1/64''$ or less or the underlying surface colors are readily discernible.

6.1.2.2 Building, rooms, compartments and other interior spaces shall be assessed in accordance with Sections 6.1.2, 6.1.3 or 6.1.4 or 6.1.5.

6.1.2.3 The process equipment shall be assessed in accordance with Section 6.1.7

6.1.3* It shall be permitted to use performance-based methods in accordance with Chapter 5 to identify dust explosion and dust flash fire hazard areas. ~~Unless supported by calculations per 6.1.4 and 6.1.5, or using the method in 6.1.6, Dust explosion hazard areas and dust flash fire hazard areas shall be deemed to exist when the total accumulated dust on any surfaces exceeds the thresholds calculated in 6.1.3.1 or 6.1.3.2, respectively.~~

A.6.1.3 The threshold dust mass establishing a building or room as a dust explosion hazard volume, $M_{basic-exp}$, should be determined per equation A.6.1.3.1.

$$M_{basic-exp} = 0.004 \cdot A_{floor} \cdot H \quad \text{Eqn A.6.1.3.1}$$

The threshold dust mass establishing a building or room as a dust deflagration hazard volume, $M_{basic-fire}$, shall be determined per equation 6.1.3.2.

$$M_{basic-fire} = 0.02 \cdot A_{floor} \quad \text{Eqn A.6.1.3.2}$$

Where, for both equations A.6.1.3.1 and A.6.1.3.2:

$M_{basic-exp}$ is the threshold dust mass (kg) based upon building damage criterion

$M_{basic-fire}$ is the threshold dust mass (kg) based upon personnel fire exposure criterion

A_{floor} is the lesser of the enclosure floor area (m^2) or $2000 m^2$

H is the lesser of the enclosure ceiling height (m) or 12 m

Because fugitive dust could accumulate in a localized area of the building or room (localized area less than 10% of the total floor area), the floor area limit (A_{floor}) used in equations A.6.1.3.1 or A.6.1.3.2 has been set to $2000 m^2$.

For an example of the calculation of threshold dust mass see Annex D.

It shall be permitted to evaluate the threshold dust mass establishing a building or room as a dust explosion hazard area, m_{exp} , per equation A.6.1.3.3.

$$M_{exp} = \left[\frac{P_{es}}{DLF} \right] \cdot \left[\frac{C_w}{P_{max}} \right] \cdot \frac{A_{floor} \cdot H}{\eta_D} \quad \text{Eqn A.6.1.3.3}$$

where:

M_{exp} = the threshold dust mass (kg) based upon building damage criterion,

P_{es} = the enclosure strength evaluated based on static pressure calculations for the weakest building structural element not intended to vent or fail (bar g) per NFPA 68,

DLF = the dynamic load factor, the ratio of maximum dynamic deflection to static deflection per NFPA 68,

C_w = the worst case dust concentration (kg/m^3) at which the maximum rate-of-pressure-rise results in tests conducted per ASTM E1226,

P_{max} = the maximum pressure (bar g) developed in ASTM E1226 tests with the accumulated dust sample,

A_{floor} = the enclosure floor area (m^2),

H = the enclosure ceiling height (m),

η_D = the entrainment fraction

In the absence of detailed structural response analysis, it shall be permitted to assume a worst-case value of DLF = 1.5 and design based on the weakest structural element of the enclosure.

The Dust Explosion Hazard Area equation originates from the NFPA-68 Partial Volume equation, which adjusts the amount of venting needed when the design scenario presumes the combustible mixture fills only a part of the enclosure. NFPA-68 uses the ratio of P_{red} to P_{max} and the fill fraction to make this adjustment. P_{red} is the maximum pressure predicted to be developed during a vented deflagration and should be less than the strength of the weakest building structural element not intended to vent or fail. Windows, for instance, might be intended to fail. NFPA-68 sets an upper bound for P_{red} , ensuring that the calculated pressure during the event does not exceed the strength of the enclosure. This upper bound is P_{es}/DLF , the dynamic strength of the weakest building structural element not

intended to vent or fail. In the implementation here, the goal is to see if any explosion venting is needed to prevent damage to the main building structural components, thus P_{red} is equated to its maximum allowable value, based on the building/room design.

In a deflagration, the pressure developed changes with the dust concentration. Equation 6.1.3.3 uses the so-called worst case concentration of dust in a combustible mixture, C_w , as defined in NFPA-68. A conservative way to evaluate the pressure attained at lower average dust concentration is to assume that all of the dust available is concentrated in a smaller volume to the worst case concentration. This smaller volume is a fraction of the total volume, the fill fraction. In Equation 6.1.3.3, the threshold dust mass, M_{exp} , divided by the product of worst case concentration and building volume is the fill fraction. When accumulated dust mass is larger than the threshold for the Explosion Hazard, then the fill fraction is greater than the ratio of P_{es}/DLF to P_{max} , and an Explosion Hazard exists.

Users should ~~it shall be permitted to~~ assume a default value of 0.25 to 1 for the entrainment fraction (η_D). A higher value for η_D is more appropriate for ducts and small enclosures less than 100 m³ and for enclosures with L/D ratios greater than 5, such as galleries. Research activities are currently in progress to define a technical basis for estimating η_D .

6.1.4.3 It shall be permitted to use an alternative value of η_D less than 0.25, based on a risk evaluation that is acceptable to the authority having jurisdiction.

6.1.5* It shall be permitted to evaluate the threshold dust mass, M_{fire} , establishing an area as a dust flash fire hazard area, per equation A.6.1.3.4.

$$M_{fire} = p \cdot C_w \cdot \left[\frac{P_{initial}}{P_{initial} + P_{max}} \right] \cdot \frac{A_{floor} \cdot D}{\eta_D} \quad \text{Eqn A.6.1.3.4}$$

Where:

M_{fire} = the threshold dust mass (kg) based upon personnel fire exposure criterion.

$P_{initial}$ = 1 bar absolute

D = the nominal height of a person (m)

p = the probability of flame impingement on a person.

6.1.5.1 The value of D in equation 6.1.5 should ~~shall~~ be 2 m.

6.1.5.2 The value of p shall should not exceed 0.05 (5% probability).

6.1.5.3* It ~~shall~~ should be permitted to assume a default value of 0.25 to 1 for the entrainment fraction (η_D).

The Dust Flash Fire Hazard Area equation estimates the fraction of the volume that could be filled by an expanded fireball from burning dust. The room or building volume up to person height is taken as the total volume for this hazard, regardless of actual building height. The threshold for the Flash Fire Hazard is based on allowing the accumulated dust mass to reach the worst case concentration in an unburnt volume which, when expanded in a fireball, is only a fraction of the volume described by the product of person height and floor area. The relation in 6.1.5 uses a probability (p) of an occupant being in the same location as the deflagration flame as its risk tolerance criterion. This choice implies that some residual risk remains.

6.1.5.4 It ~~shall~~ should be permitted to use an alternative value of η_D less than 0.25, based on a risk evaluation that is acceptable to the authority having jurisdiction.

6.1.6.1* Layer Depth Criterion Method.

6.1.6.1 The layer depth criterion establishing the presence of a dust flash fire and dust explosion hazard shall be of 1/32". This layer depth shall be permitted to be increased according to equation 6.1.6.1 for materials with bulk density less than 75 lb/ft³

$$\text{Allowable thickness (in.)} = \frac{(1/32)(75)}{\text{bulk density (lb/ft}^3\text{)}} \quad 6.1.6.1$$

6.1.6.2* A dust explosion hazard and dust flash fire hazard shall be deemed to exist where dust clouds of a hazardous concentration exist or where the accumulated dust layer exceeds the layer depth criterion in 6.1.6.1. any of the following conditions exist:

- (1) For buildings or rooms with footprint areas smaller than 20,000 ft²
 - (a) the area of dust accumulations exceeding the layer depth criterion is greater than 5% of the footprint area, or
 - (b) the total volume of dust accumulations is greater than the layer depth criterion multiplied by 5% of the footprint area.
- (2) For buildings or rooms with footprint areas greater than or equal to 20,000 ft²
 - (a) the area of dust accumulations exceeding the layer depth criterion is greater than 1000 ft², or

~~(b) the total volume of dust accumulations is greater than the layer depth criterion multiplied by 1000 ft².~~

A.6.1.6.1 Calculations suggest that surprisingly small dust layers could be capable of propagating a dust deflagration through a room or building. When bounding value assumptions are used one can calculate the following.

(Insert old Annex D here)

Renumber subsequent sections in this chapter

654- Log #72 CMD-HAP
(6.1.2.1 through 6.1.6.2)

Final Action:

Submitter: Hugh D. Castles, Entergy Services, Inc.

Comment on Proposal No: 654-22

Recommendation: Add new text to read as follows:

6.1.2.1 Those portions of the process and facility where dust accumulations exist outside of equipment shall be evaluated to determine if a dust explosion hazard ~~or flash fire hazard~~ exists, unless the dust layer depth is 1/64" or less or the underlying surface colors are readily discernible.

6.1.2.2 Building, rooms, compartments and other interior spaces shall be assessed in accordance with Sections 6.1.2, 6.1.3, 6.1.4 or 6.1.5.

6.1.2.3 Determination of exposure to personnel and protection from a dust flash fire. shall be in accordance with NFPA 2113 Standard on Selection, Care, Use, and Maintenance of Flame-Resistant Garments for Protection of Industrial Personnel Against Flash Fire.

6.1.2.3 ~~4~~ The process equipment shall be assessed in accordance with Section 6.1.10.

6.1.3* Unless supported by calculations per 6.1.4 and 6.1.5, or using the method in 6.1.6, dust explosion hazard areas ~~and dust flash fire hazard~~ areas shall be deemed to exist when the total accumulated dust on any surfaces exceeds the thresholds calculated in 6.1.3.1 or 6.1.3.2, respectively.

Delete all of 6.1.5 and associated Annex material

6.1.6.2* A dust explosion hazard ~~and dust flash fire hazard~~ shall be deemed to exist where dust clouds of a hazardous concentration exist or where any of the following conditions exist:

Substantiation: The proposed wording has criteria for determining when an individual is subject to a potential flash fire. The equations and factors provided in the proposal are in conflict with the guidance provided in NFPA 2113 which was established in OSHA Combustible Dust National Emphasis Program (Reissued) CPL-03-00-008 page 20 item g as the document industry should use. In NFPA 2113, the criteria given as determining if a dust presents a flash fire (particle size, minimum ignition temperature, and moisture) are not included in the equations in the proposal. NFPA should ensure that there is no confusion in which NFPA document should be utilized by the user.

654- Log #73 CMD-HAP
(6.1.4)

Final Action:

Submitter: Hugh D. Castles, Entergy Services, Inc. / Rep. Edison Electric Institute, Fire Protection and Loss Prevention Task Force

Comment on Proposal No: 654-22

Recommendation: Delete text to read as follows:

Delete 6.1.4 entirely

Substantiation: The Committee has made a simple process much more difficult to enforce and evaluate by using equations that are insufficiently, demonstrated or substantiated. Specifically it continues to use the "entrainment factor" which has been neither clearly defined, nor proven by experimental data. Data to assign to it cannot be found in any readily available reference. The entrainment factor issue was one of the main reasons the document was voted by the Fall 2010 Annual convention to return the document to committee. As proposed, it appears to be unworkable or unenforceable in the real world. The fact that none of the frequently cited tragic outcomes conformed to NFPA 654 in its original form clearly shows a lack of enforcement--- not requirements that were too lax. To echo the words of John Cholin, the outcomes "do not indicate a need to make the document more stringent-they indicate a need to make the document more useable."

This is not original material; its reference/source is as follows:

John Cholin, Explanation of Negative, Proposal 654-22, A2012 ROP

654- Log #93 CMD-HAP
(6.1.4)

Final Action:

Submitter: George Petino, Jr., Hazards Research Corporation, Inc.

Comment on Proposal No: 654-22

Recommendation: We are troubled by the proposed adoption of formulas based on an entrainment fraction for which, per A.6.1.4.2, "research activities are currently in progress to define a technical basis for estimating [its values]."

Substantiation: The research should be completed, peer reviewed and published before reliance on this model is incorporated into an NFPA standard.

654- Log #94 CMD-HAP
(6.1.7)

Final Action:

Submitter: George Petino, Jr., Hazards Research Corporation, Inc.

Comment on Proposal No: 654-22

Recommendation: This provision should be revised to read as follows:

"An explosion hazard shall be deemed to exist in enclosed process equipment where, based on a risk evaluation, a determination is made that the existence of all of the following conditions in the process equipment is credible ~~are possible~~:

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

(2) A means of suspending the dust is present, and

(3) An ignition source at the minimum ignition energy or the minimum ignition temperature."

Substantiation: The revision recognizes that the required determination can be made only by performing a risk evaluation. That assessment should include an assessment of potential ignition sources rather than assuming the existence of an ignition source. The appropriate test criterion is "credible" rather than "possible." Anything with a probability greater than zero is possible.

654- Log #74 CMD-HAP
(6.1.8)

Final Action:

Submitter: Hugh D. Castles, Entergy Services, Inc.

Comment on Proposal No: 654-22

Recommendation: Delete text to read as follows:

Delete new section 6.1.8.

Substantiation: Personal protective equipment (PPE) is addressed in Proposal 654-85 in new section 11.2.2 (accepted by TC). The wording in proposed new section 6.1.8 forces a decision regarding PPE per the NFPA 654 criteria for "dust flash fire hazard" per new section 6.1.6.2 which is incomplete as printed in the ROP. NFP A 2113 addresses PPE and is referenced in the text included in Proposals 654-85 (new section 11.2.2) and 654-62 (new A.8.2.2.5).

Section 6.1.6.2 is incomplete as there are no conditions listed.

Section 6.1.7 appears to be incomplete as subsection (2) ends with "and".

654- Log #69 CMD-HAP
(7.1.4)

Final Action:

Submitter: Thomas C. Scherpa, The DuPont Company, Inc.

Comment on Proposal No: 654-35

Recommendation: Add new text to read as follows:

Insert new 7.1.4.2 as follows:

7.1.4.2 The requirement of 7.1.4.1 shall not apply where all of the following conditions are met:

- (1) The material being conveyed is not a metal dust or hybrid mixture
- (2) The connecting ductwork is smaller than 4 inches (100 mm) nominal diameter
- (3) The maximum concentration of dust conveyed through the duct is less than 25% of the MEC of the material
- (4) The conveying velocity is sufficient to prevent accumulation of combustible dust in the duct
- (5) All connected equipment is properly designed for explosion protection.

Substantiation: This text was rejected at the proposal stage with a recommendation that it be modified and resubmitted at the comment stage. The first three requirements are still substantiated by text in the AICHE CCPS Guidelines for Safe Handling of Powders and Bulk Solids. Additionally, the second requirement is substantiated by text in Holbrow et al, 1999: "The experimental trials have shown that if the pipe diameter is less than 0.1 m the probability of transmission would seem to be very low, and may be ignored for design purposes."

The fourth requirement is necessary to ensure that deposited material does not contribute to an abnormally high concentration at the moment of the primary explosion. A properly designed system should satisfy this requirement anyway, and so this should not be an onerous requirement.

The fifth requirement is based on the existing text in Annex E.3.1, which has not been modified at the ROP stage.

If the committee does not consider the fourth and fifth requirements to be adequately substantiated, then one or both of these requirements could be removed and the other requirements could stand.

This is not original material; its reference/source is as follows:

Substantiation text includes a quote from P. Holbrow, G. A. Lunn, A. Tyldesley, Dust explosion protection in linked vessels: guidance for containment and venting, Journal of Loss Prevention in the Process Industries, Volume 12, Issue 3, May 1999, Pages 227-234

654- Log #95 CMD-HAP
(7.2.3.3.3)

Final Action:

Submitter: George Petino, Jr., Hazards Research Corporation, Inc.

Comment on Proposal No: 654-31

Recommendation: This provision should be revised as follows:

"The explosion protection requirements of 7.1.4~~2~~ shall not be required provided that the volume of the fixed bulk storage container is less than 8 ft³ (0.2 m³), and the fixed bulk storage container does not serve metal grinders, hot work processes, or machinery that can produce sparks.

Substantiation: We believe this provision should be consistent with the proposed enclosureless AMS provision in 7.13.1.1.2(4).

654- Log #100 CMD-HAP
(7.10.9.4)

Final Action:

Submitter: Jason Krbec, CV Technology, Inc.

Comment on Proposal No: N/A

Recommendation: Delete text to read as follows:

~~7.10.9.4 The requirement of 7.10.9.1 shall not apply to elevators that have belt speeds below 500 ft/min (150 m/min) or capacities less than 3750 ft³/hr (106 m³/hr).~~

Substantiation: The belt speed or capacity has no influence on the reduced explosion pressure or the likely hood of an event occurring in a bucket elevator. The Health and Safety Executive (HSE) published a paper by Holbrow, P., Lunn, G. A., Tyldesley, A. titled Explosion Venting of Bucket Elevators in the *Journal of Loss Prevention in the Process Industries*, 15 (2002), 373-383. The article provides extensive test data for the design of explosion venting with regards to bucket elevators.

The paper concludes that belt speed had no noticeable effect on the reduced explosion pressure. Belt misalignment, hot bearing temperatures and excessive vibration should all be monitored as they are credible ignition sources independent of the capacity of a bucket elevator.

654- Log #70 CMD-HAP
(7.12.2)

Final Action:

Submitter: Thomas C. Scherpa, The DuPont Company, Inc.

Comment on Proposal No: 654-48

Recommendation: Revise text to read as follows:

7.12.2.2* The requirement of 7.12.2.1 shall not apply to systems designed to operate at a combustible particulate solids concentration or hybrid mixture concentration of less than ~~25%~~ 10% of the MEC or the lower of the MEC or LFL for the hybrid mixture where hybrid mixtures are present.

7.12.2.3* The requirement of 7.12.2.1 shall not apply to systems meeting both of the following criteria:

(1) Systems operating at a combustible particulate solids concentration or hybrid mixture concentration equal to or greater than ~~25%~~ 10% of the MEC or the LFL for the hybrid mixture where hybrid mixtures are present.

(2) Systems protected by an approved explosion prevention or isolation system to prevent the propagation of the flame front from the fan to other equipment in accordance with 7.1.2.1(1), 7.1.2.1(4), 7.1.2.1(5), 7.1.4.2(3), 7.1.4.2(4), or 7.1.4.2(5).

7.12.2.4 Where the MEC value is unknown, it shall be permitted to assume a value of 0.03 oz/ft³ (30 g/m³)

7.12.2.5 Where an air moving device is located in the dirty air stream and the dust/air stream concentration is higher than ~~25%~~ 10% of the MEC, fans and blowers shall be of Type A or B spark-resistant construction per AMCA 99-0401-86, Classifications for Spark Resistant Construction.

A.7.12.2.2 Some systems are designed to operate at solids concentrations that pose no fire or deflagration risk. Such systems include nuisance dust exhaust systems and the downstream side of the last air-material separator in the pneumatic conveying system.

A threshold concentration limit of ~~25%~~ 10% of the MEC has been set to discriminate between such systems and other systems designed to operate at a significant combustible solid loading. This limit ensures that normal variations in processing conditions do not result in the combustible particulate or hybrid mixture concentration approaching the MEC.

A.7.12.2.5 The production of mechanical sparks is only one possible ignition mechanism from a fan or blower. Frictional heat due to contact between moving parts (misalignment) or bearing failure can present an ignition source both in the fan and downstream. Additionally, these failure mechanisms can result in a decrease in airflow through the air moving device which can result in an increase in the combustible dust concentration coincident with the creation of an ignition source.

Substantiation: At the proposal stage, the concentration threshold for requiring additional protection on fans and blowers in dirty air streams was raised from nominally 1% of MEC to 25% of MEC. One of the justifications for this change was for consistency with the 25% LEL operating limit for ovens and dryers processing flammable vapors. I disagree with the notion of equating the dust concentration limit with that of flammable vapors and gases because 1) many dust handling operations produce transient and nonuniform dust concentrations making it difficult to apply an 'average' design concentration concept as is often done with flammable vapors, and 2) unlike flammable vapors, combustible dusts can settle out of an airflow, creating deposits within the system that can be disturbed to create a dust concentration higher than the design concentration. This is supported by text in the CCPS Guidelines for Safe Handling of Powders and Bulk Solids, which states "Combustible concentration reduction is more feasible for equipment containing gases and vapors than for systems containing combustible solids because the dust concentration inside process equipment very often varies in unpredictable and uncontrollable ways. Often there is a tendency for the dust to fall out of suspension and settle on internal surfaces, later to be thrown into suspension, forming an ignitable concentration."

For these reasons, additional conservatism is warranted, and so I have proposed changing the threshold to 10% of MOC. This is an order of magnitude higher than the previous limit, yet still an order of magnitude below the MOC.

Annex material was also added to caution against other ignition sources that are possible with spark resistant fans.

This is not original material; its reference/source is as follows:

A quote in the substantiation was taken from the book "Guidelines for Safe Handling of Powders and Bulk Solids", 2005, Center for Chemical Process Safety of the American Institute of Chemical Engineers, Three Park Avenue, New York, New York, 10016.

654- Log #96 CMD-HAP
(7.12.2.5)

Final Action:

Submitter: George Petino, Jr., Hazards Research Corporation, Inc.

Comment on Proposal No: 654-48

Recommendation: This provision should be eliminated. References in the standard to 25% of the MEC should be replaced with the MEC.

Substantiation: Our experience is that use of spark-resistant construction can lead to metal-to-metal surface contact and friction generating temperatures in excess of 600°C, which exceeds the ignition temperature of most combustible dusts. Therefore, this is not a recommended design for dirty air streams.

654- Log #66 CMD-HAP
(7.13.1.1.2(4))

Final Action:

Submitter: Jack E. Osborn, Airdusco, Inc.

Comment on Proposal No: 654-53

Recommendation: New text to read as follows:

7.13.1.1.2(4) Enclosureless air-material separator meeting all the following criteria shall be permitted to be used:

- (a)* The AMS is used only for wood and wood products including paper.
- (b) The AMS is not used to vent or serve metal grinders, hot work processes, or machinery that can produce sparks.
- (c)* Each collector has a maximum air-flow handling capacity of 2.4 cu. meters (5,000 cfm) with a maximum filter volume of 8 cu. ft.
- (d) The fan motor is suitable for Class II, Division 2, or Class III, as appropriate (for example, totally enclosed, fan-cooled design).
- (e) The collected dust is removed daily or more frequently if necessary to ensure efficient operation and to limit the collected dust to less than 10 kg.
- (f) The collector is located at least 6.1 m (20 ft.) from any means of egress or area routinely occupied by personnel.
- (g)* Multiple collectors in the same room are separated from each other by at least 6.1 m (20 ft.).
- (h) The MIE of the collected materials is greater than 1000 mJ.
- (i)* If the fabric for the bag is demonstrated to meet Type B, C, or D FIBC properties, it shall not be required to meet 7.13.1.1.2(4)(g).

(j) The fan construction must be spark resistant and meet the criteria in 7.12.2.

(k)* The AMS is not used to vent or serve sanders, abrasive planers, or similar sanding process equipment.

A.7.13.1.1.2(4)(a) Enclosureless dust collectors are not meant for use with most dusts created during the venting of process equipment or other aerated dust sources. Fine dust will rapidly blind the filter which results in reduced performance and a significant increase in deflagration hazards associated with the system operation and performance. Use of the enclosureless AMS for typical sawdust, paper dust, and similar particles has been proven to be effective, within the conditions listed, when applied properly.

A.7.13.1.1.2(4)(c) Many of the enclosureless dust collectors are manifolded into multiple bags with containers. The 5,000 cfm limit refers to the overall airflow through the assembly and not just to a single bag with collected material container.

A.7.13.1.1.2(4)(g) Enclosureless dust collectors are often manifolded into multiple bags (with collected material containers). Each such manifolded assembly must be separated by the requires 6.1 m or 20 ft.

A.7.13.1.1.2(4)(i) Refer to 9.3.3 for more information.

Substantiation: The Committee has provided new test to permit the use of enclosureless dust collectors under a list of conditions. These units have been used extensively in the wood industry and have proven safe under the listed conditions. They are also permitted for use in NFPA 664 under similar conditions.

Also, by placing limits on these units for use only with certain materials and conditions, the risks involved with incorrectly applying enclosureless dust collectors for fine dust emissions is specifically avoided.

This is not original material; its reference/source is as follows:

NFPA 654 Task Group on this section.

654- Log #97 CMD-HAP
(7.13.1.2.1)

Final Action:

Submitter: George Petino, Jr., Hazards Research Corporation, Inc.

Comment on Proposal No: 654-49, 654-50, 654-53

Recommendation: This provision should be revised to read as follows:

“Where both an explosion hazard and a fire hazard exist in an air–material separator, *other than an enclosureless AMS meeting the criteria of 7.13.1.1.2(4)*, provisions for protection for each type of hazard shall be provided.”

Substantiation: Section 7.13.1.1 appears to go to a significant effort to create an exemption from the location requirements for enclosureless AMS with a filter volume of less than 8 cubic feet, but we did not see a comparable exemption in the protection requirements of 7.13.1.2, which would appear to render the exemption in 7.13.1.1 ineffective.

654- Log #67 CMD-HAP
(8.2.1.3)

Final Action:

Submitter: Mindy Wang, Ampco Safety Tools

Comment on Proposal No: 654-63

Recommendation: To add new text to read as follows:

8.2.1.3 Tools for cleanup of fugitive dusts or collecting sweepings shall be spark resistant.

Substantiation: In response to the original proposal the Committee expressed multiple concerns. The following is intended to discuss each of these concerns:

1. The Committee cites “published literature from API Recommended Practice 2214, Bureau of Mines, and Eckhoff, “Dust Explosions in the Process Industries, 3rd Edition that does not support the need for non-sparking tools in the application recommended.”

- API Recommended Practice 2214 has been withdrawn, effective May 1 2011. API announced the withdrawal of API RP 2214 on June 3 of API SmartBrief, “The withdrawal of RP 2214 is in recognition of a forthcoming revision in the 2012 edition of NFPA 30, Flammable and Combustible Liquid Code. New explanatory material provided in Annex A of NFPA 30 discusses the need to control sources of ignition, including mechanical sparks from hand tools that might have sufficient energy to ignite flammable vapors. The API Safety and Fire Protection Group determined that the new language in NFPA 30 recognizes that there is a potential for hand tool sparks to ignite flammable vapors for a limited number of chemicals and under certain unique conditions.” API now recognizes the need to control mechanical sparks from hand tools and withdraws API RP 2214.

- Bureau of Mines, “Frictional Ignition of Gas by Mining Machines”, concluded that “...Although the presence of frictional sparks is a warning of potential danger, it should be remembered that hot spots on the contacting surfaces can cause ignitions without visual sparking. To avoid ignitions, gas accumulation and frictional heating or frictional sparks must be prevented.” Although Bureau of Mines did not recommend of spark resistant tools in this report, Bureau of Mines recognized the fact that frictional sparks can ignite flammable gas. Published by OSHA, Occupational Safety and Health Guideline for Coal Dust (< 5% SiO₂) summarizes pertinent information about coal dust for workers and employers as well as for physicians, industrial hygienists, and other occupational safety and health professionals who may need such information to conduct effective occupational safety and health programs. One of the steps for undertaking of coal dust spills and leaks is to use non-sparking tools.

- In “Dust Explosions in the Process Industries” 3rd Edition, Rolf K. Eckhoff concluded that “...up to net impact energies of 20J, tangential accidental single impacts between various types of steel and between steel and rusty steel or concrete are unable to ignite clouds of grain and feed dust or flour, even if the dusts are dry.....However, for net impact energies > 20J the situation may be different.” Eckhoff’s conclusion on impact sparks ignition is limited to power density of 20J. Eckhoff does not come to clear conclusion that impact sparks greater than 20J will not pose an ignition hazard. In fact, power density from steel impact sparks can generate energy greater than 20J and is illustrated in Section 3 below.

2. The Committee stated that “The submitter’s incident citations are not applicable to the operation of cleaning or sweeping as proposed in the recommendation; the incidents cited all involve use of hand tools in a maintenance application.”

- We are perplexed by the Committee’s statement. Although the incident citations are not in cleaning operation, the combustible nature of dusts and risk for ignition from steel tools are present as evidenced by the incidents cited. The Report of the BP U.S. Refineries independent Safety Review Panel, also known as the Baker Panel Report, states that “Preventing process accidents requires vigilance. The passing of time without a process accident is not necessarily an indicator that all is well and may contribute to a dangerous and growing sense of complacency.” In a testimony to the Congress, Jordan Barab, Assistant Secretary for the Occupational Safety and Health Administration U.S. Department of Labor states that conventional injury and illness rates are not adequate indicators of the risk of fires, explosions, or other catastrophic accidents, and companies need to develop better leading indicators to assess risks in their workplaces.

3. The Committee stated that “The submitter has not provided calculations showing that the power density produced by tool impact in probable scenarios is sufficient to ignite the particulates encompassed in the scope of NFPA 654.” Calculations of power density of mechanical sparks and hot surfaces from steel hand tools can have enough energy to ignite dust/air mixture.

- Dust Explosions in the Process Industries, by Rolf K. Eckhoff, table A.1 Ignitability and Explosibility of Dusts, lists minimum ignition energy (MIE) and minimum ignition temperature(MIT) for various dust layers, a few examples:

INSERT TABLE 654_L67 here

Mechanical sparks include impact sparks and friction sparks. In his study, Initiation of Grain Dust Explosions by Heat Generated during Single Impact between Solid Bodies, Rolf K. Eckhoff reported typical spark temperatures for mild steel were ~1500°C - 2700°C. Spark temperature of steel hand tools exceeds the auto-ignition temperature of dusts within the scope of NFPA 654.

· A test conducted by W. Bartknecht, Ignition Capability of Hot Surfaces and Mechanically Generated Sparks in Flammable Gas and Dust/Air Mixtures showed that if steel is rubbed against steel for a longer duration, (0.5-2.0 seconds) then friction sparks are generated. At ignition temperature 400°C, the electrical equivalent energy by steel friction sparks range from 10mJ to 100mJ. At the same ignition temperature, dust will be ignited which have a MIE of less than 100 mJ. Bartknecht concluded that "Hot surfaces generated with steel rubbed against steel will ignite dust/air mixtures easier than flammable gas/air mixtures because the ignition process depends solely on the temperature of the hot surface and the auto-ignition temperature." Therefore, friction sparks from steel wrenches could generate enough power density to ignite dusts found within the scope of NFPA 654.

- In his study, Initiation of Grain Dust Explosions by Heat Generated during Single Impact between Solid Bodies, Eckhoff concluded that "Therefore, it seems unlikely that dust explosions involving dusts of grain, feed or flour can be initiated by heat from accidental single impacts between tramp metal, and anvils of metal, corroded metal, stone or concrete, unless the net impact energies are much higher than 20 J."

- In Ignition of Dust Control and Dust Deposits by Friction Sparks and Hotspots by R L Rogers and others reported a single impact of more than 217 Joules kinetic energy is needed to ignite saw dust.

- Kinetic energy can be calculated as $E_k = \frac{1}{2}MV^2$, m is the mass in kilograms, V is velocity in meter per second (m/s), E_k is the kinetic energy in joules. Rogers' calculation of 217 Joules kinetic energy is based on the assumption of a low velocity of 1 m/s. However, this does not directly relate to hand tools use which is frequently a high velocity application. In the field, hand tool impact can easily generate an impact greater than 1m/s. In Eckhoff's test study, he used a range of 10m/s to 25m/s. Based on assumptions of a 3 pound hammer with an impact velocity of 18m/s, calculated kinetic energy is 220 Joules. Another example, a 5 pound hammer with an impact velocity of 14m/s, calculated kinetic energy is 235 joules. Calculations here show that impact sparks from hand tools can generate power density greater than 20 J reported in Eckhoff's study or 217 J reported in Roger's.

- Rogers also stated that "In assessing the risk of ignition of powder deposits from friction of mechanical equipment it is necessary to consider not only the total power but also the temperatures that are produced." As stated earlier, spark temperature of steel hand tools exceeds the auto-ignition temperature of dusts within the scope of NFPA 654.

A few more documented steel on steel accidents in dust environments:

Friction spark from steel on steel: OSHA inspection# 15050487, a piece of tramp metal was accidentally dumped into the south side hopper along with a load of wood chips and plywood trimmings. The movement of the screens caused a spark to occur. This spark ignited the dust in the confined area of the large and open-spaced dump house.

Spark from a hand tool: listed as accident#82 on dust incident data compiled by the Chemical Safety Board(CSB), an explosion resulted as a spark created by a worker with an Allen wrench who was turning a screw to adjust a machine. The spark ignited some propellant dust and a vacuum system carried the fire another room where a barrel of dust exploded.

Impact spark from metal on metal: listed as accident#257 on dust incident data compiled by the CSB, an explosion resulted as spark from a metal on metal strike ignited sawdust and wood shavings when hot embers from a metal strike entered the dust collection system.

Without the proposed specification, steel tools are likely to be used which can be a source of ignition. The proposed text can better mitigate the flammability hazards associated with steel tools for cleanup of fugitive dusts where combustible dusts are present. We respectfully request the committee to reconsider and take action to implement safer work practices. However, if upon further consideration, the Committee still does not see the need for restricting ferrous tools we ask the Committee to at least include the proposed text in Annex text to raise the awareness of ignition hazard associated with ferrous tools in areas where airborne dust or dust accumulations are apt to occur.

This is not original material; its reference/source is as follows:

API SmartBrief, API RP 2214, "Spark Ignition Properties of Hand Tools" Withdrawn, June 3 2011. Available: <http://www.smartbrief.com/news/api/storyDetails.jsp?issueid=D7A54ABE-AE46-4C17-BBDD-7A1B9CE0F8A3©>

id=DB2EC347-F8F7-4C56-9B45-4598329D217A&brief=api&sb_code=rss&&campaign=rss Dust Explosions in the Process Industries, 3rd Edition, by Rolf K. Eckhoff Initiation of Grain Dust Explosions by Heat Generated during Single Impact between Solid Bodies, Geir H. Pedersen and Rolf K. Eckhoff Ignition Capabilities of Hot Surfaces and Mechanically Generated Sparks in Flammable Gas and Dust/Air Mixtures, W. Bartknecht Ignition of Dust Clouds and Dust Deposits by Friction Sparks and Hotspots, R L Rogers, S Hawksworth, M Beyer, C Proust, D Lakic, J Gummer & D Raveau

<u>Dust</u>	<u>MIE(mJ)</u>	<u>Equivalent Joules</u>	<u>MIT(°C)</u>
Rubber (dust from grinding):	13	0.013Joules	500
Methylmethacrylate-Butadiene-Styrene:	11	0.011Joules	470
L-Cystin	40	0.04 Joules	400
Methionine	9	0.009Joules	390
Methyl cellulose	12	0.012Joules	400
Dimethyl terephthalate	2	0.002 Joules	460
Emulgator (50% CH, 30% fat)	17	0.017Joules	430
Ferrocene	5	0.005Joules	500
Naphtalic acid anhydride	3	0.003Joules	690
Zinc stearate	5	0.005Joules	520
Stearin/calcium	25	0.025Joules	620
Toner	8	0.008Joules	530

654- Log #68 CMD-HAP
(9.1.5)

Final Action:

Submitter: Mindy Wang, Ampco Safety Tools

Comment on Proposal No: 654-69

Recommendation: To add new text to read as follows:

9.1.5 Equipment. Equipment with moving parts shall be installed and maintained so that true alignment is maintained and clearance is provided to minimize friction. Spark resistant tools shall be used to make repairs or adjustment on or around any machinery where combustible dust is present.

Substantiation: In response to the original proposal the Committee expressed multiple concerns. The following is intended to discuss each of these concerns:

1. The Committee cites “published literature from API Recommended Practice 2214, Bureau of Mines, and Eckhoff, “Dust Explosions in the Process Industries, 3rd Edition that does not support the need for non-sparking tools in the application recommended.”

- API Recommended Practice 2214 has been withdrawn, effective May 1, 2011. API announced the withdrawal of API RP 2214 on June 3 of API SmartBrief, “The withdrawal of RP 2214 is in recognition of a forthcoming revision in the 2012 edition of NFPA 30, Flammable and Combustible Liquid Code. New explanatory material provided in Annex A of NFPA 30 discusses the need to control sources of ignition, including mechanical sparks from hand tools that might have sufficient energy to ignite flammable vapors. The API Safety and Fire Protection Group determined that the new language in NFPA 30 recognizes that there is a potential for hand tool sparks to ignite flammable vapors for a limited number of chemicals and under certain unique conditions.” API now recognizes the need to control mechanical sparks from hand tools and withdraws API RP 2214.

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2. The Committee stated that “The submitter has not provided calculations showing that the power density produced by tool impact in probable scenarios is sufficient to ignite the particulates encompassed in the scope of NFPA 654.”

Calculations of power density of mechanical sparks and hot surfaces from steel hand tools can have enough energy to ignite dust/air mixture.

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INSERT TABLE 654_L68_S HERE

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Flammable Gas and Dust/Air Mixtures showed that if steel is rubbed against steel for a longer duration, (0.5-2.0 seconds) then friction sparks are generated. At ignition temperature 400°C, the electrical equivalent energy by steel friction sparks range from 10mJ to 100mJ. At the same ignition temperature, dust will be ignited which have a MIE of less than 100 mJ. Bartknecht concluded that "Hot surfaces generated with steel rubbed against steel will ignite dust/air mixtures easier than flammable gas/air mixtures because the ignition process depends solely on the temperature of the hot surface and the auto-ignition temperature." Therefore, friction sparks from steel wrenches could generate enough power density to ignite dusts found within the scope of NFPA 654.

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Rogers also stated that "In assessing the risk of ignition of powder deposits from friction of mechanical equipment it is necessary to consider not only the total power but also the temperatures that are produced." As stated earlier, spark temperature of steel hand tools exceeds the auto-ignition temperature of dusts within the scope of NFPA 654.

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Without the proposed specification, steel tools are likely to be used which can be a source of ignition. The proposed text can better mitigate the flammability hazards associated with maintenance in or around machinery and equipment with steel tools where combustible wood dusts are present. We respectfully request the committee to reconsider and take action to implement safer work practices. However, if upon further consideration, the Committee still does not see the need for restricting ferrous tools we ask the Committee to at least include the proposed text in Annex text to raise the awareness of ignition hazard associated with ferrous tools in areas where airborne dust or dust accumulations are apt to occur.

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API SmartBrief, API RP 2214, "Spark Ignition Properties of Hand Tools" Withdrawn, June 3 2011. Available: http://www.smartbrief.com/news/api/storyDetails.jsp?issueid=D7A54ABE-AE46-4C17-BBDD-7A1B9CE0F8A3©id=DB2EC347-F8F7-4C56-9B45-4598329D217A&brief=api&sb_code=rss&&campaign=rss Dust Explosions in the Process Industries, 3rd Edition, by Rolf K. Eckhoff Initiation of Grain Dust Explosions by Heat Generated during Single Impact between Solid Bodies, Geir H. Pedersen and Rolf K. Eckhoff Ignition Capabilities of Hot Surfaces and Mechanically Generated Sparks in Flammable Gas and Dust/Air Mixtures, W. Bartknecht Ignition of Dust Clouds and Dust Deposits by Friction Sparks and Hotspots, R L Rogers, S Hawksworth, M Beyer, C Proust, D Lakic, J Gummer & D Raveau

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Emulgator (50% CH, 30% fat)	17	0.017Joules	430
Ferrocene	5	0.005Joules	500
Naphtalic acid anhydride	3	0.003Joules	690
Zinc stearate	5	0.005Joules	520
Stearin/calcium	25	0.025Joules	620
Toner	8	0.008Joules	530

654- Log #99 CMD-HAP
(9.3)

Final Action:

Submitter: Bill Stevenson, CV Technology, Inc.

Comment on Proposal No: 654-14

Recommendation: Revise text to read as follows:

~~9.3.3 Intermediate Bulk Containers (IBCs):~~

~~9.3.3.1* Dispensing material from intermediate bulk containers into combustible atmospheres shall be performed only under the following conditions:~~

~~(1) A conductive (i.e., metallic) rigid intermediate bulk container (RIBC) shall be permitted to be used for dispensing into any flammable vapor, gas, dust, or hybrid atmospheres provided the RIBC is electrically grounded:~~

~~(2)* A Type B flexible intermediate bulk container (FIBC) shall be permitted to be used for dispensing into dust atmospheres where the minimum ignition energy (MIE) is greater than 3 mJ, but no flammable vapor or gas is present:~~

~~(3)* A Type C FIBC shall be permitted to be used for dispensing into any flammable vapor, gas, dust, or hybrid atmosphere for which the FIBC has been tested and found suitable, provided the FIBC is electrically grounded with a resistance less than 1 megohm to ground:~~

~~(4)* A Type D FIBC shall be permitted to be used for dispensing into flammable vapor, gas, dust, or hybrid atmospheres for which the FIBC has been tested and found suitable:~~

~~(5)* A Type A FIBC or insulating RIBCs shall not be permitted to be used for combustible powder applications, processes, or operations unless a documented risk evaluation assessing the electrostatic hazards is acceptable to the authority having jurisdiction:~~

~~9.3.3.2* FIBCs that are listed or tested by a recognized testing organization and are shown not to ignite flammable atmospheres during transfer shall be permitted to be used:~~

~~9.3.3.3 Documentation of test results shall be made available to the authority having jurisdiction:~~

~~IGNITION SOURCES 654-17~~

~~2006 Edition~~

9.3.3 Flexible Intermediate Bulk Containers (FIBCs).

9.xxx Description. Flexible intermediate bulk containers (FIBCs) are basically very large fabric bags supported in a frame. They are more convenient than rigid IBCs, because they can be fully collapsed after use, taking up little storage space.

9.xxx The fabric is usually polypropylene, and the fabric is sewn to form a three-dimensional cube or rectangle with lifting straps. An FIBC can be filled with a powder or granular material and moved about with conventional materials-handling equipment.

9.xxx An advantage of FIBCs is that they can be unloaded quickly, typically 300 kg to 500 kg in 30 sec or less. Therefore, rates at which static electric charges are generated can often exceed the rates at which the charges can relax under common conditions of use, and accumulation of a static electric charge can be expected.

9.xxx Charge Generation. Static electric charges can be generated during the filling and emptying of FIBCs and can accumulate on both the contents and the fabric of the FIBC. If the accumulated charge is strong enough and is released in the presence of an ignitable atmosphere, ignition can occur.

9.xxx Types of FIBCs and Inner Liners. The International Standard IEC 61340-4-4 describes four types of FIBCs, Type A, Type B, Type C, and Type D, defined by the construction of the FIBCs, the nature of their intended operation and associated performance requirements. FIBCs should be tested in accordance with the requirements and test procedures specified in IEC 61340-4-4 and in accordance with their intended use before being used in hazardous environments. See Table 10.1.6.3 for a summary of FIBC use, as described in Sections 10.1.6.4 through 10.1.6.7. The subject of inner liners is not addressed in this *Recommended Practice*. Guidance on the safe use of inner liners is given in IEC 61340-4-4.

9.xxx Type A FIBCs.

9.xxx Type A FIBCs are constructed of nonconductive materials (e.g. polypropylene fabric with polyester stitching) and have no special features incorporated in their design to control static electric discharge hazards. Type A FIBCs can be used for materials that do not form ignitable atmospheres in normal handling operations.

9.xxx Experience has shown that Propagating brush discharges can occur in Type A FIBCs. The energy released in propagating brush discharges can reach 1000 mJ. The following criteria apply:

(1) Type A FIBCs should not be used for powder or granular materials that have an MIE of less than 1000 mJ.

(2) Type A FIBCs should never be used in areas where a flammable (gas, vapor, hybrid) atmosphere is present.

(3) Type A FIBCs should not be used for conductive powders ($P_v < 1$ megohm-m).

9.xxx Type B FIBCs.

9.xxx Type B FIBCs, like Type A FIBCs, are constructed of nonconductive materials (e.g., polypropylene fabric with polyester stitching). However, the material of construction of Type B FIBCs is designed to have a breakdown voltage less than 6KV and hence control static electric discharge hazards.

9.xxx Type B FIBCs are designed to avoid the occurrence of propagating brush discharges. Propagating brush discharges can only occur in FIBCs if the materials from which FIBCs are constructed have sufficient electrical strength to sustain high surface charge densities. Research has shown that propagating brush discharges cannot occur if the breakdown voltage of the materials used to construct FIBCs is less than 6 kV.

9.xxx Filling charged, high resistivity powder into FIBCs may generate a region of very high space charge density within the heap of bulked powder. This leads to high electrical fields at the top of the heap. Under these circumstances, cone discharges running along the surface have been observed. Although cone discharge can occur in all forms of containers, including grounded conductive containers, cone discharges may have a much higher energy in Type B FIBCs than in grounded conductive containers, where the walls of the containers will be at close to zero potential. Energy calculations predict that in Type B FIBC, cone discharges may be incendiary to powders with MIE of up to 3 mJ.

9.xxx Since Type B FIBCs have no mechanism for dissipating electrostatic charge, brush discharges might occur that can ignite flammable gases and vapors. The following criteria apply:

(1) Type B FIBCs should be made from materials with breakdown voltage less than 6 kV.

(2) Type B FIBCs should not be used for powder or granular materials that have an MIE of 3 mJ or less.

(3) Type B FIBCs should never be used in areas where a flammable (gas, vapor, hybrid) atmosphere is present.

(4) Type B FIBCs should not be used for conductive powders ($P_v < 1$ megohm-m).

9.xxx Type C FIBCs.

9.xxx Type C FIBCs are constructed entirely from conductive material or insulating material that contain fully inter-connected conductive threads or tapes with specific spacing and can be treated the same way as conductive IBCs, as specified in Section 10.1.4. It is essential that Type C FIBCs be grounded during filling and emptying operations.

9.xxx FIBCs constructed of nonconductive fabric and containing woven, grounded, conductive filaments can be considered to be conductive. One type of FIBC has conductive filaments spaced less than 20 mm apart, each of which is connected at least once to its neighbor, preferably at both ends. They are intended to be grounded. Another type has conductive filaments or threads that form an interconnecting grid of not more than 50 mm mesh size. They also are intended to be grounded.

9.xxx The recommendations for conductive IBCs given in Section 10.1.4 also apply to conductive FIBCs. A grounding tab that is electrically connected to the conductive material or threads is provided and is intended to be connected to a ground point when the FIBC is filled or emptied. The resistance between the conductive elements in the FIBC and the grounding tabs should be less than $1.0 \times 10^2 \Omega$.

9.xxx For FIBCs constructed of multi-layer materials, the resistance between the inside or outside surface of the FIBC and the grounding tabs should be less than $1.0 \times 10^2 \Omega$. If the inside layer does not have a resistance to grounding tabs of less than $1.0 \times 10^2 \Omega$, then the material should have a breakdown voltage of less than 6 kV. All layers of multi-layer materials should remain in firm contact during filling and emptying operations.

9.xxx Materials used to construct inner baffles, other than mesh or net baffles, should meet the requirements stated in Sections 10.1.6.6.3 and 10.1.6.6.4.

9.xxx Type D FIBCs.

9.xxx Type D FIBCs are constructed from fabrics and/or threads with special electrostatic properties to control discharge incendivity and are intended for use without grounding in the presence of flammable vapors or gases with MIE of 0.14 mJ or greater, and with combustible powders, including those with ignition energies of 3 mJ or less.

9.xxx Before being used in hazardous environments, Type D FIBCs should be qualified as safe, i.e. by demonstrating that no incendiary discharge can occur under normal operating conditions. IEC 61340-4-4 describes test procedures for ignition testing that can be used for this purpose.

9.xxx If Type D FIBCs are made from materials that have an insulating layer (e.g. coating film or lamination) on the inside of the container, the materials should have a breakdown voltage of less than 6 kV. All layers of multi-layer materials shall remain in firm contact during filling and emptying operations.

*****Insert Table 9.xxx Here*****

Substantiation: The recommended changed text reflects the latest changes to the EN document. This new text is identical to that agreed to at the ROP meeting for NFPA 77. Adoption of this text would align 654 with 77 and be consistent with the EN document.

654- Log #71 CMD-HAP
(9.3.1.2)

Final Action:

Submitter: Thomas C. Scherpa, The DuPont Company, Inc.

Comment on Proposal No: 654-70

Recommendation: Revise text to read as follows:

9.3.1.2 Nonconductive system components shall be permitted where all of the following conditions are met:

- (a) Hybrid mixtures are not present
- (b) Conductive dusts are not handled
- (c) The MIE of the material being handled is greater than 3 mJ
- (d) The nonconductive components do not result in isolation of conductive components from ground
- (e)* The breakdown strength across nonconductive sheets, coatings, or membranes does not exceed ~~6~~ 4 kV when used in high surface charging processes

A.9.3.1.2(e) The potential for propagating brush discharges exists where nonconductive materials with breakdown voltages exceeding ~~6~~ 4 kV are exposed to processes that generate strong surface charges such as pneumatic conveying. Such discharges do not occur where the breakdown voltage is less than ~~6~~ 4 kV.

Substantiation: The correct threshold for propagating brush discharge in sheets, coatings, or membranes is 4 kV. The 6 kV limit is for woven materials, i.e. FIBCs.

654- Log #98 CMD-HAP
(9.3.3.1)

Final Action:

Submitter: George Petino, Jr., Hazards Research Corporation, Inc.

Comment on Proposal No: 654-75

Recommendation: This provision should be revised as follows:

"9.3.3.1* Dispensing material from intermediate bulk containers into combustible atmospheres shall be performed only under the following conditions:

(1) A conductive (i.e., metallic) rigid intermediate bulk container (RIBC) shall be permitted to be used for dispensing into any flammable vapor, gas, dust, or hybrid atmospheres provided the RIBC is electrically grounded.

(2)* A Type B flexible intermediate bulk container (FIBC) shall be permitted to be used for dispensing into dust atmospheres where the minimum ignition energy (MIE) is greater than ~~10~~ 3 mJ, but no flammable vapor or gas is present.

(3)* A Type C FIBC shall be permitted to be used for dispensing into any flammable vapor, gas, dust, or hybrid atmosphere for which the FIBC has been tested and found suitable, provided the FIBC is electrically grounded with a resistance less than 1 megohm to ground as measured at the ground tab on the FIBC.

(4)* A Type D FIBC shall be permitted to be used for dispensing into flammable vapor, gas, dust, or hybrid atmospheres for which the FIBC has been tested and found suitable.

(5)* A Type A FIBC or insulating RIBCs shall ~~not~~ be permitted to be used for combustible powder applications, processes, or operations where the minimum ignition energy (MIE) is greater than 10 mJ, but no flammable vapor or gas is present. ~~unless a documented risk evaluation assessing the electrostatic hazards is acceptable to the authority having jurisdiction."~~

Throughout the document, the phrase "acceptable to the authority having jurisdiction" should be deleted.

Substantiation: The maximum potential brush discharge from these materials is 3 mJ, but MIE test results are subject to some variability. Therefore, we recommend using 10 mJ to provide an appropriate safety factor. The repeated use of the phrase "acceptable to the authority having jurisdiction" should be eliminated because it implies that there is an obligation to apply for and obtain AHJ approval when that is not the case. The obligation to comply with the building codes is stated in other standards and legislation and there is no reason to include it in this document.

Table 9.xxx Use of different types of FIBCs

Bulk product in FIBC	Surroundings		
MIE of dust^a	Non-flammable atmosphere	Class II, Divisions 1 & 2 (1,000 mJ ≥ MIE > 3 mJ)^a	Class I, Divisions 1 & 2 (Gas Group C & D) or Class II, Divisions 1 & 2 (MIE ≤ 3 mJ)^a
MIE > 1,000 mJ	A, B, C, D	B, C, D	C, D ^b
1,000 mJ ≥ MIE ≥ 3 mJ	B, C, D	B, C, D	C, D ^b
MIE ≤ 3 mJ	C, D	C, D	C, D ^b

NOTE 1 Additional precautions are usually necessary when a flammable gas or vapour atmosphere is present inside the FIBC, e.g. in the case of solvent wet powders.

NOTE 2 Non-flammable atmosphere includes dusts having a MIE > 1,000 mJ .

^aMeasured in accordance with IEC 61241-2-3, capacitive discharge circuit (no added inductance).

^bUse of Type D shall be limited to Gas Groups C & D with MIE ≥ 0.14 mJ.