GHS Dust Explosion Guidance

ANNEX 11
Guidance on other hazards not resulting in classification

Givaudan

engage your senses

GHS Combustible Dust Guidance

1. **In the beginning…..**
2. **Influence of US Chemical Safety Board**
3. **OSHA**
4. **UN SubCommittee of Experts on the GHS**
5. **Annex 11**

In the beginning there were…

2003 ~ Catastrophic Events

Hayes Lemmerz
(automobile industry)
Huntington, IN

- Aluminum dust explosion
- Failure to control - dust collection system
- 5 injured
- 2 dead

CTA Acoustics
(automobile industry)
Corbin, KY

- Resin dust used as a phenolic binder for fiberglass mats
- 37 injured
- 7 dead

West Pharmaceutical Services
(pharmaceutical industry)
Kinston, NC

- Rubber components
- Airborne polyethylene dust
- 40 injured
- 7 dead

U.S. Chemical Safety and Hazard Investigation Board (CSB)

2006

CSB Study

- Initiated a study of Combustible Dust (CD) explosions
- 281 incidents between 1980 – 2005 resulting in:
  - 119 worker deaths
  - 718 workers injured

Conclusion

- Employers/managers unaware of dust explosion potential
- Failed to recognize seriousness of CD hazards in facilities
- Safety Data Sheets failed to communicate:
  - Dangers
  - Preventive measures

U.S. Chemical Safety and Hazard Investigation Board (CSB)

2006

CSB takes action asking OSHA to:

- Revise HazCom requirements to include CD
- Establish a National Emphasis Program focused on CD
- Offer training through the OSHA training institute on recognition of CD
- Develop a Combustible Dust Standard
- Ask UN Sub Committee to amend the GHS to:
  - Adopt a definition of combustible dust
  - Specify CD hazards to be addressed on SDS's
  - Physical properties of CD to be included in SDS

OSHA

2007

OSHA Responds to CSB noting that:

- A combustible dust hazard study conducted by the U.S. Chemical Safety and Hazard Investigation Board (CSB) found that nearly 280 dust fires and explosions have occurred in U.S. industrial facilities over the past 25 years, resulting in 119 fatalities and over 700 injuries

OSHA initiated the National Emphasis Program (NEP) to address:

- Deflagration, fire and explosion hazards that may exist at facilities handling combustible dust
- Purpose of the NEP:
  - Inspect facilities that generate or handle CD's which:
    - Pose a deflagration or other fire hazard when suspended in air or some other oxidizing medium
    - Over a range of concentrations, regardless of particle size or shape
    - Deflagrations can lead to explosions
- Puts industry on notice:
  - General Duty Clause may be issued for deflagration, other fire, or explosion hazards

OSHA

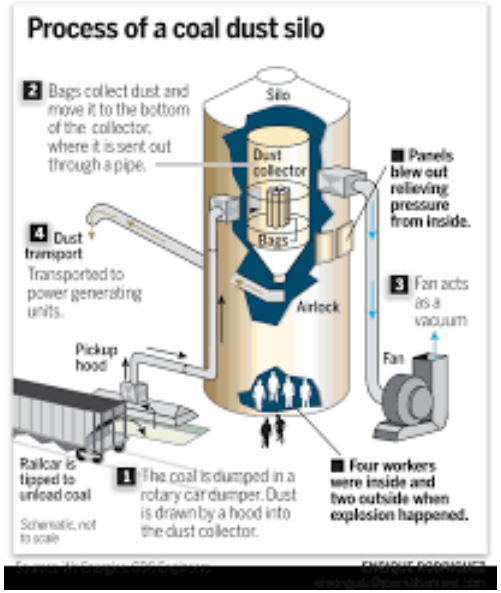
2008 & 2009 ~ Catastrophic Events

Imperial Sugar Company
Port Wentworth, GA

- Complete devastation
- 36 injured
- 14 dead

CSB Recommends

- Apply NFPA Standards
- Develop CD controls & housekeeping
- Emergency Evacuation



We Energies
Milwaukee, Wisconsin

- Coal dust silo explosion
- 8 injured
- 1 burned >50%

OSHA

2009

Commenced Rulemaking (ANPRM) in October

- Requested comments and data on issues:
  - Related to the hazards of combustible dust in the workplace
- Definition used:
  - "Combustible dust" includes:
    - Combustible particulate solids of any **size, shape, or chemical composition** that could:
      - present a **fire** or **deflagration hazard**
      - when **suspended in air** or other oxidizing medium
- Used responses to develop the proposed **standard for combustible dust**

Submitted a paper to 17th Session of the UN Subcommittee on the GHS

- CSB background statistics
- Proposed Correspondence Group be established
  - Lead by Kathy Landkrohn (OSHA)
  - Composed of other SME's in government and industry

UN Sub Committee on the GHS

2009

Correspondence Working Group created at the July session

Goals

- Collect information on dust explosion hazards from countries and Non Governmental Organizations:
  - Existing definitions or criteria for dust explosion hazards including:
    - Analytical methods
    - Methods for determining related relevant safety data
- Requirements (if any) for hazard communication on labels & SDS's
- Explosion protection concepts and safety measures
- Issues related to addressing dust explosion hazards in the GHS

UN Sub Committee on the GHS

2010

Baby steps:

- US developed survey template
- Gained agreement within the Correspondence Working Group (WG)
- Distributed to both country delegates and NGO's WG participants
- US heavily promoting the creation of a new hazard class
- Other countries - lukewarm to absolutely against a new hazard class

UN Sub Committee on the GHS

2011

Two Workstreams defined:

- Workstream 1
  - Review existing national consensus and reference regulations developed by CA's
  - Identify common pieces of information used to communicate hazards
- Workstream 2:
  - Ensure any info proposed to be included in Section 9 communicated to WG on Annex 4 Section 9

Big picture – What options are available in Purple Book?

- Create a new chapter (i.e., hazard class) in the GHS
- Focus on updating Guidance in Annex 4 only (A.4.3.2.3)
- Create a new sub category of physical hazard - Explosive hazard chapter

UN Sub Committee on the GHS

2012

Correspondence WG Meetings:

- Reached agreement that the guidance would be provided in Annex 4 of the GHS
  - Agreed on guidance for Sections 2, 5, & 7 of the SDS
    - Section 2 "**A4.3.2.3 Other hazards which do not result in classification"**
      - The statement "May form explosible dust/air mixture if dispersed" is appropriate in the case of a dust explosion hazard."
    - Section 5 "**A4.3.5.1 Suitable extinguishing media**
      - (e.g., high pressure media which could cause the formation of a potentially explosible dust/air mixture)."
    - Section 7 **"A4.3.7.1.1 Provide advice that:**
      - (c) draws attention to operations and conditions which create new risks by altering the properties of the substance or mixture, and to appropriate countermeasures

Next step: Submit a working paper to the 24th session of the Plenary

UN Sub Committee on the GHS

2013

Workstream 3 is added:

- Develop an outline or work plan for guidance, or,
- Separate chapter in the GHS containing more detailed information on the conditions under which a dust explosion hazard could be encountered

Workstream 1 report on results of surveys - Commonalities

- Qualitative definition
- Dusts of combustible materials <500 um
- Test methods (e.g., ISO 6148, ASTM 1226 and EN 14034)
- Published data on the explosibility characteristics of dusts

UN Sub Committee on the GHS

2014

Definition proposed:

"Combustible dust" means a substance or mixture that is in the form of finely divided solid particles that is liable to catch fire or explode upon ignition when dispersed in air [or other oxidizing medium].

PCI (Practical Classification Issues) WG made a further improvement:

"Combustible dust" means a ~~substance or mixture that is in the form of~~ finely divided solid particles **of a substance or mixture** that is liable to catch fire or explode upon ignition when dispersed in air [or other oxidizing medium].

UN Sub Committee on the GHS

2014

Workstream 1 – Work completed

Workstream 2 - Representatives of the Dust Explosion and Annex 4 WG's are working together to develop SDS guidance for the GHS

Workstream 3 – Tasks

1. Create definition for Combustible Dust
2. Define related criteria and contributing factors
3. Discuss hazard vs risk – Combustible Dusts in form as presented and when they are processed
4. Decide on hazard class or guidance

UN Sub Committee on the GHS

2015

Argentina Intervention

- Concern over the definition of "combustible dust" produced by flours, grains and cereals because of the trade implications that such an inclusion could produce
- Dust originated from flours, grains and cereals should not be classified as "hazardous chemical substances"
- Reasoning:
  - Flours, grain and cereal dust are not a chemical substance
  - Dust originated from flour, grain and cereal have no intrinsic explosive property
  - Dust is not a dangerous substance in itself
- Requested **explicit exclusion** from definition

UN Sub Committee on the GHS

2015

Correspondence Group response:

- Grains are chemicals processed into flours in a workplace
- Flours represent a known hazard both for workers and transporters
- 6th Revision of the GHS:
  - The GHS covers all hazardous chemicals
  - Since all chemicals in commerce are made in a workplace (including consumer products), handled during shipment and transport by workers, and often used by workers, **there are no complete exemptions** from the scope of the GHS for any particular type of chemical or product

UN Sub Committee on the GHS

2016

Thought-Starter:

- Experts from Germany, US and CEFIC developed a thought-starter for the Annex including:
  - Definitions
  - Identification of combustible dusts (flow chart)
  - Contributing factors
  - Hazard identification, risk assessment and mitigation
  - Additional information for hazard communication

UN Sub Committee on the GHS

2017

Correspondence Group January – June to fine tune

July session – Correspondence Group met to finalize Annex

Working Paper presented to the Plenary session

Success!

8th Revision of the GHS will contain

- Annex 11 Guidance On Other Hazards Not Resulting In Classification

Annex 11

"Guidance on other hazards not resulting in classification"

2014 Definition:

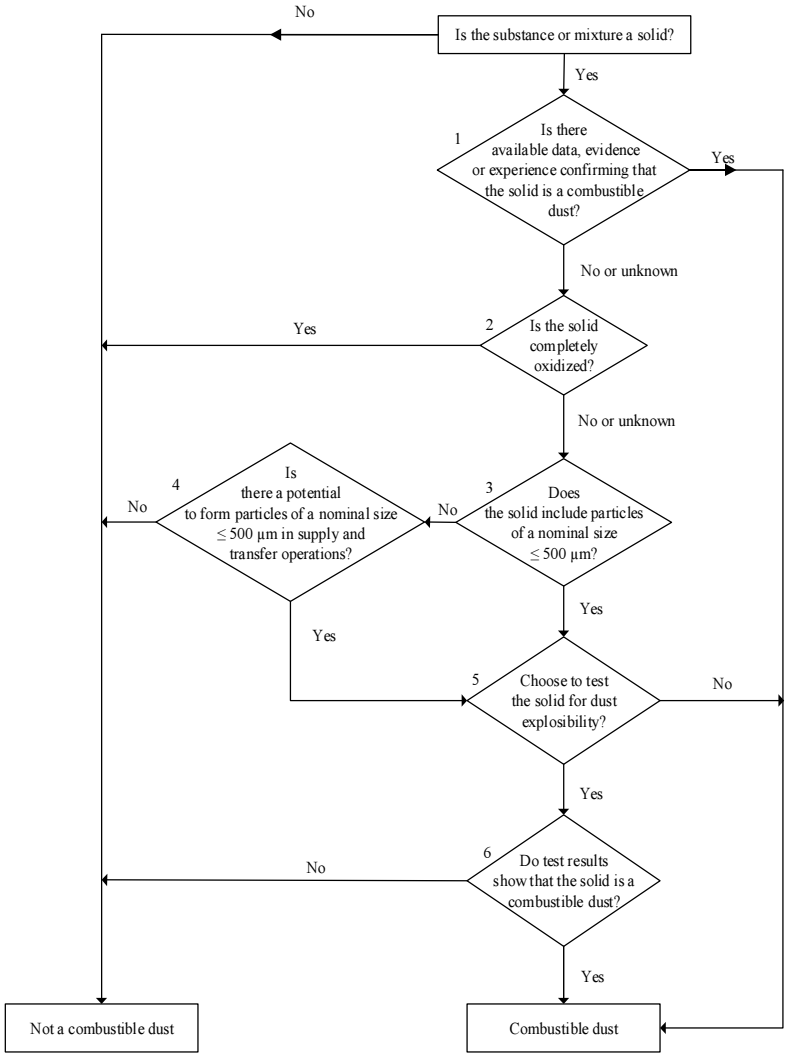
- "Combustible dust" means a substance or mixture that is in the form of finely divided solid particles that is liable to catch fire or explode upon ignition when dispersed in air [or other oxidizing medium]

Overview of Dust Explosion Hazard Annex:

- Section 2.2 Definitions
- Correspondence Group culled from recognized international and national sources
  - **Combustible dust**: Finely divided solid particles of a substance or mixture that are liable to catch fire or explode on ignition when dispersed in air or other oxidizing media

Annex 11

Section 2.3 Identification of combustible dust



Annex 11

Section 2.4 Factors contributing to a dust explosion

Section 2.4 – various factors that are considered contributors

- Particle characteristics (size and shape)
- Concentration of combustible dust
- Air or other oxidizing atmospheres
- Ignition sources with list of potentials

Annex 11

Section 2.5
Other factors impacting severity of a dust explosion

Other factors impacting severity of a dust explosion – more significant factors impacting severity

- Influence of temperature, pressure, oxygen availability, and humidity
  - ↑ Temperature may cause ↓ in MEC and MIE
  - ↑ Pressure tends to ↓ MIE and MIT while ↑ Max Explosion pressure
- Confinement
  - With confinement or without
  - Explosion pressure greater when dust is in an enclosed or limited space

Annex 11

Section 2.6
Hazard prevention, risk assessment and mitigation

Section 2.6 Hazard prevention, risk assessment and mitigation

- Table A11.2.1 General concept to prevent and mitigate dust explosions

Prevention		Mitigation
Avoidance or reduction of explosible dust atmospheres	**Avoidance of ignition sources**	**Minimizing effects of a dust explosion**
Relevant safety characteristics • *Dust explosibility* **Avoidance of combustible dusts by [examples below]** • Substitution • Passivation • Application of dust-free processes • …	**Identification of relevant ignition sources** • Identification of relevant areas and activities (zoning) • Identification of potential ignition sources • Determination of relevant safety characteristics (see below)	*Relevant safety characteristics* • *Maximum explosion pressure* • *Deflagration index (K_{st})* **Explosion pressure proof design by [examples below]** • Venting (reduction of explosion pressure) • Explosion resistance • …

- Table A11.2.2 Potential ignition sources during operations
  - Focuses on dust explosion protection during operations and processing

Annex 11

Section 2.6
Hazard prevention, risk assessment and mitigation

Type of ignition source [see A11.2.4.4.3]	Facility management	Storage	Transfer-operations			Formulation and packaging				Reaction and downstream processing				
	Construction work, repair, maintenance		Conveying (solids)	Pumping (liquids)	Other transfer operations	Mixing (no reaction)	Sieving/milling/ grinding	Formulation operations	Packaging	Reaction	Off-gas handling / scrubbing	Work-up (phase separation; crystallization; filtration, isolation)	Distillation	Drying
Hot surfaces	Caused by friction of moving parts at bearings, shaft seals, etc.					Heated equipment, pipes, heat exchangers								
Flames and hot gases	Hot work: welding, cutting, etc.	Generally not relevant								Possible formation of hot gases	Generally not relevant			
Mechanically generated sparks	Sparks generated by use of tools (e.g., hammering, drilling, grinding)		Sparks generated due to grinding, friction or impact (frequently caused by mechanical failures or entrainment of foreign parts into moving equipment or machinery)								Generally not relevant			Sparks generated due to grinding, friction or impac
Electric apparatus	Machines, process control technology installations, motors, switches, cables, lighting													
Stray electric currents and cathodic corrosion protection	Stray currents, e.g., from welding or faulty equipment	Relevant in some cases, e. g.: backflow to electricity generation plants, train tracks, vicinity of electric system with high current												
Lightning	Relevant in some cases, e. g.: thunderstorm even with invisible lightning bolts, activities near lightning protection systems													
Static electricity	Generally not relevant	Relevant in some cases	Frequently generated by flow or separation processes											
Radio frequency electromagnetic waves		Relevant in some cases, e. g.: radio transmitting station, high frequency generators for heating, curing, welding, cutting												
Electromagnetic waves		Relevant in some cases, e. g.: insolation, powerful light source, laser radiation												
Ionizing radiation		Relevant in some cases, e. g.: X-ray machine, radioactive materials												
Ultrasonics		Relevant in some cases, e. g.: ultrasound scanner, ultrasonic testing, sonic driller												
Adiabatic compression and shock waves	Generally not relevant		Compression of gases, rapidly shutting valves when conveying / pumping material			Generally not relevant				Relevant in some cases, e. g.: relaxation of high-pressure gases in pipelines, hammer blow				
Exothermic reactions	Generally not relevant	Pyrophoric and self-heating substances	Transfer of smouldering nests into other areas			Pyrophoric and self-heating substances				Strongly exothermic reaction	Self-heating and ignition of charcoal absorbers	Activated catalysts or residues	Possible decomposition of residue	Self-ignition of dust layers (esp. spray drying)

Annex 11

Section 2.7
Supplemental information for hazard & risk communication

Each party **producing or distributing a product** that is determined to be **hazardous**, including if it **becomes hazardous during downstream processing**, should create and provide their downstream user with appropriate information, in the form of a **Safety Data Sheet (SDS**) or another format as appropriate, **to alert the user to the hazards and risks**.

- Sections 2, 5, 7, and 9 of the SDS should provide information on combustible dusts
- Competent authorities may require the use of the following phrases on labels, SDS's
  - "May form explosible dust-air mixture if dispersed" or
  - "May form explosible dust-air mixture if small particles are generated during further processing, handling, or by other means."
  - The phrase "Warning" may be used in conjunction with either statement

Annex 11

Section 2.8
References - references on test methods

Test Methods

- ISO/IEC 80079-20-2, "Explosive atmospheres - Part 20-2: Material characteristics – Combustible dusts test methods"
- ASTM E1226, “Standard Test Method for Explosibility of Dust Clouds”
- VDI 2263-1, "Dust Fires and Dust Explosions; Hazards – Assessment – Protective Measures; Test Methods for the Determination of the Safety Characteristics of Dusts"

Annex 11

Section 2.8
References - references on test methods

Regulations and guidance on prevention and mitigation

- Directive 1999/92/EC of the European Parliament and of the Council (ATEX), Annex 1
- U.S. OSHA's Combustible Dust Directive (Combustible Dust National Emphasis Program)
- Health and Safety Executive, UK, HSG 103, Safe Handling of Combustible Dusts: Precautions Against Explosions
- U.S. National Fire Protection Association (NFPA)
  - NFPA 652: Standard on the Fundamentals of Combustible Dust
  - NFPA 654: Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids
  - NFPA 68: Standard on Explosion Protection by Deflagration Venting
  - NFPA 69: Standard on Explosion Prevention Systems"

Annex 4

Guidance on the preparation of Safety Data Sheets

Consequential amendment to Annex 4 of the GHS

Section A4.3.2.3

Replace the last sentence ("The statement "May form explosible dust-air mixture if dispersed" is appropriate in the case of a dust explosion hazard.") with the following:

- To communicate combustible dust hazards, and thus a potential risk of dust explosions under the approach described in Annex 11 in a standardized manner, competent authorities may allow the use of the phrases identified in A11.2.7.3 on labels, SDSs and/or in operating instructions or may leave the choice to the manufacturer or supplier

The working paper ST/SG/AC.10/C.4/2017/3 **Proposed annex to address dust explosion hazards can be found at the UNECE link shown below:**

http://www.unece.org/trans/main/dgdb/dgsubc4/c42017.html

Moral of the story…….

2017

"You can't always get
what you want,
But if you try sometime
you just might find,
You get what you need"

Thanks to Kathy Landkrohn for her patience, perseverance and leadership!

Thank you.

Barbara Lantry-Miller
DGSA
Director HazMat Compliance
NAFTA Region

Contact

barbara.lantry-miller@givaudan.com