National Fire Protection Association

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Technical Committee on Combustible Metals and Metal Dusts

AGENDA - NFPA 484 First Draft Meeting

ORNL
2370 Cherahala Blvd.
Knoxville, TN 87102
August 25-27, 2015
8:00 a.m. – 5:00 p.m.

1. Chair's welcome, call to order, and opening remarks at 8:00 a.m. (Local Time, EST)

2. Self-Introduction of Committee Members and Guests

3. Approval of Minutes from the First Pre-Draft 2015 Meeting (see *Attachment A)*

4. Staff Liaison Report:

- **A.** Review of NFPA Policies and Committee Procedures
- **B.** New Standards Process Review
- **C.** Committee Membership (see *Attachment B)*
- **D.** Revision Cycle Review and Timeline (see *Attachment C)*

5. Review Public Inputs (see *Attachment D*)

6. Tuesday, August 25th – 1:00pm Tour ORNL

7. New Business:

i. Review of Task Group Work
ii. Chapter breakdown
iii. Chapter 9 - Dust Collection
iv. Hazard Analysis
v. NFPA 1 & 5000 Reference (construction)
vi. Portable vacuums
vii. Zone Classification for Dusts in accordance with NFPA 70 *National*
viii. Electrical Code
ix. Additive manufacturing (3D printing)

x. Nano Material
xi. Compare testing requirements of 484 vs 652
xii. Explosion Isolation

8. Next Meetings: June 2016

9. Adjournment @ 5:00 p.m. Thursday, August 27, 2015

Attachments: Pre-First Draft Meeting Minutes 02-15; Committee List; Revision Cycle, 484 Public Inputs

TECHNICAL COMMITTEE ON COMBUSTIBLE METAL DUST

Minutes of Meeting – NFPA 484 Pre-First Draft Meeting
February 3rd to 5th, 2015
Albuquerque, New Mexico

Member		Attending
Mark Drake	Chair	Yes
Donna Bruce	Secretary	Yes
John Belfanti	Principal	Yes
Matthew Brown	Principal	No
Elizabeth Buc	Principal	No
Brad Burridge	Principal	No
Tom Christman	Principal	Yes
Scott Davis	Principal	Yes
Scott Dillon	Principal	Yes
Peter Downing	Principal	No
Steven Evans	Principal	Yes
Daniel Hubert	Principal	No
Dehong Kong	Principal	No
Kevin Kreitman	Principal	Yes
Kevin Laporte	Principal	No
Peter Levitt	Principal	No
Timothy Meyers	Principal	No
Kevin O'Brien	Principal	No
David Oberholtzer	Principal	Yes
Sam Rodgers	Principal	Yes
Mark Rosenberger	Principal	No
Richard Seidel	Principal	Yes
Patrick Thornton	Principal	Yes
Erdem Ural	Principal	No
Richard Varga	Principal	No
David Young	Principal	Yes
Robert Zalosh	Principal	Yes
Andrew Carpenter	Alternate	No
Ashok Dastidar	Alternate	No
Stanley Kavel	Alternate	No

John McConaghie	Alternate	No
Van Mitchell	Alternate	No
Lon Scholl	Alternate	No
Gregory Super	Alternate	Yes
Matthew Chibbaro	Non-voting member	No
Thomas Matesic	Non-voting member	No
William Hamilton	Alt. to non-voting member	No
Albert Muller	Member Emeritus	No
Robert Nelson	Member Emeritus	No
Susan Bershad	NFPA	Yes
Tomas Sanchez	Guest – Sandia Nat'l Labs	yes
Julie Cordero	Guest – Sandia Nat'l Labs	Yes

1. Chair Drake called meeting to order at 8:10 AM MST on February 3, 2015.

2. Committee members and guests made self-introductions.

3. Minutes from the 2013 Second Draft meeting from the previous revision cycle were reviewed and approved.

4. Chair Drake reviewed A2017 Cycle and Timeline

5. Chair Drake reviewed current Committee Membership

6. Kevin Kreitman presented an update on Correlating Committee (CC) work. Approval of NFPA 652 is expected during summer 2015. The Correlating Committee is recommending that all of the combustible dust committees standardize the format for the first six chapters of all the dust document. The path forward is for NFPA 652 to be the starting document that points to commodity specific standards as appropriate. Both NFPA 652 and NFPA 484 will be required to safely address metal dust. The 484 committee raised several concerns regarding the revision cycle schedules and when to extract or reference material from 652.

7. The Committee reviewed how to access NFPA 652 on the document information page. Information is located on the document information page, under next edition. Committee members need to logon to the NFPA web site to access this information

8. The CC process was reviewed. The CC reviews all dust documents and makes recommendations for next cycle drafts as well as reviews both first and second draft for inconsistencies and best language.

9. Scott Davis made a presentation on "Unknown Aspects of Metals Dusts" supporting engineering studies suggesting equations in NFPA 68 underestimate metal hazards. A recommendation was made that Scott Davis present this information to the NFPA 68 committee. A comparison of NFPA 68 and EN14491 would be a good project for the Fire Protection Research Council. The committee discussed the possibility of a TIA based on this material.

10. The committee reviewed the status and membership of new and existing task groups. These groups are listed below. Membership lists for task groups has been distributed to the committee. If anyone is interested in joining one of the task groups, please contact Chair Drake.

Task groups are listed below:

Isolation Task Group

Mechanical Conveying – Dave Young and Greg Super were added to task group

Chapter Breakdown - Patrick Thornton, Steve Evans and Donna Bruce.

Dust Collection – This topic receives the most questions from advisory services. Greg Super was added to task group.

Dust Hazards Analysis – Incorporate 652 Chapter 7 with additional information for metals. Reactivity and radiation effects will be reviewed and possibly addressed.

Portable Vacuums – Review inconsistencies between 652 and 484 regarding hose requirements

Electrical Zone Classifications – Review language in 654 6.2 which allows use of article 605 or 606.

Comparison of NFPA 652 Chapter 5 and 484 Chapter 4 – Review venting guidelines. Task Group members: Scott Davis, Kevin Kreitman, David Oberholtzer, Bob Zalosh, Sam Rogers, Jerome Taveaux and others from 68.

11. New Business:

The committee reviewed the correlating committee notes for the A2016 documents to develop material for the upcoming revision cycle for 484. Elizabeth Buc will compare the definitions in 484 and 652 and make recommendations to the committee for alignment. Other changes were proposed for Chapter 1.

12 Bob Zalosh gave a presentation on Combustible Metals Use in 3D Printers and a fire investigation involving a combustible metal and a 3D printer. A task group was formed to draft a section on additive manufacturing: Tom Christman (chair), Dehong Kong, Richard Varga, Patrick Thornton, Bob Zalosh, David Oberholtzer, Tomas Codero.
Recommendations form the investigation include the following:

a. Requirement to inert per NFPA 69 and allow indoors.
b. Require portable vacuums have interlocks for grounding and minimum liquid levels.
c. Specify requirements on training for use of 3D printers and portable dust collectors/vacuums.

13. Bob Zalosh gave a presentation on Nano Particles and concerns with testing using 20 L sphere with some nanoparticles. A task group was formed to address combustible metals nano particles: Bob Zalosh (chair), Dehong Kong, Scott Davis, Erdem Ural. The group was tasked with the following:

a.Adopt or revise 652 5.4.3.5* and consider more stringent requirements.
b. Contact ASTM committee to make aware of possible testing problems.

14: A task group was formed to develop material on portable dust collectors. Members are as follows: Kevin Kreitmen (chair), David Oberholtzer, Sam Rodgers, Steve Evans, Donna Bruce.

15. Pneumatic Conveying of Powder Discussion:
The committee discussed possible conflicts between the ACGIHIndustrial Ventilation – A Manual for Recommended Practice for Design and 484 (See 484 A9.2.1.5, A9.2.2.8 and A9.4.10.2.) and whether pneumatic conveying should be under dust collection chapter or process section. 652 includes pneumatic conveying under process equipment.

16. The committee discussed and addressed common items under the correlating committee notes on the first draft of the A2016 dust documents. Several of these correlating committee notes apply to 484 as well. The 484 committee agreed with the CC comment on scope and will address this in the first draft.

17. Several proposed inputs were made to the draft document. These will be reviewed at the first draft meeting. Material on pneumatic conveying, portable vacuums, electrical classification, and grounding and bonding (control of ignition sources) was developed.

18. The Isolation Task Group updated the committee. Based on the task group review, there are no major conflicts between 652 and 484 on isolation. The task group will address annex material for the first draft.

19. The committee recommends that the Fire Protection Research Foundation review products specifically for metals fires.

20. The committee developed several new Chapters based on correlation with 652. Drafts of a new chapter on dust hazard analysis, a chapter on general requirements (chapter 4) and a chapter on hazard identification (chapter 5) were developed. These will be further reviewed at the first draft meeting.

21. The meeting adjourned at 5 pm on February 5th. The next meeting of the committee will be the First Draft Meeting for 484. This is scheduled for August 25th, 26th, and 27th at Oak Ridge National Laboratory.

2017 ANNUAL REVISION CYCLE

*Public Input Dates may vary according to standards and schedules for Revision Cycles may change. Please check the NFPA Website for the most up-to-date information on Public Input Closing Dates and schedules at www.nfpa.org/document # (i.e. www.nfpa.org/101) and click on the Next Edition tab.

Process Stage	Process Step	Dates for TC	Dates for TC with CC
Public Input Stage `(First Draft)	Public Input Closing Date*	7/6/15	7/6/15
	Final Date for TC First Draft Meeting	12/14/15	9/14/15
	Posting of First Draft and TC Ballot	2/1/16	10/26/15
	Final date for Receipt of TC First Draft ballot	2/22/16	11/16/15
	Final date for Receipt of TC First Draft ballot - recirc	2/29/16	11/23/15
	Posting of First Draft for CC Meeting		11/30/15
	Final date for CC First Draft Meeting		1/11/16
	Posting of First Draft and CC Ballot		2/1/16
	Final date for Receipt of CC First Draft ballot		2/22/16
	Final date for Receipt of CC First Draft ballot - recirc		2/29/16
	Post First Draft Report for Public Comment	3/7/16	3/7/16
Comment Stage (Second Draft)	Public Comment closing date	5/16/16	5/16/16
	Final Date to Publish Notice of Consent Standards (Standards that received no Comments)	5/30/16	5/30/16
	Appeal Closing Date for Consent Standards (Standards that received no Comments)	6/13/16	6/13/16
	Final date for TC Second Draft Meeting	10/31/16	7/25/16
	Posting of Second Draft and TC Ballot	12/12/16	9/5/16
	Final date for Receipt of TC Second Draft ballot	1/2/17	9/26/16
	Final date for receipt of TC Second Draft ballot - recirc	1/9/17	10/3/16
	Posting of Second Draft for CC Meeting		10/10/16
	Final date for CC Second Draft Meeting		11/21/16
	Posting of Second Draft for CC Ballot		12/12/16
	Final date for Receipt of CC Second Draft ballot		1/2/17
	Final date for Receipt of CC Second Draft ballot - recirc		1/9/17
	Post Second Draft Report for NITMAM Review	1/16/17	1/16/17
Tech Session Preparation (& Issuance)	**Notice of Intent to Make a Motion (NITMAM) Closing Date**	2/20/17	2/20/17
	Posting of Certified Amending Motions (CAMs) and Consent Standards	4/17/17	4/17/17
	Appeal Closing Date for Consent Standards	5/2/17	5/2/17
	SC Issuance Date for Consent Standards	5/12/17	5/12/17
Tech Session	Association Meeting for Standards with CAMs	6/4-7/2017	6/4-7/2017
Appeals and Issuance	Appeal Closing Date for Standards with CAMs	6/27/17	6/27/17
	SC Issuance Date for Standards with CAMs	8/10/17	8/10/17

Approved: October 30, 2012 Revised_____

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Public Input No. 10-NFPA 484-2015 [Section No. 1.1.6.2]

1.1.6.2 * -

Metal-containing mixtures shall be permitted to be excluded from this standard and protected according to NFPA 654, *Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids*, or other NFPA industry- or commodity-specific standard,if by testing it is established that the mixture meets all of the following criteria:

(1) It has been demonstrated that mixture fires can be controlled safely and effectively with Class ABC fire-extinguishing agents.

(2) It has been demonstrated that mixture fires can be controlled safely and effectively with water.

(3) The material is not a UN Class 4.3 solid as tested using UN 4.3 water reactivity test methods.

(4) ~~It has been demonstrated that the volume resistivity is greater than 1 M ohm-m.~~ the Kst is below 150 and Pmax is below 8 bar

(5) It is not a metal/metal-oxide mixture (e.g., thermite).

Statement of Problem and Substantiation for Public Input

The intent of the standard is not clear as to why resistivity is a characteristic that could exclude a dust from 484. If this is not removed then the intent should be explained in the appendix. I would think that Kst and Pmax would be a better indicator for exclusion from this standard. We encounter many dusts that are produced from metal cutting on laser and plasma tables along with abrasive blasting and flame and arc spraying that have low Kst and Pmax values. These dusts are mixtures that rarely display the combustible and explosive characteristics of the pure metals. Yet industry ends up treating them as pure metals and applying 484 at great expense when the other standards would adequately control the hazards. Industry needs better guidance with respect to mixtures with metal in them.

Submitter Information Verification

Submitter Full Name: MICHAEL WALTERS
Organization: CAMFIL FARR AIR POLLUTION CONT
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jun 23 09:57:36 EDT 2015

Public Input No. 11-NFPA 484-2015 [Section No. 1.1.6.2]

1.1.6.2*

Metal-containing mixtures shall be permitted to be excluded from this standard and protected according to NFPA 654, *Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids*, or other NFPA industry- or commodity-specific standard,if by testing it is established that the mixture meets all of the following criteria:

(1) It has been demonstrated that mixture fires can be controlled safely and effectively with Class ABC fire-extinguishing agents.

(2) It has been demonstrated that mixture fires can be controlled safely and effectively with water.

(3) The material is not a UN Class 4.3 solid as tested using UN 4.3 water reactivity test methods.

(4) It has been demonstrated that the volume resistivity is greater than 1 M ohm-m.

(5) It is not a metal/metal-oxide mixture (e.g., thermite).

Statement of Problem and Substantiation for Public Input

I have used this section to exclude a dust mixture from the 484 standard. Sentences 1 and 2 should have some explanatory material to define what an acceptable demonstration is. Can the demonstration tests be performed in house or should they be done by a third party?

Submitter Information Verification

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Submittal Date: Tue Jun 23 10:36:57 EDT 2015

Public Input No. 1-NFPA 484-2015 [Chapter 2]

Chapter 2 Referenced Publications

2.1 General.

The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications.

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

NFPA 1, *Fire Code* , 2015 edition.

NFPA 10, *Standard for Portable Fire Extinguishers,* 2013 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems,* 2013 edition.

NFPA 30, *Flammable and Combustible Liquids Code,* 2015 edition.

NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials,* 2011 edition.

NFPA 34, *Standard for Dipping, Coating, and Printing Processes Using Flammable or Combustible Liquids,* 2011 edition.

NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work,* 2014 edition.

NFPA 54, *National Fuel Gas Code,* 2015 edition.

NFPA 68, *Standard on Explosion Protection by Deflagration Venting,* 2013 edition.

NFPA 69, *Standard on Explosion Prevention Systems,* 2014 edition.

NFPA 70® , *National Electrical Code®,* 2014 edition.

NFPA 80, *Standard for Fire Doors and Other Opening Protectives,* 2013 edition.

NFPA 86, *Standard for Ovens and Furnaces,* 2015 edition.

NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids,* 2010 edition.

NFPA 101® , *Life Safety Code®,* 2015 edition.

NFPA 220, *Standard on Types of Building Construction,* 2015 edition.

NFPA 221, *Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls,* 2015 edition.

NFPA 496, *Standard for Purged and Pressurized Enclosures for Electrical Equipment,* 2013 edition.

NFPA 505, *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operations,* 2013 edition.

NFPA 600, *Standard on Industrial Fire Brigades,* 2010 edition.

NFPA 654, *Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids,* 2013 edition.

NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response,* 2012 edition.

NFPA 780, *Standard for the Installation of Lightning Protection Systems,* 2014 edition.

NFPA 1081, *Standard for Industrial Fire Brigade Member Professional Qualifications,* 2012 edition.

NFPA 2112, *Standard on Flame-Resistant Garments for Protection of Industrial Personnel Against Flash Fire,* 2012 edition.

NFPA 2113, *Standard on Selection, Care, Use, and Maintenance of Flame-Resistant Garments for Protection of Industrial Personnel Against Short-Duration Thermal Exposures from Fire,* 2015 edition.

NFPA 5000® , *Building Construction and Safety Code®,* 2015 edition.

2.3 Other Publications.

2.3.1 ~~ANSI~~ **ASME** Publications.

~~American National Standards Institute, Inc., 25 West 43rd Street, 4th Floor,~~ **ASME Internatioanl, Two Park Avenue** , New York, NY ~~10036~~ **10016-5990** .

~~ANSI/~~ ASME B31.3, *Process Piping~~ Design~~* , ~~2010~~ **2014** .

~~ANSI/ISA~~ **2.3.2 ISA Publications.**

The International Society of Automation, 67 T.W. Alexander Drive, P.O. 12277, Research Triangle Park, NC 27709.

ISA 84.00.01 *Functional Safety: Safety Instrumental Systems for the Process Industry Sector–Part 2,* 2004.

2.3. ~~2~~ 3 ASTM Publications.

ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM ~~E 11~~ E11 , *Standard Specification for ~~Wire~~ **Woven** Wire **Test Sieve Cloth** and **Test Sieves** ~~for Testing Purposes~~* , ~~2009~~ **2013** .

ASTM ~~E 136~~ E136 , *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C*, 2012.

ASTM ~~E 176~~ E176 , *Standard Terminology of Fire Standards*, ~~2010~~ **2014c** .

ASTM ~~E 1226~~ E1226 , *Standard Test Method for Explosibility of Dust Clouds*, 2012**a** .

ASTM ~~E 1515~~ E1515 , *Standard Test Method for Minimum Explosible Concentration of Combustible Dust**s***, ~~2007~~ **2014** .

ASTM ~~E 2019~~ E2019 , *Standard Test Method for Minimum Ignition Energy of a Dust Cloud in Air*, ~~2007~~ **2003, Reapproved 2013** .

ASTM ~~E 2931~~ E2931 , *Standard Test Method for Limiting Oxygen (Oxidant) Concentration of Combustible Dust Clouds*, 2013.

ASTM ~~F 1002~~ F1002 , *Standard Performance ~~Specifications~~ Specification for Protective Clothing for Use by Workers Exposed to Specific Molten Substances and Related Thermal Hazards*, ~~2006~~ **2015** .

2.3. ~~3~~ 4 UN Publications.

United Nations Publications, Room DC2-853, 2 UN Plaza, New York, NY 10017.

*UN Recommendations on the Transport of Dangerous Goods: Manual of Tests and Criteria,*5th edition, 2009.

2.3. 4 5 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

Eckoff, Rolf K., *Dust Explosions in the Process Industries,* third edition, 2003. Butterworth-Heinemann Ltd., Oxford, UK.

*Explosibility of Metal Powders, Report of Investigations (RI) 6516,*1964, BuMines, U.S.Department of the Interior, Washington DC, 1965.

GESTIS-DUST-EX, Combustion and Explosion Characteristics of Dusts (database), —Institut für Arbeitsschutz der Deutschen Gesetzlichen Unfallversicherung, Germany (IFA).

2.4 References for Extracts in Mandatory Sections.

NFPA 68, *Standard on Explosion Protection by Deflagration Venting,* 2013~~ edition~~ .

NFPA 69, *Standard on Explosion Prevention Systems,* 2014~~ edition~~ .

NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids,*~~2010 edition~~ **2015** .

NFPA 654, *Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids,*~~2013 edition~~ **2017** .

NFPA 921, *Guide for Fire and Explosion Investigations,* 2014~~ edition~~ .

NFPA 5000® , *Building Construction and Safety Code®,* 2015~~ edition~~ .

Statement of Problem and Substantiation for Public Input

Referenced updated SDO addresses, standard names, and editions.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 2-NFPA 484-2015 [Chapter J]	

Submitter Information Verification

Submitter Full Name: Aaron Adamczyk
Organization: [Not Specified]
Street Address:
City:
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Zip:
Submittal Date: Sun Mar 22 22:04:15 EDT 2015

Public Input No. 6-NFPA 484-2015 [Section No. 3.1]

3.1 General.

The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary,* 11th edition, shall be the source for the ordinarily accepted meaning.

Additional Proposed Changes

File Name	Description	Approved
NFPA_484_Public_Input_Comments.docx	Suggestions for the Definitions section of NFPA 484	

Statement of Problem and Substantiation for Public Input

Consistency in application of a standard is essential for the harmonization with international standards as well as local (other NFPA) standards relating to dusts and other solid particulates. Clarification of the definitions is the first step towards a common and consistent approach.

Submitter Information Verification

Submitter Full Name: SHERYL BIHLER
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City:
State:
Zip:
Submittal Date: Tue Jun 02 09:35:19 EDT 2015

NFPA 484 Public Input Comments

3.1 General.
The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary,* 11th edition, shall be the source for the ordinarily accepted meaning.

Comment:
Consistency in definitions is essential for a repeatable and reliable implementation of the requirements of every standard. Instead of maintaining isolation through different terminology and definitions of similar words, I recommend starting with the international definitions (IEC 60050-426) followed by those within the NFPA 70 document and defining only those which are necessary for this particular standard. Consistency between the various standards and documents will only assist the reader and inspector.

Recommended changes:
"3.1 General.
For the purposes of this document, the terms and definitions in NFPA 70 and the following apply.
NOTE Additional definitions applicable to explosive atmospheres can be found in IEC 60050-426."

3.3.6.1* Combustible Metal Dust.
A combustible particulate metal that presents a fire or explosion hazard when suspended in air or the process specific oxidizing medium over a range of concentrations, regardless of particle size or shape.

Comments:
The definition is not consistent with other NFPA standards.

Recommended changes:
"3.3.6.1 Combustible Metal Dust.
A combustible metallic particulate solid that presents a fire or deflagration hazard when suspended in air or some other oxidizing medium over a range of concentrations, regardless of particle size or shape."

3.3.12 Dust.
See Combustible Metal Dust, 3.3.6.1.

Comment:
By referencing 3.3.6.1, the definition of Dust implies that only Combustible Metal Dusts exist. This is highly inconsistent with all other definitions of the word "Dust". I highly recommend utilizing the international definitions as a starting point to minimize confusion and further enhance the use of this standard as a basis for international requirements.

Recommended changes:
"3.3.12 Dust.
A particulate solid which settle out of the atmosphere under their own weight but may remain suspended in air for some time. Includes dust and grit as defined in ISO 4225."

3.3.21 Hot Work.
Any work involving burning, spark-producing, welding, or similar operations that is capable of initiating fires or explosions.

Comment:
The hazard of hot work is the generation of an ignition source.

Recommended changes:
“3.3.21 Hot Work.
Any work activity involving open flames, burning, spark-producing, welding or similar operations which may be capable of generating an ignition source. “

3.3.23.2* Pyrophoric Material.
A chemical with an auto-ignition temperature in air at or below 54.4°C (130°F). [**5000,**2015]

Comment:
There are two different auto-ignition temperatures (AIT) with solid particulates – one for a layer of dust and the other for a cloud suspended in air. It is essential that the AIT be specific with each definition – and that both AITs be identified on MSDS wherever possible.

Recommended changes:
“3.3.23.2 Pyrophoric Material.
A solid chemical material with an auto-ignition temperature of a cloud suspended in air at or below 54.4C (130F).”

3.3.24 Media Collector.
A bag house or a filter-type cartridge collector used for collecting dust.

Comment:
Other NFPA standards define a Dust Collector or an Air-Material Separator. Consistency is needed – again.

Recommended changes:
“3.3.24 Media Collector.
A collector designed to separate the conveying air from the material being conveyed. Also referred to as a Dust Collector or an Air-Material Separator.”

3.3.38 Screening Test.
For the purposes of this standard, a test performed to determine whether a material, product, or assembly, (a) exhibits any usual fire or explosion related characteristics, (b) has certain expected fire or explosion related characteristics, or (c) is capable of being categorized according to the fire or explosion characteristic in question. [**ASTM E 176,** 2010 Modified]

Comment:
One also uses a screen to determine the size of a particle – noted in the definition of “Fines” and related definitions. If the material is being “screened” for fire and deflagration characteristics, I propose the definition be changed to “Fire and Deflagration Characteristic Test” or “Material Properties Test” to better describe the intent of the definition.

In addition, I would propose that characteristics are either related to fire and explosion or not; that the adjectives “usual” and “certain” add a level of interpretation and means of inconsistent application.

The definitions of Fire and Explosion Related characteristics should also be defined and included in this standard, or in a related standard. How is the reader to understand which material characteristics are related to fires and explosions and which are not?

Recommended changes:
“3.3.38 Material Properties Test

A test or series of tests performed on a material to determine whether or not the material, product, or assembly, (a) exhibits any fire or explosion related characteristics, or (b) is capable of being categorized according to the fire or explosion characteristic in question.

3.3.40* Sponge.

Metal after it has been won from the ore but before it is melted.

Comment:
My understanding of a sponge is a device which may retain liquids. This definition doesn't seem to follow the common use of the word including the Webster's dictionary.

The phrase "won from the ore" needs further explanation – so that inspectors and other non-process experts can understand the definition.

I cannot propose changes as I have zero idea as to what is trying to be conveyed.

Public Input No. 14-NFPA 484-2015 [New Section after 3.2]

Dry Type Dust Collectors

Dry dust collectors such as cyclones or anything else that is not a media collector.

Statement of Problem and Substantiation for Public Input

The dust collection section of the standard is confusing because "dry type dust collectors" are not differentiated adequately from media type collectors.

Submitter Information Verification

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Street Address:
City:
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Submittal Date: Tue Jun 23 12:09:46 EDT 2015

Public Input No. 12-NFPA 484-2015 [Section No. 4.1.4]

4.1.4 Application of This Document.

4.1.4.1

Only those specific forms of combustible metals, powders, dusts, and alloys of those materials that can be documented through accepted testing, and shown in that form not to satisfy the conditions and definitions of combustibility and explosibility, shall qualify for exclusion from the requirements of this document.

4.1.4.2

Wherever combustibility can be shown to exist in these materials, the full scope and requirements of this document shall apply.

4.1.4.3

Wherever the documentation necessary for compliance with 4.1.2 and 4.1.3 is lacking, the requirements of this document shall apply.

Statement of Problem and Substantiation for Public Input

The exclusions listed in section 1.1.6.2 should be moved to this section. There is a lot of confusion in industries that that produce metal containing mixtures. These mixtures usually don't display the combustible and explosible properties of their parent metals. Industries need better clarification as to when to apply 484 with respect to dust collection.

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Public Input No. 7-NFPA 484-2015 [Section No. 4.1.6]

4.1.6

Forms of combustible metal dust (CMD) that have been evaluated as noncombustible shall be required to be re-evaluated whenever a change in manufacture, processing, handling, or storage conditions creates a modified form that might exhibit the characteristic of combustibility.

Additional Proposed Changes

File Name	Description	Approved
NFPA_484-Clause4.docx	Recommendations for a more formal approach	

Statement of Problem and Substantiation for Public Input

It is clear that this recommended practice is not widely enforced. By highlighting the potential changes and recommending a formal approach to any program implemented, the reader will be better able to convince upper management of the importance of following this document.

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Submittal Date: Tue Jun 02 11:01:01 EDT 2015

NFPA 484 – Section 4 comments and suggestions.

4.1.6
Forms of combustible metal dust (CMD) that have been evaluated as noncombustible shall be required to be re-evaluated whenever a change in manufacture, processing, handling, or storage conditions creates a modified form that might exhibit the characteristic of combustibility.

Comments:
This re-evaluation implies that the combustion properties and characteristics do not change over time or atmospheric conditions. I would highly recommend a note to further push the reader to periodically have the materials at their facility tested.

Recommended changes:
"4.1.6
Forms of combustible metal dust (CMD) that have been evaluated as noncombustible shall be required to be re-evaluated whenever a change in manufacturer, processing, handling, or storage conditions creates a modified form that might exhibit the characteristic of combustibility.
NOTE Atmospheric conditions such as humidity, air pressure, oxygen concentration and the like have been shown to affect the characteristics of combustibility and should not be discounted as potential reasons for re-evaluation of the material."

4.2.1
Representative samples and components of metal-containing mixtures shall be collected and identified.

Comments:
The selection and collection of the samples should be documented. There should exist a sampling, collection and testing plan for each process or facility to ensure adequate internal oversight is maintained throughout the life of the facility.

Recommended changes:
"4.2. Basic Material Characterization.
A formal plan shall be documented which describes the material characterization methodology, parameters tested for, collection and identification means, sampling schedule and locations, and other pertinent details relating to the facility and processes involved.
This plan shall be periodically reviewed for adequacy and ability to highlight potential dangerous changes in the facility, processes and material handling procedures."

Public Input No. 8-NFPA 484-2015 [Section No. 6.3.1.4]

6.3.1.4

The special hazards associated with metals in a combustible form and in contact with water shall be considered in the selection, design, and installation of automatic sprinkler systems.

Additional Proposed Changes

File Name	Description	Approved
NFPA_484-Clause6.docx	Reorganization and wording changes to Clause 6 - which is mainly addressed in duplication by NFPA 654.	

Statement of Problem and Substantiation for Public Input

Unnecessary duplication of requirements and/or the reduction of potential conflicts between the various dust standards. See NFPA 654 - it addresses most of the contents of this standard already.

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Zip:
Submittal Date: Tue Jun 02 11:21:56 EDT 2015

NFPA 484 – Section 6 comments and suggestions.

6.3.1.4
The special hazards associated with metals in a combustible form and in contact with water shall be considered in the selection, design, and installation of automatic sprinkler systems.

Comments:
I find it interesting that no definitions are included related to the water compatibility of a material such as those found in NFPA 654.

In reading through this entire clause, it seems to me that this entire section should be included in NFPA 654 and thus be eliminated from this document altogether. In fact, I have to ask the questions as to why there are so many dust-related standards to begin with. Can some not be incorporated into the others – by the use of consistent terminology and prescribed implementation techniques?

This document should only highlight those aspects which are NOT ALREADY included in NFPA 654 instead of duplicating, and possibly conflicting with NFPA 654.

6.4.1
The following information shall be provided to the emergency responders for the safe handling of combustible metal fires:
(3) Review safety data sheets (SDSs) for the involved products, and if available, contact those familiar with the product and hazards.

Comments:
First I was going to comment that the SDSs do not provide consistent information much less sufficient information.

However, in reading through this entire clause, this is NOT a list of information to be provided to the emergency responders but the actions to which the emergency responders are expected to perform.

Recommended changes:
"6.4.1
The following information shall be provided to the emergency responders for the safe handling of combustible metal fires:

(1) Hazard risk assessment
    a. List of materials and metals in immediate vicinity
    b. Plant layout showing main areas and regions
    c. Layout showing surrounding facilities, etc
    d. Potential risks of continuing fire
    e. Explosion risk level
    f. Sources of material, metals, etc
    g. List of extinguishing agents available
(2) Locations of utility controls (water, gases, power, etc)
(3) Safety data sheets (SDSs)

6.4.2
The following shall be taken into consideration by the emergency responders for the safe handling of combustible metal fires:

(1) Perform a size-up, evaluation, and identification of metals involved in the fire
(2) Etc –as is written in existing standard"

The same problem exists with **clause 6.5.2.4** – the list is not a list of INFORMATION to be provided by a list of cautions and possible reactions to be considered during the emergency preparedness plan.

Public Input No. 9-NFPA 484-2015 [Section No. 7.3.1]

7.3.1* Fugitive dust shall not be allowed to accumulate to a level that obscures the color of the surface beneath it.

Additional Proposed Changes

File Name	Description	Approved
NFPA_484-Clause7.docx	Change emphasis to elimination of fugitive dust instead of on housekeeping measures.	

Statement of Problem and Substantiation for Public Input

Cleaner working environments, fewer explosions and a lower exposure to injury by employees will be the result with an increased emphasis on the design, implementation and maintenance of dust collection systems instead of a focus on housekeeping measures.

Submitter Information Verification

Submitter Full Name: SHERYL BIHLER
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City:
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Submittal Date: Tue Jun 02 11:42:51 EDT 2015

NFPA 484 – Section 7 comments and suggestions.

7.3.1*
Fugitive dust shall not be allowed to accumulate to a level that obscures the color of the surface beneath it.

Comments.
Most international standards specify a depth of not more than 5 mm.

Recommended changes:
"7.3.1
Fugitive dust shall not be allowed to accumulate to a depth of 5 mm or to a level that obscures the color of the surface beneath it, whichever is smaller."

7.3.2*
It shall be permissible to establish, in a building or room, an alternate housekeeping dust accumulation threshold based on a documented hazard assessment acceptable to the AHJ.

Comments:
It is essential that the documentation includes a comparison of the differences in explosion and fire risks due to the additional depth of combustible particulates. Auto-ignition temperatures change with the depth of the material as do the temperature rise of any equipment being covered by the solid particulates. These aspects shall be taken into consideration during the formal hazard assessment.

Recommended changes:
"7.3.2
It shall be permissible to establish, in a building or room, an alternate housekeeping dust accumulation threshold based on a documented hazard assessment which includes the following information:

(1) Maximum depth of material
(2) Combustion characteristics of material at proposed depth
(3) Establishment of AIT for layer of proposed depth
(4) Confirmation of thermal rise for any equipment to be under the layer to a proposed depth
(5) Identification of fire and explosion risks
(6) Identification of fire and explosion consequences
(7) Identification of measures to be put in place to maintain proposed depth

The hazard assessment shall be formal and acceptable to the AHJ."

7.5.3
Due to the inherent hazards associated with the use of fixed and portable vacuum cleaning systems for finely divided combustible metal dust, special engineering consideration shall be given to the design installation, maintenance, and use of such systems. (see section 9.2).

Comments:
First, the description here should include the terminology listed in this standard. It is presumed that "Fines" is the appropriate term to be used in place of "finely divided combustible metal dust".

Second, the use of compressed air blowing mechanisms gives rise to additional particulates being thrust into the air and/or settling onto horizontal surfaces which are difficult to reach and clean. This then gives rise to a far more dangerous facility than recognized (as can be seen with each dust explosion investigation documented by the Chemical Safety Board).

This entire section needs to consider that there are certified vacuum cleaners intended for use in dusty atmospheres that have been used without incident around the world.

Recommended changes:
“7.5.3
All movement of air activities pose a risk of static electricity discharge as well as the further dispersement of the combustible dusts into the atmosphere. The surrounding area may then become increasingly combustible during these activities and a thorough hazard assessment shall be documented.

The use of vacuum cleaners shall be permitted as a primary means of cleaning as long as the vacuum cleaner has been shown to not pose an ignition risk when used with combustible metal dusts.

Non-rated vacuum cleaners, or those intended for use with standard materials, shall only be used for removal of residual dust accumulations or accumulations too small to generate a combustible concentration in the area.”

7.6 Compressed Air Cleaning Requirements

Comments:
I would highly discourage the use of compressed air as a primary means of cleaning a dusty area since it is guaranteed to disperse the media into the atmosphere. There are too many instances where a combustible dust lands on horizontal surfaces which are out of reach and/or out of sight of the user, creating a very dangerous situation and increased potential for explosions if something happens to dislodge the dust. Compressed air, even at low pressures, can loft dusts into the air in sufficient quantities to create a combustible concentration. In addition, the potential for static electricity with common air compression systems is quite high as they typically use non-conductive hoses.

The cautions currently in the standard around vacuum cleaners should also be addressed towards the compressed air systems for cleaning activities. Each system shall be shown to not generate a potential ignition source during use before it is deemed safe as a means of keeping the level of dust below the specified limits (5 mm or that specified in the hazard assessment for the facility).

Recommended changes:
Change the section to emphasize that both blowing and vacuuming with air pose a similar risk of ignition and that great care should be taken in the design, implementation and maintenance of dust collections systems over the reliance on housekeeping measures.

Again, the results of investigations by the Chemical Safety Board clearly show the importance of preventing fugitive dusts as much as possible. This entire document should be emphasizing the design and maintenance requirements of dust collection systems instead of housekeeping measures.

Public Input No. 15-NFPA 484-2015 [New Section after A.12.7.3.5.1]

A.12.7.4.5

CC Note: The Correlating Committee asks the TC to review the figures used in the section dealing with dust collection to select more appropriate examples that are consistent with the provisions in the mandatory portion of the standard.

Additional Proposed Changes

File Name	Description	Approved
pc27.pdf	NFPA 484 Public Comment 27 Hold	

Statement of Problem and Substantiation for Public Input

NOTE: This Public Input appeared as "Reject but Hold" in Public Comment No. 27 of the (A2014) Second Draft Report for NFPA 484 and per the Regs. at 4.4.8.3.1

This is a direction from the Correlating Committee on Combustible Dust in accordance with 3.4.2 and 3.4.3 of the Regulations Governing the Development of NFPA Standards.

Submitter Information Verification

Submitter Full Name: CC on CMD-AAC
Organization: NFPA Correlating Committee on Combustible Dusts
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City:
State:
Zip:
Submittal Date: Thu Jul 02 14:14:04 EDT 2015

Public Comment No. 27-NFPA 484-2013 [New Section after A.12.7.4.5]

CC Note: The Correlating Committee asks the TC to review the figures used in the section dealing with dust collection to select more appropriate examples that are consistent with the provisions in the mandatory portion of the standard.

Statement of Problem and Substantiation for Public Comment

This is a direction from the Correlating Committee on Combustible Dust in accordance with 3.4.2 and 3.4.3 of the Regulations Governing the Development of NFPA Standards.

Submitter Information Verification

Submitter Full Name: CC on CMD-AAC
Organization: CC on Combustible Dusts
Street Address:
City:
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Submittal Date: Mon May 20 08:42:00 EDT 2013

Committee Statement

Committee Action: Rejected but held

Resolution: The Committee has not had enough time to review the figure and come up with an updated figure of these types of dust collectors. The Committee will revisit this issue in the next edition.

Public Input No. 2-NFPA 484-2015 [Chapter J]

Annex J Informational References

J.1 Referenced Publications.

The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

J.1.1 NFPA Publications.

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

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2013 edition.

NFPA 30, *Flammable and Combustible Liquids Code*, 2015 edition.

NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*, 2014 edition.

NFPA 55, *Compressed Gases and Cryogenic Fluids Code*, 2013 edition.

NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities*, 2013 edition.

NFPA 68, *Standard on Explosion Protection by Deflagration Venting*, 2013 edition.

NFPA 69, *Standard on Explosion Prevention Systems*, 2014 edition.

NFPA 70 ®, *National Electrical Code* ®, 2014 edition.

NFPA 77, *Recommended Practice on Static Electricity*, 2014 edition.

NFPA 86, *Standard for Ovens and Furnaces*, 2015 edition.

NFPA *101* ®, *Life Safety Code* ®, 2015 edition.

NFPA 120, *Standard for Fire Prevention and Control in Coal Mines*, 2010 edition.

NFPA 220, *Standard on Types of Building Construction*, 2015 edition.

NFPA 221, *Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls*, 2015 edition.

NFPA 495, *Explosive Materials Code*, 2013 edition.

NFPA 496, *Standard for Purged and Pressurized Enclosures for Electrical Equipment*, 2013 edition.

NFPA 497, *Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas*, 2012 edition.

NFPA 499, *Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas*, 2013 edition.

NFPA 654, *Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids*, 2013 edition.

NFPA 655, *Standard for Prevention of Sulfur Fires and Explosions*, 2012 edition.

NFPA 664, *Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities*, 2012 edition.

NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response*, 2012 edition.

NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, 2013 edition.

NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*, 2013 edition.

NFPA 2113, *Standard on Selection, Care, Use, and Maintenance of Flame-Resistant Garments for Protection of Industrial Personnel Against Short-Duration Thermal Exposures from Fire*, 2015 edition.

Fire Protection Guide to Hazardous Materials, 2013.

J.1.2 Other Publications.

J.1.2.1 AIChE Publications.

American Institute of Chemical Engineers, 120 Wall Street, 23rd Floor, New York, NY 10005–4020.

Forbath, T. P. "Sodium Reduction Route Yields Titanium," *Chemical Engineering Progress*, March 1958.

Guidelines for Hazard Evaluation Procedures, AIChE Center for Chemical Process Safety, 3rd edition, 2008.

Powell, R. L. "Chemical Engineering Aspects of Titanium Metal Production," *Chemical Engineering Progress*, March 1954, pp. 578–581.

Britton, L.G., *Avoiding Static Ignition Hazards in Chemical Operations*, (Revised Edition), AIChE Center for Chemical Process Safety, 1999.

J.1.2.2 AMCA Publication.

Air Movement and Control Association, Inc., 30 West University Drive, Arlington Heights, IL 60004-1893.

AMCA Standard 99-~~0401~~ , ~~"Classifications for Spark Resistant Construction,"~~ *AMCA Standards Handbook*, 2010.

J.1.2.3 ANSI Publication.

American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036.

ANSI Z41, *Personal Protection — Protective Footwear*, 1999. **(Superseded by ASTM F2412 & ASTM F2413)**

J.1.2.4 ASM International Publications.

American Society of Metals, 9639 Kinsman, Materials Park, OH 44073-0002.

ASM Handbook, Volume 1: Properties and Selection: Irons, Steels, and High-Performance Alloys, 1990.

ASM Handbook, Volume 2: Properties and Selection: Nonferrous Alloys and Special-Purpose Materials, 1990.

J.1.2.5 ASTM Publications.

ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM ~~D 2240~~ D2240 , *Standard Test Method for Rubber Property — Durometer Hardness*, ~~1995~~ **2005, reapproved 2010** .

ASTM ~~E 136~~ E136 , *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C*, ~~2011~~ **2012** .

ASTM ~~E 1226~~ E1226 , *Standard Test Method for Explosibility of Dust Clouds*, ~~2010~~ **2012A** .

ASTM ~~E 1515~~ E1515 , *Standard Test Method for Minimum Explosible Concentration of Combustible Dusts*, ~~2007~~ **2014** .

ASTM ~~E 2019~~ E2019 , *Standard Test Method for Minimum Ignition Energy of a Dust Cloud in Air*, ~~2007~~ **2003, reapproved 2013** .

ASTM ~~E 2079~~ E2079 , *Standard Test Methods for Limiting Oxygen (Oxidant) Concentration in Gases and Vapors*, 2007**, reapproved 2013** .

ASTM ~~F 955~~ F955 , *Standard Test Method for Evaluating Heat Transfer through Materials for Protective Clothing Upon Contact with Molten Substances*, 2007 **(2015E1)** .

ASTM ~~F 1002~~ F1002 , *Standard Performance Specification for Protective Clothing for Use by Workers Exposed to Specific Molten Substances and Related Thermal Hazards*, ~~2006~~ **2015.**

ASTM ~~F 2621, Standard~~ **F2412, Standard Test Methods for Foot Protection, 2011.**

ASTM F2413, Standard Specification for Performance Requirements for Protective (Safety) Toe Cap Footwear, 2011.

ASTM F2621, *Standard Practice for Determining Response Characteristics and Design Integrity of Arc Rated Finished Products in an Electric Arc Exposure*, 2012.

J.1.2.6 Battelle Memorial Institute Publication.

Battelle Memorial Institute, Defense Metals Information Center, 505 King Ave., Columbus, OH 43201.

General Recommendations on Design Features for Titanium and Zirconium Production-Melting Furnaces, 1961.

J.1.2.7 BSI Publications.

British Standards Institution, 389 Chiswick High Road, London W4 4AL, United Kingdom.

BS 5958-1, *Code of Practice for Control of Undesirable Static Electricity: General Considerations*, 1991. **(Superseded by BS PD CLC/TR 50404, Code of Practice for the Avoidance of Hazards Due to Static Electricity, 2003)**

BS 6713-1/ISO 6184-1, *Explosion Protection Systems, Part I: Method for Determination of Explosion Indices of Combustible Dusts in Air*, 1986. **(Withdrawn)**

J.1.2.8 NEMA Publication.

National Electrical Manufacturers Association, 1300 North 17th Street, Suite ~~1847~~ **900** , ~~Rosslyn~~ **Arlington** , VA 22209.

Guide for Classification of All Types of Insulated Wire and Cable, 2001.

J.1.2.9 U.S. Bureau of Mines Publications.

U.S. Bureau of Mines, Pittsburgh Research Center, Cochrans Mill Road, Pittsburgh, PA 15236-0070.

RI 3722, “Inflammability and Explosibility of Metal Powders,” I. Hartmann, J. Nagy, and H. R. Brown, 1943.

RI 4835, “Explosive Characteristics of Titanium, Zirconium, Thorium, Uranium and Their Hydrides,” 1951.

RI 4879, “Recent Practice at the Bureau of Mines, Boulder City, Nev., Titanium Plant,” 1951.

RI 6516, “Explosibility of Metal Powders,” M. Jacobsen, A. R. Cooper, and J. Nagy, 1964.

J.1.2.10 U.S. Government Publications.

Title 29, Code of Federal Regulations, Part 1910.146, “Permit Required Confined Spaces.”

Title 40, Code of Federal Regulations, Part 261, Subpart (B).

Title 49, Code of Federal Regulations, Parts 100–199.

Title 49, Code of Federal Regulations, Part 1200 (DOT and HM-181).

Title 30, Code of Federal Regulations, Part 36, "Approved Requirements for Permissible Mobile Diesel-Powered Transportation Equipment."

J.1.2.11 Other Publications.

A.G. Dastidar, P.R. Amyotte, J. Going, and K. Chatrathi, “Flammability Limits of Dusts: Minimum Inerting Concentrations," *Process Safety Progress*, vol. 18, No. 1, Spring 1999.

Cashdollar, Kenneth, and Isaac Zlochower, “Explosion Temperatures and Pressures of Metals and Other Elemental Dust Clouds,” *Journal of Loss Prevention in the Process Industries*, vol. 20, issues 4-6, 2007.

Eisner, H. S., “Aluminum and the Gas Ignition Risk,”*The Engineer*, London, Feb. 17, 1967.

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Statement of Problem and Substantiation for Public Input

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