AGENDA

1. Chair Drake calls meeting to order at 8:00 AM on July 24th.

2. Welcome & Self-Introduction of Committee Members & Guests

3. Chair & Staff Liaison Remarks

4. Technical Committee Update:
   a. Review changes in Membership (See Attachment - TC List)
   b. Review guidelines for change of employment and committee membership & Special Experts affiliations/representation

5. Approve minutes from First Draft meeting in Dallas, TX, in March 2012 (See Attachment – First Draft Minutes)

6. Update on new Technical Committee addressing Fundamentals of Combustible Dusts and what effect that has on the base fundamental standards.

7. Update on new Correlating Committee and its role to review potential “inconsistencies” with the other dust standards

8. Old Business:
   a. Quick review of Task Groups status (currently 14 groups)

9. New Business:
   a. Review of Public Inputs (Proposals). There are approximately 115 proposals to be reviewed. These will be prioritized prior to the meeting.
   b. Review of Task Groups without Public Input (proposals)
   c. Potential issues to be addressed in the next revision.
   d. Determination of next meeting date and location.

12. Adjournment
Combustible Metals and Metal Dusts

Combustible Dusts

Chair
Liberty Mutual Commercial Markets
11805 West 128th Street
Overland Park, KS 66213
Alternate: Stanley C. Kavel, Jr.

Donna R. Bruce  U 1/14/2005
Secretary
KEMET Electronics Corporation
PO Box 5928
Greenville, SC 29606

John Belfanti  M 3/2/2010
Principal
ATI-Wah Chang
1600 Old Salem Road NE
Albany, OR 97321

Matthew J. Brown  M 8/9/2011
Principal
United States Steel Corporation
600 Grant Street, Room 2653
Pittsburgh, PA 15219-2800

Elizabeth C. Buc  RT 1/10/2008
Principal
Fire & Materials Research Laboratory, LLC
33025 Industrial Road
Livonia, MI 48150

Brad D. Burridge  U 8/9/2011
Principal
Novelis, Inc.
639 Players Crossing Way
Bowling Green, KY 42104

Tom Christman  SE 4/1/1994
Principal
984 Foxridge Lane
Caryville, TN 37714

Principal
Titanium Metals Corporation (TIMET)
900 Hemlock Road
Morgantown, PA 19543

Peter F. Downing  SE 8/5/2009
Principal
Environment & Safety Solutions, Inc.
120 Main Street, Suite 201
Hightstown, NJ 08520

Principal
The Boeing Company
2223 Field Avenue, NE
Renton, WA 98059

Principal
Westinghouse Electric Company
Western Zirconium Plant
10,000 West 900 South
Ogden, UT 84404-9760

Jeff Farrell  M 8/9/2011
Principal
Wheelabrator Group
1219 Corporate Drive
Burlington, ON L7L 5V5 Canada

Paul F. Hart  I 8/2/2010
Principal
XL Global Asset Protection Services
18257 Martin Avenue
Homewood, IL 60430

Daniel J. Hubert  M 3/1/2011
Principal
Janus Fire Systems
1102 Rupcich Drive, Millennium Park
Crown Point, IN 46307
Combustible Metals and Metal Dusts

Steven L. Klima  
Principal  
Babcock & Wilcox Y-12, LLC  
Y-12 National Security Complex  
Bear Creek Road, Building 301 BCR, S2.205  
PO Box 2009  
Oak Ridge, TN 37831-8107  

Dehong Kong  
Principal  
Princeton Safety Solutions, Inc.  
5 Spruce Court  
Plainsboro, NJ 08536

Kevin Krettman  
Principal  
City of Redding Fire Department  
PO Box 496071  
Redding, CA 96049  

Kevin M. Laporte  
Principal  
ProVent, LLC  
PO Box 223  
Conway, MI 49722

Peter Levitt  
Principal  
Sternvent Division of Durex, Inc.  
5 Stahuber Avenue  
Union, NJ 07083-5086

Timothy J. Myers  
Principal  
Exponent, Inc.  
9 Strathamore Road  
Natick, MA 01760  
Alternate: Scott E. Dillon

David L. Oberholtzer  
Principal  
Valimet, Inc.  
431 Sperry Road  
Stockton, CA 95206  
The Aluminum Association, Inc.

Samuel A. Rodgers  
Principal  
Honeywell, Inc.  
15801 Woods Edge Road  
Colonial Heights, VA 23834

Mark S. Rosenberger  
Principal  
Los Alamos National Laboratories  
PO Box 1663, M791  
Los Alamos, NM 87545

Richard Seidel  
Principal  
Suppression Systems Inc.  
301 South 4th Street  
Pennsburg, PA 18073  
Alternate: Lon L. Scholl

Patrick A. Thornton  
Principal  
Oak Ridge National Laboratory  
UT-Battelle  
PO Box 2008, MS 6470  
Oak Ridge, TN 37931

Erdem A. Ural  
Principal  
Loss Prevention Science & Technologies, Inc.  
810 Washington Street, Suite 4  
Stoughton, MA 02072

Richard S. Varga  
Principal  
Niagara Metallurgical Products  
400 Jones Road  
Stoney Creek, ON L8E 5P4 Canada  
Alternate: John E. McConaghe

David K. Young  
Principal  
Hughes Associates, Inc.  
2962 Chaparral Drive  
Idaho Falls, ID 83404
<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Address</th>
<th>Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robert G. Zalosh</td>
<td>Principal</td>
<td>Firexplo, 20 Rockland Street, Wellesley, MA 02481</td>
<td></td>
</tr>
<tr>
<td>Stanley C. Kavel, Jr.</td>
<td>Alternate</td>
<td>Liberty Mutual Property, One Roaring Spring Lane, Irwin, PA 15642</td>
<td></td>
</tr>
<tr>
<td>Lon L. Scholl</td>
<td>Alternate</td>
<td>Suppression Systems Inc., 301 South 4th Street, Pennsburg, PA 18073</td>
<td></td>
</tr>
<tr>
<td>Thomas J. Matesic</td>
<td>Nonvoting Member</td>
<td>1165 Mount Jackson Road, New Castle, PA 16102</td>
<td></td>
</tr>
<tr>
<td>Albert Muller</td>
<td>Member Emeritus</td>
<td>39 Still Hollow Road, Lebanon, NJ 08833</td>
<td></td>
</tr>
<tr>
<td>Martha H. Curtis</td>
<td>Staff Liaison</td>
<td>National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471</td>
<td></td>
</tr>
<tr>
<td>Scott E. Dillon</td>
<td>Alternate</td>
<td>Exponent, Inc., 1011 Warrenville Road, Suite 215, Lisle, IL 60532-0906</td>
<td></td>
</tr>
<tr>
<td>John E. McConagie</td>
<td>Alternate</td>
<td>Magnesium Elektron Powders NJ, 100 Ridgeway Boulevard, Manchester, NJ 08759</td>
<td></td>
</tr>
<tr>
<td>Matthew I. Chibbaro</td>
<td>Nonvoting Member</td>
<td>US Department of Labor, Occupational Safety &amp; Health Administration, 200 Constitution Ave. NW, Room N3609, Washington, DC 20210</td>
<td></td>
</tr>
<tr>
<td>William R. Hamilton</td>
<td>Alt. to Nonvoting Member</td>
<td>US Department of Labor, Occupational Safety &amp; Health Administration, 200 Constitution Ave. NW, Room N3609, Washington, DC 20210</td>
<td></td>
</tr>
<tr>
<td>Robert W. Nelson</td>
<td>Member Emeritus</td>
<td>28 Wing Road, PO Box 418, Pocasset, MA 02559</td>
<td></td>
</tr>
</tbody>
</table>

07/09/2012
Martha H. Curtis
CMD-CMM
Technical Committee on Combustible Metals and Metal Dusts

Pre-First Draft Meeting for NFPA 484 (A2014)
Hosted Meeting at Contran/TIMET at Lincoln Center
Dallas, Texas
March 20 – 21, 2012

I. Attendance:

**Members, Alternates, and Staff Present:**
Mark W. Drake – Liberty Mutual Commercial Markets, KS, Chair
Donna R. Bruce – KEMET Electronics Corporation, SC, Committee Secretary
John Belfanti – ATI-Wah Chang, OR (via teleconference)
Elizabeth C. Buc – Fire and Materials Research Laboratory, LLC, MI
Brad Burridge – Novelis, Inc., KY
Tom Christman – Consultant, TN, (via teleconference)
Gregory F. Creswell – Titanium Metals Corporation (TIMET), PA
Peter F. Downing – Environment & Safety Solutions, Inc., NJ
Steven C. Evans – Westinghouse Electric Company/Western Zirconium Plant, UT (via teleconference)
Paul Hart – XL Global Asset Protection Services, IL
Daniel J. Hubert – Janus Fire Systems, IN
Dehong Kong – Princeton Safety Solutions, Inc., NJ (via teleconference)
Kevin Kreitman – City of Redding Fire Department, CA (via teleconference)
Kevin M. Laporte – ProVent, LLC, MI
Peter Levitt – Sternvent Division of Durex, Inc., NJ (via teleconference)
Timothy J. Myers – Exponent, Inc., MA (via teleconference on Day 2)
Sam Rodgers – Honeywell, VA
Thomas P. Shober, Jr. – Alt., Silberline Manufacturing Company, Inc., PA (via teleconference)
Patrick A. Thornton – Oak Ridge National Lab, TN (via teleconference)
Erdem A. Ural – Loss Prevention Science & Technologies, Inc., MA (via teleconference)
David K. Young – Hughes Associates, Inc., ID (via teleconference)
Robert G. Zalosh – Firexplao, MA

Martha H. Curtis – NFPA Staff Liaison, MA

**Guests:**
Kevin O’Brien, Dallas Fire Department, TX
Celina Mikolajczak, Exponent, Inc., CA (via teleconference on Day 2)
Niels Pederson, Nederman LLC, NC
Michael McKee, Contran/TIMET Corp., TX

**Principals Absent without an Alternate Present:**
Matthew Brown – United States Steel Corporation, PA
Matthew Chibbaro – U.S. Dept. of Labor/OSHA, DC (Nonvoting)
Robert J. Eaker – The Boeing Company, WA
Jeff Farrell – Wheelabrator Group, ON, Canada
Steven L. Klima – B&W Y-12, LLC, TN
Mark Rosenberger – Los Alamos National Laboratories, NM
Technical Committee on Combustible Metals and Metal Dusts

Rick Seidel – Suppression Systems Inc. (SSI), PA
Richard S. Varga – Niagara Metallurgical Products, ON, Canada

Tuesday, March 20, 2012

II. Minutes of Meeting:

1. Chair Drake called meeting to order at 8:30 AM on March 20th.

2. Welcome & Self-Introduction of Committee Members & Guests.

3. Technical Committee Update: Newest TC member: Lon Scholl  
   a. Committee now has 29 Principals. Membership distribution is as follows:  
      9 Manufacturers; 9 Users; 7 Special Experts; 2 Insurance Representatives; 1 Enforcer; 1  
      Research & Testing; 5 Alternates; 2 OSHA (Non-voting)  
   b. Martha discussed the role of Alternates. Martha will send out an e-mail encouraging Principal  
      Members without Alternates to identify someone who could represent their company/industry as an  
      Alternate member of the Committee. (E-mail sent March 23, 2012.)

4. Chair & Staff Liaison Remarks:  
   a. Slide presentation addressing: CMD-CMM Pre-First Draft Meeting:  
      Pre-First Draft Meeting  
      Re-Engineering the Codes & Standards Process  
      Timeline  
      General procedures  
      Legal Concerns  
      Doc Info Pages  
   b. Dates for First Draft Meeting are July 24 - 26, 2012, in Salt Lake City, Utah.

5. Minutes from Pre-ROP meeting in Quincy, MA, in October 2011: Minutes were approved with  
   two changes: Tim Myers attended the Quincy meeting in person on the first day and via Live Meeting  
   on the second day and Mike Walters notified NFPA that he left his employer on Sept. 20, 2011, so he  
   will be removed from the TC.

6. Update on new Fundamentals of Combustible Dusts TC and what effect this has on the other  
   material standards: Paul Hart reported that NFPA 652 Committee met in February 2012. Scope of  
   proposed (new) NFPA 652 is to consolidate the fundamentals of combustible dusts. Document will  
   introduce the reader to the fundamentals of combustible dusts and direct the reader to other appropriate  
   dust standards. Kevin Kreitman suggested looking at NAICS codes to see if these could be used to help  
   direct specific industries to the correct combustible dust standard.

7. Update on new Correlating Committee and its role to review potential “inconsistencies” with  
   other dust standards: Correlating Committee is to drive to commonality of materials then point to  
   specifics of each type material in the appropriate specific standard.

8. Update on Hoeganaes incident in Gallatin, TN: Bob Zalosh presented information on the  
   investigation of three incidents at Hoeganaes. Employees did not recognize the hazard of the suspended  
   metal dust. Material had been tested, data received, but uncertainty as to what precautions were needed.
There is a CSB Report and Video Animation on this incident.

**Issues for the NFPA 484 TC:**

1. Is NFPA 484, Section 4.3 (4.3.4) on Determination of Dust Explosibility adequate? Explosion classification screening tests in accordance with ASTM E-1226 ($K_{St}$ & $P_{max}$). Issues of particle size.

2. Discussion of impact of surface oxidation of the dust due to delay in sampling (after incidents) on test results. Need to do either prompt sampling/testing or implement sample conditioning to prevent surface oxidation.

3. Discussion of need to have requirements for inspecting electrical equipment (i.e., exposed wiring arcing/sparking) in facilities generating combustible metal dusts.

4. Discussion of need to require periodic inspection and testing of concealed piping carrying flammable gases to/from heat treating furnaces. Proximity of open flame annealing furnaces to combustible dust accumulations. Discussion that annealing furnaces contain open flames and must address presence of combustible metal dust when in operation.

A Task Group was formed to submit comments to other standards (Furnaces (NFPA 86); Hydrogen (NFPA 2)) consisting of: Bob Zalosh, Tom Christman, Kevin Kreitman, Pete Downing, Greg Creswell, and Dave Oberholtzer.

5. Discussion of adequacy/limitations of flame-resistant clothing (NFPA 2113). Flame heat fluxes used in lab tests and mannequin test are much lower that metal dust flame heat fluxes.

---

9. **Old Business: Task Group Reports:**

a. **Chapter 14 Task Group Update: (Erdem Ural)**

4 Sub-task groups:

a. Dust classification criteria (Tim Myers, Sam Rogers, & Erdem Ural),

b. Protection Options and Practice (Trevor Burns & Peter Levitt),

c. Protection Options from Other Standards (Tom Christman & Sam Rogers)

d. Steel Industry involvement to develop steel chapter draft proposal: No luck (so far) with industry developing a chapter for inclusion into NFPA 484; Concerns from the NFPA 484 Committee about developing to placeholder chapter without participation from industry representation.

b. **NFPA 400 MAQ Limits and NFPA 484 Table 1.1.9: (Kevin Kreitman & Elizabeth Buc)**

Discussion of how NFPA 484 Table 1.1.9 relates to MAQ. Purpose of Table 1.1.9 is for applicability. MAQ needs more time and assessment than this revision cycle allows. Elizabeth Buc will review Table 1.1.9. New title for Table 1.1.9: “MAQ Applicability Threshold by Occupancy” Annex material: change wording to … entire building, not occupancy. Add footnotes to Table 1.1.9 relating to NFPA 400?

Add qualifier to applicability: “this standard should be used for reference even when only exempted quantities are in use: Timothy Myers to write a statement to this effect.

Martha to verify style format related to number of decimal places (pounds: 0, vs. kg: 3 in table).

c. **Literary Review: (Elizabeth Buc)** Task Group developed a list of lessons learned data that review should be included in report (form, composition, lessons learned). Code Fund Project?

d. **Advisory Service Inquiries: (Mark Drake)** Mark Drake to prepare public inputs to update chapters based on advisory service with help from responsible members.

e. **Inconsistencies between NFPA 484/70/499: (Sam Rodgers)** Would NFPA 484 be better served to pull info about electrical classification to front of each chapter & review wording...
for consistency? Currently minimum of 4 separate headings. Maybe place under building construction and design.

f. Recycling (technically new business): (Peter Downing) Much larger task than quick revision; want to include waste management and reclamation. Need to be certain to address change in form as received or feedstock with contaminants. Also need to address management of metals to be recycled which are not normally considered combustible. Task Group consists of: Elizabeth Buc; Brad Burridge; Greg Creswell; Peter Downing; Dave Oberholtzer.


g. NFPA 654, Section 7.4 addresses metals: (Tom Christman) Tom Christman recommended a joint NFPA 484/654 Task Group be set up to determine which document 7.4 resides in. Task Group consists of: Tom Christman, Mark Drake, & Paul Hart.

h. Storage and Recycling of Lithium Storage Batteries: Important to distinguish lithium ion batteries from lithium batteries. Electrolyte in lithium ion cells are primary fire hazard. Use of metals compatible extinguishers not necessary. Emoliers has proposed thermite reaction; Exponent researchers disagree. Phase I review was literature review. Phase II is a fire testing (calorimetry) of batteries in storage capacities. Research Foundation to study emergency response to potentially damaged lithium ion batteries. NFPA has provided information about flammable liquid (electrolyte) in battery. Question is what is the proper extinguishing agent?


- Add new definition: spark resistant.
- Elizabeth Buc to write paragraph addressing stainless steel and spark-resistance.
- Daniel Hubert to contact FM for availability of specifics of test method.

j. Review for consistent Housekeeping requirements throughout the standard:

Discussion of position of NFPA 484 TC on blow downs? Other standards default to vacuuming. NFPA 654 defaults to hand cleaning. NFPA 654 allows blow down only after cleaning using other methods; only residual dust would be present. (Also see discussion on Housekeeping in New Business 11B).

k. Task Group for application of bulk quantities of extinguishing agent, NFPA 10 vs. NFPA 484: Fire extinguisher guidance resides in NFPA 10; table for extinguishing agents for metals will remain in NFPA 484 with references back to NFPA 10. There are currently no requirements in NFPA 10 to inspect bulk agents. Proposals have been submitted to NFPA 10 and comments will be submitted as a follow-up activity by Tom Christman.

10. New Business:

a. Advisory Services Inquiries:
Technical Committee on Combustible Metals and Metal Dusts

- What is proper extinguishing agent for lithium batteries? More information is needed: other hazards present? What type and how many lithium batteries? Surrounding conditions?
- Does NFPA 484 apply to metal compounds? Does NFPA 484 apply to nuclear industry? Dan Hubert will discuss at NFPA 801 – 806 Committee meeting.
- Number of questions related to Wet Dust collectors indicates readers are confused. Discussion on possibly scaling back prohibition on dry collectors. Discussion of improvements to dry dust collectors: static dissipative bags and cartridges. 12.2.5 addresses hazard analysis which must be completed to resolve type of dust collector to use.

b. Review of Layout for 2015 edition of NFPA 484:
   X.1.4 Reactivity or Eutectic Reactions, Thermite Reactions. Combine to become: General Reactivity
   X.1.6 Alternative Methodologies: Same as Equivalency statement. Discussion of moving this to common section up front. Also discussion of how pulling this out would affect numbering. Solution is to make X.1.6 Reserved to preserve numbering.

   Errata: 8.1.6 is missing in Chapter 8.

Dust Collection is in several areas. Discussion of pros and cons of a single dust collection chapter.
   X.2.4, X.7.3: Review for consistency.
   9.4.7: Pneumatic conveying: discussion of consistency with NFPA 654 except where unique. NFPA 654 puts with process.
   X.9.2.1: Retitle as: Fugitive Dust Control. Straw vote on separate chapter on dust collection with space reserved in each metal chapter for specifics: Results: Agreed: 11; Opposed: 3. Task Group consists of: Kevin Laporte, Dave Oberholtzer, Pete Downing, & Peter Levitt.

   Road map on how to use NFPA 484 would be useful. Flow diagram planned in Fundamentals of Combustible Dusts.

c. Electrical requirements currently in several areas/sections of NFPA 484.
   X.2.3 Classification (for now, leave in individual chapters).
   X.9.3 Control of ignition sources: Consolidate into new Chapter 5 General (old Chapter 15).

   Housekeeping: Discussion of location of housekeeping and whether it should be a separate chapter. Discussion of moving current Ch. 15 Fire Prevention, Protection and Emergency Response to Ch. 5 and renaming as “Essential Requirements for Fire Prevention, Fire Protection and Emergency Response”.

   Discussion of various methods to address adequacy of housekeeping: visual, measurement, and calculation.

   Task Group: Tom Christman, Donna Bruce, Erdem Ural, Dave Young, Sam Rogers, Brad Burridge, & Dehong Kong.

Wednesday, March 21, 2012
1. Celina Mikolajczak gave presentation on traditional lithium and lithium ion batteries and fire protection for each. See prba.org.

C. Potential New Issues to be addressed in 2015 revision:

1. Bucket elevators and conveying: (Task Group consists of: Kevin Laporte, Steve Evans, Dave Oberholtzer, Brad Burridge, & Sam Rogers). Sam Rogers reported on requirements from other standards. Currently NFPA 484 has no coverage: don’t address that bucket elevators are used with metals (refer to Hoeganaes use of bucket elevators.) If used, need tight controls.

2. Section 14.2.4 Dust Collection is misnumbered. 14.8.1.2 – 14.9 needs to be renumbered to 14.7. Verify number corrections to match strawman. Martha to send electronically to Kevin Laporte and Kevin Kreitman can verify. Submit as Public Input from Committee.

3. Rename Zirconium chapter to “Zirconium and Hafnium” so hafnium users do not default to “Other Metals” chapter. Add new 13.1.1.1: All provisions apply equally to Hafnium.

4. Define shot peening, grit blasting: Instead of providing a list of processes, give examples in Annex. Qualify that list is not all inclusive. In 1.1.2.2, include shot peening and grit blasting as examples. Add Annex material to look at properties of mixture that is being circulated. Default is that mixture is combustible. Testing can be done to prove that the mixture is not combustible.

5. Review NFPA 33 Powder Coating which does not address thermal spray and arc spray. Do definitions/scope exclude metal spray?


7. Review strawman for holes, gaps, inconsistencies.

8. 2009 edition of NFPA 484 regarding 10.2.1.3 regarding the prohibited use of large low pressure ports:
In an overpressure situation, it is advantageous to have a small pressure relief port so that the vessel can be backfilled or pumped down. See Annex G.6.2 2012. Design principal could be edited to reflect goal to achieve.

Note: Some Annex material was lost in 2012 revision. Review 12.2.3.1.4 – 12.3.2.1.6; in order to prevent large influx of air in addition to water, or other materials.
Add Annex as Errata. Task group to add Annex material: Tom Christman, Mark Drake, Steve Evans, & Greg Creswell.

From Steve Evans: Low pressure venting shall be provided to prevent over-pressure during inert gas backfill to pressure up to 2 psi above ambient pressure. Low pressure vents shall be self-closing and shall not exceed 2” diameter.

9. Use of nonflammable coolant definition from Aluminum standard. Legacy language. Was original intent to have the coolant non-hazardous?? Coolant should be noncombustible. Several very fine machining processes use water or very little oil. Recommended approach: list preferred method first, and then establish equivalency with AHJ through documented hazard analysis and protection analysis.
11. Adjournment: The meeting adjourned at 3:15 p.m. CDT on March 21, 2012. The next meeting location will be Salt Lake City, UT and the tentative dates will be: July 24-26, 2012. Information will be provided as soon as it becomes available.

Respectfully submitted,

*Donna Bruce, NFPA 484 Committee Secretary*
Erdem A. Ural, Loss Prevention Science & Technologies, Inc.

**Recommendation:** Completely revise the document to integrate the individual metal chapters better. The new standard should also address the metalloids.

**Substantiation:** While improved significantly over the years, 484 still reflects its origin, and looks as if a number of separate individual standards stapled together. Same information is replicated in each chapter. There is no explanation for some of the significant differences among the chapters. A complete revision of the standard will be beneficial.

Erdem A. Ural, Loss Prevention Science & Technologies, Inc.

**Recommendation:** The statement "Dust layers 3 mm (1/8 in.) thick can be sufficient to warrant immediate cleaning of the area." appears in the annex of all individual metal chapters and in Chapter 14. Replace the phrase "3 mm (1/8 in.)" with "3/8 mm (1/64 in.)" in all occurrences.

**Substantiation:** During the previous cycle, a great majority of the committee members felt that no accumulation can be tolerated for metals that have chapters named after them. By any measure, a 1/8" accumulation is unacceptable.

In fact, the committee should correct this serious problem promptly by issuing a TIA.

Kevin Kreitman, City of Redding Fire Department

**Recommendation:** The document is not consistent on the location of material for dust collection and housekeeping. As an example some of the chapters have dust material located at *.2.4 and some in *.7.3, or in the case of Aluminum some material in both locations. Most of the chapters reference the reader to the section the material is in. Tantalum has the dust material in 11.7.3 Dust Collection but has (reserved) behind it which needs to be removed.

Review of sections in each of the metal chapters should also occur with regard to collection and conveying of powders, the chapters are not consistent at the present time and should be modified or direct the reader to an appropriate location regarding collection and conveying of powders.

**Substantiation:** The changes/modification will provide for consistency for the reader and ensure appropriate information is available.

Kevin Kreitman, City of Redding Fire Department

**Recommendation:** Based on the events which the Chemical Safety Board identified as contributing to the first incident which occurred at the Hoaganaes facility in which arcing of a motor due to exposed wires, powder/dust accumulation, and/or inadequate grounding; the Committee should review the material in all chapters including Chapters 14 and 15 to ensure appropriate safe guards and actions are include for initial installation of equipment in areas containing combustible powders and/or dusts and appropriate inspection and maintenance items that need to be addressed on an ongoing basis and inspection requirements.

**Substantiation:** We need to ensure that the Combustible Metals Standard has appropriate safeguards in place to lessen the likelihood of a fire and/or explosion event, based on the cause of the first incident as referenced by the Chemical Safety Board in their findings on the Hoaganaes Incident.
X.2 Facility Design Requirements

X.2.1 Building Construction

X.2.1.Y Electrical Power and Control

X.2.1.Y.1 All electrical equipment and wiring shall be installed in accordance with NFPA 70, National Electrical Code.

X.2.1.Y.2 All process equipment and all building steel shall be bonded and grounded in accordance with NFPA 70, National Electrical Code.

X.2.1.Y.3 All manufacturing buildings shall be provided with emergency lighting systems in accordance with NFPA 101, Life Safety Code.

X.2.1.Y.4 Control equipment, control rooms, and offices meeting the requirements of NFPA 496, Standard for Purged and Pressurized Enclosures for Electrical Equipment, shall be permitted.

X.2.1.Y.5 Preventive maintenance for electrical equipment shall be established commensurate with the environment and conditions.

X.2.1.Y.6 One or more remotely located control stations shall be provided to allow the safe and selective shutdown of process equipment in an emergency.

X.2.1.Y.7 Where process equipment presents a deflagration hazard to a normally unoccupied room or building, an interlock shall prevent process operation unless associated room doors are fully closed.

X.2.1.Y.8 Where process equipment presents an internal deflagration hazard, an interlock shall prevent equipment operation unless associated access panels are fully closed.

X.2.Y Electrical Area Classification

X.2.Y.1 In local areas of a plant where combustible or flammable liquids are present or where a hazardous quantity of dust accumulates or is present in suspension in the air, the area shall be classified, and all electrical equipment and installations in those local areas shall comply with Article 500 of NFPA 70, National Electrical Code.

A.X.2.Y.1 Housekeeping can be used to reduce or eliminate the electrical area classification for a location.

X.2.Y.2 All hazardous (classified) areas indentified in accordance with X.2.Y.1 shall be documented, and such documentation shall be maintained on file for the life of the facility.

X.2.Y.3 Electrical equipment and components installed in unclassified locations, where combustible metal dusts are processed or handled, shall be inspected both internally and externally and cleaned at least annually or more frequently if warranted.

A.X.2.Y.3 Finding combustible metal dust or powder within electrical equipment and components should warrant more frequent inspection and cleaning.

X.2.Y.4 Flashlights and other portable electrical equipment shall be listed for the locations where they are used.
Delete/modify conflicting paragraphs as below:

7.2.3 Electrical Classification (reserved)
Insert standard section here

8.2.1.18.1 (under Grounding and Lightning Protection)
Delete 8.2.1.18.1 as it is duplicated in 8.2.1.20.1 and will be retained in that standard section

8.2.1.20 Electrical Power and Control
Replace with standard section

8.2.3 Electrical Classification
Replace with standard section

8.6.1.3 Delete as redundant

8.6.2.2 Electrical Equipment
Delete as redundant

8.6.3.3 Delete as redundant

8.7.1.3 Electrical Equipment - Delete as redundant

8.7.3.18 Delete as redundant

9.2.1.1.18 Electrical Power and Control
Replace with standard section. This section seems to have an extra indent level that is not needed. Move 9.2.1.1.19 through 9.2.1.1.19.3 to be after 9.2.1.1.5 as new 9.2.1.1.6 and 9.2.1.1.7 and renumber subsequent as higher level sections (ie 9.2.1.2, etc.

9.2.3 Electrical Classification
Replace with standard section and delete or relocate 9.2.3.4 to Ignition Control Section

9.8.1.6.6 Delete as redundant

9.9.3.3 Delete as redundant

10.2.1.8 Replace with standard section

10.2.3 Replace with standard section. Section 10.2.3.2 below would be an application of NPFA 496 because purging would be needed to keep dust out of the area if it were dusty just outside the offices. Additional text was added to the general section to address offices.

10.2.3.2 Offices and similar areas within the niobium powder–manufacturing building that are segregated and free from niobium dust shall not be classified.

10.3.6.4 Delete as redundant

10.3.9.2 Delete as redundant
10.4.13 Delete section and relocate 10.4.13.3 through 10.4.13.5 to section on control of ignition sources

10.4.16 Delete as redundant

10.5.2 Delete as redundant

10.5.8.5.2 Delete as redundant

11.2.3 Replace with standard section

11.3.2.9 Delete as redundant

11.4.2.9 Delete section and relocate 11.4.2.9.3 and 11.4.2.9.4 to section on control of ignition sources

11.4.2.12 Delete as redundant

11.5.1.2 Delete as redundant

11.5.6 Delete as redundant

11.7.4.2 Delete as redundant

12.2.3 Replace with standard section

13.2.3 Replace with standard section

14.2.3 Replace with standard section

14.5.1.2 Delete as redundant

14.5.6 Delete as redundant

14.6.1.3 Delete as redundant

14.6.2.2 Delete as redundant

14.6.3.3 Delete as redundant

14.8.1.3 Delete as redundant

14.8.3.18 Delete as redundant

14.9.1.6 Delete as redundant

14.10.6.1 Delete as redundant with general electrical installation and classification sections

**Substantiation:** The current organization repeats electrical installation and classification requirements multiple times in each metals chapter. The proposed changes will eliminate specific electrical classification requirements for different processing areas and just have a single area in each chapter.
Peter F. Downing, Environment & Safety Solutions, Inc.

**Recommendation:** Standard lacks a definition for "recycling". A concrete definition of recycling is necessary in order to refer users to Chapter 16.

"Recycling - processing, reprocessing, resizing, sorting, sifting, or staging of materials formerly in the process stream or in use, that no longer serve their original and/or intended purpose, but continue to have resale value. Recycling includes, but is not limited to, mechanical and chemical processing, crushing, grinding, shearing, ... . Where a new chemical compound is made, or a material is processed such that its form is no longer recognizable from the original raw material, it is considered manufacturing."

Source unknown

**Substantiation:** No definition of recycling or recycler exists. Definition is necessary to identify who needs to meet the requirements of a revised Chapter 16.

Elizabeth C. Buc, Fire & Materials Research Laboratory, LLC

**Recommendation:** Add a new figure as shown:

**Flow Diagram**

INSERT Figure 1.1. Document flow diagram.

**Substantiation:** An overview flow diagram assists the user in navigating through the document not just their specific metal chapter. It also sends a user to NFPA 654 for non-metal dusts.

Tom Christman, Caryville, TN

**Recommendation:** Add a new section to read:

1.1.x* The scope of this standard shall include extinguishing equipment and agents that are not listed.

**Substantiation:** NFPA 10 has rejected a proposal to include extinguishing agents that are not Listed agents. As such, there is a need to ensure that these agents are covered by this standard. The annex material is provided to show how a non-listed agent can be used as an extinguishing agent.

Timothy J. Myers, Exponent, Inc.

**Recommendation:** This is a placeholder so that the committee may consider adding a relatively comprehensive list of examples of metals and industries to which this standard may apply. Preferably this would be in the mandatory section of the scope where it is more likely to be seen, but could also be placed in an appendix to the scope. NFPA 61 does this for different agricultural dusts.

**Substantiation:** A common finding in many investigations of explosions is that the facility was not aware of existing NFPA standards. Adding language about the metals and industries that may be covered by this standard would aid the public in determining if the standard applies to them.
Do you produce, use, handle, finish or store metal?

Yes

Is it combustible or explosible?

Yes

Primary

What is the principal metal?

Cerium, francium, lithium, potassium, rubidium, sodium and alloys of these metals

Chapter 7

Aluminum

Chapter 8

Magnesium

Chapter 9

Niobium

Chapter 10

Tantalum

Chapter 11

Titanium

Chapter 12

Zirconium

Chapter 13

Other metals

Chapter 14

No

Go to NFPA 654

I don't know

Go to Chapter 4

Secondary

Recycling or waste treatment?

Yes

Go to Chapter 16

I don't know

Go to Chapter 15

Do you meet the essential general requirements for fire prevention, fire protection and emergency response?

Yes

Go to Chapter 6

No

Do you have a dust explosion or flash fire hazard area?

I don't know
Erdem A. Ural, Loss Prevention Science & Technologies, Inc.

Recommendation: Develop and publish a more objective method of selecting which chapter to use for a mixture of metals.

Substantiation: While the current section 1.1.3 and A.1.1.3 sounds good, in practice this methodology can be highly subjective.

Erdem A. Ural, Loss Prevention Science & Technologies, Inc.

Recommendation: Add new text to read as follows:

1.1.4 Metals, metal alloy parts, and those materials, including scrap, that contain at least 10% metal by weight, but that do not exhibit combustion characteristics of alkali metals, aluminum, magnesium, niobium, tantalum, titanium, or zirconium are subject to the requirements of Chapter 14.

Substantiation: Current section 1.1.4 gives the impression that, in order to invoke chapter 14, Metals, metal alloy parts, and those materials, including scrap has to be pure metal. In real life these materials are often mixed with non-metals. This proposal lowers the threshold to 10%, a number that can be changed by the committee.

Erdem A. Ural, Loss Prevention Science & Technologies, Inc.

Recommendation: Insert new definition

3.3.x Threshold dust accumulation: a critical value of the dust mass per unit surface area or layer thickness, determined as a part of the hazard analysis for a particular enclosure or facility, as the limit for safe operation.

Substantiation: This term is used in chapter 5 but not defined. Annex to chapter 15 suggests the threshold accumulation is 1 kg/m2 while annexes for the individual chapters recommend 1/8".
The screening test in Section 4.2 or in Section 4.3 and 4.4 shall be conducted to determine if a metal is in combustible or explosible form. If there is any doubt about whether a metal particulate material is combustible, the screening tests described in Sections the applicability of this standard to that material.

Substantiation: There is a need for a flash fire screening test as well as a combustible and explosible screening test.

4.1.1 If either any of the screening tests described in Sections 4.2, 4.3, or [new] 4.4 produces a positive result, the material shall be considered a combustible metal.

Substantiation: There is a need for a flash fire screening test as well as a dust layer combustible and dust cloud explosibility screening test.

4.1.5.3 Samples shall be tested within 14 days of collection unless they are preserved in nitrogen or vacuum packaging.

Substantiation: Test samples can become inerted by the formation of a metal oxide layer on the surface of the particles. It is important to test before this oxide layer forms, or to prevent oxide layer formation.
4.2.1* Combustibility shall be determined for metals, metal powders, and metal dusts by the preliminary screening test set forth in the UN Recommendations on the Transport of Dangerous Goods: Model Regulations — Manual of Tests and Criteria, Part III, Subsection 33.2.1, as well as in an orientation that allows the test train to be oriented in a vertical position.

4.2.1.1 The vertical test method shall include a tube using the same dimensions as the UN Test Method referenced in 4.2.1, oriented in a vertical position.

4.2.1.2 The material to be tested shall not be packed into the tube.

4.2.1.3 For the determination using a vertical orientation, the heat source shall be applied to the top of the test media, and allowed to ignite the metal, metal powder or metal dust.

4.2.2 For purposes of determining the combustibility of metal powders, pastes, finely divided materials, and metal dusts, the results of the screening test shall be categorized as one of the following three categories:

1. No reaction
2. Glowing but no propagation along the powder train
3. Propagation along the powder train past the heated zone
4. Spark generation that continues after the removal of the heat source

4.2.3 If the results of the screening test provide either no reaction or glowing but no propagation along the powder train past the heated zone by burning with flame or smoldering, the test material shall be considered to be in a noncombustible form.

Substantiation: Review of data regarding both major accidents at facilities processing metals as well as audits of facilities utilizing materials that have combustible properties has identified a subset of combustible metals for which propagation along a horizontal train does not take place, but that supports combustion and, indeed, maintains vigorous combustion when oriented vertically. A typical example of this type of material is thermite, containing a mixture of aluminum powder and iron oxide, which when ignited, initiates an irreversible reaction at temperatures over 5500 F, but only in a vertical direction. The same material may not propagate along a horizontal train.

---

Erdem A. Ural, Loss Prevention Science & Technologies, Inc.

4.3.1* The determination of explosibility of metals, metal powders, metal dusts, and alloys of these materials shall be determined by using the explosibility classification screening test.

Substantiation: Additional tests are not needed for nonexplosible materials. Not all the listed tests needed in all applications.

A separate Public Input proposes moving the chart to the Annex.
484- Log #96  CMD-CMM  
(Figure 4.3.1) 

Submitter: Elizabeth C. Buc, Fire & Materials Research Laboratory, LLC  
Recommendation: Replace the existing figure with the following:  

INSERT Figure 4.3.1  

Substantiation: The existing figure does not include the ASTM test methods. A revised flow diagram is proposed which includes appropriate ASTM test methods and highlights the screening test.

484- Log #88  CMD-CMM  
(4.4) 

Submitter: Robert G. Zalosh, Firexplo  
Recommendation: Revise text to read:  

4.4 Risk Evaluation. Where a risk evaluation (see Annex I) is required by the AHJ, material property data and material handling and processing conditions shall be reviewed to determine the likelihood and consequences of a metal powder or dust ignition. It shall be permitted to make qualitative determinations of likelihood and consequences providing at least some of the following data shall be determined: property data are included in the determinations.  

Minimum ignition energy (MIE)  

(1) Maximum pressure (Pmax)  
(2) Pressure rise (dP/dt)  
(3) Deflagration index (KSt)  
(4) Limiting oxygen concentration (LOC)  
(5) Minimum explosible concentration (MEC)  
(6) Thermal stability  
(7) Electrostatic risk  
(8) Reactivity  

Substantiation: The current requirement to conduct the entire list of tests in order to do a risk assessment is unnecessarily burdensome. The change allows for consideration of ignitability and explosion consequence using pertinent data, without doing all the tests.
Is the dust or powder explosive?

- Yes
  - Minimum ignition energy (MIE) of a dust cloud in air
    - ASTM E2019

- No
  - Explosibility classification screening test
    - ASTM E1226

- Is the metal combustible?

- Yes
  - Minimum exploisible concentration (MEC)
    - ASTM E1515

- No
  - Explosion severity-20 liter sphere
    - Maximum explosion pressure ($P_{max}$)
    - Maximum rate of pressure rise
    - Deflagration index ($Kst$ value)
      - ASTM E1226

  - Limiting Oxygen Concentration (LOC)
    - ASTM E1515 modified
Add a new section to read:

Suggested new 4.4 (does not replace old 4.4)

4.4 Determination of Flash Fire Potential.

4.4.1 The flash fire potential of a metal particulate sample shall be assessed using the 20-liter combustion chamber screening test methodology described in Section 13 of ASTM E1226-10 and interpreted per 4.4.2, or another test satisfying the conditions described in 4.4.3.

4.4.2 If any of the explosibility screening tests conducted in accordance with ASTM E 1226-10 produce an explosion pressure ratio greater than two, the test material shall be considered to have a flash fire potential.

A.4.4.2 The ASTM E 1226 screening test entails attempts to ignite suspended dust concentrations of 1000 g/m³ and 2000 g/m³ using either a 5 kJ or 10 kJ igniter in a 20-L chamber. Although the standard allows re-testing in a larger vessel if there is concern that a positive explosibility result may be due to an “overdriven system,” any positive result is indicative of a flash fire potential for purposes of NFPA 484.

4.4.3 It shall be permitted to assess the flash fire potential using a test acceptable to the Authority Having Jurisdiction involving the dispersal in air of at least 15 grams of particulate sample projected toward a burner flame. Flaming of particulate before or after reaching the burner flame shall be considered a demonstration of flash fire potential.

A.4.4.3 Chemical Safety Board Case Study Report No. 2011-4-I-TN, “Hoeganaes Corporation: Gallatin, TN, Metal Dust Flash Fires and Hydrogen Explosion,” describes a flash fire demonstration test entailing the dispersal of 20 to 30 grams of iron dust through a multi-orifice nozzle located about 43 cm (17 in) above an 20 cm (8 in) burner. See Fig A.4.4.3.

5.1.3 It shall be permitted to use one of the methodologies described in Section 6.1 of NFPA 654 to determine if a particular area is a dust explosion hazard area or a dust flash-fire hazard area.

Substantiation: The standard does not presently have a flash fire screening test, yet the flash fire hazard is one of the primary hazards addressed in the standard.

Change “9 m (30 ft).” to “11 m (35 ft)”

Consistent with NFPA 51B, Standard for Fire Prevention during Welding, Cutting, and other Hotwork.
6.1 General. The facility and process shall be designed and operated in accordance with this section. The provisions of this section shall apply to the overall design of systems that handle combustible dusts.

6.1.1 Hazard Assessment. The facility and process equipment shall be evaluated for dust flash fire and dust explosion hazards in accordance with this section. The provisions of this section shall apply to the assessment of the hazards associated with the overall design of systems that handle combustible dusts.

6.1.1.1 Those portions of the process and facility interior where dust accumulations exist outside of equipment in sufficient depth to prevent discerning the underlying surface color shall be evaluated to determine if a dust explosion hazard or flash fire hazard exists. The provisions of this section shall apply to the assessment of the hazards associated with the overall design of systems that handle combustible dusts. 

6.1.1.2 Areas where dust clouds of a hazardous concentration exist shall be deemed to be a dust flash fire and dust explosion hazard area.

6.1.1.3* Dust flash fire or dust explosion hazard areas shall additionally be determined in accordance with any one of the four methods established below:

(1) Layer Depth Criterion Method in Section 6.1.3
(2) Mass Method A in Section 6.1.4
(3) Mass Method B in Section 6.1.5,
(4) Risk Evaluation Method in Section 6.1.6.

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.

A.6.1.1.3 For many situations the layer depth method is the easiest to use and can be used for any application or ceiling height. Either of the Mass Methods can be used for any ceiling height. Mass Method A does not require specific material properties or building strength data. Using Method A for buildings with greater than 12 meter ceiling height does not allow the user increased dust accumulation, compared to Mass Method B. Mass Method B allows the owner operator the greatest flexibility in addressing dust accumulations and takes into account specific building and material properties. However, this requires more detailed information about the building construction that might not be available for some buildings. When calculating dust loads by any method, include dust on mezzanines. When calculating the allowable volume or mass of dust, the area of the mezzanine is not added to the footprint of the building or room.
6.1.1.4 Each of the methods in Sections 6.1.3, 6.1.4, 6.1.5, and 6.1.6 shall be deemed to provide equivalent levels of safety.

6.1.1.5* It shall be permitted to determine the accumulated mass and bulk density on a dry weight basis by drying the sample to less than or equal to 5 weight percent moisture. (existing 6.1.9 of ROP moved here)

A.6.1.1.5 In some cases, such as fine particulates generated from hardwoods, it is advisable to correct for a settled bulk density in excess of the 20 lb/ft^3 (320 kg/m^3), used in this requirement.

The measurement of bulk density is very dependent upon the particle, size, shape, and chemical content. Settled bulk density is not the same as tapped bulk density. Settled bulk density is the density as the material has settled in the facility under normal operating conditions. Tapped bulk density is the maximum density that can be achieved without intentional compression. Tapped bulk density measurement numbers are almost always higher than settled bulk density measurement numbers.

Moisture content is a factor that has a profound effect on dust deflagration propagation. Moisture in dust particles raises the minimum ignition temperature (MIT), minimum ignition energy (MIE), and minimum explosible concentration (MEC) by increasing agglomeration of particles.

Moisture content can be determined using the following method:

1. Weigh the material of which a moisture content is to be determined in the moist, as-received state.
2. Then dry it for 24 hours in a drying oven set at 75ºC (167ºF).
3. Then reweigh the sample.

Calculate the moisture content from the following relation:

\[
\% \text{MC} = \left(\frac{\text{moist weight} - \text{dry weight}}{\text{moist weight}}\right)(100)
\]

While no ASTM method currently exists for determining settled bulk density, the following method has been utilized to produce usable results. Since the use of bulk density measurements is to determine the permissible dust layer depth for hazard assessment, bulk density should be based upon the dried weight, not moist weight; the water in the moist sample does not add combustible material to the mixture.

**Recommended Tools:** Neoprene or other similar plastic-type gloves, ruler, two natural bristle brushes [100 mm (4 in.) width], scales (that measure grams), pre-weighed container (weighed in grams to nearest tenth of a gram), and a drying oven.

**Recommended Procedure:**

1. Pre-weigh and record container weight.
2. Locate horizontal surface area where dust is present and is evenly distributed across a flat surface. This is an important criterion.
(3) Mark off a 1 ft² (0.09 m²) area. (It is easier if one of the four sides is the horizontal surface ledge). If one square foot is not available due to size of surface use: 1⁄2 ft × 2 ft; 1⁄4 ft × 4 ft, etc.

(4) Using the ruler as a guide, carefully scrape the other dust surrounding the marked 1 ft² (0.09 m²) (or other established one square foot dimension) back away from the dust square (or rectangle) to at least 8–12 in. Use the first brush if needed to clean dust away from the 1 ft² (0.09 m²) selected for density measurement [ensuring that the 1 ft² (0.09 m²) area does not receive any of the dust being brushed away].

(5) Measure and record the height (to the nearest 1⁄32 in.) of the dust layer as it sits on the horizontal layer. Take a minimum of three to five measurements along the edge of the dust layer to establish an average height (to the nearest 1⁄32 in.) of the dust layer.

(6) Take the second clean, natural bristle brush and carefully brush the dust contained inside the 1 ft² (0.09 m²) area into the pre-weighed container.

(7) At this time, the dust sample must be dried as outlined above.

(8) Weigh the dried dust sample and the container together and record the weight in grams.

(9) Subtract the weight of the container from the weight of the dried dust-filled container to obtain the weight of the dried dust in grams. Record the dust weight.

(10) Calculate volume of the dust layer using average height measured (in inches) × length (12 in.) × height (12 in.) to obtain cubic inches of volume.

(11) Convert cubic inches to cubic feet.

(12) Convert grams of dust measured to pounds. (Note: 453.6 g = 1 lb).

(13) Divide pounds of dust by cubic feet to establish estimated density in pound per cubic feet (lb/ft³).

Example:
Container pre-weight is 500 g.
Average dust height measured is 2 1⁄32 in.
Container plus dust weight is 660 g.

**Dust Volume Determination in cubic feet (ft³):**
2 1⁄32 in. = 65⁄32 in., or 2.03125 in. (51.6 mm)
Volume (in.³) = L × W × H = 12 in. × 12 in. × 2.03125 in. = 292.5 cubic in.³
Convert cubic inches to cubic feet: There are 1728 in.³ in 1 ft³.
Volume (ft³) = Volume (in.³) ÷ 1728 = 292.5 ÷ 1728 = 0.169 ft³ (0.0048 m³)
(305 mm × 305 mm × 51.6 mm) = (0.305 m × 0.305 m × 0.0516 m = 0.0048 m³)

**Dust Weight Determination in pounds (lb):**
To obtain the weight of the dust, subtract container weight in grams from weight of the container containing the dried sample:
660 g – 500 g = 160 g
Convert grams to pounds. There are 453.6 g in 1 lb, therefore:
160 g ÷ 453.6 g/lb = 0.353 lb (of dust)

**Dust Density Determination:**
Divide pounds of dust by volume of dust in cubic feet:
0.353 lb ÷ 0.169 ft³ = 2.087 lb/ft³.
Round off to nearest tenth of a pound = 2.1 lb/ft³
[0.16 kg ÷ 0.0048 m³] (33.43 kg/m³).

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

6.1.1.7 All dust accumulated on structures above the lowest footprint shall be evaluated as if accumulated on the lowest footprint.

6.1.1.8 Dust accumulation amounts shall reflect the conditions that exist just prior to routinely scheduled cleaning, and shall not include short term accumulations cleaned in accordance with Chapter 8.

6.1.1.9 The process equipment shall be assessed in accordance with Section 6.1.7.

6.1.1.10 Personnel exposed to a dust flash fire hazard shall be protected in accordance with Section 11.2.2.

6.1.2 Those portions of the facility and process where a dust explosion hazard or flash fire hazard exists shall be protected from the effects of these hazards in accordance with this section as well as Sections 6.2, 6.3, and 6.4 and Chapter 7.

6.1.3* Layer Depth Criterion Method.
A dust flash fire or dust explosion hazard area exists when the dust layer thickness measured outside of process equipment exceeds the quantity determined below.

A.6.1.3 See Annex D for example calculations applying the layer depth criterion method.

6.1.3.1 The layer depth criterion is 1/32” and shall be permitted to be increased according to equation 6.1.3.1 for materials with bulk density less than 75 lb/ft³

*****Insert Equation 6.1.3.1 (from ROP Eq 6.1.6.1) Here****

6.1.3.2* A dust explosion hazard and dust flash fire hazard shall be deemed to exist in any building or room 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 ft$^2$ 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 accumulation is greater than the
layer depth criterion multiplied by 1000 ft$^2$.

(1) For buildings or rooms with footprint areas smaller than 20,000 ft$^2$
(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 ft$^2$
(a) the area of dust accumulations exceeding the layer depth criterion is greater than 1000
ft$^2$, or
(b) the total volume of dust accumulations is greater than the layer depth criterion
multiplied by 1000 ft$^2$.[654-22 (CP#4)]

A.6.1.3.2 See D.2 for example of how to apply this method.

6.1.4* Mass Method A. A dust flash fire or dust explosion hazard area exists when the
total accumulated dust outside of process equipment exceeds the quantities determined
from the equations below.

A.6.1.4 Mass per unit area derived from these mass determination methods can be used to
derive a measurable layer depth using the fact that mass divided by settled bulk density
equals layer depth. See D.3 for an example of how to apply this method.

6.1.4.1 The threshold dust mass establishing a building or room as a dust explosion
hazard area, $M_{basic\text{-exp}}$, shall be determined per equation 6.1.4.1.

Eqn 6.1.4.1 (existing equation 6.1.3.1 from ROP)

6.1.4.2 The threshold dust mass establishing a building or room as a dust flash fire hazard
area, $M_{basic\text{-fire}}$, shall be determined per equation 6.1.4.2.

Eqn 6.1.4.2 (existing equation 6.1.3.2 from ROP)

Where, for both equations 6.1.4.1 and 6.1.4.2:

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

A.6.1.3.4 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 6.1.34.1 or 6.1.34.2 has been set to 2000 m$^2$. For an example of the calculation of threshold dust mass see Annex D.

**6.1.5* Mass Method B.** A dust flash fire or dust explosion hazard area exists when the total accumulated dust outside of process equipment exceeds the quantities determined from the equations below.

A.6.1.5 See D.3 for an example of how to apply this method.

6.1.5.1* The threshold dust mass establishing a building or room as a dust explosion hazard area, $M_{exp}$, shall be determined per equation 6.1.5.1.

A.6.1.5.41 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 6.1.5.4 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 6.1.5.41, 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.

*****Insert Eqn 6.1.5.1 (existing equation 6.1.4 from ROP) Here****

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).

$\eta_D$ = the entrainment fraction $= 0.25$

**6.1.5.1.1** 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.

**6.1.5.1.2** It shall be permitted to use an alternative value of $\eta_D$ less than 0.25, based on a risk evaluation that is acceptable to the authority having jurisdiction.


A higher value for $\eta_D$ is more appropriate for ducts and small enclosures less than 100 m$^3$ 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 $\eta_D$.

**6.1.5.2** The threshold dust mass establishing a building or room as a dust flash fire hazard area, $M_{fire}$, shall be determined per equation 6.1.5.2.

A.6.1.5.2 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 6.1.5.2 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.

*****Insert Eqn 6.1.5.2 (existing equation 6.1.5 from ROP) Here*****

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.

**6.1.5.2.1** The value of $D$ in equation 6.1.5.2 shall be 2 m.
6.1.5.2.2 The value of p shall not exceed 0.05 (5% probability).

6.1.5.2.3* It shall be permitted to use an alternative value of \( \eta_D \) less than 0.25, based on a risk evaluation that is acceptable to the authority having jurisdiction.

A.6.1.5.3 See A.6.1.4.2.

A.6.1.5.2.3 See A.6.1.5.1.2

6.1.6* Risk Evaluation Method. A documented risk evaluation acceptable to the AHJ shall be permitted to be conducted to determine whether or where a dust explosion hazard or dust flash fire hazard area exists.

A.6.1.6 The risk evaluation method in 6.1.6 supplements the process hazard analysis required in Chapter 4. It is intended to focus on material properties and inherent design features of the equipment and facility necessary to determine the extent of the hazard areas.

6.1.7 An explosion hazard shall be deemed to exist in enclosed process equipment where all of the following conditions 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
Layer Depth Criterion (in) = \frac{\left( \frac{1}{32} \, \text{in} \right) \left( \frac{75 \, \text{lb}}{\text{ft}^2} \right)}{\text{Bulk Density} \, \frac{\text{lb}}{\text{ft}^3}}
\[ M_{\text{tor-exp}} = 0.004 \cdot A_{\text{tor}} \cdot H \]
$$M_{\text{base - far}} = 0.02 \cdot A_{\text{far}}$$
\[ M_{eq} = \left[ \frac{P_{el}}{DFL} \right] \left[ \frac{C_{wp}}{\mu_{\text{base}}} \right] \frac{A_{\text{base}} \cdot H}{\eta_{D}} \]
\[ M_{\text{fuel}} = p \cdot C_{eq} \cdot \left( \frac{P_{\text{inlet}}}{P_{\text{inlet}} + P_{\text{loss}}} \right) \cdot \frac{A_{\text{fuel}}}{D} \cdot \frac{\eta_{\text{p}}}{\eta_{\text{p}}}. \]
Add a new Figure as shown:

Alkali Metal Flow Diagram

Figure 7. Alkali metal flow diagram.

**Substantiation:** The alkali metal chapter flow diagram assists the user in navigating through the various sections of this chapter as well as other associated chapters in the document.
Do you meet the general essential requirements?  
- I don't know → See section 7.1 and Chapter 15
- Yes
  - Is this a new process?  
    - Yes → Hazard analysis requirements see section 7.2.5
    - No
      - Does your facility meet design requirements?  
        - I don't know → See section 7.2
        - Yes
          - Do you perform primary processing?  
            - Yes → Melting & Casting- See section 7.3.2  
            Processing & Handling- See section 7.6
            - No
              - Are you machining, fabricating or finishing product?  
                - Yes → See section 7.7
                - No
                  - Are you storing solid or molten alkali metals?  
                    - Yes → See section 7.8
                    - No
                      - Are you sending materials to recycling or waste treatment?  
                        - Yes → Go to Chapter 16
                        - No
                          - Are your fire and explosion prevention measures in place?  
                            - Yes → See section 7.9
                            - No
A.7.7 Section 7.7 applies to operations where alkali or alkali alloys are subjected to processing or finishing operations. The operations specified in 7.7 can include, but are not limited to, grinding, buffing, polishing, sawing, and machining of solids. Medial blasting operations include, but are not limited to, abrading, etching, applying an anchor pattern, wheel blast, centrifugal wheel blast, sand blast, grit blast, air blast, airless blast, siphon blast, suction blast, abrasive shot blast, peening, and shot peening of solids.

A.8.7 Section 8.7 applies to operations where aluminum or aluminum alloys are subjected to processing or finishing operations. The operations specified in 8.7 can include, but are not limited to, grinding, buffing, polishing, sawing, and machining of solids. Medial blasting operations include, but are not limited to, abrading, etching, applying an anchor pattern, wheel blast, centrifugal wheel blast, sand blast, grit blast, air blast, airless blast, siphon blast, suction blast, abrasive shot blast, peening, and shot peening of solids.

A.9.7 Section 9.7 applies to operations where magnesium or magnesium alloys are subjected to processing or finishing operations. The operations specified in 9.7 can include, but are not limited to, grinding, buffing, polishing, sawing, and machining of solids. Medial blasting operations include, but are not limited to, abrading, etching, applying an anchor pattern, wheel blast, centrifugal wheel blast, sand blast, grit blast, air blast, airless blast, siphon blast, suction blast, abrasive shot blast, peening, and shot peening of solids.

A.10.7 Section 10.7 applies to operations where niobium or niobium alloys are subjected to processing or finishing operations. The operations specified in 10.7 can include, but are not limited to, grinding, buffing, polishing, sawing, and machining of solids. Medial blasting operations include, but are not limited to, abrading, etching, applying an anchor pattern, wheel blast, centrifugal wheel blast, sand blast, grit blast, air blast, airless blast, siphon blast, suction blast, abrasive shot blast, peening, and shot peening of solids.

A.11.7 Section 11.7 applies to operations where tantalum or tantalum alloys are subjected to processing or finishing operations. The operations specified in 11.7 can include, but are not limited to, grinding, buffing, polishing, sawing, and machining of solids. Medial blasting operations include, but are not limited to, abrading, etching, applying an anchor pattern, wheel blast, centrifugal wheel blast, sand blast, grit blast, air blast, airless blast, siphon blast, suction blast, abrasive shot blast, peening, and shot peening of solids.

A.12.7 Section 12.7 applies to operations where titanium or titanium alloys are subjected to processing or finishing operations. The operations specified in 12.7 can include, but are not limited to, grinding, buffing, polishing, sawing, and machining of solids. Medial blasting operations include, but are not limited to, abrading, etching, applying an anchor pattern, wheel blast, centrifugal wheel blast, sand blast, grit blast, air blast, airless blast, siphon blast, suction blast, abrasive shot blast, peening, and shot peening of solids.

A.13.7 Section 13.7 applies to operations where zirconium or zirconium alloys are subjected to processing or finishing operations. The operations specified in 13.7 can include, but are not limited to, grinding, buffing, polishing, sawing, and machining of solids. Medial blasting operations include, but are not limited to, abrading, etching, applying an anchor pattern, wheel blast, centrifugal wheel blast, sand blast, grit blast, air blast, airless blast, siphon blast, suction blast, abrasive shot blast, peening, and shot peening of solids.

A.14.7 Section 14.7 applies to operations where metal or metal alloys are subjected to processing or finishing operations. The operations specified in 14.7 can include, but are not limited to, grinding, buffing, polishing, sawing, and machining of solids. Medial blasting operations include, but are not limited to, abrading, etching, applying an anchor pattern, wheel blast, centrifugal wheel blast, sand blast, grit blast, air blast, airless blast, siphon blast, suction blast, abrasive shot blast, peening, and shot peening of solids.
Current standard does not mention media blasting operations which in many cases are not machining, fabrication or finishing operations. As an industry, many users do not see their operations covered by NFPA 484 and therefore do not apply the standard.

**Substantiation:**

Currently the standard does not mention media blasting operations which in many cases are not machining, fabrication or finishing operations. As an industry many users do not see their operations covered by NFPA 484 and therefore do not apply the standard.

---

**Log #70 CMD-CMM**

(7.9.3)

**Final Action:**

**Submitter:** Samuel A. Rodgers, Honeywell, Inc.

**Recommendation:** Revise to read:

7.9.3 Control of Ignition Sources.

7.9.3.1 Control of Ignition Sources shall be in accordance with Chapter 15.

7.9.3.1.1.1 Alkali metal fire residue containers shall be permitted to be stored outside where placed in a steel overpack drum and inspected daily.

7.9.3.1.2 Alkali metal fire residue containers shall be disposed of within 7 days unless the AHJ allows longer storage.

7.9.3.2.1 Alkali metal fire residue shall be protected, to prevent adverse reactions and to prevent the formation of reactive or unstable compounds.

7.9.3.2.2 Alkali metal fire residues shall be disposed of in accordance with federal, state, and local regulations.

7.9.3.2.3 Prior to disposal, containers of alkali metal fire residue shall be inspected and the results recorded daily by individuals who are trained in the hazards of alkali metals and able to recognize potential problems associated with these containers.

7.9.3.2.4 Alkali metal fire residues shall be stored in metal containers that are recommended by the alkali metal manufacturer.

**Substantiation:** The additional statement provides a link to Chapter 15 for control of ignition sources and allows elimination of duplicate sections in Chapter 7.

---

**Log #71 CMD-CMM**

**Final Action:**

**Submitter:** Samuel A. Rodgers, Honeywell, Inc.

**Recommendation:** Delete all of 7.9.4.

**Substantiation:** This section is included in the Control of Ignition Sources in Chapter 15, referenced in the prior section by a linked input. This deletion eliminates redundancy.

---

**Log #100 CMD-CMM**

(Figure 8.1.1 (New))

**Final Action:**

**Submitter:** Elizabeth C. Buc, Fire & Materials Research Laboratory, LLC

**Recommendation:** Add a new Figure as shown:

Aluminum Chapter Flow Diagram

Figure 8. Aluminum flow diagram.

**Substantiation:** An aluminum chapter flow diagram will assist the user in navigating to various sections of the aluminum chapter and other associated chapters in the document.
Do you meet the general essential requirements?  I don't know

Yes

Is this a new process?  Yes

Hazard analysis requirements see section 8.2.5

No

Does your facility meet design requirements?  I don't know

Yes

Do you perform primary processing?  Yes

See section 8.3
Powder Handling & Use- See section 8.5 Processing -See section 8.6

No

Are you machining, fabricating or finishing product?  Yes

See section 8.7

No

Are you storing combustible aluminum or aluminum alloys?  Yes

See section 8.8

No

Are you sending materials to recycling or waste treatment?  Yes

Go to Chapter 16

No

Are your fire and explosion prevention measures in place?  Yes

See section 8.9

I don't know
Delete the following:

Fugitive dust shall not be allowed to accumulate.

Periodic cleanup of fugitive dusts shall be accomplished by using one of the following:

1. Conductive, nonsparking scoops and soft brooms
2. Brushes that have natural fiber bristles
3. Dedicated vacuum cleaning systems designed for handling combustible metal powders in accordance with 8.1.2.3

Spills shall be removed at once, using conductive scoops and soft bristle brushes having natural fiber bristles:

Scoops shall be nonsparking unless otherwise authorized for the specific application.

Vacuum cleaners shall be permitted to be used only for residual amounts of material remaining after preliminary cleanup.

Vacuum cleaning systems shall be bonded and grounded to minimize accumulation of static electric charge.

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

When being used for aluminum powders and aluminum dust, portable vacuum cleaners shall be used only if listed or approved for use with Group E dusts (combustible aluminum dust) and shall be identified for use with aluminum only.

When a vacuum cleaner is used for other materials, the equipment shall be thoroughly cleaned prior to use and identified accordingly.

Vacuum cleaner hose shall be conductive, and nozzles or fittings shall be made of conductive, nonsparking material.

Assembled components shall be conductive, and bonded where necessary.

Periodic tests for continuity shall be performed.

Compressed air blowdown shall not be permitted, except only in certain areas that are otherwise impossible to clean by vacuuming or other means.

Where permitted, compressed air blowdown shall be performed under carefully controlled conditions, with all potential ignition sources prohibited in or near the area and with all equipment shut down.

Vigorous sweeping or blowing down with compressed air produces dust clouds and shall be permitted only where the following requirements are met:

1. Electrical equipment not suitable for Class II, Group E locations and other sources of ignition shall be shut down or removed from the area;
2. Compressed air shall not exceed a gauge pressure of 206 kPa (30 psi), unless otherwise determined to be safe by a documented hazard analysis;

The use of water for cleaning shall not be permitted in manufacturing areas unless the following requirements are met:

1. Competent technical personnel have determined that the use of water will be the safest method of cleaning in the shortest exposure time;
2. Operating management has full knowledge of and has granted approval of its use;
3. Ventilation, either natural or forced, is available to maintain the hydrogen concentration safely below the lower flammable limit (LFL);
4. Complete drainage of all water effluent to a safe, contained area is available.
8.1.2.6 Cleaning Frequency-

8.1.2.6.1* The accumulation of excessive dust on any portions of buildings or machinery not regularly cleaned in daily operations shall be minimized.

8.1.2.6.2 Regular, periodic cleaning of buildings and machinery, with all machinery idle and power off, shall be carried out as frequently as conditions warrant.

8.1.2.6.3 Regular, periodic cleaning of fugitive metal dust from buildings and machinery shall be carried out as frequently as conditions warrant.

8.1.2.6.4 Fugitive metal dust shall be removed to a designated storage or disposal area.

Substantiation: Housekeeping is such a critical safety component of combustible metals safety that it should be a separate chapter.

---

8.7.2.5.1* Nonflammable noncombustible coolants shall be used for wet grinding, cutting, or sawing operations.

Add the following annex material:

A.8.7.2.5.1 Cutting oils with a flashpoint greater than 100 deg F are acceptable with some combustible metals however we hardly ever see oil based fluids in our business anymore due to environmental issues. Most water-based fluids are adequate from a quality control and fire standpoint. Most of our oil-based fluids are used on steel tool machining (drill bits, shears etc.) due to the lower risk of corrosion.

Any oil-based coolant with a listed flash point would be considered flammable, or possess the potential to ignite and burn. In these cases the aluminum chips are not really the main concern, it is the oil (coolant) itself.

"Non-flammable" means impossible to ignite or incapable of burning. It does not mean the substitution of a flammable liquid with a combustible liquid.

Absent a definition in NFPA 484, the preferred NFPA definition is presumed to apply. The preferred NFPA definition of nonflammable is in NFPA 921. "Nonflammable (1) Not readily capable of burning with a flame. (2) Not liable to ignite and burn when exposed to flame. Its antonym is flammable."

Perhaps a clearer term would be noncombustible, but the definitions arrive at the same point. The preferred NFPA definition of noncombustible is in NFPA 80. "Noncombustible - Not capable of igniting and burning when subjected to a fire."

Flashpoint is not involved and thus the coolant would not have a flashpoint and would not burn under atmospheric condition when exposed to a flame. More typically such coolants are silicon or water-based.

Substantiation: Clarifying intent of the document on which several inquiries have been received.

---

8.7.3.19.5.6 Branch ducts shall not be disconnected, and unused portions of the system shall not be blanked off, without means being provided to maintain required airflow.

Substantiation: The existing statement is incorrect. It is not the intent of the document to allow ducts to be disconnected or blanked off without a means to maintain airflow.
Refer to 8.1.2.

Housekeeping is such a critical safety component of combustible metals safety that it should be a separate chapter.

Add a new Figure as shown:

Magnesium chapter flow diagram

A magnesium chapter flow diagram assists the user in navigating to various sections in the chapter and other associated chapters in the document.
Do you meet the general essential requirements? 
Yes
Is this a new process? 
Yes
Hazard analysis requirements see section 9.2.5 
No
Does your facility meet design requirements? 
Yes
Do you perform primary processing? 
Yes
See section 9.3
Melting & Casting-See section 9.3.2
Powder production- See section 9.4
Processing -See section 9.6
No
Are you machining, fabricating or finishing product? 
Yes
See section 9.7
No
Are you storing combustible magnesium alloys? 
Yes
See section 9.8
No
Are you sending materials to recycling or waste treatment? 
Yes
Go to Chapter 16
No
Are your fire and explosion prevention measures in place? 
Yes
See section 9.9
Create a separate housekeeping chapter and delete the following:

Fugitive dust shall not be allowed to accumulate.

Periodic cleanup of fugitive dusts shall be accomplished by using one of the following:

1. Conductive, nonsparking scoops and soft brooms
2. Brushes that have natural fiber bristles
3. Dedicated vacuum cleaning systems designed for handling combustible metal powders in accordance with 9.1.2.2

Preliminary cleanup of the bulk of the powder shall be accomplished by using conductive, nonsparking scoops and soft brooms as well as brushes that have natural fiber bristles.

Spills shall be removed at once, using conductive scoops and soft bristle brushes that have natural fiber bristles.

Scoops shall be nonsparking unless otherwise authorized for the specific application.

Compressed-air blowdown shall not be permitted.

Vacuum cleaning systems shall be used only for removal of dust accumulations too small, too dispersed, or too inaccessible to be thoroughly removed by hand brushing.

Vacuum cleaning systems shall be effectively bonded and grounded to minimize the accumulation of static electric charge.

Due to the inherent hazards associated with the use of fixed and portable vacuum cleaning systems for finely divided combustible magnesium dust, special engineering considerations shall be given to the design, installation, maintenance, and use of such systems.

Portable vacuum cleaners shall be used only if listed or approved for use with combustible magnesium dust.

Vacuum cleaner hose shall be conductive, and nozzles or fittings shall be made of conductive, nonsparking material.

Assembled components shall be conductive and bonded where necessary.

Periodic tests for continuity shall be performed.

Combustible magnesium dust picked up by a fixed vacuum cleaning system shall be discharged into a container or collector located outside the building.

Cleaning Frequency:

The accumulation of excessive dust on any portions of buildings or machinery not regularly cleaned in daily operations shall be minimized.

Regular, periodic cleaning of buildings and machinery, with all machinery idle and power off, shall be carried out as frequently as conditions warrant.

Regular, periodic cleaning of fugitive metal dust from buildings and machinery shall be carried out as frequently as conditions warrant.

Fugitive metal dust shall be removed to a designated storage or disposal area.

Housekeeping is such a critical safety component of combustible metals safety that it should be a separate chapter.
NOTE: This proposal appeared as Comment 484-31 (Log #33) which was held from the A11 ROC on Proposal 484-14.
Submitter: David L. Oberholtzer, Valimet, Inc.
Recommendation: Add new sections to 9.8.1.5.4:
  9.8.1.5.4.1 Sources of ignition shall be kept away from the top of the container and the vent.
  9.8.1.5.4.2 Containers shall not be stacked.
Substantiation: Provides clarification of the requirement in 9.8.1.5.4
This is not original material; its reference/source is as follows:
Technical Committee on Combustible Dusts

Submitter: Donna R. Bruce, KEMET Electronics Corporation
Recommendation: Delete the following text:
  9.9.2.4 Supplies shall be stored in an orderly manner with properly maintained aisles to allow routine inspection and segregation of incompatible materials:
  9.9.2.5 Supplies of materials in magnesium-processing areas shall be limited to those amounts necessary for normal operation:
  9.9.2.6 Periodic cleaning of magnesium chips or powder from buildings and machinery shall be carried out as frequently as conditions warrant:
  9.9.2.7 Magnesium chips or powder shall be removed to a safe storage or disposal area.
Substantiation: Housekeeping is such a critical safety component of combustible metals safety that it should be a separate chapter.

Submitter: Elizabeth C. Buc, Fire & Materials Research Laboratory, LLC
Recommendation: Add a new Figure as shown:
Niobium Flow Diagram
Figure 10. Niobium flow diagram.
Substantiation: A niobium chapter flow diagram assists the user in navigating through the various sections in the chapter and to associated chapters in the document.
Do you meet the general essential requirements?  
- Yes: Go to Chapter 16  
- No: See section 10.2

Is this a new process?  
- Yes: Hazard analysis requirements see section 10.2.5  
- No: Do your facility meet design requirements?  
  - Yes: See section 10.3  
  - No: Are you storing combustible niobium alloys?  
    - Yes: See section 10.8  
    - No: Are you machining, fabricating or finishing product?  
      - Yes: See section 10.7  
      - No: Are you sending materials to recycling or waste treatment?  
        - Yes: Go to Chapter 16  
        - No: Are your fire and explosion prevention measures in place?  
          - Yes: See section 10.9  
          - No: See section 10.1 and Chapter 15
Donna R. Bruce, KEMET Electronics Corporation

Recommendation: Create a separate housekeeping chapter and delete the following:

NIOBIUM

10.1.2 Housekeeping. See Chapter X.

10.1.2.1 Cleanup Procedures for Fugitive Dust Accumulations.

10.1.2.1.1 Fugitive dust shall not be allowed to accumulate.

10.1.2.1.2 Periodic cleanup of fugitive dusts shall be accomplished by using one of the following:

(1) Conductive, nonsparking scoops and soft brooms

(2) Brushes that have natural fiber bristles

(3) Dedicated vacuum cleaning systems designed for handling combustible metal powders in accordance with 10.1.2.2

10.1.2.2 Cleanup of Spilled Niobium Powder.

10.1.2.2.1 Spills shall be removed at once, using conductive scoops and soft bristle brushes with natural fiber bristles.

10.1.2.2.2 Vacuum cleaners shall be permitted to be used only for residual amounts of material remaining after preliminary cleanup:

10.1.2.3 Vacuum Cleaning Systems.

10.1.2.3.1 Vacuum cleaning systems shall be used only for removal of dust accumulations too small, too dispersed, or too inaccessible to be thoroughly removed by hand brushing.

10.1.2.3.2 Vacuum cleaning systems shall be bonded and grounded to minimize accumulation of static electric charge.

10.1.2.3.3 Due to the inherent hazards associated with the use of fixed and portable vacuum cleaning systems for finely divided combustible niobium dust, special engineering consideration shall be given to the design, installation, maintenance, and use of such systems.

10.1.2.3.4 When being used for niobium powders and niobium dust, portable vacuum cleaners shall be used only if listed or approved for use with Group E dusts (combustible niobium dust) and shall be identified for use with niobium only.

10.1.2.3.5 When a vacuum cleaner is used for other materials, the equipment shall be thoroughly cleaned prior to use and identified accordingly.

10.1.2.3.6 Vacuum cleaner hose shall be conductive, and nozzles or fittings shall be made of conductive, nonsparking material.

10.1.2.3.7 Assembled components shall be conductive and bonded where necessary:

10.1.2.3.8 Periodic tests for continuity shall be performed.

10.1.2.3.9 Combustible niobium dust picked up by a fixed vacuum cleaning system shall be discharged into a container or collector located outside the building.

10.1.2.4 Compressed Air Cleaning Requirements. Compressed air blowdown shall not be permitted, only except in certain areas that are otherwise impossible to clean by vacuuming or other means, and, where permitted, shall be performed under carefully controlled conditions with all potential ignition sources prohibited in or near the area and with all equipment shut down:

10.1.2.4.1 Vigorous sweeping or blowing down with compressed air produces dust clouds and shall be permitted only where the following requirements are met:

(1) Electrical equipment not suitable for Class II, Group E locations and other sources of ignition shall be shut down or removed from the area;

(2) Compressed air shall not exceed a gauge pressure of 206 kPa (30 psi), unless otherwise determined to be safe by a documented hazard analysis.

10.1.2.5 Cleaning Frequency.

10.1.2.5.1 The accumulation of excessive dust on any portions of buildings or machinery not regularly cleaned in daily operations shall be minimized:

10.1.2.5.2 Regular, periodic cleaning of buildings and machinery, with all machinery idle and powered off, shall be carried out as frequently as conditions warrant.

10.1.2.5.3 Regular, periodic cleaning of fugitive metal dust from buildings and machinery shall be carried out as frequently as conditions warrant.

10.1.2.5.4 Fugitive metal dust shall be removed to a designated storage or disposal area.
Substantiation: Housekeeping is such a critical safety component of combustible metals safety that it should be a separate chapter.

Electrostatic and media collectors shall not be used.

Media collectors shall be permitted to be used where the filter media is designed to be conductive so as to dissipate static charge.

Dry-type cyclone dust collectors shall be located outside of buildings.

Industry experience has clearly demonstrated that an eventual explosion can be expected where a bag- or media-type collector is used to collect fines of combustible metals that are easily ignitable. Seldom, if ever, can the source of ignition be positively identified. In those unusual instances when it is necessary to collect very small fines for a specific commercial product, it is customary for the producer to employ a bag or media-type collector. With the knowledge that strong explosive potential is present, the producer will locate the bag- or media-type collector a safe distance from buildings and personnel.

If a bag- or media-type collector is used, the shaking system or dust removal system can be such as to minimize sparking due to frictional contact or impact. Pneumatic- or pulse-type cleaning is more desirable, because no mechanical moving parts are involved in the dusty atmosphere. If the bags are provided with grounding wires, they can be positively grounded through a low-resistance path to ground. Where bags are used, it is customary that the baghouse be protected by an alarm to indicate excessive pressure drop across the bags. An excess air-temperature alarm is also frequently employed. A bag- or media-type collector is customarily located at least 15 m (50 ft) from any other building or operation.

It is not customary to permit personnel to be within 15 m (50 ft) of the collector during operation or when shaking bags. Explosion vents are usually built into the system, as described in NFPA 68, Standard on Explosion Protection by Deflagration Venting. Care should be exercised in locating the vents because of the possibility of blast damage to personnel or adjacent structures.

Substantiation: Dry media type dust collectors are sometimes required to remove fine materials from air streams. They are allowed in the aluminum (6.3.5.2) chapter of the current version of NFPA 484 and the Committee should allow their use in other chapters. The Committee may wish to limit the use of media type collectors to certain dusts that represent a lower explosion hazard. Criterion such as MIE, MAIT, $K_\text{st}$, or $P_{\text{max}}$, could be used to delineate dusts that can be processed in media type dust collectors. Currently at a facility, it may be allowable to process aluminum in a media dust collector while in another portion of the facility it may be prohibited to use a media dust collector with another metal that actually represents a lower dust explosion hazard, i.e. higher MIE and MAIT, lower $K_\text{st}$ and $P_{\text{max}}$.

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

Text is revised from other sections of current NFPA 484 text.
Donna R. Bruce, KEMET Electronics Corporation

Recommendation: Delete the following text:

10.9.2 Housekeeping:
10.9.2.1 Dust Control (Reserved)
10.9.2.2 Good housekeeping practices shall be followed so that accumulations of niobium powder are minimized.
10.9.2.3 Special attention shall be paid to niobium powder accumulations in crevices and joints between walls and floors. (See 11.9.6.1.)

Substantiation: Housekeeping is such a critical safety component of combustible metals safety that it should be a separate chapter.

Elizabeth C. Buc, Fire & Materials Research Laboratory, LLC

Recommendation: Add a new Figure as shown:

Tantalum flow diagram

Figure 11. Tantalum flow diagram

Substantiation: A tantalum chapter flow diagram assists the user in navigating to various sections in the chapter and other chapters in the document.
Do you meet the general essential requirements?

Yes

Is this a new process?

Yes

Hazard analysis requirements see section 11.2.5

No

Does your facility meet design requirements?

Yes

I don't know

See section 11.2

No

I don't know

Yes

See section 11.3

Melting and casting—See section 11.3.2

Powder production—See sections 11.4 & 11.5

No

Are you machining, fabricating or finishing product?

Yes

See section 11.7

No

Are you storing combustible tantalum?

Yes

See section 11.8

No

Are you sending materials to recycling or waste treatment?

Yes

Go to Chapter 16

No

Are your fire and explosion prevention measures in place?

Yes

See section 11.9

No
Donna R. Bruce, KEMET Electronics Corporation

Recommendation: Create a separate housekeeping chapter and delete the following:

TANTALUM
11.1.2 Housekeeping. See Chapter X.

11.1.2.1 Cleanup Procedures for Fugitive Dust Accumulations.—

11.1.2.1.1 Fugitive dust shall not be allowed to accumulate.

11.1.2.1.2 Periodic cleanup of fugitive dusts shall be accomplished by using one of the following:

(1) Conductive, nonsparking scoops and soft brooms

(2) Brushes that have natural fiber bristles

(5) Dedicated vacuum cleaning systems designed for handling combustible metal powders in accordance with 11.1.2.3. Special attention shall be paid to tantalum powder accumulations in crevices and joints between walls and floors. (See 11.9.6.1.)

11.1.2.2 Cleanup of Spilt Tantalum Powder.—

11.1.2.2.1 Spills shall be removed at once, using conductive scoops and soft bristle brushes having natural fiber bristles. Scoops shall be nonsparking unless otherwise authorized for the specific application.

11.1.2.2.2 Vacuum cleaners shall be permitted to be used only for residual amounts of material remaining after preliminary cleanup.

11.1.2.3 Vacuum Cleaning Systems.—

11.1.2.3.1 Vacuum cleaning systems shall be used only for removal of dust accumulations too small, too dispersed, or too inaccessible to be thoroughly removed by hand brushing.

11.1.2.3.2* Vacuum cleaning systems shall be bonded and grounded to minimize accumulation of static electric charge.

11.1.2.3.3* Due to the inherent hazards associated with the use of fixed and portable vacuum cleaning systems for finely divided combustible aluminum dust, special engineering consideration shall be given to the design, installation, maintenance, and use of such systems:

11.1.2.3.4* When being used for aluminum powders and aluminum dust, portable vacuum cleaners shall be used only if listed or approved for use with Group E dusts (combustible aluminum dust) and shall be identified for use with aluminum only.

11.1.2.3.4.1* When a vacuum cleaner is used for other materials, the equipment shall be thoroughly cleaned prior to use and identified accordingly:

11.1.2.3.5 Vacuum cleaner hose shall be conductive, and nozzles or fittings shall be made of conductive, nonsparking material.

11.1.2.3.5.1 Assembled components shall be conductive and bonded where necessary.

11.1.2.3.5.2 Periodic tests for continuity shall be performed.

11.1.2.3.6* Combustible aluminum dust picked up by a fixed vacuum cleaning system shall be discharged into a container or collector located outside the building.

11.1.2.4 Compressed Air Cleaning Requirements. Compressed air blowdown shall not be permitted, only except in certain areas that are otherwise impossible to clean by vacuuming or other means and, where permitted, shall be performed under carefully controlled conditions with all potential ignition sources prohibited in or near the area and with all equipment shut down:

11.1.2.4.1 Vigorous sweeping or blowing down with compressed air produces dust clouds and shall be permitted only where the following requirements are met:

(1) Electrical equipment not suitable for Class II, Group E locations and other sources of ignition shall be shut down or removed from the area.

(2) Compressed air shall not exceed a gauge pressure of 206 kPa (30 psi), unless otherwise determined to be safe by a documented hazard analysis.

11.1.2.5 Water Cleaning Requirements. The use of water for cleaning shall not be permitted in manufacturing areas unless the following requirements are met:

11.1.2.5.1 Competent technical personnel have determined that the use of water will be the safest method of cleaning in the shortest exposure time:

11.1.2.5.2 Operating management has full knowledge of and has granted approval of its use:

11.1.2.5.3 Ventilation, either natural or forced, is available to maintain the hydrogen concentration safely below the lower—
flammable limit (LFL).

(4) Complete drainage of all water effluent to a safe, contained area is available.

11.1.2.6 Cleaning Frequency:

11.1.2.6.1 The accumulation of excessive dust on any portions of buildings or machinery not regularly cleaned in daily operations shall be minimized.

11.1.2.6.2 Regular, periodic cleaning of buildings and machinery, with all machinery idle and powered off, shall be carried out as frequently as conditions warrant.

11.1.2.6.3 Regular, periodic cleaning of fugitive metal dust from buildings and machinery shall be carried out as frequently as conditions warrant.

11.1.2.6.4 Fugitive metal dust shall be removed to a designated storage or disposal area.

Substantiation: Housekeeping is such a critical safety component of combustible metals safety that it should be a separate chapter.
Electrostatic and media collectors shall not be used. Media collectors shall be permitted to be used where the filter media is designed to be conductive so as to dissipate static charge.

Dry-type cyclone dust collectors shall be located outside of buildings. A high-efficiency cyclone-type collector presents less hazard than a bag- or media-type collector and, except for extremely fine powders, will usually operate with fairly high collection efficiency. Where cyclones are used, the exhaust fan discharges to the atmosphere, away from other operations. It should be recognized that there will be some instances in which a centrifugal type collector can be followed by a fabric-type, bag-type, or media-type collector or by a scrubber-type collector where particulate emissions are kept at a low level. The hazards of each collector should be recognized, and protection against the hazards should be provided.

In each instance, the fan will be the last element downstream in the system. Because of the extreme hazard involved with a bag- or media-type collector, consideration should be given to a multiple series cyclone with a liquid final stage. Industry experience has clearly demonstrated that an eventual explosion can be expected where a bag- or media-type collector is used to collect fines of combustible metals that are easily ignitable. Seldom, if ever, can the source of ignition be positively identified. In those unusual instances when it is necessary to collect very small fines for a specific commercial product, it is customary for the producer to employ a bag or media-type collector. With the knowledge that strong explosive potential is present, the producer will locate the bag- or media-type collector a safe distance from buildings and personnel.

If a bag- or media-type collector is used, the shaking system or dust removal system can be such as to minimize sparking due to frictional contact or impact. Pneumatic- or pulse-type cleaning is more desirable, because no mechanical moving parts are involved in the dusty atmosphere. If the bags are provided with grounding wires, they can be positively grounded through a low-resistance path to ground. Where bags are used, it is customary that the bag house be protected by an alarm to indicate excessive pressure drop across the bags. An excess air-temperature alarm is also frequently employed. A bag- or media-type collector is customarily located at least 15 m (50 ft) from any other building or operation.

Explosion vents are usually built into the system, as described in NFPA 68, Standard on Explosion Protection by Deflagration Venting. Care should be exercised in locating the vents because of the possibility of blast damage to personnel or adjacent structures.

Dry media type dust collectors are sometimes required to remove fine materials from air streams. They are allowed in the aluminum (Section 6.3.5.2) chapter of the current version of NFPA 484 and the Committee should allow their use in other chapters. The Committee may wish to limit the use of media type collectors to certain dusts that represent a lower explosion hazard. Criterion such as MIE, MAIT, Ktw, or Pmax, could be used to delineate dusts that can be processed in media type dust collectors. Currently at a facility, it may be allowable to process aluminum in a media dust collector while in another portion of the facility it may be prohibited to use a media dust collector with another metal that actually represents a lower dust explosion hazard, i.e. higher MIE and MAIT, lower Ktw and Pmax.

This is not original material; its reference/source is as follows: Text is revised from other sections of current NFPA 484 text.
Doc#:  Log #54  CMD-CMM

**Recommendation:** Delete the following text:

Fugitive tantalum dust shall not be allowed to accumulate. *(See A.11.1.2.1.1)*

Systematic cleaning of the specific section of the building containing dust-producing equipment, including roof members, pipes, conduits, and other components, shall be conducted as conditions warrant.

Cleaning shall include machinery.

Cleaning methods shall be limited to those methods that minimize the probability of fire or explosion, as determined by a person knowledgeable in the properties of tantalum dust.

Chips or powder shall be removed to a designated storage or disposal area.

Bulk accumulations of fine tantalum shall be removed by natural fiber push brooms and nonsparking scoops or shovels before vacuum cleaning equipment is used.

Cleanup of the bulk of spilled powder shall be accomplished using conductive, nonsparking scoops and brooms or brushes that have natural fiber bristles.

Vacuum cleaning, using vacuum cleaning systems designed and approved for handling combustible metals, shall be permitted only for small amounts of residue material remaining after preliminary cleanup.

Due to the inherent hazards associated with the use of vacuum cleaning systems and portable vacuum systems for finely divided tantalum dust, special engineering analysis shall be given to the design, installation, maintenance, and use of such systems.

The use of vacuum sweeping devices shall be permitted for cleaning.

If vacuum apparatus is used, both stationary and portable types shall be grounded and bonded and checked for electrical continuity from pickup nozzle to piping system.

Vacuum sweeping devices, if electrical, shall be of a class approved for use in atmospheres containing tantalum dust. *(See 11.2.3.1)*

Blowing down of any surfaces by compressed air shall be prohibited.

**Substantiation:** Housekeeping is such a critical safety component of combustible metals safety that it should be a separate chapter.

Doc#:  Log #97  CMD-CMM

**Recommendation:** Add a new Figure as shown:

INSERT Figure 12 Titanium Flow Diagram

Titanium and Titanium Alloy Flow Diagram

**Substantiation:** A chapter flow diagram would assist the user in identifying various applicable sections of the metal specific chapter as well as other related chapters such as fire prevention and recycling.
Do you meet the general essential requirements? I don't know
See section 12.1 and Chapter 15

Is this a new process? Yes
Hazard analysis requirements see section 12.2.5
No

Does your facility meet design requirements? I don't know
See section 12.2
Yes

Do you perform primary processing? Yes
See section 12.7
No

Are you machining, fabricating or finishing product? Yes
See section 12.7
No

Are you storing combustible titanium or titanium alloys? Yes
See section 12.8
No

Are you sending materials to recycling or waste treatment? Yes
Go to Chapter 16
No

Are your fire and explosion prevention measures in place? Yes
See section 12.9
Donna R. Bruce, KEMET Electronics Corporation

Recommendation: Create a separate housekeeping chapter and delete the following:

TITANIUM

12.1.2 Housekeeping. See Chapter X.

12.1.2.1 Combustible materials in titanium storage, handling, and processing areas shall be minimized. Titanium-storage areas shall be well-ventilated, shall be equipped with required fire protection equipment as specified, and shall be plainly marked with “No Smoking” signs:

12.1.2.1.1 Smoking, when permitted, shall be located in designated areas outside of buildings.

12.1.2.2 Sludge from dust collectors and vacuum cleaning system precipitators shall be removed weekly as a minimum and when equipment is shut down after use.

12.1.2.3 See 15.2.2 for additional requirements.

12.1.2.4 Cleaning methods shall be limited to those methods that minimize the probability of causing a fire or explosion, as determined by a person knowledgeable in the properties of titanium dust.

12.1.2.5 Due to the inherent hazards associated with the use of fixed vacuum cleaning systems for finely divided titanium dust, special engineering considerations shall be given to the design, installation, maintenance, and use of such systems:

12.1.2.6 To prevent potential explosions caused by the inadvertent use of high-pressure compressed air in place of low-pressure inert gas, fittings used on outlets of compressed-air and inert-gas lines shall not be interchangeable.

12.1.2.7 Regular, periodic cleaning of titanium dust and fines from buildings and machinery including roof members, pipes, conduits, and so on, shall be carried out as frequently as conditions warrant, based on visual inspections.

12.1.2.7.1 Dust and fines shall be removed to a safe storage or disposal area.

12.1.2.7.2 Potential ignition sources associated with the operation of equipment during the cleaning operation shall be reviewed and appropriate actions to isolate, eliminate or minimize the potential hazards shall be taken.

12.1.2.7.3 The review of the hazards associated with cleaning operations shall include isolation, minimization, and elimination of the hazards:

12.1.2.7.4 Spills shall be removed at once, using conductive scoops and soft bristle brushes having natural fiber bristles. Scoops shall be nonsparking unless otherwise authorized for the specific application.

12.1.2.8 See Chapter 15 for additional requirements.

12.1.2.9 Hose used for cleaning and wash down purposes shall be pressurized only while in active use for cleaning and wash down purposes.

12.1.2.10 Cleaning Frequency:

12.1.2.10.1 The accumulation of excessive dust on any portions of buildings or machinery not regularly cleaned in daily operations shall be minimized.

12.1.2.10.2 Regular, periodic cleaning of buildings and machinery, with all machinery idle and powered off, shall be carried out as frequently as conditions warrant.

12.1.2.10.3 Regular, periodic cleaning of fugitive metal dust from buildings and machinery shall be carried out as frequently as conditions warrant.

12.1.2.10.4 Fugitive metal dust shall be removed to a designated storage or disposal area.

Substantiation: Housekeeping is such a critical safety component of combustible metals safety that it should be a separate chapter.
Electrostatic and media collectors shall not be used.

Media collectors shall be permitted to be used where the filter media is designed to be conductive so as to dissipate static charge.

Dry-type cyclone dust collectors shall be located outside of buildings.

12.7.3.5.2 Dry-type cyclone dust collectors shall be located outside of buildings.

A 12.7.3.5.1.1 A high-efficiency cyclone-type collector presents less hazard than a bag- or media-type collector and, except for extremely fine powders, will usually operate with fairly high collection efficiency. Where cyclones are used, the exhaust fan discharges to the atmosphere, away from other operations. It should be recognized that there will be some instances in which a centrifugal type collector can be followed by a fabric-type, bag-type, or media-type collector or by a scrubber-type collector where particulate emissions are kept at a low level. The hazards of each collector should be recognized, and protection against the hazards should be provided.

In each instance, the fan will be the last element downstream in the system. Because of the extreme hazard involved with a bag- or media-type collector, consideration should be given to a multiple series cyclone with a liquid final stage. Industry experience has clearly demonstrated that an eventual explosion can be expected where a bag- or media-type collector is used to collect fines of combustible metals that are easily ignitable. Seldom, if ever, can the source of ignition be positively identified. In those unusual instances when it is necessary to collect very small fines for a specific commercial product it is customary for the producer to employ a bag or media-type collector. With the knowledge that strong explosive potential is present the producer will locate the bag- or media-type collector a safe distance from buildings and personnel.

If a bag- or media-type collector is used, the shaking system or dust removal system can be such as to minimize sparking due to frictional contact or impact. Pneumatic- or pulse-type cleaning is more desirable, because no mechanical moving parts are involved in the dusty atmosphere. If the bags are provided with grounding wires, they can be positively grounded through a low-resistance path to ground. Where bags are used, it is customary that the bag house be protected by an alarm to indicate excessive pressure drop across the bags. An excess air-temperature alarm is also frequently employed. A bag- or media-type collector is customarily located at least 15 m (50 ft) from any other building or operation.

It is not customary to permit personnel to be within 15 m (50 ft) of the collector during operation or when shaking bags. Explosion vents are usually built into the system, as described in NFPA 68, Standard on Explosion Protection by Deflagration Venting. Care should be exercised in locating the vents because of the possibility of blast damage to personnel or adjacent structures.

Substantiation: Dry media type dust collectors are sometimes required to remove fine materials from air streams. They are allowed in the aluminum (Section 6.3.5.2) chapter of the current version of NFPA 484 and the Committee should allow their use in other chapters. The Committee may wish to limit the use of media type collectors to certain dusts that represent a lower explosion hazard. Criterion such as MIE, MAIT, Kst, or Pmax, could be used to delineate dusts that can be processed in media type dust collectors. Currently at a facility, it may be allowable to process aluminum in a media dust collector while in another portion of the facility it may be prohibited to use a media dust collector with another metal that actually represents a lower dust explosion hazard, i.e., higher MIE and MAIT, lower Kst and Pmax.

This is not original material; its reference/source is as follows: Text is revised from other sections of current NFPA 484 text,
Delete the following text:

Dust resulting from the crushing of titanium sponge shall be managed safely to minimize the risk of fires and explosions.

Substantiation: Housekeeping is such a critical safety component of combustible metals safety that it should be a separate chapter.

Changing Chapter title to "Zirconium & Hafnium" also changing all "zirconium" references to "zirconium or hafnium".

Include 484_L78 (PI #74)

Hafnium is being added to Chapter 13 Zirconium as they both have very similar characteristics.

Add a new Figure as shown:

INSERT Chapter 13 Flow Diagram

The chapter flow diagram assists users in navigating the various sections of the zirconium chapter and other related chapters in the document.
13.1 **General Provisions.**

13.1.1 **Retroactivity.** The requirements of 13.1.2 through 13.1.5 shall apply to new and existing facilities.

13.1.2 **Housekeeping.**

13.1.2.1 Combustible materials in zirconium storage, handling, and processing areas shall be minimized. Zirconium or Hafnium storage areas shall be well-ventilated, shall be equipped with required fire protection equipment as specified, and shall be plainly marked with “No Smoking” signs.

13.1.2.2 Smoking, when permitted, shall be located in designated areas outside of buildings.

13.1.2.3 Sludge from dust collectors and vacuum cleaning system precipitators shall be removed weekly as a minimum and when equipment is shut down after use.

13.1.2.4 See 15.2.2 for additional requirements.

13.1.2.5 Cleaning methods shall be limited to those methods that minimize the probability of causing a fire or explosion, as determined by a person knowledgeable in the properties of zirconium or hafnium dust.

13.1.2.6 Due to the inherent hazards associated with the use of fixed vacuum cleaning systems for finely divided zirconium or hafnium dust, special engineering considerations shall be given to the design, installation, maintenance, and use of such systems.

13.1.2.7 To prevent potential explosions caused by the inadvertent use of high-pressure compressed air in place of low-pressure inert gas, fittings used on outlets of compressed-air and inert-gas lines shall not be interchangeable.

13.1.2.8 Regular, periodic cleaning of zirconium or hafnium dust and fines from buildings and machinery, including roof members, pipes, conduits, and so on, shall be carried out as frequently as conditions warrant, based on visual inspections.

13.1.2.8.1 Dust and fines shall be removed to a safe storage or disposal area.

13.1.2.8.2 Potential ignition sources associated with the operation of equipment during the cleaning operation shall be reviewed, and appropriate actions to isolate, eliminate or minimize the potential hazards shall be taken.

13.1.2.8.3 The review of the hazards associated with cleaning operations shall include isolation, minimization, and elimination of the hazards.

13.1.2.8.4 Spills shall be removed at once, using conductive scoops and soft bristle brushes having natural fiber bristles. Scoops shall be nonsparking unless otherwise authorized for the specific application.
13.1.2.9  See Chapter 15 for additional requirements.

13.1.2.10  Hose used for cleaning and wash down purposes shall be pressurized only while in active use for cleaning and wash down purposes.

13.1.2.11  Cleaning Frequency.

13.1.2.11.1* The accumulation of excessive dust on any portions of buildings or machinery not regularly cleaned in daily operations shall be minimized.

13.1.2.11.2  Regular, periodic cleaning of buildings and machinery, with all machinery idle and powered off, shall be carried out as frequently as conditions warrant.

13.1.2.11.3  Regular, periodic cleaning of fugitive metal dust from buildings and machinery shall be carried out as frequently as conditions warrant.

13.1.2.11.4  Fugitive metal dust shall be removed to a designated storage or disposal area.

13.1.3  Personal Protective Equipment (PPE).

13.1.3.1* Personnel shall wear PPE appropriate to tasks they are engaged in or hazards they are exposed to.

13.1.3.2  Outer clothing shall be clean, flame retardant, and non–static generating where combustible zirconium or hafnium dust is present and shall be designed to be easily removable.

13.1.3.2.1 Tightly woven, smooth fabrics treated with a flame-retardant chemical and from which dust can readily be brushed shall be used if necessary.

13.1.3.2.2 Wool, silk, or synthetic fabrics that can accumulate high static electric charges shall not be used.

13.1.3.3 Work clothing shall be designed to minimize the accumulations of combustible zirconium or hafnium dust (e.g., trousers shall not have cuffs).

13.1.3.4* Safety shoes shall have no exposed metal, and shall be appropriate for the type of operation taking place, and where necessary, safety shoes shall be static-dissipating.

13.1.3.5 Personnel involved in reduction-furnace tapping, removal of molten zirconium or hafnium chloride, and refining and casting shall wear tight-fitting, above-the-ankle safety shoes, flame-resistant garments, heat-resistant gloves, and face shields.

13.1.3.6 Personnel handling dry zirconium or hafnium powder shall wear static dissipative shoes and noncombustible or flame-resistant garments without pockets, cuffs, laps, or pleats in which powder can accumulate.

13.1.4  Reactivity. It shall be the responsibility of the facility to evaluate processes and materials for potentially dangerous reactions that could occur in the course of its operations.
**13.1.4.1** **Thermite Reactions.** Caution shall be exercised in the mixing of zirconium or hafnium fines or molten material with metal oxides [e.g., iron oxide (rust)].

**13.1.4.2** **Eutectic Reactions.**

**13.1.4.2.1** It shall be the responsibility of the facility to research processing and materials for potentially dangerous reactions and eutectic compositions, which could occur in the course of their activities.

**13.1.5** **Management of Change.**

**13.1.5.1** The requirements of 13.1.5.2 through 13.1.5.5 shall apply to new and existing facilities and processes.

**13.1.5.2** Written procedures shall be established and implemented to manage a proposed change to process materials, technology, equipment, procedures, and facilities.

13.1.5.3 The procedures shall ensure that the following are addressed prior to any change:

1. The technical basis for the proposed change
2. Safety and health implications, including hazard analysis (see 13.2.5)
3. Whether the change is permanent or temporary
4. Modifications to operating and maintenance procedures
5. Employee training requirements
6. Authorization requirements for the proposed change
7. Results of characterization tests used to assess the hazard, if conducted

13.1.5.4 Implementation of the management of change procedure shall not be required for (identical) replacements-in-kind.

13.1.5.5 Design documentation shall be updated to incorporate the change.

13.1.6 **Alternative Methodologies. (Reserved)**

13.1.7 **Test Results. (Reserved)**

13.1.8 **Other. (Reserved)**

13.2 **Facility Design Requirements.**

13.2.1 **Building Construction.**

13.2.1.1 Individuals or firms not previously knowledgeable in designing facilities and/or equipment for the processing of zirconium or hafnium shall be briefed by individual(s) or firm(s) knowledgeable in the specific hazards associated with handling, processing, and storage and this standard.
13.2.1.2 Buildings housing furnaces, boring and crushing facilities, and zirconium or hafnium refining operations shall be constructed of noncombustible materials.


13.2.1.4* Interior surfaces where dust accumulations can occur shall be designed and constructed to facilitate cleaning and to minimize combustible dust accumulations.

13.2.1.5 All walls of areas where fugitive dust can be produced shall have a smooth finish and shall be sealed so as to leave no interior or exterior voids where dust can infiltrate and accumulate.

13.2.1.6 Explosion venting, if provided, shall be in accordance with NFPA 68, Standard on Explosion Protection by Deflagration Venting.

13.2.1.7 Floors in reduction, boring, and crushing buildings shall be made of noncombustible materials, such as concrete, brick, or steel plate.

13.2.1.8 Zirconium Winning, refining, and casting operations shall be protected from rain and from other possibilities of inadvertent contact with water.

13.2.1.9 Permanent water lines in the winning, refining, and casting operations area shall be of all-metal construction.

13.2.1.10 Fuel supply lines shall have an emergency shutoff valve located within easy access outside of the building.

13.2.1.11 Emergency shutoff valves shall be clearly identified.

13.2.1.12 Aisles shall be provided for maneuverability of material-handling equipment, for accessibility, and to facilitate fire-fighting operations.

13.2.1.13 Drying rooms (for zirconium or hafnium powder) shall be of Type I construction, as defined by NFPA 220, Standard on Types of Building Construction.

13.2.1.13.1 Drying rooms shall be segregated as far as possible from other operations and at no time less than 15.2 m (50 ft).

13.2.1.13.2 An analysis shall be performed to determine whether drying rooms require deflagration venting.

13.2.1.14 Flash-Fire and Explosion Hazard Protection. (Reserved)

13.2.2 Fire Protection.

13.2.2.1 The provisions of 13.2.2 shall apply to all new and existing zirconium or hafnium production, processing, handling, and storage operations.

13.2.2.2 See Chapter 15 for additional information.

13.2.2.3 Equipment used for the processing of zirconium or hafnium shall be bonded and grounded.
13.2.2.4 Tanks in which flammable or combustible solvents are used for degreasing shall comply with NFPA 30, *Flammable and Combustible Liquids Code*.

13.2.3 Electrical Classification.

13.2.3.1 In local areas of a plant where a hazardous dust accumulates or is present in suspension in the air, the area shall be classified and all electrical equipment and installations in those local areas shall comply with Article 500 of *NFPA 70, National Electrical Code*.

13.2.3.2 All electrical equipment and components in zirconium production, processing, handling, and storage facilities shall comply with *NFPA 70, National Electrical Code*.

13.2.3.3 All metal objects or equipment used to process zirconium shall be bonded and grounded to prevent accumulations of static electricity.

13.2.4 Dust Collection.

13.2.4.1 All dust collection systems shall be installed in accordance with NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids*.

13.2.4.1.1 The design of the fan or blower shall not allow the transported zirconium powder to pass through the fan before entering the final collector, unless the zirconium or hafnium powder–conveying system is inerted.

13.2.4.2 Dust-Producing Operations.

13.2.4.2.1 Machines that produce fine particles of zirconium or hafnium shall be provided with hoods, capture devices, or enclosures that are connected to a dust collection system having suction and capture velocity to collect and transport all the dust produced.

13.2.4.2.2 Dust shall be collected by means of hoods or enclosures at each operation.

13.2.4.2.3 Multiple pieces of zirconium or hafnium dust–producing equipment shall be permitted to be connected to a single zirconium or hafnium dust–collecting unit.

13.2.4.2.4 A hazard analysis shall be made to determine whether multiple pieces of dust–producing equipment can be served safely by a single dust-collecting unit.

13.2.4.2.4.1 The hazard analysis shall consider the fire and deflagration risks associated with ductwork related to the connection of multiple pieces of dust-producing equipment to a single collector.

13.2.4.2.4.2 The hazard analysis shall consider industrial hygiene conditions created by the connection of multiple pieces of dust-producing equipment to a single collector.

13.2.4.2.5 Hoods and enclosures shall be designed and maintained so that fine particles will either fall or be projected into the hoods and enclosures in the direction of airflow.

13.2.4.2.6 The hoods or enclosures shall be connected to liquid precipitation separators, and the suction unit shall be installed so that the dust is converted to sludge without contact, in the dry state, with any high-speed moving parts.
13.2.4.2.7 Special attention shall be given to the location of all dust-producing machines with respect to the location of the dust collection system to ensure that the connecting ducts will be as straight as possible.

13.2.4.2.8 Electrostatic and media collectors shall not be used for dust collection on zirconium-zirconium or hafnium producing equipment.

13.2.4.2.9 Dust collection fans that handle combustible dust and air mixtures shall be constructed of nonsparking materials.

13.2.4.2.10* The power supply to the dust-producing equipment shall be interlocked with the airflow from the exhaust blower and the liquid-level controller of the collector so that improper functioning of the dust collection system will shut down the equipment it serves.

13.2.4.2.11 A time delay switch or equivalent device shall be provided on the dust-producing equipment to prevent starting of its motor drive until the collector is in complete operation.

13.2.4.2.12 If the zirconium-zirconium or hafnium dust-collecting unit is to be used for other materials, it shall be thoroughly cleaned of all incompatible materials prior to and after use.

13.2.4.2.13 Grinders, buffers, and associated equipment with dust collectors utilized for processing zirconium-zirconium or hafnium shall be provided with a placard that reads as follows:

CAUTION: Current Use: Zirconium Zirconium or Hafnium Metal — Fire or Explosion Can Result with Other Metals

13.2.4.3 Dust Collection Ducts and Ductwork.

13.2.4.3.1 Ducts shall be designed to maintain a velocity of not less than 1372 m/min (4500 ft/min) to ensure the transport of both coarse and fine particles and to ensure re-entrainment if for any reason the particles fall out before delivery to the collector (e.g., in the event of power failure).

13.2.4.3.2* Ducts shall be designed to handle a volumetric flow rate that maintains dust loads safely below the MEC.

13.2.4.3.3 Ducts shall be as short as possible and shall have as few bends and irregularities as possible to prevent interference with free airflow.

13.2.4.3.4 Connecting ducts or suction tubes between points of collection and separators shall be completely bonded and grounded.

13.2.4.3.5 The discharge duct for all dust collection equipment shall terminate at a safe outdoor location except where permitted by 13.2.4.3.3.

13.2.4.4 Duct Construction.

13.2.4.4.1 Ducts shall be constructed of conductive material and shall be carefully fabricated and assembled with smooth interior surfaces and with internal lap joints facing in the direction of airflow.
13.2.4.4.2 There shall be no unused capped outlets, pockets, or other dead-end spaces that might allow accumulations of dust.

13.2.4.4.3 Duct seams shall be oriented in a direction away from personnel.

13.2.4.4.4 External flanges shall be used to connect duct work together, and no gasket material shall be used.

13.2.4.4.5 Additional branch ducts shall not be added to an existing system without redesign of the system.

13.2.4.4.6 Branch ducts shall not be disconnected, and unused portions of the system shall not be blanked off without providing means to maintain required airflow.

13.2.4.4.7 Duct systems, dust collectors, and dust-producing machinery shall be bonded and grounded to minimize the accumulation of static electric charge.

13.2.4.5 Wet-Type Dust Collectors.

13.2.4.5.1 The exhaust vent shall terminate outside the building and shall be securely fastened.

13.2.4.5.2 The duct shall be as short and straight as possible and shall be designed to withstand the same explosion pressure as the wet-type dust collector.

13.2.4.5.3 The cleaned air shall be permitted to be returned to the work area when tests conducted by an approved testing organization prove that the collector’s efficiency is great enough to provide safety to both personnel and property in the particular installation, with regard to particulate matter in the cleaned air and accumulations of particulate matter and hydrogen in the work area.

13.2.4.5.4 The exhaust vent shall be inspected periodically and cleaned as necessary to prevent buildup of combustible deposits of metal dusts on the interior of the duct.

13.2.4.5.5 The dust collector shall be arranged so that contact between dust particles and parts moving at high speed is prevented.

13.2.4.5.6 The blower for drawing the dust-laden air into the collector shall be located on the clean-air side of the collector.

13.2.4.5.7 The dust collector shall be arranged so that the dust-laden air stream is thoroughly scrubbed by the liquid to achieve the desired efficiency.

13.2.4.5.8 The sump of water wet-type dust collectors shall be ventilated at all times and shall remain open and unobstructed when the machine is shut down.

13.2.4.5.9 When the dust collector is not in operation, ventilation shall be permitted to be provided by an independent blower or by an unimpeded vent.

13.2.4.5.10 The use of additional dry-filter media downstream of a wet collector shall not be permitted.

13.2.4.5.11 Sludge shall be removed from the collector on a regular schedule.
13.2.4.5.12 Removed sludge shall be stored in a covered, vented metal container.

13.2.4.5.13 Sludge removed from wet-type dust collectors shall be disposed of in accordance with applicable local, state, and federal regulations.

13.2.4.5.14 Systems shall be periodically inspected and maintained to ensure proper operation.

13.2.4.6 **Dry-Type Dust Collectors.**

13.2.4.6.1 Electrostatic and media collectors shall not be used to collect combustible metal dust.

13.2.4.6.2 Dry-type dust collectors shall be fabricated of conductive material and grounded and bonded.

13.2.4.6.3* Dry-type dust collectors for combustible metal dust material shall be located outside buildings and shall be provided with explosion vents in accordance with NFPA 68, *Standard on Explosion Protection by Deflagration Venting*.

13.2.4.6.4 The selection of the type and location of the collector shall be designed to minimize injury to personnel and to minimize blast and fire damage to nearby equipment or structures.

13.2.4.6.5 Dry-type dust collection systems shall be designed and maintained so that internal cleanliness is ensured.

13.2.4.6.6 The accumulation of material inside any area of the collector other than in the discharge containers designed for that purpose shall not be permitted.

13.2.4.6.7 Accumulation or condensation of water at any point in the dry dust collection system shall be prevented.

13.2.4.6.8 Dust shall be removed from the dry collectors at the end of each workday and at more frequent intervals if conditions warrant.

13.2.4.6.9 Extreme care shall be taken in removing dust from the collectors to avoid creating dust clouds.

13.2.4.6.10 The dust shall be discharged into properly bonded and grounded metal containers, which shall be covered promptly to avoid the creation of airborne fugitive dust.

13.2.4.6.11 Dry collector discharge containers shall be emptied before or when 100 percent of the storage capacity of the container is attained.

13.2.4.6.12 The maximum volume of zirconium or hafnium fines collected before emptying shall not exceed 19 L (5 gal).

13.2.4.6.13 The dust removed shall be managed in accordance with local, state, and federal regulations.

13.2.4.6.14 The cyclone dust collector shall be of conductive metal construction suitable for the service intended.

13.2.4.6.15 The cyclone dust collector shall be solid welded with smooth internal seams.
13.2.4.6.16 The equipment shall be provided with a spark-proof air lock on the hopper discharge and connected to a covered material receiver.

13.2.4.6.17 Exhaust fans used in conjunction with the equipment shall be installed on the clean-air side of the system and shall be of spark-proof construction.

13.2.4.6.18 Motors and controls of any type associated with the process air stream shall be located outside the process air stream.

13.2.4.6.19 Recycling of air from dry dust collectors into buildings shall be prohibited.

13.2.4.7 Repairs.

13.2.4.7.1 Where repairs on dust collectors are necessary, the collectors shall be emptied and residual accumulations of dust thoroughly removed.

13.2.4.7.2 Ductwork leading into the collector shall be disconnected and blanked off before repair work shall be permitted to be started.

13.2.4.7.3 The interior of hoods and ducts shall be cleaned regularly wherever there is the possibility of buildup of wax, lint, zirconium, zirconium, hafnium, or other combustible material.

13.2.4.7.4 The dust collector shall be arranged so that contact between dust particles and parts moving at high speeds is prevented.

13.2.4.7.5 The blower for drawing the dust-laden air into the collector shall be located on the clean-air side of the collector.

13.2.4.7.6 Dry media collectors shall not be used for the collection of zirconium or hafnium sponge fines.

13.2.5 Hazard Analysis.

13.2.5.1* The design of the fire and explosion safety provisions shall be based on a hazard analysis of the facility, the process, and the associated fire or explosion hazards.

13.2.5.2 The results of the hazard analysis shall be documented and maintained for the life of the process.

13.2.5.3 The hazard analysis shall be reviewed and updated at least every 5 years.

13.2.5.4 New and/or altered operations, equipment, and/or facilities shall be reviewed prior to operation for potential hazards.

13.2.5.5 Written records shall be maintained of all hazard analyses conducted.

13.2.5.6 Hazard analyses shall be signed off, prior to operation, by a cognizant authority at the facility.

13.2.5.7 Appropriate safeguards shall be put in place with regard to findings of the hazard analysis.
13.2.5.8 Corrective actions as a result of the hazard analysis shall be tracked and completed to ensure all identified hazards have been abated or the level of risk reduced to an acceptable level by a knowledgeable authority.

13.3 Primary Metal Production.

13.3.1 Reduction.

13.3.1.1 Reactor vessels shall be air-cooled.

13.3.1.2 Sealed zirconium or hafnium-reduction vessels shall be permitted to be water cooled and shall be designed to prevent water from entering the reaction vessel.

13.3.1.3 All containers used to receive molten magnesium, molten zirconium, molten hafnium, or molten zirconium or hafnium chloride shall be cleaned and dried thoroughly before use.

13.3.1.4 Sponge discharged from dryers shall be collected in containers that have a capacity no larger than 1814 kg (4000 lb).

13.3.1.5 Zirconium or hafnium storage areas shall be kept free of combustible materials, shall be well ventilated, shall be equipped with the required fire protection equipment, and shall be plainly marked with “No Smoking” signs.

13.3.1.6 Dust resulting from the crushing of zirconium or hafnium sponge shall be managed safely to minimize the risk of fires and explosions.

13.3.2 Melting and Casting.

13.3.2.1 General Provisions.

13.3.2.1.1 The water supply to crucibles shall be monitored continuously by a system that automatically interrupts power to the furnace upon a drop in water pressure or water flow.

13.3.2.1.2 An emergency source of cooling water shall be provided for crucibles and shall be actuated automatically by flow interlock in the event of interruption of the primary cooling water.

13.3.2.1.3 The upper chamber of the furnace shall be provided with a pressure-relieving device to aid in safely relieving pressure if water enters the furnace.

13.3.2.1.4 Means shall be provided to prevent the influx of air through the pressure-relief port.

13.3.2.1.5 The release pressure of the rupture disc shall be at a gauge pressure of 138 kPa (20 psi) maximum.

13.3.2.1.6 Large low-pressure ports shall not be used.

13.3.2.1.7 The furnace shall be equipped with a device that continuously senses pressure within the furnace.

13.3.2.1.8 The device shall automatically interrupt power to the melting heat source in the event of an expected sharp rise in pressure.
13.3.2.1.9 The furnace shall be equipped with the following equipment:

1. Water flow, temperature, and pressure sensors on all cooling systems
2. Furnace pressure sensors and recorders
3. Set point alarms on all systems to warn of abnormal conditions

13.3.2.1.10 The casting chamber shall be cooled or shall be sufficiently massive to accommodate a spill, or both, since mold breaks are inevitable.

13.3.2.1.11 Iron scale and metal spillage shall be minimized in furnaces.

13.3.2.1.12 All furnace pits and bunkers shall be evaluated as confined spaces.

13.3.2.2 Molds and Crucibles.

13.3.2.2.1 Molds (and crucibles) for zirconium casting shall be made of material that is compatible with molten zirconium.

13.3.2.2.2 Molds (and crucibles) shall be dried thoroughly and stored carefully to prevent accumulation of moisture in the molds.

13.3.2.2.3 All pieces of zirconium metal shall be clean and dry when charged to reactors.

13.3.2.3 Vacuum Arc Remelt (VAR) and Electroslag Remelting (ESR).

13.3.2.3.1 Water-cooled furnaces shall be located in a protective concrete vault, or the crucible and its water-jacket shall be isolated to protect personnel and to minimize damage if an explosion occurs.

13.3.2.3.2 A clearance shall be maintained at all times between the electrode and the crucible wall to minimize arcing to the crucible wall.

13.3.2.3.3 The use of a magnetic field to deflect the electric arc away from the crucible wall shall be considered.

13.3.2.3.4 Furnaces shall be equipped with the following equipment:

1. Arc voltage recorders and melting power recorders
2. Electrode position indicators
3. Control consoles for water-cooled melting and casting operations shall be located remote from melting areas and outside furnace vaults

13.3.2.4 Electron Beam (EB) and Plasma Arc Melting (PAM). (Reserved)

13.3.2.5 Vacuum Induced Melting (VIM) and Skull. (Reserved)

13.3.3 Refining. (Reserved)

13.4 Powder Production.
13.4.1  Drying and Storage.

13.4.1.1  Wetted powder shall be dried at a temperature not exceeding 110°C (230°F).

13.4.1.2  Drying rooms shall be of Type I construction, as defined by NFPA 220, *Standard on Types of Building Construction.*

13.4.1.3  Drying rooms shall be segregated as far as possible from other operations and at no time less than 15.2 m (50 ft).

13.4.1.4  An analysis shall be performed to determine whether drying rooms require deflagration venting.

13.4.1.5  Zirconium or hafnium powder shall be stored in sealed containers in well-ventilated areas.

13.4.1.6  The containers shall be kept free of combustibles.

13.4.1.7  The containers shall be protected from damage.

13.4.2  Zirconium or Hafnium Powder Handling.

13.4.2.1  Special care shall be taken to prevent spills or dispersions that produce dust clouds.

13.4.2.2  Powder or dust shall not be allowed to accumulate in the furnace or near the heating elements.

13.4.2.3  Hot zones of furnaces that handle zirconium in any form shall be provided with inert atmospheres or vacuum.

13.4.2.4  The furnaces shall be designed in accordance with NFPA 86, *Standard for Ovens and Furnaces,* and shall be of sparkproof construction and good engineering practice.

13.4.2.5  To minimize the risk of fire or explosion hazards in the handling of dry zirconium powder, the equipment and processes shall be designed by persons knowledgeable in the hazards of zirconium powder.

13.4.2.6  Only nonsparking tools and utensils shall be used in handling zirconium powder.

13.5  End Users of Powders. (Reserved)

13.6  Processing and Handling. (Reserved)

13.6.1  Machinery and Operations. (Reserved)

13.6.2  Flake and Paste. (Reserved)

13.6.3  Plasma Spray Operations. (Reserved)

13.6.4  Transfer Operations. (Reserved)

13.6.5  Processing Recycled Material. (Reserved)
13.7 Machining, Fabrication, and Finishing.

13.7.1 Hot Work Operations.

13.7.1.1 All hot work operations shall follow NFPA 51B, Standard for Fire Prevention During Welding, Cutting, and Other Hot Work.

13.7.1.2 Fabrication processes that use electric arcs or open flames or that create sparks shall not be permitted within 10.7 m (35 ft) of any area where zirconium chips, fines, and dust or any combustible materials are produced, handled, packaged, or stored.

13.7.1.3 All welding of zirconium shall be carried out under an inert atmosphere, such as helium or argon, or under vacuum.

13.7.1.4 The facility shall have a review system prior to any hot work (to include but not be limited to welding, grinding, or cutting operations that might ignite zirconium fines) being performed.

13.7.2 Chip Processing.

13.7.2.1 Machining.

13.7.2.1.1 Cutting tools shall be of proper design and shall be kept sharp for satisfactory work with zirconium.

13.7.2.1.2 Noncombustible coolants shall be used for wet grinding, cutting, and sawing operations.

13.7.2.1.3 The coolant shall be filtered on a continuous basis, and the collected solids shall not be permitted to accumulate in quantities greater than 19 L (5 gal) and shall be moved to a safe storage or disposal area.

13.7.2.1.4 Operations in which zirconium is subjected to processing or finishing shall include, but shall not be limited to grinding, buffing, polishing, sawing and machining of solids.

13.7.2.1.5 Mill operations shall cover the forging and finishing of zirconium products in a primary production facility.

13.7.3 Dust Collection. See 13.2.4.

13.7.4 Processing.

13.7.4.1 Furnaces or other equipment used for heating zirconium shall be cleaned to minimize the presence of iron scale or residue that could react exothermically with the metal being heated.

13.8 Storage and Handling.

13.8.1 Storage of Product.

13.8.1.1 Magnesium for use in the sponge producing process shall be stored in accordance with Chapter 9.
13.8.1.2 Chlorine shall be handled and stored in accordance with accepted industry practice.

13.8.1.3 Bulk containers of liquid zirconium tetrachloride (ZrCl₄) shall be stored in a well-ventilated place located away from areas of acute fire hazard. Containers shall be identified plainly and sealed tightly until used.

13.8.1.4 General Storage.

13.8.1.4.1 Zirconium or hafnium storage areas shall be kept free of combustible materials, shall be well-ventilated, shall be equipped with required fire protection equipment as specified in Section 13.9, and shall be plainly marked with “No Smoking” signs.

13.8.1.4.2 Where zirconium or hafnium is collected or stored in containers, material handling equipment with sufficient capability to remove any container from the immediate area in the case of an emergency shall be readily available.

13.8.1.4.3 Where drums are used, storage shall be limited to one-drum tiers per pallet with a height of not more than four pallet loads.

13.8.1.4.4 Stacked storage shall be positioned in such a manner as to ensure stability.

13.8.1.4.5 Aisles shall be provided for maneuverability of material-handling equipment, for accessibility, and to facilitate fire-fighting operations.

13.8.1.4.6 The maximum weight of material (per pallet or container) shall be capable of being moved by the available equipment.

13.8.1.4.7 Open storage of sheet, plate, forgings, or massive pieces of scrap presents no fire risk and shall be permitted.

13.8.1.4.8 Storage of materials in closed noncombustible containers shall be permitted except as noted for sponge. (See 13.8.1.5.2.)

13.8.1.5 Sponge Storage.

13.8.1.5.1 Zirconium or hafnium sponge shall be stored in closed metal containers.

13.8.1.5.2 Containers shall not be sealed unless they are inerted.

13.8.1.5.3 Storage of sponge shall comply with 13.8.1.4.

13.8.1.5.4 Sealed zirconium or hafnium-reduction vessels shall be permitted to be water cooled and shall be designed to prevent water from entering the reaction vessel.

13.8.2 Scrap Handling, Storage, and Disposal.

13.8.2.1 Residue from casting furnaces shall be placed in steel boxes and moved outside the building.

13.8.2.2 Covered, vented steel containers shall be used to transport collected sludge (from wet dust collectors) to a safe storage area or for disposal.

13.8.2.3 Sludge shall be disposed of in accordance with local, state, and federal regulations.
13.8.3 Recycling. Recycling shall be in accordance with Chapter 16.

13.8.4 Chip Processing. (Reserved)

13.9 Fire and Explosion Prevention.

13.9.1 The requirements of Chapter 15 shall apply.

13.9.2 Housekeeping.

13.9.2.1 Dust Control. Dust resulting from the crushing of zirconium or hafnium sponge shall be managed safely to minimize the risk of fires and explosions.

13.9.3 Control of Ignition Sources. (Reserved)

13.9.4 Hot Work Operations. (Reserved)

13.9.5 Control of Combustible Materials. (Reserved)

13.9.6 Inspection, Maintenance, and Training.

13.9.6.1 Regular inspections shall be conducted to detect the accumulation of excessive zirconium or hafnium dust, chips, or fines on any portions of buildings or machinery not regularly cleaned in daily operations.

13.9.6.2 Records shall be kept of the inspections conducted in 13.9.6.1.

13.10 Other. (Reserved)

Annex Material

A.13.1.2.11.1 A relatively small initial dust explosion will disturb, and suspend in air, dust that has been allowed to accumulate on the flat surfaces of a building or equipment. This dust cloud provides fuel for the secondary explosion, which usually causes the major portion of the damage. Reducing dust accumulations is, therefore, a major factor in reducing the hazard in areas where a dust hazard can exist.

Dust layers 3 mm (1/8 in.) thick can be sufficient to warrant immediate cleaning of the area. Dust accumulation on overhead beams and joists contributes significantly to the secondary dust cloud. Other surfaces, such as the tops of ducts and large equipment, can also contribute significantly to the dust cloud potential. Due consideration should be given to dust that adheres to walls, because it is easily dislodged.

Attention and consideration should also be given to other projections, such as light fixtures, that can provide surfaces for dust accumulation.

A.13.1.3.1 The use of eye, head, and respiratory protection (e.g., face shields, safety glasses, hard hats) is recommended and should be determined by a PPE hazard assessment, as required by OSHA.
A.13.1.3.4 Where static-dissipative safety shoes are used, a testing program to confirm that the shoes are static dissipating should be in place.

A.13.1.4.1 Thermite reactions are extremely exothermic [e.g., temperatures in excess of 2204°C (4000°F)]. A thermite reaction typically occurs between one metal oxide and another metal that reduces that oxide. The main concern is for iron oxide and fine magnesium particulate, especially powder, and molten magnesium, although there are documented instances of magnesium grinding fines initiating such a reaction. The thermite reaction is not necessarily limited to magnesium and iron oxide. There have been recorded incidents where copper oxide and/or lead oxide in contact with magnesium have created the conditions for a thermite reaction. Once initiated via a heat source, a thermite reaction is vigorous and should be treated as a metal fire.

A.13.1.4.2.1 For practical consideration, a eutectic reaction involving zirconium or hafnium is one involving another metal, usually iron or nickel base, where the mixture melts at a lower temperature than either of the individual metals.

For this reaction to take place, heat, pressure, and intimate contact are required; the reaction would be accelerated via finely divided particulate of either material.

The hazard is of the unexpected occurrence of flowing, molten, highly reactive metal. Treat the molten mixture as a metal fire and contain it with refractory material.

A.13.1.5 It is essential to have thorough written documentation as the slightest changes to procedures, processes, and/or equipment, including those from suppliers can have a dramatic impact on the overall hazard analysis. Change includes something as benign as process materials replacements-in-kind from a different manufacturer, same manufacturer using new methods to produce the product, or changes in formulation. These changes from a supplier’s end can impact the characteristics of the processes and/or materials.

A.13.1.5.1 Thermite reactions are extremely exothermic [e.g. temperatures in excess of 2204°C (4000°F)]. A thermite reaction typically occurs between one metal oxide and another metal that reduces that oxide. The main concern is for iron oxide and fine zirconium or hafnium particulate, especially powder, although there are documented instances of zirconium or hafnium grinding fines initiating such a reaction. The thermite reaction is not necessarily limited to zirconium or hafnium and iron oxide, and even thin metal sheet can be ignited. There have been recorded incidents where chrome oxide, copper oxide, and/or lead oxide in contact with zirconium or hafnium have created the conditions for a thermite reaction.

A.13.1.5.2 Change includes something as benign as process materials replacements-in-kind from different manufacturer, same manufacturer using new methods to produce the product, or changes in formulation. These changes from suppliers can impact the characteristics of the processes and/or materials.

A.13.2.1.4 Where surfaces on which dust can collect are unavoidably present, they can be covered by a smooth concrete, plaster, or noncombustible mastic fillet having a slope sufficient to prevent accumulation. An angle greater than the angle of repose is recommended.
A.13.2.4.2.10 Water level in the operation of wet-type dust collectors is very important to the overall efficiency of the equipment. Therefore, water level control logic that shuts the machine down in an under-fill or over-fill situation is necessary.

In both situations, power to the dust collector should drop out and both visual and audio alarms should energize to warn operators of the condition.

A.13.2.4.3.2 When combustible dust concentration control is the primary means of explosion prevention, the margin of safety below the MEC is established by Section 8.3 of NFPA 69, *Standard on Explosion Prevention Systems*. Combustible material design concentrations per Section 8.3 of NFPA 69 are required to be less than 25 percent of the MEC if the concentration is not going to be continuously monitored. Where automatic monitoring instrumentation with safety interlocks is installed, Section 8.3 of NFPA 69 allows the combustible material concentration to be as large as 60 percent of the MEC. There is also an allowance in 8.3.1(2) of NFPA 69 for aluminum powder production systems designed and operated in accord with the requirements of NFPA 484 to have combustible dust concentrations as large as 60 percent of the MEC.

A.13.2.4.6.3 The purpose of this is to protect dust collection that has combustible metals present in the collector. Many dry collectors are utilized for collection of grindings and similar operations in which the collected material is not combustible.

A.13.2.5.1 One method by which this requirement can be satisfied is with a process hazard analysis conducted in accordance with the methods outlined by the AIChE Center for Chemical Process Safety in “Guidelines for Hazard Evaluation Procedures.” [654, 2006]

To determine if a dust deflagration hazard exists, consider the following:


2. Determine where in the process a dust cloud sufficient to support a deflagration could occur. Use loss records and knowledge of process conditions to make this assessment.

3. Identify likely ignition sources. Recognize that ignition sources are complex and not always predictable. It is best to assume ignition is possible in all cases.

4. Assess the likelihood of an event. For example, a material with a low MIE has a greater likelihood of ignition, all else being equal. Determine MIE, if appropriate, using ASTM E 2019, *Standard Test Method for Minimum Ignition Energy of a Dust Cloud in Air*.

5. In terms of a worst case scenario, consider predictable consequences. Start with predictable primary events and then secondary events.

6. If the consequences are intolerable to either the owner/operator or the AHJ, ask the following:
   a. Can the risk be eliminated?
   b. Can controls be applied to minimize the likelihood?
(c) Can the risk be tolerated utilizing mitigation techniques to reduce or control the consequences?
Do you meet the general essential requirements?
- Yes
- No
  - I don't know
    - See section 13.1 and Chapter 15

Is this a new process?
- Yes
  - Hazard analysis requirements
    - See section 13.2.5
- No

Does your facility meet design requirements?
- Yes
- No
  - I don't know
    - See section 13.2

Do you perform primary processing?
- Yes
  - Reduction-See section 13.3.1
  - Melting & Casting- See section 13.3.2
  - Powder Production- See section 13.4
  - Processing & Handling-See section 13.6
- No

Are you machining, fabricating or finishing product?
- Yes
  - See section 13.7
- No

Are you storing combustible zirconium or zirconium alloys?
- Yes
  - See section 13.8
- No

Are you sending materials to recycling or waste treatment?
- Yes
  - Go to Chapter 16
- No

Are your fire and explosion prevention measures in place?
- Yes
  - See section 13.9
- No
Create a separate housekeeping chapter and delete the following:

**ZIRCONIUM**

13.1.2 Housekeeping. See Chapter X.

13.1.2.1 Combustible materials in zirconium storage, handling, and processing areas shall be minimized. Zirconium storage areas shall be well-ventilated, shall be equipped with required fire protection equipment as specified, and shall be plainly marked with "No Smoking" signs.

13.1.2.2 Smoking, when permitted, shall be located in designated areas outside of buildings.

13.1.2.3 Sludge from dust collectors and vacuum cleaning system precipitators shall be removed weekly as a minimum and when equipment is shut down after use.

13.1.2.4 See 15.2.2 for additional requirements.

13.1.2.5 Cleaning methods shall be limited to those methods that minimize the probability of causing a fire or explosion, as determined by a person knowledgeable in the properties of zirconium dust.

13.1.2.6 Due to the inherent hazards associated with the use of fixed vacuum cleaning systems for finely divided zirconium dust, special engineering considerations shall be given to the design, installation, maintenance, and use of such systems.

13.1.2.7 To prevent potential explosions caused by the inadvertent use of high-pressure compressed air in place of low pressure inert gas, fittings used on outlets of compressed air and inert gas lines shall not be interchangeable.

13.1.2.8 Regular, periodic cleaning of zirconium dust and fines from buildings and machinery, including roof members, pipes, conduits, and so on, shall be carried out as frequently as conditions warrant, based on visual inspections.

13.1.2.8.1 Dust and fines shall be removed to a safe storage or disposal area.

13.1.2.8.2 Potential ignition sources associated with the operation of equipment during the cleaning operation shall be reviewed; and appropriate actions to isolate, eliminate or minimize the potential hazards shall be taken.

13.1.2.8.3 The review of the hazards associated with cleaning operations shall include isolation, minimization, and elimination of the hazards.

13.1.2.8.4 Spills shall be removed at once, using conductive scoops and soft bristle brushes having natural fiber bristles. Scoops shall be nonsparking unless otherwise authorized for the specific application.

13.1.2.8.5 See Chapter 15 for additional requirements.

13.1.2.8.9 Hose used for cleaning and wash down purposes shall be pressurized only while in active use for cleaning and wash down purposes.

13.1.2.11 Cleaning Frequency:

13.1.2.11.1 The accumulation of excessive dust on any portions of buildings or machinery not regularly cleaned in daily operations shall be minimized.

13.1.2.11.2 Regular, periodic cleaning of buildings and machinery, with all machinery idle and powered off, shall be carried out as frequently as conditions warrant.

13.1.2.11.3 Regular, periodic cleaning of fugitive metal dust from buildings and machinery shall be carried out as frequently as conditions warrant.

13.1.2.11.4 Fugitive metal dust shall be removed to a designated storage or disposal area.

**Substantiation:** Housekeeping is such a critical safety component of combustible metals safety that it should be a separate chapter.
Donna R. Bruce, KEMET Electronics Corporation

Delete the following text:

Dust resulting from the crushing of zirconium sponge shall be managed safely to minimize the risk of fires and explosions.

Substantiation: Housekeeping is such a critical safety component of combustible metals safety that it should be a separate chapter.

Erdem A. Ural, Loss Prevention Science and Technologies, Inc.

Insert New Text at the beginning of New Chapter 14:

Compliance with NFPA 654 shall be considered fully equivalent to compliance with NFPA 484 for production, processing, handling, conveying and storage of combustible dust mixtures containing metals when all of the following criteria are met:

\[ \text{The dust KSt is less than or equal to } 200 \text{ bar-m/s and} \]
\[ \text{The dust Pmax is less than or equal to } 8 \text{ bar-g and} \]
\[ \text{The dust does not present special hazards such as excessive reactivity or binary compatibility in the process.} \]

For example, pyrophoric material, molten material or thermite reaction hazards are not addressed in NFPA 654.

NFPA 484 predominantly applies to highly reactive, severely explosible, or fast burning metals. As a result, it is the most conservative among the occupancy dust standards. Through its scope statement, NFPA 484 also applies to marginally explosible dusts such as steel shot or sandpaper debris from polishing operations. NFPA 654 is better suited for dusts in the latter category.

This revision will also alleviate some of the difficulties users will experience with the blank (reserved) sections of the new Chapter 14.

Kevin Kreitman, City of Redding Fire Department

Insert a new Chapter 14:

Include 484_L65 (PI #73)

Substantiation: Will correct numbering and content errors currently in the 2012 edition of the standard.

14.1.1 Retroactivity. The requirements of 14.1.2 through 14.1.5 shall apply to new and existing facilities.

14.1.2 Housekeeping. Housekeeping shall be in accordance with 15.2.2.

14.1.3 Personal Protective Equipment (PPE).

14.1.3.1 Operating and maintenance procedures shall address PPE for tasks involving processing or handling of combustible metal dust or molten metal.

14.1.3.1.1 A hazard assessment shall be conducted to evaluate the level of PPE required for the particular operation.

14.1.3.2 Combustible Metal Dusts.

14.1.3.2.1 PPE shall include flame-resistant garments in accordance with the workplace hazard assessment required by NFPA 2113, Standard on Selection, Care, Use, and Maintenance of Flame-Resistant Garments for Protection of Industrial Personnel Against Flash Fire.

14.1.3.2.2 Where a dust explosion hazard or dust flash fire hazard exists, flame-resistant garments shall be required for all exposed personnel.

14.1.3.2.3 Outer garments shall be clean and static dissipative where combustible metal dust is present.

14.1.3.2.3.1 Outer garments shall be designed to be removable.

14.1.3.2.3.2 Outer garments containing wool, silk, or synthetic fabrics that can accumulate high static electric charges shall not be used.

14.1.3.2.4 Garments shall be designed to minimize the accumulations of combustible metal dust (e.g., trousers shall not have cuffs).

14.1.3.2.5 Safety shoes shall be static-dissipative, where necessary, shall have no exposed metal, and shall be appropriate for the type of operation taking place.

14.1.3.3 Molten Metal.

14.1.3.3.1 Operators in melting and casting areas where there is an opportunity for the operator to come into contact with molten metal shall wear flame-resistant garments, high top leather safety shoes [minimum 150 mm (6 in.) high shoe], and face protection.

14.1.3.3.2 Garments worn where molten metal is present shall have no exposed pockets or cuffs that could trap and retain metal.
14.1.3.4* Garment Fires.
14.1.3.4.1 Emergency procedures for handling garment fires shall be established.
14.1.3.4.2 If deluge showers are installed, they shall be located such that water from the shower cannot enter dry metal powder–processing and –handling areas.

14.1.3.5* Emergency Procedures.
14.1.3.5.1 Emergency procedures to be followed in case of fire or explosion shall be established.
14.1.3.5.2 All employees shall be trained in the emergency procedures.

14.1.4 Reactivity.
14.1.4.1 Thermit Reactions. It shall be the responsibility of the facility to evaluate processes and materials for potentially dangerous reactions that could occur in the course of their operations.

14.1.4.1.1* Caution shall be exercised in the mixing of fines or molten material with metal oxides [e.g. iron oxide (rust)].

14.1.4.2 Eutectic Reactions. (Reserved)

14.1.5* Management of Change.
14.1.5.1 The requirements of 14.1.5.2 through 14.1.5.5 shall apply to new and existing facilities and processes.
14.1.5.2 Written procedures shall be established and implemented to manage a proposed change to process materials, technology, equipment, procedures, and facilities.
14.1.5.3 The procedures shall ensure that the following are addressed prior to any change:
   (1) The technical basis for the proposed change
   (2) Safety and health implications, including hazard analysis
   (3) Whether the change is permanent or temporary
   (4) Modifications to operating and maintenance procedures
   (5) Employee training requirements
   (6) Authorization requirements for the proposed change
   (7) Results of characterization tests used to assess the hazard, if conducted
14.1.5.4 Implementation of the management of change procedure shall not be required for (identical) replacements-in-kind.
14.1.5.5 Design documentation shall be updated to incorporate the change.
14.1.6 Alternative Methodologies. (Reserved)

14.1.7 Test Results. (Reserved)

14.1.8 Other. (Reserved)

14.2 Facility Design Requirements.

14.2.1 Building Construction.

14.2.1.1 Buildings housing combustible metals operations shall be of noncombustible construction, unless a hazard analysis has been performed that shows that noncombustible construction is not required.


14.2.1.3 Building areas where combustible metal dusts might be present shall be designed so that all internal surfaces are accessible, to facilitate cleaning.

14.2.1.3.1 All walls of areas where fugitive dust can be produced shall have a smooth finish and shall be sealed so as to leave no interior or exterior voids where dust can infiltrate and accumulate.

14.2.1.3.2 The annulus of all pipe, conduit, and ventilation penetrations shall be sealed.

14.2.1.4 Roofs.

14.2.1.4.1 Roofs of buildings that house combustible metal dust–producing operations shall be supported on girders or structural members designed to minimize surfaces on which dust can collect.

14.2.1.4.2* Interior surfaces where dust accumulations can occur shall be designed and constructed to facilitate cleaning and minimize combustible dust accumulations.

14.2.1.5 Floors, elevated platforms, balconies, and gratings shall be hard surfaced and installed with a minimum number of joints in which powder or dust can collect.

14.2.1.6 Roof decks and basements shall be watertight.

14.2.1.7* Explosion venting in accordance with NFPA 68, Standard on Explosion Protection by Deflagration Venting, shall be required for all buildings or building areas where combustible metal powders or dusts are present, unless a hazard analysis has been performed that shows that explosion venting is not required.

14.2.1.8 All doors in interior fire-rated partitions shall be listed, self-closing fire doors installed in accordance with NFPA 80, Standard for Fire Doors and Other Opening Protectives.

14.2.1.9 Enclosed Passageways.

14.2.1.9.1 Where buildings or process areas are interconnected by enclosed passageways, the passageways shall be designed in accordance with NFPA 68, Standard on Explosion Protection by Deflagration Venting, to prevent propagation of an explosion or fire from one unit to another.
14.2.1.9.2 All enclosed passageways that can be occupied and that connect with one or more processing areas shall be provided with means of egress in accordance with NFPA 101, *Life Safety Code*.

14.2.1.10 Buildings or portions of buildings of noncombustible construction used principally for combustible-metal storage or handling shall not be permitted to be equipped with automatic sprinkler protection.

14.2.1.11 Sprinkler systems installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, shall be permitted in areas where combustibles other than combustible metals create a more severe hazard than the combustible metals and where acceptable to an authority having jurisdiction that is knowledgeable of the hazards associated with the combustible metal.

14.2.1.12 Fittings used on outlets of compressed-air and inert-gas lines shall not be interchangeable, to prevent potential explosions caused by inadvertently using compressed air in place of low-pressure inert gas.

14.2.1.13 Water leakage inside or into any building where the water can contact metal powder shall be prevented to avoid possible water–metal reactions.

14.2.1.14 One or more remotely located control stations shall be provided to allow the selective shutdown of process equipment in an emergency.

**14.4.3.2.1.15 Heating and Cooling of Powder Production Buildings.**

14.4.3.2.1.15.1 Buildings shall be permitted to be heated by indirect hot-air heating systems, by bare-pipe heating systems using steam or hot water as the heat transfer medium, or by listed electric heaters.

14.4.3.2.1.15.2 Indirect hot air shall be permitted if the heating unit is located in a combustible metal dust–free area adjacent to the room or area where heated air is required.

14.4.3.2.1.15.3 Fans or blowers used to convey the heated or cooled air shall be located in a combustible metal dust–free location.

14.4.3.2.1.15.4 The air supply shall be taken from outside or from a location that is free of combustible metal dust.

14.4.3.2.1.15.5 Make-up air for building heating or cooling shall have a dew point low enough to ensure that no free moisture can condense at any point where the air is in contact with combustible metal dust or powder.

14.4.3.2.1.15.6 The requirements of 14.4.3.2.1.15.1 through 14.4.3.2.1.15.5 shall not apply to areas where metal is melted.

**14.2.2 Fire Protection.** Fire protection shall be in accordance with Chapter 15.
14.2.3  Electrical Classification.

14.2.3.1* In local areas of a plant where a hazardous quantity of dust accumulates or is present in suspension in the air, the area shall be classified, and all electrical equipment and installations in those local areas shall comply with Article 500 of NFPA 70, National Electrical Code.

14.2.3.2 All electrical equipment and wiring shall comply with NFPA 70, National Electrical Code.

14.2.3.3* Grounding. All process equipment and all building steel shall be bonded and grounded.

14.2.3.4 Flashlights, electronic devices, and other portable electrical equipment shall be listed for use in hazardous locations.

14.2.4 Dust Collection. (Reserved) See 14.7.3 Dust Collection

14.2.4.1 Dust collection for tantalum powder production operations shall follow the requirements of 14.7.3.2.

14.2.5 Hazard Analysis.

14.2.5.1* The design of the fire and explosion safety provisions shall be based on a hazard analysis of the facility, the process, and the associated fire or explosion hazards.

14.2.5.2 The results of the hazard analysis shall be documented and maintained for the life of the process.

14.2.5.3 The hazard analysis shall be reviewed and updated at least every 5 years.

14.2.5.4 New and/or altered operations, equipment, and/or facilities shall be reviewed prior to operation for potential hazards.

14.2.5.5 Written records shall be maintained of all hazard analyses conducted.

14.2.5.6 Hazard analyses shall be signed off, prior to operation, by a cognizant authority at the facility.

14.2.5.7 Appropriate safeguards shall be put in place with regard to findings of the hazard analysis.

14.2.5.8 Corrective actions as a result of the hazard analysis shall be tracked and completed to ensure all identified hazards have been abated or the level of risk reduced to an acceptable level by a knowledgeable authority.

14.3 Primary Metal Production.

14.3.1 Reduction. (Reserved)

14.3.2 Melting and Casting.
14.3.2.1* Water-cooled vacuum arc furnaces shall be designed with safety interlock systems that will allow the furnace to operate only if there is sufficient cooling waterflow to prevent over-temperature of the melting crucible.

14.3.2.2 Vacuum arc furnace electrodes shall be firmly affixed to the electrode stinger in such a fashion that the electrode will not become detached during the melting operation.

14.3.2.3 Buildings used for the melting and casting of metals shall be noncombustible.

14.3.2.4 Floors shall be kept free of standing water.

14.3.2.5* All solid metal shall be thoroughly dried throughout by preheating or other methods prior to coming into contact with molten metal.

14.3.2.6 Ovens and furnaces shall comply with NFPA 86, Standard for Ovens and Furnaces.

14.3.2.7 Fuel supply lines shall comply with NFPA 54, National Fuel Gas Code.

14.3.2.8 Use of flammable and combustible liquids shall comply with NFPA 30, Flammable and Combustible Liquids Code.

14.3.2.9 Areas of furnaces that can come into contact with molten metal in the event of a runout shall be kept dry and free of iron oxide.

14.3.2.10 Crucible interiors and covers shall be maintained free of iron oxide scale, which could fall into the molten metal.

14.3.2.11 Molten metal systems shall overflow or relieve to secondary containments designed to handle 110 percent of the largest expected failure and shall be provided with the means to prevent contact with incompatible materials.

14.3.2.12 Pots and Crucibles.

14.3.2.12.1 Melting pots and crucibles shall be inspected regularly.

14.3.2.12.2 Pots and crucibles that show evidence of possible failure or that allow molten metal to contact iron oxide, concrete, or other incompatible materials shall be repaired or discarded.

14.3.2.13 Ladles, skimmers, and sludge pans shall be thoroughly dried and preheated before contacting molten metal.

14.3.2.14 Extreme care shall be exercised in pouring metal castings, to avoid spillage.

14.3.2.15 All molds shall be thoroughly preheated before pouring.

14.3.2.16 Operators' Garments.

14.3.2.16.1 Operators in melting and casting areas where there is an opportunity for the operator to come into contact with molten metal shall wear flame-resistant clothing, high top safety shoes, and face protection.

14.3.2.16.2 Garments worn where molten metal is present shall have no exposed pockets or cuffs that could trap and retain metal.
14.3.3 Refining. (Reserved)

14.4 Powder Production.

8.4.1 Handling and Conveying of Aluminum Powder.

8.4.1.1 Where aluminum powder is present, good housekeeping practices shall be maintained.

8.4.1.2 Aluminum powder shall be handled so as to avoid spillage and the creation of airborne dust.

8.4.1.3 Scoops, shovels, and scrapers used in the handling of aluminum powder shall be electrically conductive and shall be grounded when necessary, and hand tools shall be made of spark-resistant materials.

8.4.1.4 Each container for aluminum powders shall be conductive and covered while in storage or in transit.

8.4.1.5 When aluminum powders are being charged to or discharged from machines, the containers shall be bonded to the grounded machine.

8.4.1.6 When aluminum powder is being transferred between containers, the containers shall be bonded and at least one of the containers shall be grounded.

8.4.2 Portable Containers.

8.4.2.1 In-plant transport of aluminum powders shall be done in covered conductive containers as described in 8.4.1.4.

8.4.3 Ductwork for Pneumatic Conveying Systems. Conveyor ducts shall be fabricated of nonferrous spark-resistant metal or spark-resistant stainless steel.

8.4.3.1 Plastics or other nonconductive ducts or duct liners shall not be used.

8.4.3.2 Ducts shall be electrically bonded and grounded to minimize accumulation of static electric charge.

8.4.3.3 Where the conveying duct is exposed to weather or moisture, it shall be moisture-tight.

8.4.3.4 A minimum conveying velocity of 1372 m/min (4500 ft/min) shall be maintained throughout the conveying system to prevent the accumulation of dust at any point and to pick up any dust or powder that can drop out during unscheduled system stoppages.

8.4.3.5 If the conveying gas is air, the aluminum powder-to-air ratio throughout the conveying system shall be held below the minimum explosible concentration (MEC) of the combustible aluminum dust at normal operating conditions.

8.4.3.6 Deflagration venting such as rupture diaphragms shall be provided on ductwork.

8.4.3.6.1 Deflagration vents shall relieve to a safe location outside the building.
8.4.3.6.2 Deflagration venting shall not be required for ductwork provided with explosion isolation systems identified in NFPA 69, Standard on Explosion Prevention Systems, that can prevent propagation of a deflagration into other parts of the process.

8.4.3.7 Whenever damage to other property or injury to personnel can result from the rupture of the ductwork, or where deflagration relief vents cannot provide sufficient pressure relief, the ductwork shall be designed to withstand a suddenly applied gauge pressure of at least 690 kPa (100 psi).

8.4.3.8 If a portion of the ductwork is so located that no damage to property or injury to personnel will result from its bursting, that portion shall be permitted to be of lightweight construction so as to intentionally fail, thereby acting as an auxiliary explosion vent for the system.

8.4.4 Conveying Using an Inert Medium.

8.4.4.1* Inert gas–conveying systems shall be permitted if designed in accordance with NFPA 69, Standard on Explosion Prevention Systems.

8.4.4.2* The inert gas used shall be based on such gases as argon, carbon dioxide, helium, nitrogen, or flue gas and shall have a limiting oxygen concentration (LOC) determined by test to be appropriate to the inert gas except that, where the aluminum powder is never exposed to air, the oxygen content shall be permitted to be zero.

8.4.4.3 The inert gas shall have a dew point such that no free moisture can condense or accumulate at any point in the system.

8.4.4.4 The inert gas stream shall be continuously monitored for oxygen content and shall be arranged to sound an alarm if the oxygen content is not within the prescribed range.

8.4.4.5 A minimum conveying velocity of 1372 m/min (4500 ft/min) shall be maintained throughout the conveying system to prevent the accumulation of dust at any point and to pick up any dust or powder that drops out during an unscheduled system stoppage.

8.4.4.6 If the conveying gas is inducted into the system in a relatively warm environment and the ducts and collectors are relatively cold, the ducts and collectors shall be either insulated or provided with heating so that the gas temperature does not fall below the dew point, causing condensation.

8.4.5 Fan and Blower Construction and Arrangement.

8.4.5.1* Blades and housings of fans used to move air or inert gas in conveying ducts shall be constructed of conductive, non-sparking metal such as bronze, non-magnetic stainless steel, or aluminum.

8.4.5.2 The design of the fan or blower shall not allow the transported aluminum powder to pass through the fan before entering the final collector, unless the aluminum powder–conveying system is inerted.

8.4.5.3 Personnel shall not be permitted within 15 m (50 ft) of the fan or blower while it is operating, except as provided in 8.4.5.3.2 and 9.4.9.2.2.
8.4.5.3.1 No maintenance shall be performed on the fan until it is shut down.
8.4.5.3.2 If personnel approach the fan or blower while it is operating, such as for a pressure test, the test shall be done under the direct supervision of competent technical personnel and with the knowledge and approval of operating management and with the flow of aluminum powder cut off.
8.4.5.4* Fans or blowers shall be located outside of all manufacturing buildings and shall be located to minimize entrance of dust into the building from the fan exhaust.
8.4.5.5* Fans or blowers shall be equipped with ball or roller bearings.
8.4.5.5.1 Bearings shall be equipped with temperature-indicating devices.
8.4.5.5.2 Bearings shall be arranged to sound an alarm in case of overheating.
8.4.5.6 Fans or blowers shall be electrically interlocked with powder-producing machinery so that the machines are shut down if the fan stops.

8.4.6 Powder Collection.
8.4.6.1* Collectors.
8.4.6.1.1 Dry-type collectors shall be located outside in a safe location and shall be provided with barriers or other means for protection of personnel.
8.4.6.1.2* The area around the collector shall be posted with a sign that reads as follows:

CAUTION:
This dust collector can contain explosible dust. Keep outside the marked area while equipment is operating.
8.4.6.1.3 Collectors shall be constructed of metal to allow dissipation of static electricity.
8.4.6.1.4 Ductwork shall comply with the provisions of 8.4.3.
8.4.6.1.5* The entire collection system, including the collector, shall be completely bonded and grounded to minimize accumulation of static electric charge.
8.4.6.1.6 Recycling of air from powder collectors into buildings shall be prohibited.
8.4.6.1.7* Where an explosion hazard exists, dry-dust collectors shall be provided with deflagration vents.
8.4.6.1.7.1 Extreme care shall be taken in the selection of the type and location of vents or weak sections of the collector to minimize injury to personnel and blast damage to nearby equipment or structures.
8.4.6.1.7.2 Deflagration vents shall be positioned so that a potential blast is not directed toward any combustible or frangible structure.
8.4.6.1.8 Repairs.
8.4.6.1.8.1 Where repairs on dry-dust collectors are necessary, the collectors shall be emptied and residual accumulations of dust thoroughly removed. (See 8.1.2.2 and 8.9.4.)

8.4.6.1.8.2* Ductwork leading into the collector shall be disconnected and isolated by blanking before repair work is permitted to be started.

8.4.6.2 High-Temperature Warning.

8.4.6.2.1 Cyclone or other dry-type collectors shall be equipped with instruments for recording the surface temperature.

8.4.6.2.2 An overheating alarm or warning device shall be included, and the limit setting shall be below the maximum service temperature of the filter medium or 50°C (122°F) below the ignition temperature of the powder cloud, whichever is lower.

8.4.6.2.3 The devices specified in 8.4.6.2.2 shall give audible and visual alarms at normally attended locations.

8.4.6.3* Collector Filter Medium. Collector filter medium made from synthetic fabrics that accumulate static electric charges shall not be used.

8.5 End Users of Powder.

8.5.1 Aluminum Powder Handling and Use.

8.5.1.1 Scope. The provisions of Section 8.5 shall apply to operations including, but not limited to, the use of aluminum powder in the production of paste, flake powders, powdered metallurgy component manufacturing, fireworks and pyrotechnics, propellants, plasma spray coating, chemical processing, and refractories.

8.5.1.2 Storage. Dry aluminum powder and aluminum paste shall be stored in accordance with the provisions of 8.8.1.

8.5.1.3* Handling. The requirements of Section 8.5 shall apply to both regular and “nondusting” grades of aluminum powder, as well as to aluminum paste.

8.5.1.4 Where aluminum powder or paste is used or handled, good housekeeping practices shall be maintained in accordance with 8.1.2.

8.5.1.5 Scoops, shovels, and scrapers used in the handling of aluminum powder and paste shall be electrically conductive and shall be grounded when necessary, and hand tools shall be made of spark-resistant materials.

8.5.1.6 Powered industrial trucks shall be selected in accordance with NFPA 505, Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operations, and consistent with 8.2.3.1.

14.4.1.1* Machines that produce fine particles of metal shall be provided with hoods, capture devices, or enclosures that are connected to a dust collection system having suction and capture velocity to collect and transport all the dust produced.
14.4.1.1  Hoods and enclosures shall be designed and maintained so that the fine particles will either fall or be projected into the hoods and enclosures in the direction of airflow.

14.4.1.2  Dust shall be collected by means of hoods or enclosures at each operation.

14.4.1.2* Special attention shall be given to the location of all dust-producing machines with respect to the location of the dust collection system to ensure that the connecting ducts will be as straight and as short as possible.

14.4.1.3  Grinding operations shall not be served by the same dust collection system as buffing and polishing operations.

14.4.1.4  Dry-type dust collectors shall be located outside of buildings.

14.4.1.4.1* Individual machines with portable dust collection capability shall be permitted to be used indoors when the object being processed or finished is incapable of being moved to a fixed hood or enclosure.

14.4.1.4.2  The operation of portable dust collection devices shall be subject to a hazards analysis to ensure that the risk to personnel and operations from flash fire and shrapnel is minimized.

14.4.1.4.3  Personal protective clothing shall comply with 14.1.3.

14.4.1.4.4  The collector shall be designed to dissipate static electricity.

14.4.1.4.5  Collector retention capacity shall be limited to 0.45 kg (1 lb).

14.4.1.4.5* Dry-type collectors shall be provided with barriers or other means for protection of personnel.

14.4.1.6* The area around the collector shall be posted with a sign that reads as follows:

CAUTION:

This dust collector can contain explosible dust. Keep outside the marked area while equipment is operating.

14.4.1.7* If the metal dust–collecting unit is to be used for other materials, it shall be thoroughly cleaned of all incompatible materials prior to and after use.

14.4.1.8  Grinders, buffers, and associated equipment with dust collectors utilized for processing metal dust shall be provided with a placard that reads as follows:

CAUTION: Current Use: [Type of Metal] — Fire or Explosion Can Result with Other Metals

14.4.1.9* Cutting tools shall be designed for use with the metal being worked and shall be kept sharp.

14.4.1.10* Sawing, grinding, and cutting equipment shall be grounded.
14.4.1.11 All metal chips, oily crushed lathe turnings, raw turnings, and swarf shall be collected in closed-top containers and removed daily, at a minimum, to a designated storage or disposal area.

14.4.1.12 Nonflammable coolants shall be used for wet grinding, cutting, and sawing operations.

14.4.1.12.1 The coolant shall be filtered on a continuous basis.

14.4.1.12.2 The collected solids shall not be allowed to accumulate in quantities greater than 19 L (5 gal) and shall be removed to a designated storage or disposal area.

14.4.2 Powder Handling and Use.

14.4.2.1 Where metal powder or paste is used or handled, good housekeeping practices shall be maintained.

14.4.2.2 Metal powder and paste shall be handled so as to avoid spillage and the creation of airborne dust.

14.4.2.3 Scoops, shovels, and scrapers used in the handling of metal powder and paste, in atmospheres other than inert atmospheres, shall be electrically conductive and shall be bonded and grounded, and hand tools shall be made of spark-resistant materials.

14.4.2.4 Powered industrial trucks shall be selected in accordance with NFPA 505, Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operations, and consistent with 14.5.1.2.

14.4.2.5 For plasma spray operations, media collectors, if used, shall be located at a distance from the point of collection to eliminate the possibility of hot metal particles igniting the filter medium in the collector.

14.4.2.6 Metal overspray temperatures at the dust collector shall be compatible with the limiting temperature of the filter medium element.

14.4.4 Transfer Operations. Operations involving the transfer of combustible metal dusts or powders from one container to another shall be designed and operated to protect personnel, equipment, or buildings from the fire or dust explosion hazard produced by airborne suspensions of combustible metal dusts or powders.

14.4.4.1 Precautions shall be taken to prevent spills or dispersions that produce dust clouds.

14.4.4.2 Special temperature controls shall be required on sintering furnaces that handle metal parts that are fabricated from powder.

14.4.4.2.1 Powder or dust shall not be permitted to accumulate in the furnace or near the heating elements.

14.4.4.2.2 Furnaces shall be provided with inert atmospheres.
14.4.4.3* To minimize the risk of fire or explosion hazards in the handling of dry metal powders, the equipment and processes shall be designed by persons knowledgeable in the hazards of metal powders.

14.5 End Users of Powder.

14.5.1 General.

14.5.1.1* Equipment shall be constructed to mitigate the potential for ignition of the powder.

14.5.1.2* All electrical wiring and equipment shall be installed in accordance with NFPA 70, National Electrical Code, and all components of equipment shall be electrically bonded and grounded.

14.5.1.3 A hazards analysis shall be performed for areas where powder is present to determine risk factors and appropriate controls.

14.5.1.4* Where the hazards analysis shows that controls are required to manage the risk of static generation and that static-dissipative flooring or static-dissipative floor mats are required, personnel shall wear static-dissipative footwear or equivalent grounding devices.

14.5.1.5* Where static-dissipative flooring or static-dissipative floor mats are required, personnel shall wear flame-resistant clothing designed to minimize the accumulation of powder.

14.5.1.6* Spark-resistant tools shall be used.

14.5.1.7 Backup methods or systems shall be provided to allow for the orderly shutdown of critical processes in case of primary system failure.

14.5.2 Powder Storage.

14.5.2.1 Daily supplies of powder shall be allowed to be stored in the production area.

14.5.2.1.1 The powder shall be stored in covered containers and shall be segregated from other combustible materials.

14.5.2.1.2 The maximum capacity of the container shall be such that it can be moved by available equipment.

14.5.2.1.3 The containers shall be protected from damage.

14.5.2.2 Stacked Storage.

14.5.2.2.1 When powder is stored in sealed containers, stacked storage shall be arranged to ensure stability.

14.5.2.2.2 Aisles shall be provided for maneuverability of material-handling equipment, for accessibility, and to facilitate fire-fighting operations.

14.5.3 Dry Powder Handling.

14.5.3.1* Precautions shall be taken to prevent spills or dispersions that produce dust clouds.
14.5.3.2 Sintering furnaces that handle compacted powder shall be installed and operated in accordance with NFPA 86, *Standard for Ovens and Furnaces*.

14.5.3.2.1 Powder or dust shall not be allowed to accumulate in the furnace or near the heating elements.

14.5.3.2.2 Furnaces shall be operated with inert atmospheres of argon or helium or under vacuum.

14.5.4 Handling of Wet Powder by End Users.

14.5.4.1* When water-wetted powder is air-dried at atmospheric pressure, the temperature shall not exceed 80°C (176°F).

14.5.4.2 When powders wetted with fluids other than water are air-dried, the temperature shall be governed by the characteristics of the fluid but shall not exceed 80°C (176°F).

14.5.4.3 When powders are dried under controlled atmospheric conditions (e.g., vacuum or inert atmosphere) and the temperature of the powder exceeds 80°C (176°F), the powder shall be cooled to less than 80°C (176°F) prior to exposure to air.

14.5.5 Heat Treatment and Passivation.

14.5.5.1 General.

14.5.5.1.1 Equipment shall be designed, constructed, and installed to mitigate the potential for ignition and accumulation of the powder.

14.5.5.1.2 Fuel supply lines to gas-fired furnaces or other gas-fired equipment shall be installed and maintained in accordance with NFPA 54, *National Fuel Gas Code*.

14.5.5.1.3 Furnaces shall comply with NFPA 86, *Standard for Ovens and Furnaces*.

14.5.6 Electrical Installations. The electrical equipment shall be installed in accordance with the requirements of NFPA 70, *National Electrical Code*.

14.5.7* Personnel Safety Precautions.

14.5.7.1 The metal shall be handled only by trained personnel who are knowledgeable of the hazards associated with that particular metal.

14.5.7.2 Access to metal-handling areas by unauthorized personnel shall not be permitted.

14.5.7.3 Backup methods or systems shall be provided to allow for the orderly shutdown of critical processes in case of primary system failure.

14.5.8 Powder Heat Treatment and Sintering.

14.5.8.1 After powder furnacing, the powder shall be passivated prior to exposure to air atmosphere.

14.5.8.2 Furnaced powder shall be cooled to 50°C (122°F) or less prior to starting passivation.
14.5.9* Heat Treatment and Sintering of Compacts.

14.5.9.1* Sintered compacts shall be cooled to 50°C (122°F) or less prior to removal from the furnace.

14.5.9.2 Sintered compacts shall be isolated from other combustible materials until their temperature has stabilized below 50°C (122°F).

14.5.10 Safety Precautions.

14.5.10.1 If the furnace’s primary cooling source fails, an alternative system shall provide cooling for the furnace for any required cool-down time period.

14.5.10.2 The alternative cooling system specified in 14.5.10.1 shall be activated automatically upon failure of the main cooling source and shall be interlocked to prevent operation of the furnace.

14.6 Processing.

14.6.1 Machining and Operations.

14.6.1.1 Requirements for Machinery.

14.6.1.2 All combustible metal dust–producing machines and conveyors shall be designed, constructed, and operated so that fugitive dust is minimized.

14.6.1.3 All machinery and equipment shall be installed in accordance with NFPA 70, National Electrical Code.

14.6.1.4* All machinery shall be bonded and grounded to minimize accumulation of static electric charge.

14.6.1.5 Bearings.

14.6.1.5.1* Ball or roller bearings shall be sealed against dust.

14.6.1.5.2 Where exposed bearings are used, the bearings shall be protected to prevent ingress of combustible metal dust and shall have a lubrication program.

14.6.1.6 Clearances between moving surfaces that are exposed to paste, powder, or dust shall be maintained to prevent rubbing or jamming.

14.6.1.7 Permanent magnetic separators, pneumatic separators, or screens shall be installed ahead of mills, stamps, or pulverizers wherever there is any possibility that tramp metal or other foreign objects can be introduced into the manufacturing operation.

14.6.1.8 Startup Operations. All areas of processing machinery that will be in contact with metal powder shall be free of foreign material and water before being placed into operation.

14.6.2 Flake and Paste.

14.6.2.1 Machinery and Operations.
14.6.2.1.1* Wet Milling of Metal Powder. The requirements of 14.6.2.1.1 through 14.6.2.1.6 shall not apply to machining and rolling operations.

14.6.2.1.1.1* Where metal is added to a mill in the presence of a liquid that is chemically inert with respect to the metal, the milling shall be done in air in a vented mill or in an inerting atmosphere containing sufficient oxygen to oxidize any newly exposed surfaces as they are formed.

14.6.2.1.1.2* Where metal is slurried in tanks or processed in blenders or other similar equipment in the presence of a liquid that is chemically inert with respect to the metal, the operation shall be carried out in air or in an inerting atmosphere containing sufficient oxygen to oxidize any newly exposed surfaces as they are formed.

14.6.2.1.1.3 The dew point of the atmospheres in 14.6.2.1.1.1 and 14.6.2.1.1.2 shall be maintained below the point where condensation occurs.

14.6.2.1.1.4 Bearings of wet mills shall be grounded across the lubricating film by use of current collector brushes, a conductive lubricant, or other applicable means.

14.6.2.1.1.5* Ventilation in accordance with NFPA 30, Flammable and Combustible Liquids Code, shall be maintained in areas where flammable or combustible solvents are handled, particularly in areas where combustible metal dusts or powders are present.

14.6.2.1.1.6 Solvent or slurry pumps shall be installed with controls that ensure that a flow exists and that the pumps run with safe operating temperatures.

14.6.2 Electrical Equipment.

14.6.2.2.1 All electrical wiring and equipment shall conform to the provisions of NFPA 70, National Electrical Code.

14.6.2.2.2 When continuous contact is interrupted, metallic jumpers shall be installed for effective bonding.

14.6.2.2.3* Wet solvent milling areas or other areas where combustible or flammable liquids are present shall be classified, where applicable, in accordance with Article 500 of NFPA 70, National Electrical Code, with the exception of control equipment meeting the requirements of NFPA 496, Standard for Purged and Pressurized Enclosures for Electrical Equipment.

14.6.3 Plasma Spray Operations.

14.6.3.1 For plasma spray operations, media collectors, if used, shall be located at a distance from the point of collection to eliminate the possibility of hot metal particles igniting the filter media in the collector.

14.6.3.2 Metal overspray temperatures at the dust collector shall be compatible with the limiting temperature of the filter media element.

14.6.3.3 In local areas of a plant where a hazardous quantity of dust accumulates or is present in suspension in the air, the area shall be classified and all electrical equipment and installations in those local areas shall comply with Article 500 of NFPA 70, National Electrical Code.
14.6.4  Transfer Operations.

14.6.4.1* Operations involving the transfer of combustible metal dusts or powders from one container to another shall be designed and operated to protect personnel, equipment, and buildings from the fire or dust explosion hazard produced by airborne suspensions of combustible metal dusts or powders.

14.6.4.2  Prevention of Fugitive Dust Accumulations. See 14.1.2.

14.6.5  Processing Recycled Material. The requirements of Chapter 16 shall apply to processes handling recycled metal that is in a combustible form.

14.7* Machining, Fabrication, and Finishing.

14.8  Hot Work.

14.8.1  Hot Work Operations.

14.8.1.1  Hot work operations in facilities covered by this standard shall comply with the requirements of NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*.

14.8.1.2  General Precautions.

14.8.1.2.1  Any equipment used for the machining, fabrication, or finishing of metal shall be dedicated to metal only and marked with a placard that reads as follows:

**WARNING:** Metal Only — Fire or Explosion Can Result with Other Metals.

14.8.1.2.2  Equipment producing metal in a combustible form shall be permitted to be used for other materials only when the system is thoroughly cleaned of all incompatible materials prior to and after its use.

14.8.1.3  Electrical Equipment.

14.8.1.3.1  All electrical wiring and equipment shall conform to the provisions of *NFPA 70, National Electrical Code*.

14.8.2  Chip Production and Processing.

14.8.2.1  Machining and Sawing Operations.

14.8.2.2*  Cutting tools shall be of proper design and shall be kept sharp for satisfactory work with the metal.

14.8.2.3*  Sawing, grinding, and cutting equipment shall be grounded.

14.8.2.4  All metal chips, oily crushed lathe turnings, raw turnings, and swarf shall be collected in closed-top containers dedicated to the specific metal only and removed daily, at a minimum, to a safe storage or disposal area.

14.8.2.5  Coolant.
14.8.2.5.1 Nonflammable coolants shall be used for wet grinding, cutting, or sawing operations.

14.8.2.5.2 The coolant shall be filtered on a continuous basis, and the collected solids shall not be allowed to accumulate in quantities greater than 19 L (5 gal) and shall be removed to a safe storage or disposal area.

14.8.3* Dust Collection.

14.8.3.1* Machines that produce fine particles of other combustible metals shall be provided with hoods, capture devices, or enclosures that are connected to a dust collection system having suction and capture velocity to collect and transport all the dust produced.

14.8.3.2 Hoods and enclosures shall be designed and maintained so that the fine particles will either fall or be projected into the hoods and enclosures in the direction of airflow.

14.8.3.3* Special attention shall be given to the location of all dust-producing machines with respect to the location of the dust collection system to ensure that the connecting ducts will be as straight and as short as possible.

14.8.3.3.1 The discharge duct for all dust collection equipment shall terminate at a safe outdoor location except where permitted by 14.8.3.5.1.

14.8.3.4 Grinding operations shall not be served by the same dust collection system as buffing and polishing operations.

14.8.3.5* Dry-type dust collectors shall be located outside of buildings.

14.8.3.5.1* Individual machines with portable dust collection capability shall be permitted to be used indoors when the object being processed or finished is incapable of being moved to a properly arranged fixed hood or enclosure, and shall incorporate the safeguards in 14.8.3.5.1.1 through 14.8.3.5.1.4.

14.8.3.5.1.1 The operation of portable dust collection devices shall be subject to a hazards analysis to ensure that the risk to personnel and operations from flash fire and shrapnel is minimized.

14.8.3.5.1.2 Personal protective clothing shall comply with 14.1.3.

14.8.3.5.1.3 The collector shall be designed to dissipate static electricity.

14.8.3.5.1.4 Collector retention capacity shall be limited to 0.45 kg (1 lb).

14.8.3.5.2* Dry-type collectors shall be provided with barriers or other means for protection of personnel.

14.8.3.5.3* The area around the collector shall be posted with a sign that reads as follows:

**CAUTION:**

This dust collector can contain explosible dust. Keep outside the marked area while equipment is operating.
14.8.3.6* Dust collection systems shall be dedicated to the collection of other combustible metals or other combustible metals alloy dust only.

14.8.3.6.1 Grinders, buffers, and associated equipment with dust collectors utilized for processing other combustible metals shall be provided with a placard that reads as follows:

**WARNING:**

[Other Combustible Metals] Only — Fire or Explosion Can Result with Other Metals.

14.8.3.6.2 If the other combustible metals dust collection system is to be used for other materials, the system shall be disassembled and thoroughly cleaned of all incompatible materials prior to and after its use.

14.8.3.7* Bonding and Grounding.

14.8.3.7.1 All components of dust collection systems shall be bonded and grounded.

14.8.3.7.2 When continuous contact is interrupted, metallic jumpers shall be installed for effective bonding.

14.8.3.8 Electrostatic collectors shall not be used.

14.8.3.9* Dust-collecting filter medium shall be designed to be conductive so as to dissipate static electric charges.

14.8.3.10 Dry-dust collection systems shall be designed and maintained so that internal cleanliness is ensured. The accumulation of material inside any area of the collector other than in the discharge containers designed for that purpose shall not be permitted.

14.8.3.11 The accumulation or condensation of water at any point in the dry-dust collection system shall be prevented.

14.8.3.12 Dust shall be removed from dry collectors at least once each day and at more frequent intervals if conditions warrant.

14.8.3.12.1 Extreme care shall be taken in removing dust from the collectors, to avoid creating dust clouds.

14.8.3.12.2 The material shall be discharged into metal containers that shall be promptly and tightly covered to avoid the creation of airborne fugitive dust.

14.8.3.13* Dry Collectors.

14.8.3.13.1 Dry collectors used for other combustible metals dust shall be provided with deflagration vents.

14.8.3.13.2 The selection of the type and location of vents or weak sections of the collector shall be designed to minimize injury to personnel and to minimize blast and fire damage to nearby equipment or structures.

14.8.3.13.3 Material removed from the dry-type dust collector shall be permitted to be recycled into a process or mixed with an inert material in a volume ratio of five parts inert material to one
part metal dust and, once mixed, shall be recycled or disposed of in accordance with local, state, and federal regulations.

14.8.3.14 Where repairs on dry-dust collectors are necessary, the collectors shall be emptied and residual accumulations of dust thoroughly removed (see 14.1.2). Ductwork leading into the collector shall be disconnected and blanked off before repair work is permitted to be started.

14.8.3.15 The interior of hoods and ducts shall be regularly cleaned wherever there is the possibility of buildup of wax, lint, other combustible metals fines, or other combustible material.

14.8.3.16 The dust collector shall be arranged so that contact between dust particles and parts moving at high speeds is prevented. The blower for drawing the dust-laden air into the collector shall be located on the clean air side of the collector.

14.8.3.17 Recycling of exhaust air from dry-dust collectors into buildings shall be prohibited.

14.8.3.18 All electrical wiring and equipment shall conform to the provisions of NFPA 70, *National Electrical Code*.

14.8.3.19 Dust Collection Ducts and Ductwork.

14.8.3.19.1 All dust collection systems shall be installed in accordance with NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids*.

14.8.3.19.2 Ducts shall be designed to maintain a velocity of not less than 1372 m/min (4500 ft/min) to ensure the transport of both coarse and fine particles and to ensure re-entrainment if, for any reason, the particles can fall out before delivery to the collector (for example, in the event of a power failure).

14.8.3.19.3* Ducts shall be designed to handle a volumetric flow rate that maintains dust loading safely below the MEC.

14.8.3.19.4* Ducts shall be as short as possible and shall have as few bends and irregularities as possible, to prevent interference with free airflow.

14.8.3.19.5 Duct Construction.

14.8.3.19.5.1 Ducts shall be constructed of conductive material and shall be carefully fabricated and assembled with smooth interior surfaces and with internal lap joints facing the direction of airflow.

14.8.3.19.5.2 There shall be no unused capped outlets, pockets, or other dead-end spaces that might allow accumulations of dust.

14.8.3.19.5.3 Duct seams shall be oriented in a direction away from personnel.

14.8.3.19.5.4 Additional branch ducts shall not be added to an existing system without redesign of the system.

14.8.3.19.5.5 Branch ducts shall not be disconnected.
14.8.3.19.5.6 Unused portions of the system shall be blanked off without means being provided to maintain required airflow.

14.8.3.19.5.7* Duct systems, dust collectors, and dust-producing machinery shall be bonded and grounded to minimize accumulation of static electric charge.

14.8.3.20 Reserved.

14.8.3.21 Wet-Type Dust Collectors.

14.8.3.21.1* The exhaust vent shall terminate to a safe location outside of the building and shall be securely fastened except as provided in 14.8.3.21.1.1.

14.8.3.21.1.1 The cleaned air shall be permitted to be returned to the work area when tests conducted by an approved testing organization prove that the collector’s efficiency is great enough to provide safety to both personnel and property safety in the particular installation, with regard to particulate matter in the cleaned air and accumulations of particulate matter and hydrogen in the work area.

14.8.3.21.1.2 The duct shall be as short and straight as possible and shall be designed to withstand the same explosion pressure as the wet-type dust collector.

14.8.3.21.2* The exhaust vent shall be inspected and cleaned frequently to prevent buildup of highly combustible deposits of metal dusts on the interior surfaces of the duct.

14.8.3.21.3 Arrangement of Wet-Type Dust Collector Components.

14.8.3.21.3.1 The dust collector shall be arranged so that contact between dust particles and parts moving at high speed is prevented.

14.8.3.21.3.2 The blower for drawing the dust-laden air into the collector shall be located on the clean air side of the collector.

14.8.3.21.3.3* The dust collector shall be arranged so that the dust-laden airstream is thoroughly scrubbed by the liquid to achieve the desired efficiency. The use of additional dry filter medium downstream of a wet collector shall not be permitted.

14.8.3.21.3.4 Collector Sump Venting.

(A)* The sump of water wet-type dust collectors shall be ventilated at all times.

(B) Vents shall remain open and unobstructed when the machine is shut down.

(C) When the dust collector is not in operation, ventilation shall be permitted to be provided by an independent blower or by an unimpeded vent.

14.8.3.21.3.5 Power Supply.

(A) The power supply to the dust-producing equipment shall be interlocked with the airflow from the exhaust blower and the liquid-level controller of the collector so that improper functioning of the dust collection system will shut down the equipment it serves.
A time delay switch or equivalent device shall be provided on the dust-producing equipment to prevent the starting of its motor drive until the collector is in complete operation.

14.8.3.21.3.6* Disposal of Collector Sludge from Water Wet-Type Dust Collectors.

(A)* Sludge from water wet-type dust collectors shall be removed at least once each day or more frequently if conditions warrant.

(B)* Covered, vented metal containers shall be used to transport the collected sludge for disposal.

(C)* Sludge from wet-type dust collectors shall be permitted to be managed prior to disposal in accordance with applicable federal, state, and local regulations.

(D) Material removed from wet-type dust collectors shall be permitted to be mixed with an inert material (e.g., sand or material nonreactive with other combustible metals) in a volume ratio of five parts inert material to one part metal dust.

(E) Sludge shall be recycled or disposed of in accordance with federal, state, and local requirements.

(F)* Smoking or open flames shall be prohibited in the disposal area and throughout the disposal process.

14.8.3.22 Combustible Metal Dry-Type Dust Collectors.

14.8.3.22.1 Dry-type dust collectors handling combustible metal dust shall be located outside of buildings.

14.8.3.22.2 Dry collector discharge containers shall be emptied before or when 100 percent of the storage capacity of the container is attained.

14.8.3.22.3 Outside Dry Media Collectors for Other Metals.

14.8.3.22.3.1* Media collectors shall not be permitted unless the combustible dust $K_p$ is less than 150 bar-m/s and the following ignition prevention measures are all implemented.

(1) The filter media shall be conductive and shall be effectively bonded to the conductive filter frame.

(2) Accumulations on filter media are limited to levels below the thresholds for any oxidative self-heating ignition and any possible ignition due to exothermic reaction with humid air. These thresholds shall be determined as part of the dust collection risk analysis conducted in accordance with 14.2.5.

(3) Accumulation levels during operation shall be monitored by pressure drop across the media or by some equivalent sensor. If the accumulation exceeds the predetermined limits, a controlled shutdown of the collector and dust generation equipment shall be implemented.

(4) Periodic inspections and replacement of media shall be based on intervals determined by the pressure drop across the filter media and by indication of self-heating detection equipment based on moisture reactivity.
14.8.3.22.3.2 Spark detection and either extinguishing methods or methods of diversion away from the collector shall be installed in the duct from any equipment prone to spark generation.

14.8.3.22.3.3 The filter media shall not be chemically reactive with the collected dust, including any contaminants carried in the dust stream with the combustible metal. Any possible reactivity shall be evaluated as part of the documented risk analysis conducted in accordance with 14.2.5.

14.8.3.22.3.4 The collector design shall prevent the accumulation of hydrogen due to a metal-moisture reaction.

14.8.3.22.4 Dry-type dust collectors handling combustible metal dust shall be protected by a minimum of one of the following explosion protection methods:

(1)* Deflagration venting in accordance with NFPA 68, *Standard on Explosion Protection by Deflagration Venting*

(2) Oxidant concentration reduction in accordance with NFPA 69, *Standard on Explosion Prevention Systems*

(a) Where oxygen monitoring is used, it shall be installed in accordance with ISA 84.00.01, *Functional Safety: Application of Safety Instrumented Systems for the Process Industry Sector*.

(b)* Where the chemical properties of the material being conveyed require a minimum concentration of oxygen to control pyrophoricity, that level of concentration shall be maintained.

(3) Deflagration pressure containment in accordance with NFPA 69, *Standard on Explosion Prevention Systems*

(4) Deflagration suppression systems handling dusts with a $P_{\text{max}}$ less than 8 bar and a $K_{\text{St}}$ less than 150 bar-m/s in accordance with NFPA 69, *Standard on Explosion Prevention Systems*, where the suppressant has been shown to be chemically compatible and effective with the material collected

(5)* Dilution with a compatible, noncombustible material to render the mixture noncombustible

(6)* Deflagration venting through a listed dust retention and flame-arresting device

14.8.3.22.4.1 If the method in 14.8.3.22.4(5) is used, test data for specific dust and diluent combinations shall be provided and shall be acceptable to the authority having jurisdiction.

14.8.3.22.5* Explosion isolation protection shall be provided in accordance with NFPA 69, *Standard on Explosion Prevention Systems*, between the dust collector and the upstream process for all dry-type dust collection systems that are handling combustible metal dust.

14.8.3.22.6 Dust shall be removed from dry collectors at least once each day and at more frequent intervals if conditions warrant.
14.8.3.22.6.1 Precautions shall be taken in removing dust from the collectors to avoid creating dust clouds.

14.8.3.22.6.2 The dust shall be discharged into metal containers that shall be promptly and tightly covered to avoid the creation of airborne fugitive dust.

14.8.3.22.6.3 The dust removed shall be recycled or disposed of in accordance with local, state, and federal regulations.

14.8.3.22.7* Dry collectors used for combustible metal dust shall be provided with deflagration vents.

14.8.3.22.8 The selection of the type and location of the collector shall be designed to minimize injury to personnel and to minimize blast and fire damage to nearby equipment or structures.

14.8.3.23 Repairs.

14.8.3.23.1 Where repairs on dry-type dust collectors are necessary, the collectors shall be emptied and residual accumulations of dust thoroughly removed.

14.8.3.23.2 Ductwork leading into the collector shall be disconnected and blanked off before repair work shall be permitted to be started.

14.8.3.23.3 The interior of hoods and ducts shall be regularly cleaned wherever there is the possibility of buildup of wax, lint, metal fines, or other combustible material.

14.8.3.23.4 The dust collector shall be arranged so that contact between dust particles and parts moving at high speeds shall be prevented.

14.8.3.23.5 The blower for drawing the dust-laden air into the collector shall be located on the clean-air side of the collector.

14.8.3.24 Recycling of Exhaust Air. Recycling of air from dry dust collectors into buildings shall be prohibited.

14.9 Storage and Handling.

14.9.1 Storage of Combustible Metal Powder.

14.9.1.1 Buildings used to store metal powder shall be of noncombustible construction.

14.9.1.2 The use of automatic sprinklers in metal powder storage buildings shall be prohibited.

14.9.1.3 Metal powder shall be kept separated from other ordinary combustibles or incompatible materials.

14.9.1.4 Metal powder shall be stored in closed steel drums or other closed noncombustible containers.

14.9.1.5 Metal-powder storage areas shall be kept dry and checked for water leakage.
14.9.1.6* In local areas of a plant where a hazardous quantity of dust accumulates or is present in suspension in the air, the area shall be classified, and all electrical equipment and installations in those local areas shall comply with Article 500 of NFPA 70, National Electrical Code.

14.9.1.7* Where metal powder in drums is stacked for storage, the maximum height shall not exceed 3.7 m (12 ft).

14.9.1.7.1 Storage drums shall be stacked in a manner that ensures stability.

14.9.1.7.2 Under no circumstances shall containers be allowed to topple over.

14.9.1.8* Storage of Other Metal Products.

14.9.1.8.1 Storage in quantities greater than 1.4 m³ (50 ft³) shall be separated from storage of other materials that are either combustible or in combustible containers by aisles with a minimum width equal to the height of the piles of metal products.

14.9.1.8.2 Metal products stored in quantities greater than 28 m³ (989 ft³) shall be separated into piles, each not larger than 28 m³ (989 ft³), with the minimum aisle width equal to the height of the piles but not less than 3.1 m (10 ft).

14.9.1.8.3* The storage area shall be protected by automatic sprinklers in any of the following situations:

1. Where storage in quantities greater than 28 m³ (989 ft³) is contained in a building of combustible construction
2. Where metal products are packed in combustible crates or cartons
3. Where other combustible storage is within 9 m (30 ft) of the metal

14.9.2 Scrap Handling, Storage, and Disposal.

14.9.2.1 Storage of Combustible Scrap Metal.

14.9.2.1.1 Paragraph 14.9.2.1 shall apply to the storage of scrap metal in the form of solids, chips, turnings, swarf, or other fine particles.

14.9.2.1.2 Buildings used for the indoor storage of metal scrap shall be of noncombustible construction.

14.9.2.1.3 Scraps shall be kept well separated from other combustible materials.

14.9.2.1.3.1 Scraps shall be kept in covered steel or other noncombustible containers and shall be kept in such manner or locations that they will not become wet.

14.9.2.1.3.2 Outside storage of metal fines shall be permitted if such storage is separated from buildings or personnel and precautions are exercised to prevent the fines from becoming wet.

14.9.2.1.4 Wet metal scrap (chips, fines, swarf, or sludge) shall be kept under water in a covered and vented steel container at an outside location.

14.9.2.1.4.1 Sources of ignition shall be kept away from the container vent and top.
14.9.2.1.4.2 Containers shall not be stacked.

14.9.2.1.5 Storage of dry scrap in quantities greater than 1.4 m³ (50 ft³) [six 208 L drums (six 55 gal drums)] shall be kept separate from other occupancies by fire-resistive construction or by an open space of at least 15 m (50 ft).

14.9.2.1.6 Buildings used for storage of dry scrap shall be well ventilated to avoid the accumulation of hydrogen in the event that the scrap becomes wet.

14.9.2.1.7 Solid metal scrap, such as clippings and castings, shall be stored in noncombustible bins or containers.

14.9.2.1.8 The storage of oily rags, packing materials, and similar combustibles shall be prohibited in storage bins or areas that store solid metal scrap.

14.9.2.1.9 The use of automatic sprinklers in metal-scrap storage buildings or areas shall be prohibited.

14.9.3 Recycling. (Reserved)

14.9.4 Chip Processing. (Reserved)

14.10 Fire and Explosion Prevention.

14.10.1 Fire and explosion prevention shall be in accordance with Chapter 15.

14.10.2 Housekeeping.

14.10.2.1 Dust Control. Dust control shall be in accordance with Chapter 15.

14.10.2.1.1* Fugitive dust shall not be allowed to accumulate.

14.10.2.1.2 Periodic cleanup of fugitive dusts shall be accomplished by using conductive, nonsparking scoops and soft brooms or brushes that have natural fiber bristles.

14.10.2.1.2.1 Preliminary cleanup of the powder shall be accomplished by using conductive, nonsparking scoops and soft brooms, as well as brushes that have natural fiber bristles.

14.10.2.1.2.2 Vacuum cleaning systems shall be used only for removal of dust accumulations too small, too dispersed, or too inaccessible to be thoroughly removed by hand brushing.

14.10.2.1.2.3* Vacuum cleaning systems shall be effectively bonded and grounded to minimize the accumulation of static electric charge.

14.10.2.1.3 Because of the inherent hazards associated with the use of fixed and portable vacuum cleaning systems for finely divided combustible metal dust, special engineering analysis shall be given to the design, installation, maintenance, and use of such systems.

14.10.2.1.4* Portable vacuum cleaners shall be used only if listed or approved for use with combustible metal dust.

14.10.2.1.5 Vacuum cleaner hose, nozzles, and fittings shall be made of conductive nonsparking material.
14.10.2.1.5.1 Assembled components shall be conductive and bonded where necessary.

14.10.2.1.5.2 Periodic tests for continuity shall be performed.

14.10.2.1.6 Combustible metal dust picked up by a fixed vacuum cleaning system shall be discharged into a container or collector located outside the building.

14.10.2.1.7 Compressed-Air Cleaning Requirements. Compressed-air blowdown shall not be permitted, unless the conditions of 14.10.2.1.7.1 are met.

14.10.2.1.7.1 In certain areas that are otherwise impossible to clean, compressed-air blowdown shall be permitted under controlled conditions with all potential ignition sources prohibited in or near the area and with all equipment shut down.

14.10.2.1.8 Water-Cleaning Requirements. The use of water for cleaning shall not be permitted in manufacturing areas unless the following requirements are met:

1. Competent technical personnel have determined that the use of water will be the safest method of cleaning in the shortest exposure time.

2. Operating management has full knowledge of, and has granted approval of, its use.

3. Ventilation, either natural or forced, is available to maintain the hydrogen concentration safely below the LFL.

4. Complete drainage of all water and powder to a remote area is available.

14.10.2.1.9 Cleaning Frequency.

14.10.2.1.9.1 The accumulation of excessive dust on any portions of buildings or machinery not regularly cleaned in daily operations shall be minimized.

14.10.2.1.9.2 Regular, periodic cleaning of buildings and machinery, with all machinery idle and powered off, shall be carried out as frequently as conditions warrant.

14.10.2.1.9.3 Supplies of production materials in processing areas shall be limited to the amounts necessary for normal operation.

14.10.2.1.9.4 Ordinary combustible materials, such as paper, wood, cartons, and packing material, shall not be stored or allowed to accumulate in combustible metals–processing areas unless necessary for the process and then only in designated areas.

14.10.2.1.9.5 Regular, periodic cleaning of fugitive metal dust from buildings and machinery shall be carried out as frequently as conditions warrant.

14.10.2.1.9.6 Fugitive metal dust shall be removed to a designated storage or disposal area.

14.10.2.1.10 Inspections.

14.10.2.1.10.1 Regular inspections shall be conducted to detect the accumulation of excessive fugitive metal dust on any portions of buildings or machinery not regularly cleaned in daily operations.
14.10.2.10.2 Records shall be kept of the inspections specified in 14.10.2.1.10.1.

14.10.2.1.11 Ordinary combustible materials shall not be discarded in containers used for the collection of combustible metal dust or scrap.

14.10.2.1.12 Designated containers shall be used for the collection of fugitive metal dust.

14.10.2.1.13 Combustible or flammable liquid accidental spills shall be cleaned up promptly.

14.10.2.2 Cleanup of Spilled Metal Powder. Spills shall be removed at once, using conductive scoops and soft bristle brushes that have natural fiber bristles. Scoops shall be nonsparking unless otherwise authorized for the specific application.

14.10.3 Control of Ignition Sources. (Reserved)

14.10.4 Hot Work Operations. Hot work operations shall be in accordance with Chapter 15.

14.10.5 Control of Combustible Materials. (Reserved)

14.10.6 Inspection, Maintenance, and Training.

14.10.6.1 Electrical Equipment Maintenance.

14.10.6.1.1 Preventive maintenance for electrical equipment shall be established commensurate with the environment and conditions.

14.10.6.1.2 Electrical equipment shall be inspected and cleaned at least once each year or more frequently if conditions warrant it.

14.10.6.2* Emergency Procedures. Emergency procedures shall be in accordance with Chapter 15.

14.10.6.2.1 Emergency procedures to be followed in case of fire or explosion shall be established.

14.10.6.2.2 All employees shall be trained in the emergency procedures.

14.11 Other. (Reserved)
14.0 Compliance with NFPA 654 shall be considered fully equivalent to compliance with NFPA 484 for production, processing, handling, conveying and storage of combustible dust mixtures containing metals when all of the following criteria are met:

14.0.1 The dust KSt is less than or equal to 150 bar-m/s and
14.0.2 The dust Pmax is less than or equal to 8 bar-g and
14.0.3 The minimum ignition energy (MIE) is greater than 100 mJ
14.0.4 The material is not a 4.2 solid as tested using UN 4.2 self heating test methods.
14.0.5 The material is not a 4.3 solid as tested using UN 4.3 water reactivity test methods
14.0.6* The dust does not present special hazards such as excessive reactivity or binary compatibility in the process.

Substantiation: NFPA 484 predominantly applies to highly reactive, severely exploable, or fast burning metals. As a result, it is the most conservative among the occupancy dust standards. Through its scope statement, NFPA 484 also applies to marginally exploable dusts such as steel shot or sandpaper debris from polishing operations. NFPA 654 is better suited for dusts in the latter category. This revision will also alleviate some of the difficulties users will experience with the blank (reserved) sections of the new chapter 14.

Substantiation: Other Metals Flow Diagram

An other metals chapter flow diagram assists the user in navigating to various sections in the chapter and other chapters in the document.

Substantiation: Housekeeping shall be in accordance with 15.2.2 Chapter X.

Substantiation: Housekeeping is such a critical safety component of combustible metals safety that it should be a separate chapter.
Do you meet the general essential requirements? 

Yes

Is this a new process? 

Yes

Hazard analysis requirements see section 14.2.5

No

Does your facility meet design requirements? 

I don't know

See section 14.2

Yes

Do you perform primary processing? 

Yes

See section 14.3

Melting and casting-See section 14.3.2

Powder production-See sections 14.4 & 14.5

Processing-See section 14.6

No

Are you machining, fabricating or finishing product? 

Yes

See section 14.7

No

Are you performing hot work, machining, sawing or generating dust? 

Yes

See section 14.8

No

Are you storing combustible metals? 

Yes

See section 14.9

No

Are you sending materials to recycling or waste treatment? 

Yes

Go to Chapter 16

No

Are your fire and explosion prevention measures in place? 

Yes

See section 14.10

No
14.1.3.4.2 If deluge showers are installed, they shall be located such that water from the shower cannot enter dry metal powder–processing and –handling areas where the metals are not compatible with water.

Some metals covered by this chapter are compatible with water. For instance water is listed as an acceptable extinguishing agent for iron.

14.1.4.1.1* Caution shall be exercised in the mixing of reduced fines or molten material with metal oxides [e.g. iron oxide (rust)] that exothermically react with the reduced metal.

The reference to iron oxide is too specific. Some metals potentially covered by this chapter do not exothermically react with iron oxide and most metals covered by this chapter can exothermically react with other metal oxides besides iron oxide. For instance iron won't exothermically react iron oxide.

14.2.1.6 Roof decks and basements shall be watertight where molten metal or metals that are not compatible with water are being processed.

Not all metals covered by this chapter are incompatible with water.
14.2.4.1 Indoor Dry Collectors for Other Metals.

14.2.4.1.1 Dry dust collectors shall be permitted to be located indoors where the material being collected meets all of the following criteria:

1. The Pmax is less than 8 bar-g as measured using the ASTM E1226 test method
2. The KSt is less than 150 bar-m/s as measured using the ASTM E1226 test method
3. The minimum ignition energy (MIE) is greater than 100 mJ as measured using the ASTM E2019
4. The material is not a 4.2 solid as tested using UN 4.2 self-heating test methods.
5. The material is not a 4.3 solid as tested using UN 4.3 water reactivity test methods.

14.2.4.1.1.1 Media collectors shall not be permitted unless all of the following ignition prevention measures are implemented.

1. Where the MIE of the dust is less than 1000 mJ, the filter media shall be conductive and shall be effectively bonded to the conductive filter frame.
2. Accumulations on filter media are limited to levels below the thresholds for any oxidative self-heating ignition and any possible ignition due to exothermic reaction with humid air. These thresholds shall be determined as part of the dust collection risk analysis conducted in accordance with 14.2.5.
3. Accumulation levels during operation shall be monitored by pressure drop across the media or by some equivalent sensor and, if the accumulation exceeds the predetermined limits, a controlled shutdown of the collector and dust generation equipment shall be implemented.
4. Periodic inspections and replacement of media shall be based on intervals determined by the pressure drop across the filter media or by indication of self-heating detection equipment based on moisture reactivity.

14.2.4.1.1.2 Spark detection and either extinguishing methods or methods of diversion away from the collector shall be installed in the duct from any equipment prone to spark generation.

14.2.4.1.1.3 The filter media shall not be chemically reactive with the collected dust, including any contaminants carried in the dust stream with the combustible metal. Any possible reactivity shall be evaluated as part of the documented risk analysis conducted in accordance with 14.2.5.

14.2.4.1.1.4 The collector design shall prevent the accumulation of hydrogen due to a metal-moisture reaction.

14.2.4.1.2 Indoor dry-type dust collectors handling combustible metal dust shall be protected by a minimum of one of the following explosion protection methods:

1. Deflagration venting ducted to a safe location outside of the building in accordance with NFPA 68, Standard on Explosion Protection by Deflagration Venting
2. Oxidant concentration reduction in accordance with NFPA 69, Standard on Explosion Prevention Systems
(a) Where oxygen monitoring is used, it shall be installed in accordance with ISA 84.00.01, Functional Safety: Application of Safety Instrumented Systems for the Process Industry Sector.

(b)*Where the chemical properties of the material being conveyed require a minimum concentration of oxygen to control pyrophoricity, that level of concentration shall be maintained.

(3) Deflagration pressure containment in accordance with NFPA 69, Standard on Explosion Prevention Systems

(4) Deflagration suppression systems in accordance with NFPA 69, Standard on Explosion Prevention Systems, where the suppressant has been shown to be chemically compatible and effective with the material collected

(5)*Dilution with a compatible, noncombustible material to render the mixture noncombustible

(6)*Deflagration venting through a listed dust retention and flame-arresting device

[A.14.2.4.1.2 (2)(b) The maximum allowable concentration of oxygen is very dependent on the material, its chemical composition, and, in the case of particulate solids, the particle sizes. In addition, with many combustible metals, it is not advisable to completely eliminate oxygen from the transport gas. During transport, particles can be abraded and broken, exposing unoxidized metal (virgin metal) to the transport gas. When that metal is finally exposed to oxygen-containing air, the rapid oxidation of the virgin metal could produce sufficient heat to ignite the material. It is, therefore, preferable to provide for a low concentration of oxygen in the transport gas stream to ensure the oxidation of virgin metal as it is exposed during the course of transport.]

[A.14.2.4.1.2 (5) This method is limited in effectiveness due to the high concentrations of inert material required and the potential for separation during handling.]

[A.14.2.4.1.2 (6) For information on dust retention and flame-arresting devices, see NFPA 68, Standard on Explosion Protection by Deflagration Venting, Section 9.7.]

14.2.4.1.2.1 If the method in 14.2.4.1.2 (5) is used, test data for specific dust and diluent combinations shall be provided and shall be acceptable to the authority having jurisdiction.

14.2.4.1.3* Explosion isolation protection shall be provided in accordance with NFPA 69, Standard on Explosion Prevention Systems, between the dust collector and the upstream process for all dry-type dust collection systems that are handling combustible metal dust.

**Substantiation:** There are some facilities where it is not feasible to locate dust collectors outside of buildings. Examples include existing facilities where equipment requiring dust collection is located near the center of a building and there are overhead cranes, making it difficult if not impossible to route ducts to the exterior of the building; facilities where dust collectors cannot be located outside of buildings due to zoning laws; and facilities where there is not sufficient land to locate dust collectors outside of buildings. Dust collectors are allowed inside of buildings in other occupancies covered by other NFPA dust standards, including facilities handling dust that may be a greater fire and explosion hazard than some of the metal dusts covered by this chapter. This proposal would allow dust collectors to be located inside of buildings using protection methods that are more stringent than those required by other NFPA dust standards. This is being limited to metal dusts that meet certain criteria related to the adiabatic flame temperature, maximum overpressure, maximum rate of pressure rise, water reactivity, self heating tendency, and ease of ignition by an electric spark.
484- Log #74  CMD-CMM
(14.2.4.x (New) )

**Final Action:**

**Submitter:** Timothy J. Myers, Exponent, Inc.

**Recommendation:** Consolidate all requirements related to dust collection in Chapter 14 to this one location.

**Substantiation:** Currently requirements for dust collection systems appear in many different sections of Chap. 14 and are not consistent.

---

484- Log #79  CMD-CMM
(14.2.4.1 and 14.2.4.2 (New) )

**Final Action:**

**Submitter:** Mark W. Drake, Liberty Mutual Commercial Markets

**Recommendation:** Add new text to read:

14.2.4.1 Dust collection for powder production operations shall follow the requirements of 14.4.1.

14.2.4.2 Dust collection for machining, fabricating, and finishing operations shall follow the requirements of 14.7.3.

**Substantiation:** Dust collection is currently covered in two sections of the chapter, which were not specified in this section.

---

484- Log #8  CMD-CMM
(14.3.2.9)

**Final Action:**

**Submitter:** Timothy J. Myers, Exponent, Inc.

**Recommendation:** Revise to read:

14.3.2.9 Areas of furnaces that can come into contact with molten metal in the event of a runout shall be kept dry and free of iron oxide metal oxides that exothermically react with the molten metal.

**Substantiation:** The reference to iron oxide is too specific. Some metals potentially covered by this chapter do not exothermically react with iron oxide and most metals covered by this chapter can exothermically react with other metal oxides besides iron oxide. For instance iron won't exothermically react iron oxide.

---

484- Log #9  CMD-CMM
(14.3.2.10)

**Final Action:**

**Submitter:** Timothy J. Myers, Exponent, Inc.

**Recommendation:** Revise to read:

14.3.2.10 Crucible interiors and covers shall be maintained free of iron oxide scale metal oxide scales that exothermically react with the molten metal, which could fall into the molten metal.

**Substantiation:** The reference to iron oxide is too specific. Some metals potentially covered by this chapter do not exothermically react with iron oxide and most metals covered by this chapter can exothermically react with other metal oxides besides iron oxide. For instance iron won't exothermically react iron oxide.
14.3.2.12.2 Pots and crucibles that show evidence of possible failure or that allow molten metal to contact iron oxide metal oxides that exothermically react with the molten metal, concrete, or other incompatible materials shall be repaired or discarded.

**Substantiation:** The reference to iron oxide is too specific. Some metals potentially covered by this chapter do not exothermically react with iron oxide and most metals covered by this chapter can exothermically react with other metal oxides besides iron oxide. For instance iron won’t exothermically react iron oxide.

**NOTE:** This proposal appeared as Comment 484-49 (Log #45) which was held from the A11 ROC on Proposal 484-20.

**Submitter:** Peter Levitt, Sternvent Co., Inc.

**Recommendation:** Revise text to read as follows:

Dry type dust collectors shall be located outdoors. The preferred location for dry type dust collectors is outdoors. When dry dust collectors are located indoors,...

**Substantiation:** The existing requirement is overly burdensome and typically ignored for small (1500 cfm) steel abrasive operations, such as surface grinders. The requirements of this chapter seem similar to the requirements for aluminum. There needs to be some discussion about new Chapter 14.

14.6.1.8 Startup Operations. All areas of processing machinery that will be in contact with metal powder shall be free of incompatible foreign material and water before, where the metal powder is not compatible with water, before being placed into operation.

**Substantiation:** Clarifying foreign material as incompatible materials, and clarifying that restrictions on water only apply where the metal is not compatible with water.

14.8.3.11 The accumulation or condensation of water at any point in the dry-dust collection system shall be prevented where the metal dust is not compatible with water.

**Substantiation:** Not all metals covered by this chapter are incompatible with water.
484- Log #94  CMD-CMM  
(14.8.3.22.1)  

Submitter: Robert G. Zalosh, Firexplo  
Recommendation: Revise to read:  
14.8.3.22.1 Dry-type dust collectors handling combustible metal dust shall, other than iron or steel dust, shall be located outside of buildings.  
Substantiation: Iron and steel dust do not produce hydrogen when wet, even when burning, so there is no worry about hydrogen accumulation in the building, as there is with other combustible metals.  

484- Log #20  CMD-CMM  
(14.9.1.5)  

Submitter: Timothy J. Myers, Exponent, Inc.  
Recommendation: Revise to read:  
14.9.1.5 Metal-powder storage areas shall be kept dry and checked for water leakage where the metal powder is not compatible with water.  
Substantiation: Not all metals covered by this chapter are incompatible with water.
Delete the following text:

Dust control shall be in accordance with Chapter 15.
Fugitive dust shall not be allowed to accumulate.
Periodic cleanup of fugitive dusts shall be accomplished by using conductive, nonsparking scoops and soft brooms or brushes that have natural fiber bristles.
Preliminary cleanup of the powder shall be accomplished by using conductive, nonsparking scoops and soft brooms, as well as brushes that have natural fiber bristles.
Vacuum cleaning systems shall be used only for removal of dust accumulations too small, too dispersed, or too inaccessible to be thoroughly removed by hand brushing.
Vacuum cleaning systems shall be effectively bonded and grounded to minimize the accumulation of static electric charge.
Because of the inherent hazards associated with the use of fixed and portable vacuum cleaning systems for finely divided combustible metal dust, special engineering analysis shall be given to the design, installation, maintenance, and use of such systems.
Portable vacuum cleaners shall be used only if listed or approved for use with combustible metal dust.
Vacuum cleaner hose, nozzles, and fittings shall be made of conductive nonsparking material.
Assembled components shall be conductive and bonded where necessary.
Periodic tests for continuity shall be performed.
Combustible metal dust picked up by a fixed vacuum cleaning system shall be discharged into a container or collector located outside the building.
Compressed-air blowdown shall not be permitted, unless the conditions of 14.10.2.1.7.1 are met.
In certain areas that are otherwise impossible to clean, compressed-air blowdown shall be permitted under controlled conditions with all potential ignition sources prohibited in or near the area and with all equipment shut down.
The use of water for cleaning shall not be permitted in manufacturing areas unless the following requirements are met:

1. Competent technical personnel have determined that the use of water will be the safest method of cleaning in the shortest exposure time.
2. Operating management has full knowledge of, and has granted approval of, its use.
3. Ventilation, either natural or forced, is available to maintain the hydrogen concentration safely below the LFL.
4. Complete drainage of all water and powder to a remote area is available.

The accumulation of excessive dust on any portions of buildings or machinery not regularly cleaned in daily operations shall be minimized.
Regular, periodic cleaning of buildings and machinery, with all machinery idle and powered off, shall be carried out as frequently as conditions warrant.
Supplies of production materials in processing areas shall be limited to the amounts necessary for normal operation.
Ordinary combustible materials, such as paper, wood, cartons, and packing material, shall not be stored or allowed to accumulate in combustible metals-processing areas unless necessary for the process and then only in designated areas.
Regular, periodic cleaning of fugitive metal dust from buildings and machinery shall be carried out as frequently as conditions warrant.
Fugitive metal dust shall be removed to a designated storage or disposal area.
Regular inspections shall be conducted to detect the accumulation of excessive fugitive metal dust on any portions of buildings or machinery not regularly cleaned in daily operations.
Records shall be kept of the inspections specified in 14.10.2.1.10.1.
Ordinary combustible materials shall not be discarded in containers used for the collection of combustible...
Designated containers shall be used for the collection of fugitive metal dust.

Combustible or flammable liquid accidental spills shall be cleaned up promptly.

Spills shall be removed at once, using conductive scoops and soft bristle brushes that have natural fiber bristles. Scoops shall be nonsparking unless otherwise authorized for the specific application.

Substantiation: Housekeeping is such a critical safety component of combustible metals safety that it should be a separate chapter.

---

**Recommendation:** Revise to read:

14.10.2.1.8 Water-Cleaning Requirements. The use of water for cleaning shall not be permitted in manufacturing areas containing metal that is not compatible with water, unless the following requirements are met:

Substantiation: Not all metals covered by this chapter are incompatible with water.

---

**Recommendation:** Delete the following text:

Fugitive metal dust shall not be allowed to accumulate to a level that creates a potential secondary explosion or flashfire hazard.

Housekeeping shall be in accordance with 15.2.2.

The housekeeping frequency shall be established to ensure that the accumulated dust levels on walls, floors, and horizontal surfaces, such as equipment, ducts, pipes, conduits, hoods, ledges, beams, roof members, and above-suspended ceilings and other concealed areas, such as the interior of electrical enclosures, does not exceed the threshold accumulation.

Procedures for unscheduled housekeeping of unplanned or accidental spillage of combustible metal dusts in operating areas shall be established as part of a documented housekeeping plan.

Substantiation: Housekeeping is such a critical safety component of combustible metals safety that it should be a separate chapter.

---

**Recommendation:** Add new text to read:

(9) Piping systems which carry and/or transport combustible/flammable gases, liquids, and or hazardous chemicals, or materials that may interact and present hazard should a release occur, (i.e. water lines in the vicinity of molten metal).

Substantiation: In one of the incidents involving the Hoagenaes facility, the Chemical Safety Board identified a leak in flammable gas piping as a contributing cause.
A documented housekeeping program shall be established.

Fugitive metal dust shall not be allowed to accumulate to a level that creates a potential secondary explosion or flash-fire hazard.

Systematic cleaning of areas containing dust-producing equipment, including roof members, pipes, conduits, and other components shall be conducted as frequently as conditions warrant.

The cleaning shall include machinery.

Cleaning methods shall be limited to those methods that minimize the probability of fire or explosion, as determined by a person knowledgeable in the properties of combustible metal dusts.

Chips or powder sweepings shall be removed to a designated storage or disposal area.

Special attention shall be paid to areas utilizing powder for accumulations in crevices and joints between walls, ceilings, and floors.

The housekeeping frequency shall be established to ensure that the accumulated dust levels on walls, floors, and horizontal surfaces, such as equipment, ducts, pipes, conduits, hoods, ledges, beams, roof members, and above suspended ceilings and other concealed areas, such as the interior of electrical enclosures, does not exceed the threshold accumulation.

Procedures for unscheduled housekeeping of unplanned or accidental spillage of combustible metal dusts in operating areas shall be established as a part of a housekeeping plan.

Bulk Accumulations:

Splits shall be removed at once, using conductive scoops and soft bristle brushes that have natural fiber bristles. Scoops shall be nonsparking unless otherwise authorized for the specific application.

Vacuum Cleaning:

Vacuum cleaning systems shall be used only for removal of dust accumulations too small, too dispersed, or too inaccessible to be thoroughly removed by hand brushing.

Vacuum cleaning systems shall be effectively bonded and grounded to minimize the accumulation of static electric charge.

Because of the inherent hazards associated with the use of vacuum cleaning systems and portable vacuum systems for finely divided combustible metal dusts, special engineering analysis shall be given to the design, installation, maintenance, and use of such systems.

Portable vacuum cleaners shall be used only if rated or approved for use with combustible metals dust:

(A) They shall be permitted only for small amounts of residual material remaining after preliminary cleanup.

(B) They shall be emptied at the end of each operational period or shift.

(C) They shall not be used as primary dust collectors.

Vacuum cleaner hose, nozzles, and fittings shall be made of conductive nonsparking material.

Assembled components shall be conductive and bonded where necessary.

Periodic test for continuity shall be performed.

Combustible metal dust picked up by a fixed vacuum cleaning system shall be discharged into a container or collector location outside the building.

Compressed-air blowdown shall not be permitted, unless the conditions of 15.2.4.3.2 are met.

In certain areas that are otherwise impossible to clean, compressed-air blowdown shall be permitted under controlled conditions with all potential ignition sources prohibited in or near the area and with all equipment shutdown.

To prevent potential explosions caused by the inadvertent use of high-pressure compressed air in place of low-pressure inert gas, fittings used on outlets of compressed air and inert gas lines shall not be interchangeable.

Water Cleaning Requirements:

Water cleaning shall not be permitted in areas that have exposed alkali materials.

The use of water for cleaning shall not be permitted in manufacturing areas unless the following:
requirements are met:

(1) Competent technical personnel have determined that the use of water will be the safest method of cleaning in the shortest exposure time:

(2) Operating management has full knowledge of, and has granted approval of, its use:

(3) Ventilation, either natural or forced, is available to maintain the hydrogen concentration safely below the LFL:

(4) Complete drainage of all water and powder to a safe, remote area is available:

15.2.2.4.5 Supplies of production materials in processing areas shall be limited to the amounts necessary for normal operations:

15.2.2.4.6 Ordinary combustible materials, such as paper, wood, cartons, and packing material, shall not be stored or allowed to accumulate in combustible metals processing areas unless necessary for the process and then only in designated areas:

15.2.2.4.7 Regular, periodic cleaning of fugitive combustible metal dust from buildings and machinery shall be carried out as frequently as conditions warrant:

15.2.2.4.8 Fugitive combustible metal dusts shall be removed to a designated storage or disposal area:

15.2.2.4.9 Oil spills shall be cleaned up promptly:

15.2.2.4.10 Supplies shall be stored in an orderly manner in designated areas to allow routine inspection and segregation of incompatible materials:

15.2.2.4.11 Except for alkali metals, floor sweepings from combustible metal dust operations shall be permitted to contain small amounts of ordinary combustible materials:

15.2.2.4.12 Potential ignition sources associated with the operation of equipment during the cleaning operation shall be reviewed, and appropriate actions to isolate, eliminate, or minimize the potential hazards shall be taken:

15.2.2.4.13 The review of the hazards associated with cleaning operations shall include isolation, minimization, and elimination of the hazards:

15.2.2.5 Cleaning Frequency:

15.2.2.5.1 The accumulation of excessive dust on any portions of buildings or machinery not regularly cleaned in daily operations shall be minimized:

15.2.2.5.2 Regular, periodic cleaning of buildings and machinery, with all machinery idle and powered off, shall be carried out as frequently as conditions warrant:

15.2.2.5.3 Regular, periodic cleaning of fugitive dust from buildings and machinery shall be carried out as frequently as conditions warrant:

15.2.2.5.4 Fugitive metal dust shall be removed to a designated storage or disposal area:

15.2.2.6 Housekeeping Inspections. Corrective actions shall be tracked for identified issues from the housekeeping program to ensure completion:

Substantiation: Housekeeping is such a critical safety component of combustible metals safety that it should be a separate chapter.
15.2.4 Static Control of Static Electricity. All permanently installed process equipment and all building structural steel shall be grounded by permanent ground wires to prevent accumulation of static electricity.

15.2.3.4 Movable or mobile process equipment or tools of metal construction shall be bonded and/or grounded prior to use.

15.2.3.5 Static-conductive belts shall be used on belt-driven equipment.

15.2.3.6 All machinery where nonconductive components present a discontinuity in the grounding path shall be bonded between adjacent conductive components.

15.2.3.7 The wire between two bonding clips shall be verified as conductive.

15.2.3.8 Grounded and bonded bearings shall be used.

15.2.5 Friction Control of Friction Hazards. All machinery shall be installed and maintained in such a manner that the possibility of friction sparks is minimized.

15.2.6 Bearings.

15.2.6.1 Ball or roller bearings shall be sealed against dust.

15.2.6.2 Where exposed bearings are used, the bearings shall be protected to prevent ingress of combustible metal dust and shall have a lubrication program.

15.2.6.3 Clearances between moving surfaces that are exposed to paste, powder, or dust shall be maintained to prevent rubbing or jamming.

15.2.6.4 Localized frictional heating of bearings in any machine shall be minimized.

Substantiation: The current organization of the document repeats elements of ignition control in multiple places throughout the various metal chapters. This change combines the current ignition sources into a single section of Chapter 15 and makes it possible to have a single directing statement in each metal chapter. A linked global input will list the various ignition control statements that can be deleted as a result.

15.3.1.1 Automatic sprinkler protection shall not be permitted in areas where combustible metals are produced or handled unless allowed by 15.3.1.2, 15.3.1.3, and 15.3.1.4.

Substantiation: Iron and steel are compatible with water as an extinguishing agent as indicated in Table A.15.3.3 and in several incidents in which steel dust fires have been successfully extinguished by automatic sprinkler systems.

15.3.1.2 Sprinkler systems installed in accordance with NFPA 13, Standard for the Installation of Sprinkler Systems, shall be permitted in areas where combustibles other than combustible metals in molten form or metals that are not compatible with water and are in a state that could cause an immediate explosive reaction with water create a more severe hazard, as determined by a hazards analysis, than the metals and where acceptable to an authority having jurisdiction knowledgeable of the hazards associated with metal powder combustible metals.

Substantiation: Not all metals covered by this chapter are incompatible with water.
15.3.3.5 The following agents shall not be used as extinguishing agents on a combustible-metal fires because of adverse reactions or ineffectiveness unless they are compatible with the metal and are an effective extinguishing agent:

(5)* Nitrogen (except on iron, steel, and alkali metals, excluding lithium)

(6) Halon replacement agents

Substantiation: Some of the metals covered by this chapter are compatible with water, and water is listed as an acceptable extinguishing agent.

(9) Most fires involving combustible metals cannot be extinguished in a manner other than by providing an inert atmosphere of argon or helium (and also nitrogen for alkali metals or iron) if the product is dry. In most cases, the fire is controlled by application of argon or helium (or nitrogen for alkali metals or iron) or by the development of an oxide crust. The temperature of the material involved can remain extremely hot, and the fire can flare up again if the product is disturbed prior to complete oxidation of the product or self-extinguishment.

(10) Water in contact with molten combustible metals will result in violent steam explosions and can cause hydrogen explosions and reactions with some metals.

(11) Large fires might be impossible to extinguish. The best approach is to isolate the material as much as possible, if it can be done safely. Exposures shall be permitted to be protected with water streams if adequate drainage is present to prevent the contact of water with burning material that is not compatible with water. The fire shall be permitted to be allowed to burn itself out naturally to minimize hazards to personnel and losses to exposures.

Substantiation: Not all metals covered by this chapter are incompatible with water and in Table A.15.3.3 of this standard water and nitrogen are listed as acceptable extinguishment agents for some metals (iron and steel) covered by this chapter.

(1) Water, when applied to most burning combustible metals, results in an increase in burning intensity and possible explosion, particularly if alkali metals are present.

(2) Application of carbon dioxide on combustible-metal fire has results similar to the application of water; the carbon dioxide adds to the intensity of the burning. Most combustible metals ignite and burn in 100 percent carbon dioxide atmospheres.

(6) When water is applied to non-alkali combustible metal, it dissociates to the basic compounds, oxygen and hydrogen. Similar results occur with carbon dioxide.

(20) Combustible metal fines and dusts that are reduced and that come into contact with iron oxides can result in thermite reactions.

Substantiation: Some of the language in this section was too general. Some metals that are potentially covered by this standard do not have a significant exothermic reaction with water. For instance, water is listed as an acceptable extinguishing agent for iron in this standard. Some of the language was too specific. For instance metals covered by this chapter can exothermically react with more oxides than just iron oxide.
Flash fire resistant garments are significantly more effective than ordinary clothing in preventing burn injury upon exposure to low-to-moderate heat fluxes, but cannot prevent burn injuries to personnel immersed in combustible metal flash fires. See Chemical Safety Board Case Study report on Hoaganaes iron dust flash fires.

Submitter: Robert G. Zalosh, Firexplo
Recommendation: None given.
Substantiation: The previous text had limited applicability and gaps with recycle operations. The technical committee discussed the need for this revision at the March 20-21st meeting in Dallas, TX. This version is a thorough review of the current chapter, as well as other metal chapters to include requirements not currently included.

Submitter: Brad D. Burridge, Novelis, Inc.
Recommendation: Replace Chapter 16 with the following:

***Insert Include Here***

Substantiation: Waste treatment facilities are receiving combustible metal waste. There is little guidance for waste generators and waste treatment facilities. Chapter 16 was expanded to include waste treatment facilities.

Submitter: Elizabeth C. Buc, Fire & Materials Research Laboratory, LLC
Recommendation: Revise to read:
16.1 General Provisions

16.1.1 Retroactivity. The requirements of this chapter shall apply to new and existing facilities recycling metals that have the potential to become or contain combustible dust.

16.1.1.1 Metal recycling facilities vary in scope and scale and combustible dust hazards vary due to differing process steps. The provisions of 484 shall apply only to areas where hazards exist. Each site must develop and determine the hazardous areas within the facility. Once the determination has been made that a combustible hazard is present, and the appropriate area for the hazard has been identified, this chapter shall be applied to limit risk. Aluminum recycling facilities handle and process aluminum in many forms, the vast majority of which are not reactive. A combustible dust hazard should be identified by testing prior to application of any of the provisions of this chapter.

16.1.2. For the purpose of this chapter, combustible metals are defined as follows: By-Product Combustible Metal - finely divided combustible material resulting from the handling, processing, or storage of purchased non-combustible scrap intended for recycling and Recycled combustible metal - finely divided combustible scrap metal purchased for the intention of recycling.

16.1.2.1. By-Product Combustible Metal - Collection, Storage, and Handling of fines generated during scrap receiving, storage, recycling.

16.1.2.1.1 Receiving Criteria. Acceptance criteria for recycled metals that can potentially produce combustible dust as a by-product of normal handling shall include provisions for the handling of any possible resulting dusts.

16.1.2.2 Recycled Combustible Metal - Collection, Storage, and Handling of fines generated during scrap receiving, storage, recycling.

16.1.2.2.1 Receiving Criteria. Incoming combustible material shall be inspected for acceptance criteria.

16.1.2.2.1.1 Acceptance criteria for recycled combustible metals being recycled shall be established by the recycler.

16.1.2.2.1.1.1 The acceptance criteria for recycled combustible metals shall include the following as a minimum:
(1) Acceptable packaging
(2) Forms
(3) Identification/manifest (DOT shipping papers)
(4) Required protection against foreign material
(5) Identification and segregation of any radiation/contamination of materials
(6) MSDS
(7) Certificate of insurance
(8) Authorized signature of acceptance of material

16.1.2.2.1.2 The acceptance criteria shall be documented and available for review by the AHJ.

16.1.2.2.1.2.1 Material that cannot be stored, handled, or processed by the receiving facility shall be rejected.

16.1.2.2.1.2.2 Rejected material shall be returned to the supplier within 5 working days or disposed of in accordance with local, state, and federal regulations. Why 5 days?

16.1.2.2.1.2.3 Rejected material shall be labeled and segregated in an area identified for storage of rejected material.

16.1.2.2.1.3 Storage of Combustible Metals for Recycling
16.1.2.2.1.3.1 Materials that can potentially produce combustible dust as a result of normal handling shall include provisions for the handling of any possible resulting dusts as defined in this section.

16.1.2.2.1.3.2 Containers and areas where combustible metals are stored shall be labeled or identified as to the type of metal stored, form of metal, and date of receipt.

16.1.2.2.1.3.3 A tracking system shall be implemented for inventory control and shall include the following:
   (1) Type and form of combustible metal
   (2) Storage location
   (3) Date of receipt

16.1.2.2.1.3.4 The tracking records shall be available for inspection by the authority having jurisdiction.

16.1.2.2.1.3.5 Area and container labels or identification shall reference the appropriate material safety data sheets (MSDSs) on file.

16.1.2.2.1.3.6 Buildings used for the indoor storage of combustible metal shall be of noncombustible construction and shall meet the requirements of 14.2.1.

16.1.2.2.1.3.7 Combustible metals shall be separated from other combustible materials.

16.1.2.2.1.3.8 Combustible metals in a dry condition shall be kept in covered steel or other noncombustible containers and shall be kept in such manner or locations that they will not become wet. (when the recycled material has the potential for water reactivity, provisions shall be made to keep it dry).

16.1.2.2.1.3.9 Outside storage of dry combustible metals shall be permitted if such storage is separated from buildings or personnel.

16.1.2.2.1.3.10 Wet Recycled Combustible Metals.

16.1.2.2.1.3.11 Wet recycled combustible metals shall be stored at an outside location identified for that use.

16.1.2.2.1.3.12 Open flames and sparks shall be kept 15 m (50 ft) away from the container unless a hot-work permit allows an open flame within 15 m (50 ft).

16.1.2.2.1.3.13 * Wet combustible metals shall be kept under water in a covered and vented container.

16.1.2.2.1.3.14 Open flames and sparks shall be kept 15 m (50 ft) away from the container unless a hot-work permit allows an open flame within 15 m (50 ft).

16.1.2.2.1.3.15 Containers of wet combustible metals shall not be stacked.

16.1.2.2.1.3.16 Container Limits.

16.1.2.2.1.3.17 Where drums or other containers are used for storage of dry combustible metals, storage shall be limited to a height that would require no more than three movements using available equipment to remove a stack, and no stack shall exceed 3.1 m (10 ft) in height.

16.1.2.2.1.3.18 The maximum weight of any material container and/or pallet shall be capable of being moved by the available equipment.

16.1.2.2.1.3.19 Stacked storage shall be arranged to ensure stability.

16.1.2.2.1.3.20 Aisles shall be provided for maneuverability of material handling equipment, for accessibility, and to facilitate firefighting operations.

16.1.2.2.1.3.21 Storage of dry combustible metals in quantities greater than 1.4m³ (50 ft³) [six 208 L drums (six 55 gal drums)] shall be kept separate from other occupancies by fire-resistive construction or by an open space of at least 15 m (50 ft).

16.1.2.2.1.3.22 Buildings used for storage of dry combustible metal shall be well ventilated to avoid the accumulation of hydrogen in the event that the combustible metal becomes wet.
16.1.2.1.3.4.4 Solid combustible metals, such as clippings and castings, shall be stored in noncombustible bins or containers.

16.1.2.1.3.4.5 The storage of oily rags, packing materials, and similar combustibles shall be prohibited in storage bins or areas that store solid recycled combustible metal.

16.1.2.1.3.4.6 The use of automatic sprinklers in buildings or areas where recycled combustible metals are stored shall be prohibited unless a process hazard analysis indicates that such systems could reduce the risk to life and or property damage.

16.1.2.1.3.4.7 Periodic inspections of the facility shall be in accordance with 15.2.1.

16.1.3 Sample Collection for metal powders, paste, finely divided material and metal dust.

16.1.3.1 When the combustibility of a metal is unknown, the metal shall be tested as specified in Chapter 4 to determine whether it is a combustible material.

16.1.3.2 Collection of samples shall represent a “worst case” scenario.

16.1.3.3 Each site shall develop a sampling strategy and protocol to ensure that samples are collected in all areas where combustible dust can reasonably be assumed to be present. The following shall be considered in developing the sampling strategy:

16.1.3.3.1 All processes that produce dust, e.g. UBC processing; remelt and casting; alloying molten metal; aluminum scrap chopping, conveyance, shredding, handling and sawing; etc.

16.1.3.3.2 Horizontal surfaces on and around the process identified.

16.1.3.3.3 Various heights on the equipment and in the building. Note: lighter, small particle size dust tends to collect higher in the structure.

16.1.3.3.4 Recessed or hidden areas where dusts may have collected,

16.1.3.3.5 Inside bins, hoppers, baghouses, cyclones, ductwork, etc. used to store, collect and convey materials.

16.1.3.4 Samples shall be taken and promptly submitted to the testing lab as dust tends to oxidize over time. (should, could samples should be stored and shipped in a manner that retains to the extent possible, the integrity of sample)

16.1.3.5 Personal Protective Equipment (PPE).

16.1.3.6 Outer clothing shall be clean, flame retardant where combustible aluminum dust has been determined to be present. All personnel in an identified combustible dust environment shall wear long sleeve shirts, long pants and gloves made of flame-retardant material. The flame-retardant garments shall be in accordance with NFPA 2112 – “Flame-Resistant Garments for Protection of Industrial Personnel against Flash Fire”, or equivalent standard.

16.1.3.7 PPE intended for use in explosive atmospheres must be so designed and manufactured that it cannot be the source of an electric, electrostatic or impact-induced arc or spark likely to cause an explosive mixture to ignite.

16.1.3.8 Tightly woven, smooth fabrics treated with a flame retardant chemical and from which dust can readily be brushed shall be used if necessary.

16.1.3.9 Non-Flame Retardant disposable coveralls and other non-flame retardant disposable garments shall not be worn by personnel engaged in cleaning of combustible dust.
16.1.4.5 Where molten metal hazards exist, Garments for the Recycling and Remelt/Casting area shall be protective for molten metal splash.

16.1.4.6 Clothing Fires

16.1.4.6.1 Emergency procedures for handling clothing shall be established.

16.1.5 Reactivity.

16.1.5.1 It shall be the responsibility of the facility to evaluate processes and materials for potentially dangerous reactions that could occur in the course of their operations.

16.1.5.2 Contact with Water.

16.1.5.2.1 Water leakage inside or into any building where the water can contact aluminum powder shall be prevented to avoid possible spontaneous heating.

16.1.5.3 Thermite Reaction.

16.1.5.3.1 Caution shall be exercised in the mixing of aluminum fines and metal oxides [e.g., iron oxide (rust)].

16.1.6 Management of Change.

16.1.6.1 The requirements of 8.1.5.2 through 8.1.5.5 shall apply to new and existing facilities and processes.

16.1.6.2 Written procedures shall be established and implemented to manage a proposed change to process materials, technology, equipment, procedures, and facilities.

16.1.6.3 The procedures shall ensure that the following are addressed prior to any change:

(1) The technical basis for the proposed change
(2) Safety and health implications, including hazard analysis
(3) Whether the change is permanent or temporary
(4) Modifications to operating and maintenance procedures
(5) Employee training requirements
(6) Authorization requirements for the proposed change
(7) Results of characterization tests used to assess the hazard, if conducted

16.1.6.4 Implementation of the management of change procedure shall not be required for replacements-in-kind.

16.1.6.5 Design documentation shall be updated to incorporate the change.

16.2 Facility Design Requirements

16.2.1 Building Construction

16.2.1.1 Location of Recycling Plants.

16.2.1.1.1 A hazards analysis shall be conducted to determine the minimum separation distance for individual buildings and operations within recycling plants.

16.2.1.2 All buildings used for the manufacture, packing, or loading for shipment of recycling materials shall be constructed of noncombustible materials throughout and shall have non-load-bearing walls.

16.2.1.3 The buildings specified in 8.2.1.2 shall be designed so that all internal surfaces are readily accessible, to facilitate cleaning.

16.2.1.4 All walls of areas where fugitive dust can be produced shall have a smooth finish and shall be sealed so as to leave no interior or exterior voids where aluminum powder can infiltrate and accumulate.

16.2.1.5 The annuli of all pipe, conduit, and ventilation penetrations shall be sealed.
16.2.1.6 Floors shall be hard surfaced and shall be installed with a minimum number of joints in which aluminum powder or dust can collect.

16.2.1.7 The requirements of 16.2.1.4 shall also apply to elevated platforms, balconies, floors, and gratings.

16.2.1.8 Roofs of buildings that house combustible aluminum dust-producing operations shall be supported on girders or structural members designed to minimize surfaces on which dust can collect.

16.2.1.9* Interior surfaces where dust accumulations can occur shall be designed and constructed to facilitate cleaning and to minimize combustible dust accumulations.

16.2.1.10 Where surfaces on which dust can collect are unavoidably present, they shall be covered by a smooth concrete, plaster, or noncombustible mastic fillet having a minimum slope of 55 degrees to the horizontal.

16.2.1.11 Roof decks and basements shall be watertight.

16.2.1.12 Explosion venting in accordance with NFPA68, Standard on Explosion Protection by Deflagration Venting, shall be provided for buildings where aluminum powder is processed.

16.2.1.13 Deflagration venting shall not be required for areas where aluminum powder is stored or moved only in covered or sealed containers.

16.2.1.14 Door and Window Construction.

16.2.1.15 All doors in interior fire-rated partitions shall be listed self-closing fire doors, installed in accordance with NFPA 80, Standard for Fire Doors and Other Opening Protectives.

16.2.1.16* Emergency exits shall be provided in compliance with NFPA 101, Life Safety Code.

16.2.1.17 Enclosed Passageways.

16.2.1.17.1* Where buildings or process areas are interconnected by enclosed passageways, the passageways shall be designed to prevent propagation of an explosion or fire from one unit to another in accordance with NFPA 68, Standard on Explosion Protection by Deflagration Venting.

16.2.1.17.2 All enclosed passageways that connect with one or more processing areas shall be provided with means of egress in accordance with NFPA 101, Life Safety Code.

16.2.1.18 Grounding and Lightning Protection.

16.2.1.18.1* All process equipment and all building steel shall be bonded and grounded in accordance with NFPA 70, National Electrical Code.

16.2.1.18.2 All buildings shall be provided with a lightning protection system in accordance with NFPA 780, Standard for the Installation of Lightning Protection Systems.

16.2.1.18.3 Lightning protection systems shall not be required for office buildings and buildings that are used for storage and handling of closed containers.

16.2.1.19 Heating and Cooling of Aluminum Recycling - Production Buildings.

16.2.1.19.1 Buildings shall be permitted to be heated by indirect hot-air heating systems or by bare-pipe heating systems using steam or hot water as the heat transfer medium, or by listed electric heaters.

16.2.1.19.2 (MODIFY) Indirect hot air shall be permitted if the heating unit is located in an adjacent room or area that is free of combustible aluminum dust.

16.2.1.19.3 Fans or blowers used to convey heated or cooled air shall be located in an area that is free of combustible aluminum dust.

16.2.1.19.4 The air supply shall be taken from outside or from a location that is free of combustible aluminum dust.
16.2.19.5 Makeup air for building heating or cooling shall have a dew point low enough to ensure that no free moisture can condense at any point where the air is in contact with combustible aluminum dust or powder.

16.2.19.6 The requirements of 16.2.19.1 through 16.2.19.5 shall not apply to areas where aluminum metal is melted.

16.2.1.20 Electrical Power and Control.

16.2.1.20.1* All process equipment and all building steel shall be bonded and grounded in accordance with NFPA70, National Electrical Code.

16.2.1.20.2 All electrical equipment and wiring shall be installed in accordance with NFPA 70, National Electrical Code.

16.2.1.20.3 Control equipment meeting the requirements of NFPA 496, Standard for Purged and Pressurized Enclosures for Electrical Equipment, shall be permitted.

16.2.1.20.4 One or more remotely located control stations shall be provided to allow the safe and selective shutdown of process equipment in an emergency.

16.2.1.20.5 All manufacturing buildings shall be provided with emergency lighting systems in accordance with Section 7.9 of NFPA 101, Life Safety Code.

16.2.1.20.6 Preventive maintenance for electrical equipment shall be established commensurate with the environment and conditions.

16.2.1.20.7* Electrical equipment and components shall be inspected and cleaned at least once each year or more frequently if conditions warrant.

16.2.1.20.8 The accumulation of aluminum metal fines inside electrical equipment and components shall be mitigated.

16.2.2 Fire Protection.

16.2.2.1 Extinguishing Agents and Application Techniques for Use on Combustible Aluminum Dusts.

16.2.2.1.1* An incipient fire shall be ringed with a dam of dry sand, dry inert granular material, or a listed Class D extinguishing powder in accordance with the manufacturer’s instructions.

16.2.2.1.2 Application of dry extinguishing agent shall be conducted in such a manner as to avoid any disturbance of the combustible aluminum dust, which could cause a dust cloud.

16.2.2.1.3 The dry extinguishing agent shall be stored in such a manner that it remains clean and dry.

16.2.2.1.4* The dry extinguishing agent shall be carefully applied with a nonsparking metal scoop or shovel or applied from a listed Class D fire extinguisher.

16.2.2.1.5 Drafts shall be eliminated by shutting off fans and machinery and by closing doors and windows.

16.2.2.2 Fire Extinguishers. Portable or wheeled fire extinguishers shall be provided in accordance with NFPA 10, Standard for Portable Fire Extinguishers.

16.2.2.2.1 Areas where dry combustible aluminum dust is present shall not have fire extinguishers rated for Class A, Class B, or Class C fires.

16.2.2.2.2 Where Class A, Class B, or Class C fire hazards are in the combustible aluminum powder area, extinguishers suitable for use on such fires shall be permitted, provided they are marked “Not for Use on Aluminum Powder Fires.”

16.2.2.2.3* Extinguishers listed for use on Class B fires shall be provided in areas where solvent cleaning and washing are performed.

16.2.2.2.3.1 Conspicuous signs shall be placed adjacent to such extinguishers, stating that the extinguishers shall not be used for combustible aluminum dust fires.

16.2.2.2.3.2 Halogenated extinguishing agents shall not be used.
16.2.2.3 Water Use. Manual water application shall be used on a combustible dust fire only as a last resort, when other methods of control have failed and the fire shows evidence of burning out of control.

16.2.2.3.1 Only low-velocity spray or fog nozzles shall be used.

16.2.2.3.2 Manual application of water shall be conducted in such a manner as to avoid creating a dust cloud.

16.2.2.3.3 Once water is used, its use shall be continued until the fire is extinguished or until the area becomes untenable.

16.2.2.3.4 After extinguishment, the area shall be immediately cleaned of all wetted combustible materials.

16.2.2.3.5 Ventilation shall be provided during cleanup to avoid concentrations of hydrogen from the exothermic reaction of the aluminum with water.

16.2.2.3.6* Fire flow containment shall not be required for existing facilities.

16.2.2.4 Automatic Sprinkler Protection

16.2.2.4.1 The use of automatic sprinklers in buildings or areas where recycled combustible metals are stored shall be prohibited unless a process hazard analysis indicates that such systems could reduce the risk to life and or property damage.

16.2.3 Electrical Classification.

16.2.3.1* In local areas of a plant where a hazardous quantity of dust accumulates or is present in suspension in the air, the area shall be classified, and all electrical equipment and installations in those local areas shall comply with Article 500 of NFPA 70, National Electrical Code.

16.2.3.2 Flashlights and other portable electrical equipment shall be listed for the locations where they are used.

16.2.3 Hazard Analysis.

16.2.3.1* The design of the fire and explosion safety provisions shall be based on a hazard analysis of the facility, the process, and the associated fire or explosion hazards.

16.2.3.2 The results of the hazard analysis shall be documented and maintained for the life of the process.

16.2.3.3 The hazard analysis shall be reviewed and updated at least every 5 years.

16.2.3.4 New and/or altered operations, equipment, and/or facilities shall be reviewed prior to operation for potential hazards.

16.2.3.5 Written records shall be maintained of all hazard analyses.

16.2.3.6 Hazard analyses shall be signed off on, prior to operation, by a knowledgeable authority at the facility.

16.2.3.7 Appropriate safeguards shall be put in place with regard to findings of the hazard analysis.

16.2.3.8 Corrective actions as a result of the hazard analysis shall be tracked and completed to ensure that all identified hazards have been abated or the level of risk has been reduced to an acceptable level by a knowledgeable authority.

16.3 Emergency Preparedness.

16.3.1 Procedures.

16.3.1.1 Emergency procedures shall be established to address fire and explosion events.

16.3.1.2 The emergency procedures shall be documented.

16.3.1.3 In cases were a process hazard analysis indicates that application of low velocity water may be beneficial for the preservation of life and/or property, the provisions of 15.3.3.5 shall be superceded. If the determination is made to apply low velocity water to a fire, the following guidelines shall be observed:

(A) Care should be taken to prevent the formation of a dust cloud.

Comment [U12]: Review Ch 15 requirements to ensure that they are parallel with general industry
(B) Area should be determined to be well ventilated, and/or ventilation should be maximized prior to water application, in order to prevent the accumulation of hydrogen gas. (C) After extinguishment, the area should be cleaned of all wetted powder, paste or slurry, and ventilation should be continued throughout this process.

16.3.2* Training.

16.3.2.1 All employees shall be trained in the emergency procedures and the hazards of combustible metals.

16.3.2.2 Training shall be documented and available for inspection by the authority having jurisdiction.

16.4 Processing.

16.4.1 Control of ignition sources shall be in accordance with the requirements of 15.2.3 and recyclers shall determine the combustibility/ explosivity characteristics of any by-product, intermediate or final material generated as a result of on-site processing.

16.4.1.1* Documentation of the determination in 16.4.1 shall be maintained and available for review by the authority having jurisdiction.

16.4.1.2 For all processing of recycled combustible metals for which there are specific chapters, the requirements of those chapters shall apply unless addressed specifically in Chapter 16.

16.4.1.3 For all other recycled combustible metal and alloy processing, the requirements of Chapter 14 shall apply.

16.4.1.4 Combustible or flammable liquids resulting from recycling of combustible metals shall be handled and stored in accordance with NFPA 30, Flammable and Combustible Liquids Code.

16.4.1.5 Hazardous materials resulting from recycling of combustible metals shall be handled and stored in accordance with local, state, and federal regulations and NFPA 1, Fire Code.

16.4.2 Machining and Operations.

16.4.2.1 Requirements for Machinery.

16.4.2.2 All combustible aluminum dust–producing machines and conveyors shall be designed, constructed, and operated so that fugitive dust is minimized.

16.4.2.3 All machinery and equipment shall be installed in accordance with NFPA 70, National Electrical Code.

16.4.2.4* All machinery shall be bonded and grounded to minimize accumulation of static electric charge.

16.4.2.5 Bearings.

16.4.2.5.1 Ball or roller bearings shall be sealed against dust.

16.4.2.5.2 Where exposed bearings are used, the bearings shall be protected to prevent ingress of combustible aluminum dust and shall have a lubrication program.

16.4.2.5.3 Clearances between moving surfaces that are exposed to paste, powder, or dust shall be maintained to prevent rubbing or jamming.

16.4.2.5.4 Permanent magnetic separators, pneumatic separators, or screens shall be installed ahead of mills, stamps, or pulverizers wherever there is any possibility that tramp metal or other foreign objects can be introduced into the manufacturing operation.

16.4.2.5.5 Startup Operations. All areas of processing machinery that will be in contact with aluminum materials shall be free of foreign material and water before being placed in operation.

Comment [U13]: The purpose of Ch 16 is to supersede requirements of some chapters.
16.4.3 Transfer Operations.

16.4.3.1* Operations involving the transfer of combustible aluminum dusts or powders from one container to another shall be designed and operated to protect personnel, equipment, and buildings from the fire or dust explosion hazard produced by airborne suspensions of combustible aluminum dusts or powders.

16.4.3.2 Equipment producing material in a combustible form shall be permitted to be used for other materials only when the system is thoroughly cleaned of all incompatible materials prior to and after its use.

16.4.5 Electrical Equipment.

16.4.5.1 All electrical wiring and equipment shall conform to the provisions of NFPA 70, National Electrical Code.

16.4.6 Chip Processing.

16.4.7 Machining and Sawing Operations.

16.4.7.1* Cutting tools shall be of proper design and shall be kept sharp for satisfactory work with aluminum.

16.4.7.2* Sawing, grinding, and cutting equipment shall be grounded.

16.4.8 Coolant.

16.4.8.1 Nonflammable coolants shall be used for wet grinding, cutting, or sawing operations.

16.4.8.2 The coolant shall be filtered on a continuous basis, and the collected solids shall not be allowed to accumulate in quantities greater than 19 L (5 gal) and shall be removed to a safe storage or disposal area.

16.4.9* Dust Collection.

16.4.9.1* Machines that produce fine particles of aluminum shall be provided with hoods, capture devices, or enclosures that are connected to a dust collection system having suction and capture velocity to collect and transport all the dust produced.

16.4.9.2 Hoods and enclosures shall be designed and maintained so that the fine particles will either fall or be projected into the hoods and enclosures in the direction of airflow.

16.4.9.3* Special attention shall be given to the location of all dust-producing machines with respect to the location of the dust collection system to ensure that the connecting ducts will be as straight and as short as possible.

16.4.9.4 Grinding operations shall not be served by the same dust collection system as buffing and polishing operations.

16.4.9.5* Dry-type dust collectors shall be located outside of buildings.

16.4.9.6 Waste Disposal. A disposal plan for all combustible metals included in process residues shall be documented and made available to the authority having jurisdiction.

16.4.9.7 Air–Material Separators.

16.4.9.7.1 Where an explosion hazard exists, air–material separators shall be located outside of buildings.

16.4.9.7.2* The requirement of 7.13.1.1.1 shall not apply to the following:

(1) Air–material separators that are protected in accordance with 7.1.2.1(1), 7.1.2.1(3), 7.1.2.1(4), 7.1.2.1(5), or 7.1.2.1(6)
(2) Air–material separators that meet all of the following criteria:
   (a) They are equipped with deflagration vents that are vented through ducts to the outside.
   (b) The reduced venting efficiency due to the duct has been taken into account.
   (c) The ducts are designed to withstand the effects of the deflagration.
(3) Air–material separators that have a volume of less than 8 ft3 (0.2 m3)

16.4.9.7.3 Where both an explosion hazard and a fire hazard exist in an air–material separator, provisions for protection for each type of hazard shall be provided.

(may be more included… second piece of P.Hart’s email excerpt from 654)
16.4.9.8* Individual machines with portable dust collection capability shall be permitted to be used indoors when the object being processed or finished is incapable of being moved to a properly arranged fixed hood or enclosure and shall incorporate the safeguards in 8.7.3.5.1.1 through 8.7.3.5.1.4.

16.4.9.8.1 The operation of portable dust collection devices shall be subject to a hazards analysis to ensure that the risk to personnel and operations from flash fire and shrapnel is minimized.

16.4.9.8.2 Personal protective clothing shall comply with 8.1.3.

16.4.9.8.3 The collector shall be designed to dissipate static electricity.

16.4.9.8.4 Collector retention capacity shall be limited to 8 cubic feet. 0.45 kg (1 lb).

16.4.9.9 If the combustible aluminum dust collection system is to be used for other materials, the system shall be disassembled and thoroughly cleaned of all incompatible materials prior to and after its use.

16.4.9.10* Bonding and Grounding.

16.4.9.10.1 All components of dust collection systems shall be bonded and grounded.

16.4.9.10.2 When continuous contact is interrupted, metallic jumpers shall be installed for effective bonding.

16.4.9.11 Electrostatic collectors shall not be used.

16.4.9.12* Dust-collecting filter medium shall be designed to be conductive so as to dissipate static electric charges.

16.4.9.13 Dry-dust collection systems shall be designed and maintained so that internal cleanliness is ensured. The accumulation of material inside any area of the collector other than in the discharge containers designed for that purpose shall not be permitted.

16.4.9.14 The accumulation of condensation of water at any point in the dry-dust collection system shall be prevented.

16.4.9.15 Dust shall be removed from dry collectors at least once each day and at more frequent intervals if conditions warrant.

16.4.9.15.1 Extreme care shall be taken in removing dust from the collectors, to avoid creating dust clouds.

16.4.9.15.2 The material shall be discharged into metal containers that shall be promptly and tightly covered to avoid the creation of airborne fugitive dust.

16.4.9.16* Dry Collectors.

16.4.9.16.1 Dry collectors used for combustible aluminum dust shall be provided with deflagration vents.

16.4.9.16.2 The selection of the type and location of vents or weak sections of the collector shall be designed to minimize injury to personnel and to minimize blast and fire damage to nearby equipment or structures.

16.4.9.16.3 Material removed from the dry-type dust collector shall be permitted to be recycled into a process or mixed with an inert material to a ratio that has tested to be non-combustible. Once mixed, the material shall be recycled or disposed of in accordance with local, state, and federal regulations.

16.4.9.17 Where repairs on dry-dust collectors are necessary, the collectors shall be emptied and residual accumulations of dust thoroughly removed. Ductwork leading into the collector shall be disconnected and blanked off before repair work is permitted to be started.

16.4.9.18 The interior of hoods and ducts shall be regularly cleaned wherever there is the possibility of buildup of wax, lint, aluminum fines, or other combustible material.

16.4.9.19 The dust collector shall be arranged so that contact between dust particles and parts moving at high speeds is prevented. The blower for drawing the dust-laden air into the collector shall be located on the clean air side of the collector.

16.4.9.20 Recycling of exhaust air from dry-dust collectors into buildings shall be prohibited.
16.4.9.21 All electrical wiring and equipment shall conform to the provisions of NFPA 70, National Electrical Code.

16.4.9.22 Dust Collection Ducts and Ductwork.

16.4.9.22.1 All dust collection systems shall be installed in accordance with NFPA 91, Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids.

16.4.9.22.2 Ducts shall be designed to maintain a velocity of not less than 1372 m/min (4500 ft/min) to ensure the transport of both coarse and fine particles and to ensure re-entrainment if, for any reason, the particles can fall out before delivery to the collector (for example, in the event of a power failure).

16.4.9.22.3 Ducts shall be designed to handle a volumetric flow rate that maintains dust loading safely below the MEC.

16.4.9.22.4 Ducts shall be as short as possible and shall have as few bends and irregularities as possible, to prevent interference with free airflow.

16.4.9.22.5 Duct Construction.

16.4.9.22.5.1 Ducts shall be constructed of conductive material and shall be carefully fabricated and assembled with smooth interior surfaces and with internal lap joints facing the direction of airflow.

16.4.9.22.5.2 There shall be no unused capped outlets, pockets, or other dead-end spaces that might allow accumulations of dust.

16.4.9.22.5.3 Longitudinal duct seams shall be oriented in a direction away from personnel.

16.4.9.22.5.4 Additional branch ducts shall not be added to an existing system without redesign of the system.

16.4.9.22.5.5 Branch ducts shall not be disconnected.

16.4.9.22.5.6 Unused portions of the system shall not be blanked off without means being provided to maintain required airflow.

16.4.9.22.5.7 Duct systems, dust collectors, and dust-producing machinery shall be bonded and grounded to minimize accumulation of static electric charge.

16.4.9.23 Wet-Type Dust Collectors.

16.4.9.23.1 The exhaust vent shall terminate to a safe location outside the building and shall be securely fastened except as provided in 8.7.3.21.1.1.

16.4.9.23.1.1 The cleaned air shall be permitted to be returned to the work area when tests conducted by an approved testing organization prove that the collector’s efficiency is great enough to provide safety to both personnel and property safety in the particular installation, with regard to particulate matter in the cleaned air and accumulations of particulate matter and hydrogen in the work area.

16.4.9.23.1.2 The duct shall be as short and straight as possible and shall be designed to withstand the same explosion pressure as the wet-type dust collector.

16.4.9.23.2 The exhaust vent shall be inspected and cleaned frequently to prevent buildup of highly combustible deposits of metal dusts on the interior surfaces of the duct.

16.4.9.23.3 Arrangement of Wet-Type Dust Collector Components.

16.4.9.23.3.1 The dust collector shall be arranged so that contact between dust particles and parts moving at high speed is prevented.

16.4.9.23.3.2 The blower for drawing the dust-laden air into the collector shall be located on the clean air side of the collector.

16.4.9.23.3.3 The dust collector shall be arranged so that the dust-laden airstream is thoroughly scrubbed by the liquid to achieve the desired efficiency. The use of an additional dryfilter medium either downstream or combined with a wet collector shall not be permitted.
16.4.9.23.3.4* Collector Sump Venting.
(A) The sump of water wet-type dust collectors shall be ventilated at all times.
(B) Vents shall remain open and unobstructed when the machine is shut down.
(C) When the dust collector is not in operation, ventilation shall be permitted to be provided by an independent blower or by an unimpeded vent.

16.4.9.23.3.5* Power Supply.
(A) The power supply to the dust-producing equipment shall be interlocked with the airflow from the exhaust blower and the liquid-level controller of the collector so that improper functioning of the dust collection system will shut down the equipment it serves.
(B) A time delay switch or equivalent device shall be provided on the dust-producing equipment to prevent the starting of its motor drive until the collector is in complete operation.

16.4.9.23.3.6* Disposal of Sludge from Water Wet-Type Dust Collectors.
(A) Sludge from water wet-type dust collectors shall be removed at least once each day or more frequently if conditions warrant.
(B) Covered, vented metal containers shall be used to transport the collected sludge for disposal.
(D) Material removed from wet-type dust collectors shall be permitted to be mixed with an inert material (e.g., sand or material that is nonreactive with aluminum) in a volume ratio of five parts inert material to one part metal dust.
(E) Sludge shall be recycled or disposed of in accordance with federal, state, and local requirements.
(F) Smoking or open flames shall be prohibited in the disposal area and throughout the disposal process.

16.4.9.24 Powered industrial trucks used for on-site transportation shall be selected in accordance with NFPA 505, Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operations, and consistent with 8.2.3.1.

16.4.9.25* Employee Training Program. Training programs shall be instituted to inform employees about the hazards involved in the manufacture of aluminum powder, paste, or granules and the hazards involved in processing or finishing operations that generate fine combustible aluminum dust, as appropriate to the operation. ((end of Ch 8 Inclusions))

16.5 Fire and Explosion Prevention.

16.5.1 The requirements of Chapter 15 shall apply.

16.5.2 Housekeeping.

16.5.2.1. It shall be permissible to use vacuum cleaning as an alternative to hand cleaning if the vacuum cleaning equipment utilized is specifically designed for use with combustible dust.

16.5.3 Control of Ignition Sources. (Reserved)

16.5.4 Hot Work Operations. (Reserved)

16.5.5 Control of Combustible Materials.

16.5.5.1. It shall be permissible to use an open top container to collect metal chips, lathe turnings and swarf if the container is grounded and has shelter to prevent water entainment.

16.5.6 Inspection, Maintenance, and Training.

16.5.6.1 Regular inspections shall be conducted to detect the accumulation of excessive zirconium dust, chips, or fines on any portions of buildings or machinery not regularly cleaned in daily operations.

16.5.6.2 Records shall be kept of the inspections conducted in 16.9.6.1.
Chapter 16 Combustible Metal Recycling Facilities and Waste Treatment Facilities

16.1 General.
The requirements of this chapter shall apply to new and existing facilities where combustible metals are recycled and handled for disposal as waste including incineration.

16.1.1 This chapter shall apply to companies recycling combustible metals from and disposing of combustible metals and combustible metal mixtures from outside sources.

16.1.2* The requirements of Chapter 15 shall apply to recycling and waste treatment facilities.

16.1.3* When

Combustibility

16.1.3.1 For recycling operations, when the combustibility of a metal is unknown, the metal shall be tested as specified in Chapter 4 to determine whether it is a combustible metal.

16.1.3.2 For material to be disposed or incinerated, the waste manifest sheet shall disclose the combustibility of the material offered for waste including mixtures. The combustible metal shall be identified by name (i.e., zirconium turnings). If the waste is a mixture containing a combustible metal, the name(s) and percent(s) combustible metal shall be reported.

16.2 Receiving Criteria for Recycling Facilities.

Incoming material shall be inspected for acceptance criteria.

16.2.1 Acceptance criteria for combustible metals being recycled shall be established by the recycler.

16.2.2 The acceptance criteria shall include the following as a minimum:

1. Acceptable packaging
2. Forms
3. Identification/manifest (DOT shipping papers)
4. Required protection against foreign material
5. Identification and segregation of any radiation/contamination of materials
6. MSDS
7. Certificate of insurance
8. Authorized signature of acceptance of material

16.2.3 The acceptance criteria shall be documented and available for review by the AHJ.

16.2.4* Material that cannot be stored, handled, or processed by the receiving facility shall be rejected.

16.2.5 Rejected material shall be returned to the supplier within 5 working days or disposed of in accordance with local, state, and federal regulations.

16.2.6* Rejected material shall be labeled and segregated in an area identified for storage of rejected material.

16.3 Storage of Combustible Metals for Recycling and Waste Treatment Facilities.

16.3.1 Containers and areas where combustible metals are stored shall be labeled or identified as to the type of metal stored, form of metal, and date of receipt.

16.3.2 A tracking system shall be implemented for inventory control and shall include the following:

1. Type and form of combustible metal
2. Storage location
3. Date of receipt

16.3.3 The tracking records shall be available for inspection by the authority having jurisdiction.

16.3.4 Area and container labels or identification shall reference the appropriate material safety data sheets (MSDSs) on file.

16.3.5 Buildings used for the indoor storage of combustible metal shall be of noncombustible construction and shall meet the requirements of 14.2.1.

16.3.6 Combustible metals shall be separated from other combustible materials and incompatible materials.

16.3.6.1 Combustible metals in a dry condition shall be kept in covered steel or other noncombustible containers and shall be kept in such manner or locations that they will not become wet.

16.3.6.2 Outside storage of dry combustible metals shall be permitted if such storage is separated from buildings or personnel and precautions are exercised to prevent the combustible metals from becoming wet.

16.3.7 Wet Combustible Metals.

16.3.7.1 Wet combustible metals shall be stored at an outside location identified for that use.

16.3.7.2* Wet combustible metals shall be kept under water in a covered and vented container.

16.3.7.2.1 Open flames and sparks shall be kept 15 m (50 ft) away from the container unless a hot-work permit allows an open flame within 15 m (50 ft).

16.3.7.2.2 Containers of wet combustible metals shall not be stacked.

16.3.8 Container Limits.

16.3.8.1 Where drums or other containers are used for storage of dry combustible metals, storage shall be limited to a height that would require no more than three movements using available equipment to remove a stack, and no stack shall exceed 3.1 m (10 ft) in height.

16.3.8.2 The maximum weight of any material container and/or pallet shall be capable of being moved by the available equipment.

16.3.9 Stacked storage shall be arranged to ensure stability.

16.3.10 Aisles shall be provided for maneuverability of material-handling equipment, for accessibility, and to facilitate fire-fighting operations.

16.3.11 Storage of dry combustible metals in quantities greater than 1.4 m³ (50 ft³) [six 208 L drums (six 55 gal drums)] shall be kept separate from other occupancies by fire-resistive construction or by an open space of at least 15 m (50 ft).

16.3.12 Buildings used for storage of dry combustible metal shall be well ventilated to avoid the accumulation of hydrogen in the event that the combustible metal becomes wet.

16.3.13 Solid combustible metals, such as clippings and castings, shall be stored in noncombustible bins or containers.
The storage of oily rags, packing materials, and similar combustibles shall be prohibited in storage bins or areas that store solid combustible metal.

16.3.15
The use of automatic sprinklers in buildings or areas where combustible metals are stored shall be prohibited.

16.3.16
Periodic inspections of the facility shall be in accordance with 15.2.1.

16.4 Processing at Recycling Facilities.

16.4.1
The recyclers shall determine the combustibility/explosivity characteristics of any intermediate or final material generated as a result of on-site processing. The characteristics shall be reported on the waste manifest sheet if the processed material or products of processing are collected for waste disposal.

16.4.1.1*
Documentation of the determination in 16.4.1 shall be maintained and available for review by the authority having jurisdiction.

16.4.2
For all processing of combustible metals for which there are specific chapters, the requirements of those chapters shall apply.

16.4.3
For all other combustible metal and alloy processing, the requirements of Chapter 14 shall apply.

16.4.4
Combustible or flammable liquids resulting from recycling of combustible metals shall be handled and stored in accordance with NFPA 30, Flammable and Combustible Liquids Code.

16.4.5
Hazardous materials resulting from recycling of combustible metals shall be handled and stored in accordance with local, state, and federal regulations and NFPA 1, Fire Code.


16.5.1 Procedures.

16.5.1.1 Emergency procedures shall be established to address fire and explosion events.

16.5.2* Training.

16.5.2.1 All employees shall be trained in the emergency procedures and the hazards of combustible metals.

16.5.2.2 Training shall be documented and available for inspection by the authority having jurisdiction.

16.6 Ignition Sources.

Control of ignition sources shall be in accordance with the requirements of 15.2.3.

16.7 Waste Disposal.

A disposal plan for all combustible metals included in process residues shall be documented and made available to the authority having jurisdiction. The disposal plan shall clearly state the fire and explosion hazards such as flammable solid or spontaneously combustible if dry.
In 16.3.7. Add a new section to read:

16.3.7 Wet Combustible Metals.

Add a new 16.3.17 to read:

16.3.17 Non-conforming material shall be segregated from all other materials.

Revise 16.4.2 and 16.4.3 to read:

16.4.2 For all processing of combustible metals for which there are specific chapters, the requirements of those chapters shall also apply.

16.4.3 For all other combustible metal and alloy processing, the requirements of Chapter 14 shall also apply.

Add a new section 16.4.6 to read:

16.4.6 Sumps and trenches in manufacturing and process areas should be cleaned at the end of the work shift to prevent accumulation of fines and incompatible materials.

Revise 16.5.1.1 to read:

16.5.1.1 Emergency procedures shall be established to address fire and explosion events generated in accordance with 15.4 and 15.5 of this standard.

Substantiation: Chapter does not adequately address needs of recycling facilities. These changes will increase safety at such facilities, especially regarding qualification of incoming materials.

Add new sections to read:

16.3.6.3 Insert material from 16.3.11

16.3.6.4 Add new language on addressing minimum requirements for the exterior storage of materials based on quantity and distance from property lines and/or other structures. Allow storage with exterior "bunkers" or similar area which provide four (4) hour separation/segregation on three sides, and that extends a minimum of "x" feet above the height of the storage, add additional language to include maximum storage within each bunker area.

Substantiation: Current language in 16.3.6.2 allows outside storage of dry combustible metals if such storage is separated from building or personnel and precautions are exercised to prevent the combustible metals from becoming wet. Section 16.3.11 addresses storage of dry combustible metals in quantities greater than 1.4 m3 (50 ft3) shall be kept separate from other occupancies by fire-resistant construction or by and open space of at least 15 m (50 ft).

Enforcers in some communities are dealing with recycling operators which are in dense industrial areas and lack the knowledge and experience to appropriately address storage of large quantities of combustible metals they are seeing in some operations. I believe the committee should discuss this area and provide additional comments/clarification and direction for the exterior storage of combustible metals and usage of bunkers for protection of said storage.
Submitter: Kevin Kreitman, City of Redding Fire Department

Recommendation: Add new/clarifying language (proposed 16.3.6.4) addressing minimum requirements for the exterior storage of materials based on quantity and distance from property lines and/or other structures. Allow storage within exterior “bunkers” or similar areas which provide four (4) hour separation/segregation on three sides, and that extends at a minimum of “x” feet above the height of the storage and add language to include maximum storage within each bunker area, relocate Section 16.3.11 to 16.3.6.3.

Substantiation: Current language in 16.3.6.2 allows outside storage of dry combustible metals if such storage is separated from building or personnel and precautions are exercised to prevent the combustible metals from becoming wet. Section 16.3.11 addresses storage of dry combustible metals in quantities greater than 1.4 m³ (50 ft³) shall be kept separate from other occupancies by fire-resistive construction or by and open space of at least 15 m (50 ft.).

Enforcers in some communities are dealing with recycling operators which are in dense industrial areas and lack the knowledge and experience to appropriately address storage of large quantities of combustible metals they are seeing in some operations. I believe the committee should discuss this area and provide additional comments/clarification and direction for the exterior storage of combustible metals and usage of bunkers for protection of said storage.
Donna R. Bruce, KEMET Electronics Corporation

Recommendation: Create a separate housekeeping chapter as follows:

Housekeeping

x.1.1 Cleanup Procedures for Fugitive Dust Accumulations.

x.1.1.1 A documented housekeeping program shall be established.

x.1.1.2 Fugitive metal dust shall not be allowed to accumulate to a level that creates a potential secondary explosion or flash-fire hazard. (See Al annex material.)

x.1.1.3 Systematic cleaning of areas containing dust producing equipment, including roof members, pipes, conduits, and other components shall be conducted as frequently as conditions warrant.

x.1.1.4 Cleaning methods shall be limited to those methods that minimize the probability of fire or explosion, as determined by a person knowledgeable in the properties of combustible metal dusts. (use 8.1.2.1.2 as annex material)

x.1.1.5 Chips or powder sweepings shall be removed to a designated storage or disposal area.

x.1.1.6 Special attention shall be paid to areas utilizing powder for accumulations in crevices and joints between walls, ceilings, and floors. (See 11.9.6.1 Ta)

x.1.1.7 The housekeeping frequency shall be established to ensure that the accumulated dust levels on walls; floors; horizontal surfaces, such as equipment, ducts, pipes, conduits, hoods, ledges, beams, roof members; and above suspended ceilings and other concealed areas, such as the interior of electrical enclosures, does not exceed the threshold accumulation.

x.1.1.8 Procedures for unscheduled housekeeping of unplanned or accidental spillage of combustible metal dusts in operating areas shall be established as a part of a housekeeping plan.

x.1.1.4 Bulk Accumulations.

x.1.1.4.1 Preliminary cleanup of the bulk of the powder shall be accomplished by using conductive non-sparking scoops and soft brooms as well as brushes that have natural fiber bristles.

x.1.1.4.2 Spills shall be removed at once, using conductive scoops and soft bristle brushes that have natural fiber bristles. Scoops shall be nonsparking unless otherwise authorized for the specific application.

x.1.1.4.3 Vacuum cleaners shall be permitted to be used only for residual amounts of material remaining after preliminary cleanup.

x.1.1.5 Vacuum Cleaning.

x.1.1.5.1 Vacuum cleaning systems shall be used only for removal of dust accumulations too small, too dispersed, or too inaccessible to be thoroughly removed by hand brushing.

x.1.1.5.2 Vacuum cleaning systems shall be effectively bonded and grounded to minimize the accumulation of static electric charge.

x.1.1.5.3 Because of the inherent hazards associated with the use of vacuum cleaning systems and portable vacuum systems for finely divided combustible metal dusts, special engineering analysis shall be given to the design, installation, maintenance, and use of such systems.

x.1.1.5.4 Portable vacuum cleaners shall be used only if rated or approved for use with combustible metals dust. (review Al annex 8.1.2.3.4)

(A) They shall be permitted only for small amounts of residual material remaining after preliminary cleanup.

(B) They shall be emptied at the end of each operational period or shift.

(C) They shall not be used as primary dust collectors.

x.1.1.5.5 Vacuum cleaner hose, nozzles, and fittings shall be made of conductive nonsparking material.

x.1.1.5.6 Assembled components shall be conductive and bonded where necessary.

x.1.1.5.7 Periodic test for continuity shall be performed.

x.1.1.5.8 Combustible metal dust picked up by a fixed vacuum cleaning system shall be discharged into a container or collector location outside the building.

x.1.1.6 Compressed Air Cleaning Requirements. Compressed air blowdown shall not be permitted, except only in certain areas that are otherwise impossible to clean by vacuuming or other means.

x.1.1.6.1 Where permitted, compressed air blowdown shall be performed under carefully controlled conditions, with all potential ignition sources prohibited in or near the area and with all equipment shut down.

x.1.1.6.2 Vigorous sweeping or blowing down with compressed air produces dust clouds and shall be permitted only...
where the following requirements are met:
(1) Electrical equipment not suitable for Class II, Group E locations and other sources of ignition shall be shut down or removed from the area.
(2) Compressed air shall not exceed a gauge pressure of 206 kPa (30 psi), unless otherwise determined to be safe by a documented hazard analysis.

x.1.1.7 Water-Cleaning Requirements. The use of water for cleaning shall not be permitted in manufacturing areas unless the following requirements are met:
(1) Competent technical personnel have determined that the use of water will be the safest method of cleaning in the shortest exposure time.
(2) Operating management has full knowledge of and has granted approval of its use.
(3) Ventilation, either natural or forced, is available to maintain the hydrogen concentration safely below the lower flammable limit (LFL).
(4) Complete drainage of all water effluent to a safe, contained area is available.

x.1.1.8 Cleaning Frequency.
x.1.1.8.1 The accumulation of excessive dust on any portions of buildings or machinery not regularly cleaned in daily operations shall be minimized.
x.1.1.8.2 Regular, periodic cleaning of buildings and machinery, with all machinery idle and power off, shall be carried out as frequently as conditions warrant.
x.1.1.8.3 Regular, periodic cleaning of fugitive metal dust from buildings and machinery shall be carried out as frequently as conditions warrant.
x.1.1.8.4 Fugitive metal dust shall be removed to a designated storage or disposal area.

x.1.1.9 Housekeeping Inspections
Corrective actions shall be tracked for identified issues from the housekeeping program to ensure completion.
x.1.1.9.1 Regular inspections shall be conducted to detect the accumulation of excessive fugitive metal dust on any portions of buildings or machinery not regularly cleaned in daily operations.
x.1.1.9.3 Records shall be kept of the inspections specified in 14.10.2.1.10.1.
x.1.1.9.4 Ordinary combustible materials shall not be discarded in containers used for the collection of combustible metal dust or scrap.
x.1.1.9.5 Designated containers shall be used for the collection of fugitive metal dust.

x.1.1.10 Dust Control.
x.1.1.10.1 Fugitive dust shall not be allowed to accumulate. *(See A.11.1.2.1.1.)*
x.1.1.10.2 All containers used shall be cleaned and dried thoroughly before use.
x.1.1.10.2 Supplies shall be stored in an orderly manner with properly maintained aisles to allow routine inspection and segregation of incompatible materials.
x.1.1.10.3 Supplies of materials in processing areas shall be limited to those amounts necessary for normal operation.
x.1.1.10.4 Blowing down of any surfaces by compressed air
x.1.1.10.5 Ordinary combustible materials, such as paper, wood, cartons, and packing material, shall not be stored or allowed to accumulate in combustible metals-processing areas unless necessary for the process and then only in designated areas.
x.1.1.10.6 Regular, periodic cleaning of fugitive metal dust from buildings and machinery shall be carried out as frequently as conditions warrant.
x.1.1.10.7 Fugitive metal dust shall be removed to a designated storage or disposal area.

**Substantiation:** Housekeeping is such a critical safety component of combustible metals safety that it should be a separate chapter.
**Recommendation:** Add a new section to read:

A.1.1.x Where Class D fire hazards exist, it is common place to place bulk quantities of extinguishing agent near the potential Class D hazard. Depending on what type of metal is present, the Class D agent selected for the protection of the hazared may not be a listed fire extinguishing agent. In the case of the production of lithium metal, the agent of choice is lithium chloride as this material is feed stock to the electrolytic cell where the lithium metal is manufactured. The use of lithium chloride on a lithium fire will not poison the electrolytic cell in which case the cell would have to be drained and relined with fire brick. There are several Class D agents that have been shown to be effective on specific Class D fires. Additional information on Class D agents is provided in Chapter 15 of this standard.

**Substantiation:** NFPA 10 has rejected a proposal to include extinguishing agents that are not Listed agents. As such, there is a need to ensure that these agents are covered by this standard. The annex material is provided to show how a non-listed agent can be used as an extinguishing agent.

**Recommendation:** Add new text:

Specific criteria in this standard are advisable for facilities that fall outside this document’s scope. A hazard and risk analysis should be performed to identify areas where specific criteria are appropriate.

Quantities of combustible metals listed in Table 1.1.9 may be stored in properly labeled storage units void of incompatible materials. Reference Material Safety Data Sheets for additional information.

**Substantiation:** Clarify safe storage practice of combustible metals in quantities less than the threshold by Occupancy quantities, which are outside the scope of the document.

**Recommendation:** Move the chart from 4.3.1 to the annex. Delete current A.4.3.1, and replace it with the following:

A.4.3.1 If the explosibility screening test result is positive, additional tests seen in the flow chart in Figure A.4.3.1 may be needed to characterize the hazard.

Additional tests are not needed for nonexplosible materials. Not all the listed tests needed in all applications.

**Recommendation:** Add text to read:

When combustible dust concentration control is the primary means of explosion prevention, the margin of safety below the MEC is established by Section 8.3 of NFPA 69, Standard on Explosion Prevention Systems. Combustible material design concentrations per Section 8.3 of NFPA 69 are required to be less than 25 percent of the MEC if the concentration is not going to be continuously monitored. Where automatic monitoring instrumentation with safety interlocks is installed, Section 8.3 of NFPA 69 allows the combustible material concentration to be as large as 60 percent of the MEC.

**Substantiation:** This statement will provide consistancy between other chapters in the document along with NFPA 69.
484- Log #82 CMD-CMM (A.11.7) Final Action:

Submitter: Mark W. Drake, Liberty Mutual Commercial Markets
Recommendation: Change A.11.7 to A.11.6.
Substantiation: The statement is misplaced and should be located under the heading 11.6 Processing and Handling.

484- Log #83 CMD-CMM (A.12.2.4.3.2) Final Action:

Submitter: Mark W. Drake, Liberty Mutual Commercial Markets
Recommendation: Delete the following text:
There is also an allowance in 8.3.1.(2) of NFPA 69 for aluminum powder production systems designed and operated in accord with the requirements of NFPA 484 to have combustible dust concentrations as large as 60 percent of the MEC.
Substantiation: A public input to revise NFPA 69 and remove the aluminum provision is being made. This will maintain consistancy throughout the document and NFPA 69.

484- Log #41 CMD-CMM (A.14.0.6 (New)) Final Action:

Recommendation: A.14.0.6 For example, pyrophoric material, molten material or thermite reaction hazards are not addressed in NFPA 654.
Substantiation: NFPA 484 predominantly applies to highly reactive, severely explosive, or fast burning metals. As a result, it is the most conservative among the occupancy dust standards. Through its scope statement, NFPA 484 also applies to marginally explosible dusts such as steel shot or sandpaper debris from polishing operations. NFPA 654 is better suited for dusts in the latter category. This revision will also alleviate some of the difficulties users will experience with the blank (reserved) sections of the new chapter 14.
Thermite reactions are extremely exothermic (e.g., temperatures in excess of 2204°C (4000°F)). A thermite reaction typically occurs between one metal oxide and another metal that reduces that oxide. The main concern is for iron oxide and fine magnesium particulate, especially powder, and molten magnesium, although there are documented instances of magnesium grinding fines initiating such a reaction. The thermite reaction is not necessarily limited to magnesium and iron oxide. There have been recorded incidents where copper oxide and/or lead oxide in contact with magnesium have created the conditions for a thermite reaction. The most well known thermite reactions are reduced magnesium or aluminum reducing iron oxide to form a magnesium or aluminum oxide. Thermite reactions can occur with other metal and metal oxide mixtures. The hazard of metal and metal oxide mixtures can be assessed using Ellingham diagrams which provide thermodynamic information about the metal oxidation reactions or through test methods like differential scanning calorimetry (DSC) or accelerating rate calorimetry (ARC). At room temperature, the affinity for oxygen in order of greatest to least is Mg, Li, Al, Ti, V, Mn, Cr, Zn, Fe, Ni, Pb, Cu, Hg, Ag. Reduced metals with a much greater affinity for oxygen will reduce metal oxides in an exothermic reaction. For instance elemental magnesium will exothermically react with iron oxide to form magnesium oxide, but elemental iron will not react with magnesium oxide. Once initiated via a heat source, a thermite reaction is vigorous and should be treated as a metal fire.

Substantiation: This explanatory material should come earlier in the section. A more general description of thermite reactions is needed for this chapter than can apply to a number of different metals.

A.14.8.3.21.1 The reaction of water and most combustible metals produces hydrogen. Hydrogen is extremely flammable and very easy to ignite. It should not be trapped in nonventilated areas of buildings, equipment, or enclosures.

Substantiation: Not all metals covered by this chapter react with water.

A.14.8.3.21.3.6 It should be remembered that wetted dust that is many wetted combustible metal dusts that are not submerged under a cover of water is are highly flammable and very dangerous.

Substantiation: Not all metals covered by this chapter react with water, nor are all metals covered by the chapter extremely flammable when wetted with water.
A.15.3.1.1 Sprinkler systems in buildings or portions of buildings where combustible metals are produced, handled, or stored can pose a serious risk for explosion. When water is applied to most burning combustible metals, hydrogen gas can be generated. When confined in an enclosed space, dangerous levels of hydrogen gas can collect and result in the potential for a hydrogen explosion. The metal will likely spread and spew burning material. Substantiation: Most but not all combustible metals covered by this chapter are water reactive.

A.15.4 The objectives in fighting combustible-metal fires are isolation and containment, rather than extinguishment. Water and other liquids have proved ineffective in extinguishing most combustible-metal fires. Streams of water intensify the fire most combustible metal fires by feeding it oxygen. There is also the possibility of causing a steam or hydrogen explosion, particularly if large amounts of combustible metal are involved. The great affinity of high-temperature combustible metal for oxygen frees a considerable amount of hydrogen, which can reach explosive concentrations in confined spaces. Entrapment of water under any burning or hot combustible metal can result in a steam explosion. Substantiation: Not all metals covered by this chapter are water reactive.