OSHA COMBUSTIBLE DUST TESTING PRACTICES

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CAVEAT

- Presentation is based on Bob Zalosh experience as a consultant to the Dept of Labor and to companies cited following combustible dust NEP site visits.
- Presentation has neither been reviewed nor authorized by OSHA.

BACKGROUND
OSHA Basis for Combustible Dust Testing

OSHA and NIOSH in 1979 contracted with the National Materials Advisory Board (NMAB) of the National Academy of Sciences to develop recommendations for combustible dust test methods and for the classification of combustible dusts per the National Electrical Code Article 500: **Hazardous (Classified) Locations, Classes I, II, and III, Divisions 1 and 2**

Background Continued: NMAB Reports

NMAB 353-2, "Test Equipment for Use in Determining Classifications of Combustible Dusts," 1979.

NMAB 353-3, "Classification of Combustible Dusts in Accordance with the National Electrical Code," 1980.

NMAB 448, "The Explosion Hazard Classification of Gases and Dusts Relative to Use of Electrical Equpment," 1988.

NMAB 448 Recommendation 7

Establish a laboratory in the U.S. dedicated to the measurement of dust combustibility and electrical conductivity and the development of standards.

Report also described limitations of 1.2 liter Hartmann cylinder and suggested that the new lab use a 20-liter sphere similar to that of the U.S. Bureau of Mines.

OSHA Salt Lake Tech Center Combustible Dust Testing Lab became operational shortly after report.

NMAB 353-3-80, Classification of Combustible Dusts in Accordance with the National Electrical Code

Explosion Severity Index (E.S.I.)

$$E.S.I. = \frac{\left[P_{MAX}\left(dP/dt\right)_{\max}\right]_{sample\ material}}{\left[P_{MAX}\left(dP/dt\right)_{\max}\right]_{Pittsburgh\ coal}}$$

- If E.S.I. ≥ 0.5, material is classified as Class II dust
- If E.S.I. < 0.5, should use Ignition Sensitivity Index to make Class II classification determination (per NFPA 499); OSHA SLC Lab does not run Ignition Sensitivity tests unless 0.4 < E.S.I < 0.5

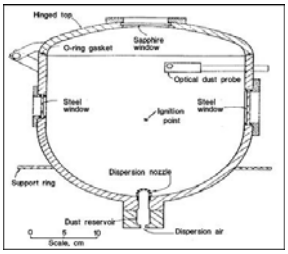
Hartmann 1.2 liter test used for E.S.I. Tests at OSHA Salt Lake Tech Center

Results are used to determine if sampled material is a Class II material such that NEC Article 502 – 504 paragraphs would be applicable to material and facility area where sample was collected.

Challenges to Use of Explosion Severity Index

- Use of 1.2 liter Hartmann cylinder has been criticized because it is not consistent with data from 20 liter and larger vessels.
- P_{max} and K_{ST} provide different measures of explosion severity and their product has no physical interpretation.
- The choice of 0.5 as a threshold value for Class II materials seems arbitrary.
- Apparently, the upcoming 2012 edition of NFPA 499 will no longer have Explosion Severity Index as an Annex criterion to determine Class II materials.

OSHA Tech Center P_{max} – K_{ST} Tests conducted in Bureau of Mines 20-liter test vessel



Maximum Normalized Rate of Pressure rise (dP/dt), $K_{ST} = (dP/dt)_{max} V^{1/3}$

1) The sample dust is suspended in a 20-liter explosion chamber. (Use 2500 J Sobbe igniters in the BoM test chamber.)

2) The dust is tested "as received" (except drying, if the moisture content is greater than 5%).

3) Test at three to five dust concentrations, from 500 g/m^3 to about 2500 g/m^3, plotting the found Dp/dt values verses dust concentration, and reporting the highest value from the plateau of the plot.

4) Test method (igniter & turbulence level) is <u>not</u> consistent with ASTM E1226 method.

OSHA Tech Center Criterion for Designating a Dust Sample as Explosive (Combustible)

Pressure Ratio (PR) ≥ 2

$$\mathbf{PR = (P_{ex,a} — \Delta P_{ignitor})/P_{ignitiona}}$$

Where:
$P_{ex,a}$ = The maximum absolute explosion pressure generated during the test.
$\Delta P_{ignitor}$ The pressure generated by the ignition source.
$P_{ignition,a}$ = The absolute pressure in the vessel at the time of ignition (typically I bara).

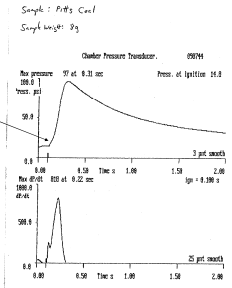
Tests conducted in Tech Center 20-liter vessel;

$\Delta P_{ignitor}$ in Tech Center vessel < $\Delta P_{ignitor}$ in ASTM E1226 test method

Example of Tech Center Benchmark Test with Pittsburgh Seam Coal Dust (400 g/m^3) Using BOM Low Turb 20-liter test vessel

Note 0.10 s ignition delay;

Compared to 0.06 s for ASTM E1226



Representative 20-liter Vessel Test Data for Pittsburgh Pulverized Coal

Parameter	ASTM E 1226	OSHA Tech Center
K_{st} (bar-m/s)	117 ± 20%	25
P_{max} (bar-g)	7.0 ± 10%	6
Pressure Ratio	~ 6.3*	6.2

* P.R. for PPC not specified in ASTM E1226

OSHA Compliance Safety Officer (CSHO) Role In Dust Testing

- CSHO decides where to take samples in facility.
- CSHO designates whether to request Class II material determination (Explosion Severity Index) or BOM low turb K_{ST} determination.
- CSHO responsible for shipping samples to Salt Lake Tech Center and receiving results.
- CSHO together with OSHA Area Director and Regional Comb Dust Reviewer decide on appropriate citations consistent with Tech Center data.

Tech Center Report for Each Sample includes Sieve Size Analysis & % Moisture

ASTM Standard Sieve Sizes

OSHA Lab usually only uses Sieve numbers 20, 40 and 200 for routine tests.

Sieve Number	Nominal Sieve Opening (μm)
40	**425**
60	250
80	180
100	150
200	**75**
230	63
325	45
400	38

Looking Ahead to Some Mountainous Issues in OSHA Combustible Dust Testing

- Will OSHA draft regulation on combustible dust continue to use the same test methods and test criteria to determine if a material sample is combustible or a Class II material?
- Will Tech Center have sufficient staff and resources to continue to provide the needed dust testing for all the OSHA federal district offices; for state plan offices?

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