Conducting a NFPA 652 Dust Hazard Analysis (DHA): Practical Tips & Approaches

Pulp & Paper Safety Association
Safety & Health Conference
June 18, 2018

Mike Snyder PE CSP CFPS
Executive Vice President, Process Safety
Email: process-safety-usa@dekra.com
Phone: (609) 799-4449

DEKRA

Outline for Today's Discussion:

- Introduction
- Combustible Dust Basics
  - Assessing Flash Fire & Explosion Dust Hazards
  - What Makes a Dust Become a Combustible Hazard?
- Data & Information for Combustible Dust Classification
- Conducting a NFPA Dust Hazard Analysis (DHA)
- New (and Old) Requirements in IFC (2018)
- Changes in NFPA 652 (2019)
- Introduce the Table of References
- Discussion & Questions

DEKRA

DEKRA Process Safety: Serving as a Trusted Safety Advisor

- **Integrated Solutions Provider**
  - Process Safety Consulting, Engineering and Laboratory Testing
  - Combustible Dust Testing & Analysis
  - Data Management & Analytics
  - Organizational Safety
  - Organizational Reliability (Human Error & Fatigue)

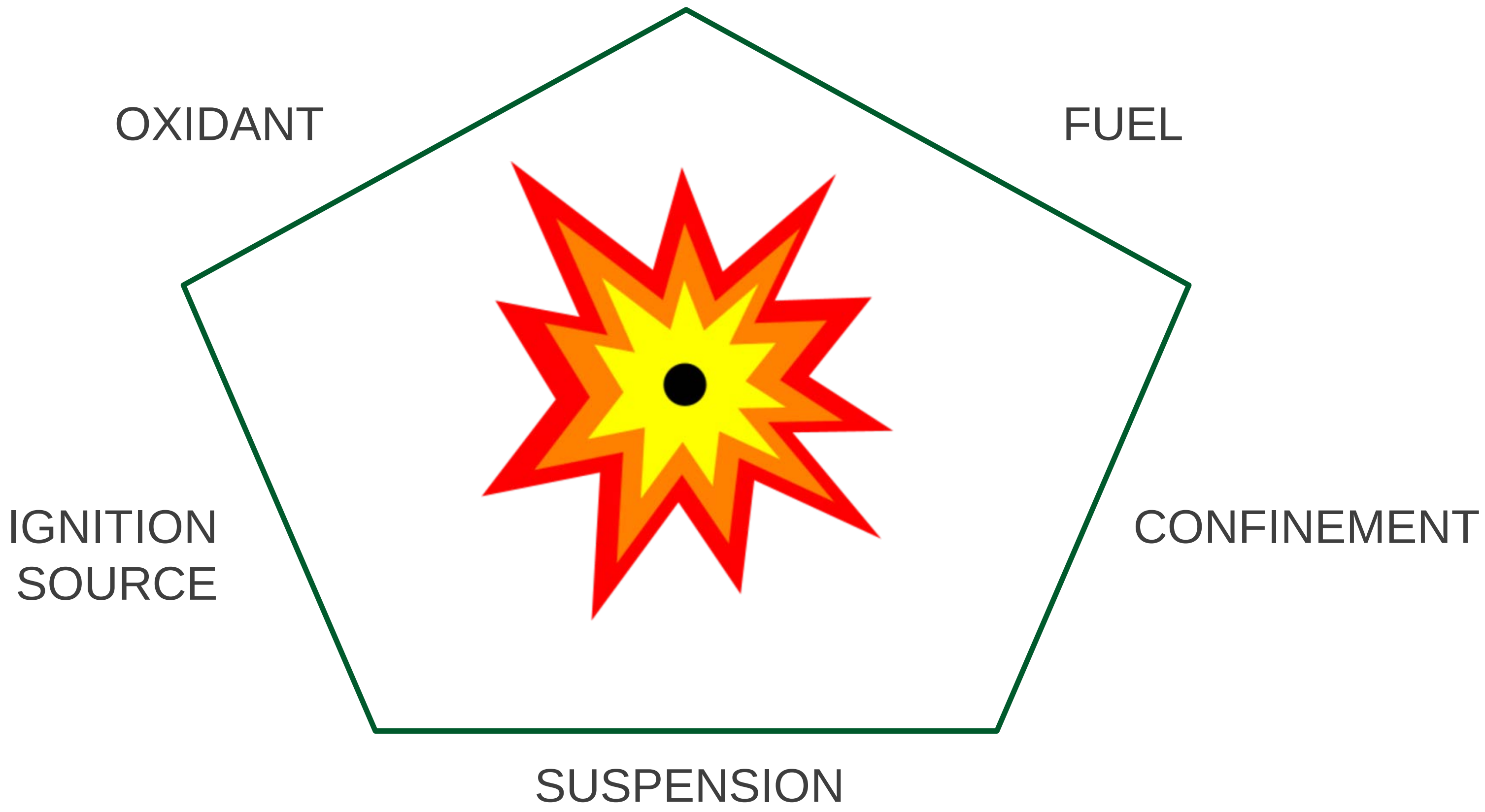
For more information:

www.dekra-process-safety.com

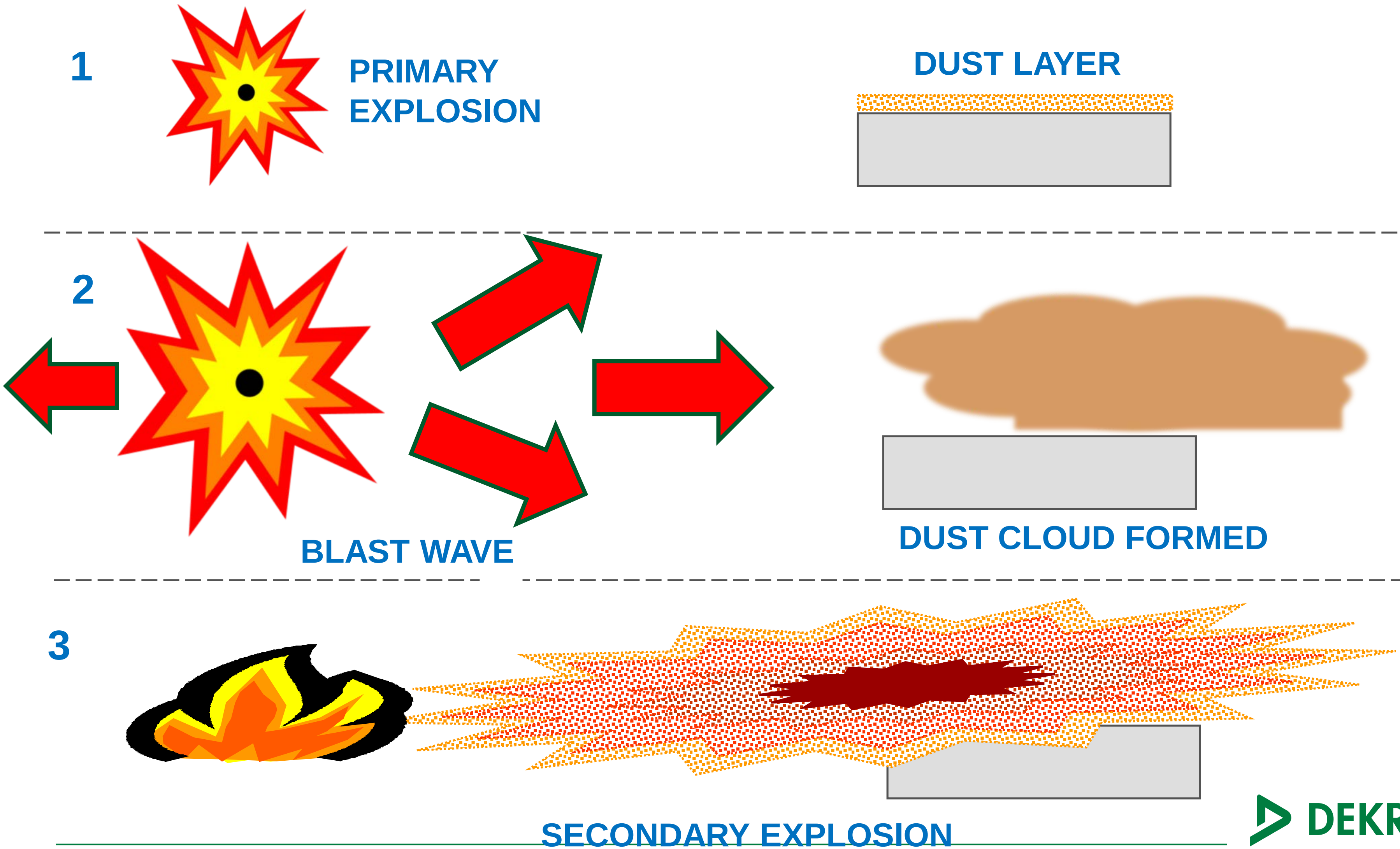
DEKRA

Combustible Dust Hazard Basics

Conditions for a Combustible Dust Fire or Dust Explosion

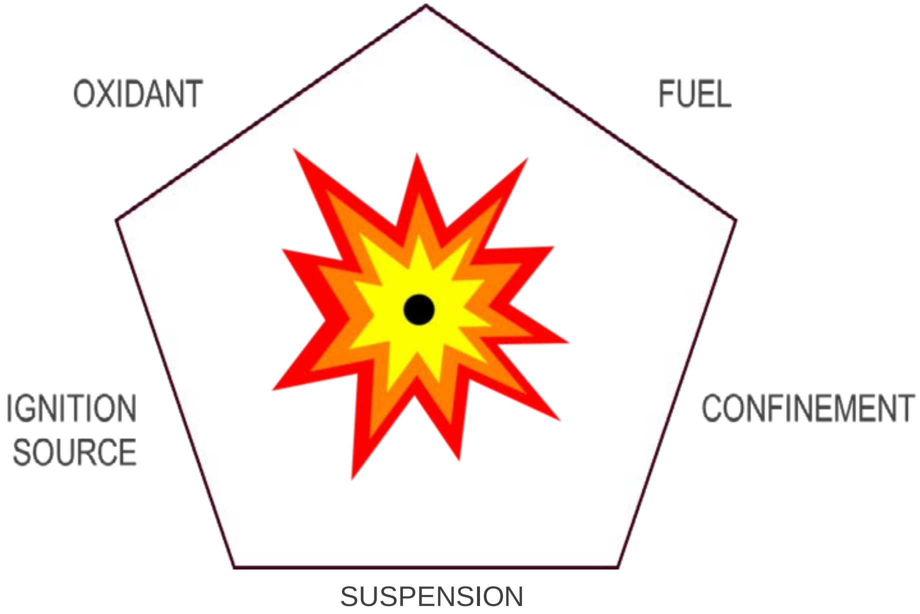


Secondary Explosions Present Additional Risks



DEKRA

Combustible Dust Fire or Dust Explosion?



Remove the CONFINEMENT Leg ➔ **Flash Fire**
Remove the SUSPENSION Leg ➔ **"Regular" Fire**
Remove any other Leg ➔ **NO Explosion or Fire!**

Assessing Combustible Dust Hazards

Cost Effectively Collecting Proper Data

DEKRA

Examples of Combustible Materials
Focus is on particles < 500 microns (35 mesh)

Agricultural Products
- Egg white
- Milk, powdered
- Milk, nonfat, dry
- Soy flour
- Starch, corn
- Starch, rice
- Starch, wheat
- Sugar
- Sugar, milk
- Sugar, beet
- Tapioca
- Whey
- Wood flour

Agricultural Dusts
- Alfalfa
- Apple
- Beet root
- Carrageen
- Carrot
- Cocoa bean dust
- Cocoa powder
- Coconut shell dust
- Coffee dust
- Corn meal
- Cornstarch
- Cotton
- Cottonseed
- Garlic powder
- Gluten
- Grass dust
- Green coffee
- Hops (malted)
- Lemon peel dust
- Lemon pulp
- Linseed
- Locust bean gum
- Malt
- Oat flour
- Oat grain dust
- Olive pellets
- Onion powder
- Parsley (dehydrated)
- Peach
- Peanut meal and skins
- Peat
- Potato
- Potato flour
- Potato starch
- Raw yucca seed dust
- Rice dust
- Rice flour
- Rice starch
- Rye flour
- Semolina
- Soybean dust
- Spice dust
- Spice powder
- Sugar (10x)
- Sunflower
- Sunflower seed dust
- Tea
- Tobacco blend
- Tomato
- Walnut dust
- Wheat flour
- Wheat grain dust
- Wheat starch
- Xanthan gum

Carbonaceous Dusts
- Charcoal, activated
- Charcoal, wood
- Coal, bituminous
- Coke, petroleum
- Lampblack
- Lignite
- Peat, 22%H_20
- Soot, pine
- Cellulose
- Cellulose pulp
- Cork
- Corn

Chemical Dusts
- Adipic acid
- Anthraquinone
- Ascorbic acid
- Calcium acetate
- Calcium stearate
- Carboxy-methylcellulose
- Dextrin
- Lactose
- Lead stearate
- Methyl-cellulose
- Paraformaldehyde
- Sodium ascorbate
- Sodium stearate
- Sulfur

Metal Dusts
- Aluminum
- Bronze
- Iron carbonyl
- Magnesium
- Zinc

Plastic Dusts
- (poly) Acrylamide
- (poly) Acrylonitrile
- (poly) Ethylene (low-pressure process)
- Epoxy resin
- Melamine resin
- Melamine, molded (phenol-cellulose)
- Melamine, molded (wood flour and mineral filled phenol-formaldehyde)
- (poly) Methyl acrylate
- (poly) Methyl acrylate, emulsion polymer
- Phenolic resin
- (poly) Propylene
- Terpene-phenol resin
- Urea-formaldehyde/ cellulose, molded
- (poly) Vinyl acetate/ ethylene copolymer
- (poly) Vinyl alcohol
- (poly) Vinyl butyral
- (poly) Vinyl chloride/ ethylene/vinyl acetylene suspension copolymer
- (poly) Vinyl chloride/ vinyl acetylene emulsion copolymer

Source: OSHA Combustible Dust Poster

DEKRA

Combustibility / Explosibility of Dusts

- Determination of combustibility or explosibility shall be permitted to be based on the following:
  - **Historical facility data or published data that are deemed to be representative of current materials & process conditions**
  - Laboratory analysis of representative samples
    - Permitted to test a sample sieved to <75μm
    - Permitted to test the as-received sample
    - Permitted to assume a material is explosible, forgoing the laboratory analysis
- Absence of previous incidents shall not be used as basis for deeming a particulate non-combustible or non-explosible

Note:

- **Test results strongly influenced by particle size, moisture content, presence of contaminants**
- **Be sure test results are representative for your material!**

DEKRA

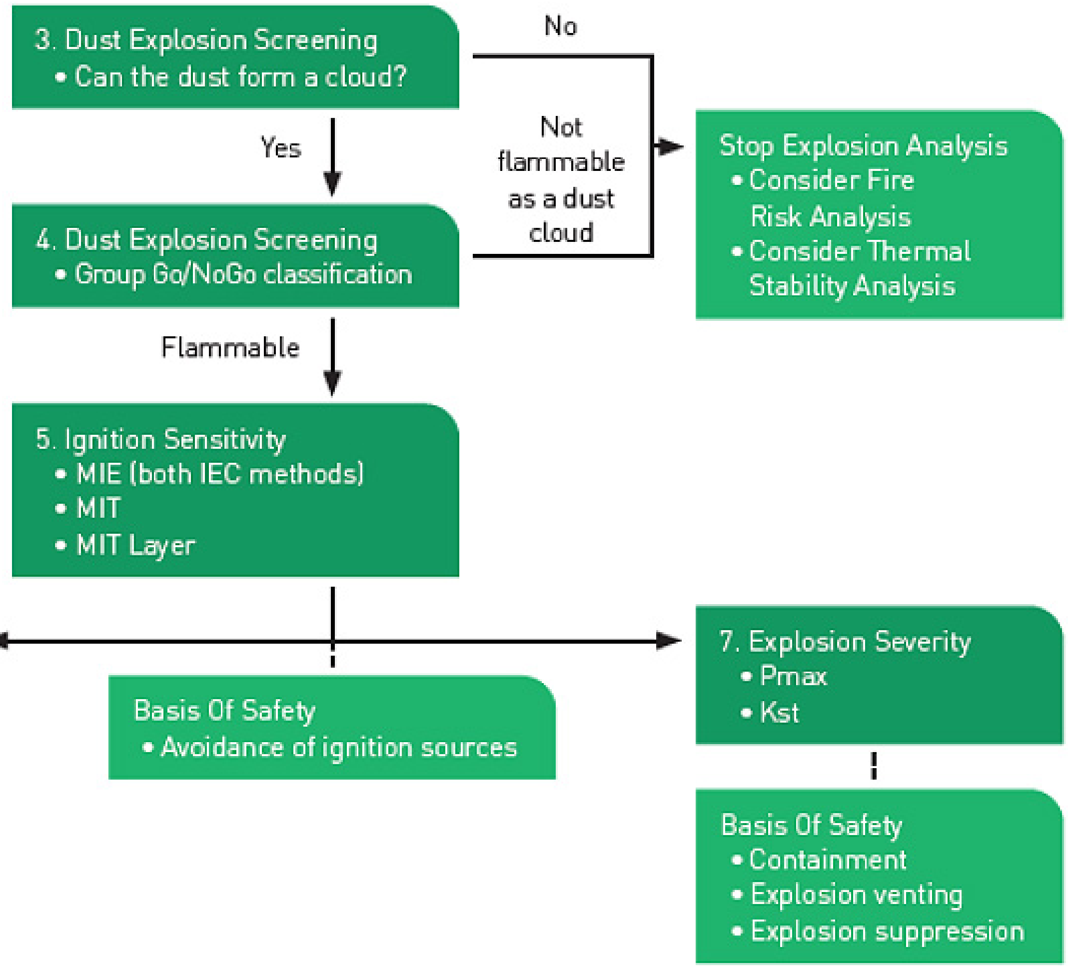
Typical Combustible Dust Tests

Test	Hazard Evaluated
Go/No Go Test (ASTM E1226)	Does the Dust Explode? (with a High Energy Ignition Source)
Minimum Ignition Energy (MIE)	The energy required to ignite a dust cloud under fairly ideal conditions.
Minimum Explosible Concentration (MEC)	The minimum amount of dust (dispersed in air) for an explosion.
Maximum Pressure Rise (Pmax) and Max Rate of Pressure Rise (Kst)	Dust Explosion Pressure Factors for Design of Containment and Relief Systems
Minimum Ignition Temperature (MIT) for Clouds and Layer	Used for Electrical Area Classification and for Dust Analysis if handled at Elevated Temperatures
Limiting Oxygen Concentration	Ignition prevention below what level of oxygen (used for inerting system design)
Electrostatic Chargeability	Determines How Easily a Material Develops and Retains Charge

DEKRA

Strategy for Dust Explosion Testing & Implications for Basis of Safety

Source:
DEKRA Process Safety SAFETY GUIDE:
A strategic guide to characterization and understanding Handling Dusts and Powders Safely



DEKRA

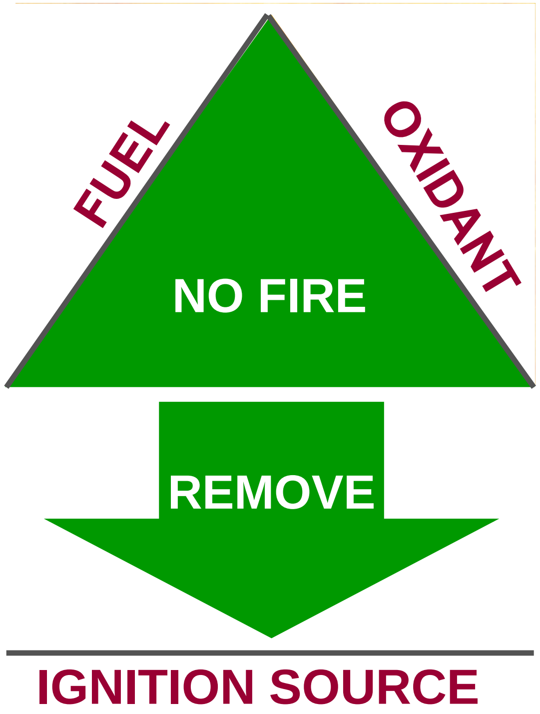
An Overview of Dust Hazard Analysis (DHA)

Establishing a Basis of Safety

Hazard Management: Prevention & Mitigation

Basis of Safety

- Avoidance of flammable atmospheres
- Elimination of ignition sources
- Provision against consequences of ignition



Managing Combustible Dust Fire and Explosion Hazards Requires…

Detailed knowledge of:

- Combustible material properties
- Process equipment
- Operating conditions
- Maintenance practices
- Existing controls (safeguards)
- and More…
- **These are Generally Collected and Analyzed through a Dust Hazard Analysis (DHA), using NFPA 652**

NFPA 652 Compliance Requirements: A Framework for Dust Hazard Management

- Owner/operator of facility with potentially combustible dust shall be responsible for:
  - Determining combustibility and explosibility hazards of materials (Chapter 5)
  - Conducting a Dust Hazard Analysis (DHA) - Identifying and assessing fire, flash fire, and explosion hazards (Chapter 7)
  - Managing identified fire, flash fire, and explosion hazards
    - Prescriptive Approach (Chapters 5, 7, 8, 9)
    - It shall be permitted to use performance-based alternative designs for a building, equipment, ignition source control, and explosion protection in lieu of prescriptive requirements in Chapter 8 (Chapter 6)
- Establishing Safety Management Systems (Chapter 9)

DEKRA

Conducting a Dust Hazard Analysis (DHA): Methodology

- Identification and evaluation where Fire, Flash Fire, and Explosion Hazards Exist
- When these Hazards Exist, Identification and Evaluation of Specific Fire and Deflagration Scenarios:
  - Identification of Safe Operating Ranges
  - Identification of Safeguards that are in place
    - Mitigation and Prevention Measures in Chapter 8
    - Aligned with Recognized and Generally Accepted Good Engineering Practices (RAGAGEP)
- Recommendation of additional safeguards when warranted, including plan for implementation

DEKRA

Conducting a Dust Hazard Analysis (DHA): Evaluation

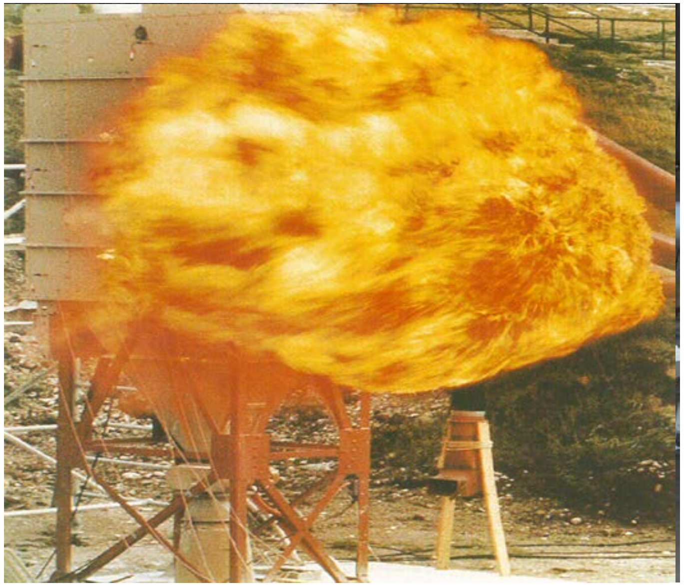
- **Process Systems**
  - When Combustible Dust is Present:
    - Oxidizing Atmosphere
    - Credible Ignition Sources
    - Suspension
  - Evaluation of Dust & Deflagration Propagation between Units
- **Building and Building Components**
    - Prevention of Fugitive Emissions
    - Dust Collection
    - Housekeeping
      - Hazardous Area (Electrical) Classification
      - NFPA 499, Tables A 6.3.2(a) and A 6.3.2(b)

DEKRA

Control of Combustible Dust Atmospheres (Control of Fugitive Emissions)

- Equipment should be maintained and operated in a manner that minimizes the escape of dust
- Continuous local exhaust ventilation should be provided for processes where combustible dust is liberated in normal operation so as to minimize the escape of dust.
  - The dust should be conveyed to dust collectors
- Regular cleaning frequencies should be established for floors and horizontal surfaces, such as ducts, pipes, hoods, ledges, and beams, to minimize dust accumulations within operating areas of the facility **(1/32 inch; 0.8 mm – with adjustments)**
  - **Warning Indicators that your Dust Accumulations are too large:**
    - **Can you tell the color of the surface below the dust?**
    - **Can you write your name in the dust?**

The Important Role of Dust Collectors



- Prevents Dust Accumulations
  - Collection & Removal of Fugitive Dusts
  - Controls Fugitive Dust Accumulations
- Key Design Considerations
  - Adequate Air Transport Velocity in Ductwork
    - Need to Prevent Dust Settling & Accumulation
  - Proper Design (and Direction) of Explosion Venting
  - Typically Installed Outdoors
  - Specific design features required to recirculate air
  - Never Store Dust in the Hopper

DEKRA

NFPA 652 (Chapter 9): Management Systems

- Operating Procedures & Practices
- Inspection, Testing, & Maintenance
- Training & Hazard Awareness
- Management of Contractors
- Emergency Planning & Response
- Incident Investigation
- Management of Change
- Documentation Retention
- Management System Review
- Employee Participation

Implications of International Fire Code (2018) on Combustible Dust Operations

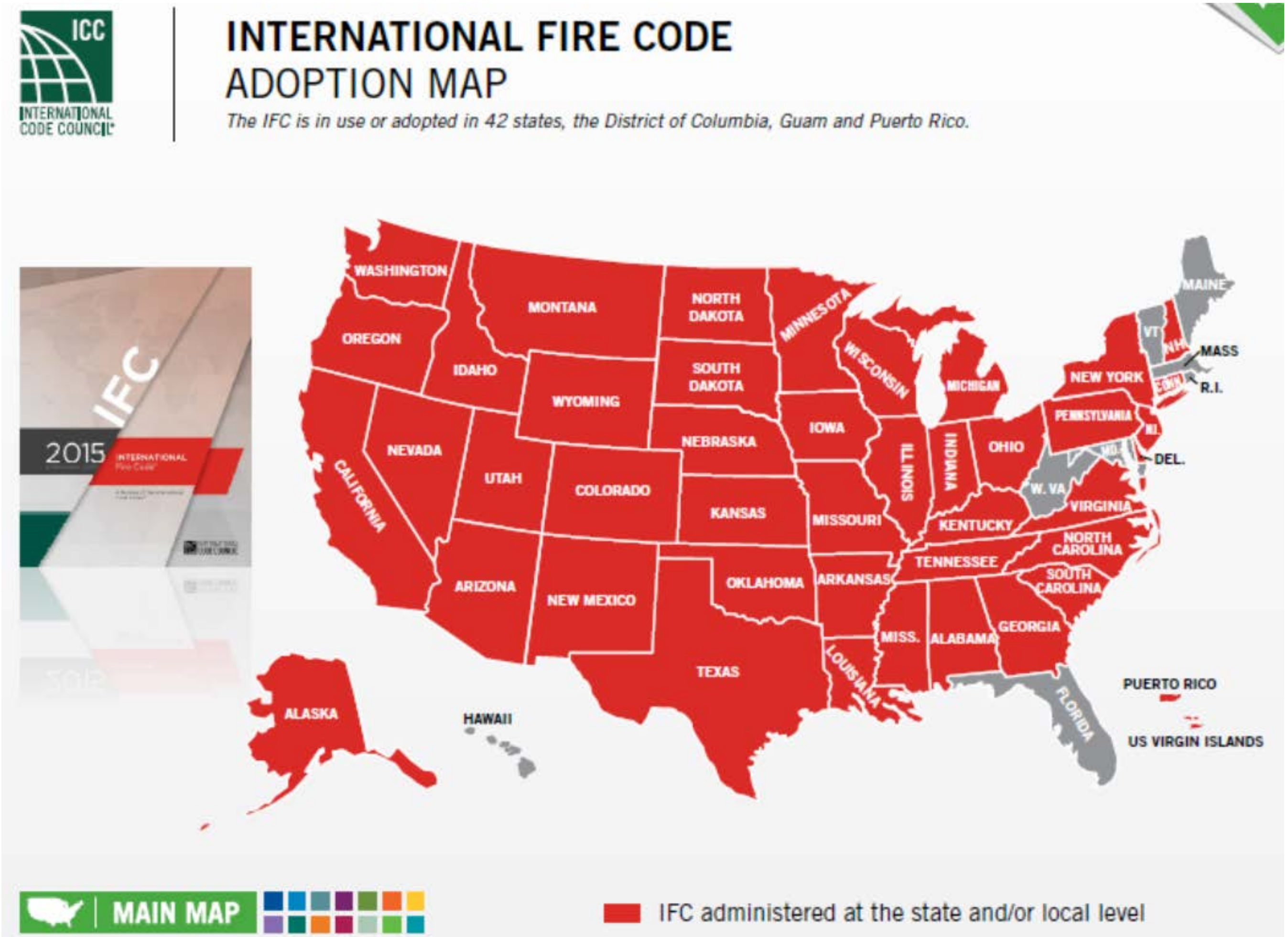
Sources of Requirements for Managing Combustible Dust

- **OSHA**
  - CPL 00-03-08 – Combustible Dust NEP
- **Non-Regulatory Requirements**
  - Insurance Company Standards (e.g. FM Global)
  - NFPA Codes & Standards
- **Building & Fire Codes**
  - Typically Adopted at Local & State Level
  - Applied for Issuance of Building Permits
  - Routine Inspections
  - Post-Incident

DEKRA

Regulatory Landscape: International Fire Code

Source:
https://www.iccsafe.org/wp-content/uploads/Code_Adoption_Maps.pdf



DEKRA

What is an Occupancy Classification?

- A classification of buildings and structures that manages the use and occupancy
- To provide a rationale criteria that is relative to fire hazard and life safety considerations
- Implications on Building Construction, Size, & Layout

- Typical Classifications
  - Group F: Factory Industrial
  - Group S: Moderate- and Low-Hazard Storage
  - Group H: High Hazard

DEKRA

International Fire Code (2018)

- **Group H Occupancy Classification**
  - Uses Tables in Chapter 50, Section 5003
  - General Rule based on “Exempt Amounts” for Storage & Use.
    - Amounts Greater than these levels become Group H
  - Adjustments allowed for Sprinkler Protection
- **Combustible Dust Classification (2012)**
  - No “Exempt Amounts”
  - Dust Manufactured or Used in a Fashion Presenting a Fire or Explosion Hazard (Table 5003.1.1(1))
    - Occupancy Group H2 Classification
  - Engineering Evaluation in Section 104.7.2 is required to quantitatively document risk analysis to <u>not</u> classify as Group H2

DEKRA

Chapter 22:
Combustible Dust-Producing Operations

- **Existing Requirements**
  - Forced air or similar methods shall not be used to remove dust from surfaces
    - More stringent than existing NFPA requirements
  - Operational permits required for operations producing combustible dusts, such as flour mills and grain elevators
- **New Requirements in 2018 Edition**
  - Dust Hazard Analysis Required (NFPA 652)
    - 3 Year Implementation Cycle
  - Explosion Protection per NFPA Industry- or Commodity- Specific Standards

DEKRA

Introducing NPFA 652 (2019)

NFPA 652 (2019): Updates & Changes

- **Issued as Consent Document (April 2018)**
- **Changes to DHA Timelines**
  - DHA must be completed for Existing Processes by Sept 7, 2020
    - 2 Year Extension from NFPA 652 (2016)
  - 5 Year Revalidation Schedule
- **Coordination with other NFPA Dust Standards**
  - 2020 Edition of NFPA 654 proposes same Deadline
  - 2020 Editions of NFPA 61 and 664 have not yet had First Draft Meetings
- **Rearrangement of Chapter 8 & Chapter 9**
  - Hazard Management: Mitigation & Prevention
  - Management Systems

DEKRA

References

Sources of Recognized and Generally Accepted Good Engineering Practices (RAGAGEP)

References (with Free Access)

- **National Fire Protection Association (NFPA)**
  - NFPA 652 (2016), Standard on the Fundamentals of Combustible Dust.
  - NFPA 654 (2017), Standard for the Prevention of Fires and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids.
  - NFPA 499 (2017), Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemicals Process Areas.
  - NFPA 68 (2018), Explosion Protection by Deflagration Venting
  - NFPA 69 (2014), Standard on Explosion Prevention Systems
  - NFPA 61 (2017), Dusts in Agricultural and Food Processing Facilities
  - NFPA 484 (2015), Standard for Combustible Metals
  - NFPA 655 (2017), Standard for Prevention of Sulfur Fires and Explosions
  - NFPA 664 (2017), Dusts in Wood Processing and Woodworking Facilities

DEKRA

References (with Free Access)

- **OSHA Dust Resources**
  - OSHA Combustible Dust National Emphasis Program
  - Firefighting Precautions at Facilities with Combustible Dust
- **FM Global**
  - FM Global, Data Sheet No. 7-76, Prevention and Mitigation of Combustible Dust Explosions and Fire (2017 Edition).
- **United Kingdom Health & Safety Executive**
  - Safe handling of combustible dusts: Precautions against explosions
- **DEKRA Process Safety**
  - **SAFETY GUIDE** : A strategic guide to characterization and understanding Handling Dusts and Powders Safely

DEKRA

Thank you for Participating in Today's Presentation

Process-safety-usa@dekra.com
Mike.Snyder@dekra.com

609-799-4449

DEKRA

DEKRA Process Safety

We help our clients to adapt PSM to their needs & to build internal PS competence

Consulting	Laboratory Testing	Competence Development
		

Consulting

Process Safety Engineering

- Dust Flash Fire & Explosion Hazards
- Gas & Vapor Flammability Hazards
- Electrostatic Hazards
- Chemical Reaction Hazards

Process Safety Management

- Program Implementation & Improvement
- Gap Analysis
- Process Hazard Analysis
- Quantitative Risk Assessments
- Consequence Modeling
- Incident Investigations

Laboratory Testing

- Combustible Dust Fire & Explosion
- Gas & Vapor Flammability
- Thermal Instability
- Chemical Reactivity
- Static Electricity
- DOT & UN Transportation of Hazardous Materials
- Explosivity / Energetic Materials
- Customized & Large-Scale Testing

Competence Development

- Courses Covering all Key Aspects of Process Safety
- Continuing Education Units (CEU's)
- Multiple Languages
- Multimedia
- Instructor-Led Content
- Computer-Based Training

DEKRA