OFFICE OF MINE SAFETY AND HEALTH RESEARCH

# Rock Dust Partnership Meeting

## August 20, 2013

CDC Workplace Safety and Health

NIOSH National Institute for Occupational Safety and Health

AB85-COMM-8-2

# Agenda

- Opening remarks
- OMSHR progress
  - Proposed guidelines
  - In-mine studies
  - Caking tests
- Industry discussion
- Action Items
- Concluding comments





# Opening Remarks

- Mark Ellis, IMA-NA
- Emily Coyner, NSSGA
- Hunter Prillaman, NLA
- George Gardner, MSHA





# Current Rock Dust Definition 30 CFR 75.2

- Pulverized limestone, dolomite, gypsum, anhydrite, shale, adobe, or other inert material, preferably light colored
- 100% <20 mesh, 70% <200 mesh
- When wetted and dried will not cohere to form a cake which will not be dispersed into separate particles by a light blast of air
- Does not contain more than 5 percent combustible matter or more than a total of 4 percent free and combined silica ($SiO_2$), or, where the Secretary finds that such silica concentrations are not available, which does not contain more than 5 percent of free and combined silica





# What do we know?

- Rock dust must be dispersible in sufficient quantities to be effective in preventing explosion propagation
- Coal dust is hydrophobic (does not wet; remains dispersible); rock dust is hydroscopic (wets and forms non-dispersible cake)
- Rock dust does not meet the non-caking requirement of 30 CFR 75.2
- Coal dust is generated continuously while rock dust is most often applied intermittently resulting in stratified layers





# What do we know?

- The 80% incombustible content (IC) required to prevent explosion propagation is based on dry homogeneous mixtures of coal and rock dust - not stratified layers
- A thin stratified layer of float coal dust on top of dry dispersible rock dust requires over 90% IC to prevent explosion propagation
- No amount of dispersible rock dust on the floor can compensate for explosible accumulations of fine rib/roof coal dust
- Dispersible rock dust on the roof and ribs can compensate for explosible accumulations of coal dust on the floor
- Rock dust particles >200 mesh (>75 µm) are not effective in inerting coal dust explosions





# Major Outcome and Impact

- 47% of 393 rock dust samples contained less than 70% passing through 200-mesh sieve
- Noncompliant rock dust was found at 51% of the 278 mines sampled
- In October 2011, NIOSH issued a Hazard ID on non-conforming rock dust
  - Mine operators test rock dust to ensure it meets the requirements of 30 CFR 75.2
  - Rock dust manufacturers test their product and provide documented assurance that it meets the requirements of 30 CFR 75.2

# Other Issues Not Addressed by the Hazard ID

- Compliance testing was not conducted
- The intent was to use rock dust in both dry and wet conditions, however:
  - all rock dusts cake when wetted and dried
  - no rock dust will meet the caking requirement
- No standard test methods identified:
  - to determine dispersibility
    - when wetted and dried will not cohere to form a cake
    - light-blast-of-air
  - to determine compliance with particle size requirements
- No justification found for permitting up to 5% combustible matter in a rock dust





# Key Factors Impacting Rock Dust Effectiveness

- Must consist of inert material(s)
- Must be of fine enough size to rapidly extract heat from the combustion front to reduce the flame temperature below the minimum level needed to support sustained flame propagation
- Must be dispersible in sufficient quantity to inert
- Must not contain combustible matter that reduces inerting effectiveness
- Must not exceed silica requirements





# Must consist of inert material(s)

- Only limestone and/or dolomite are used
- The future use of other inert materials would be based on performance testing to meet the requirements of the new standard

Proposed change

- From
  - *Pulverized limestone, dolomite, gypsum, anhydrite, shale, adobe, or other inert material, preferably light colored,…*
- To
  - *Pulverized limestone, dolomite, or other inert material, preferably light colored,…*





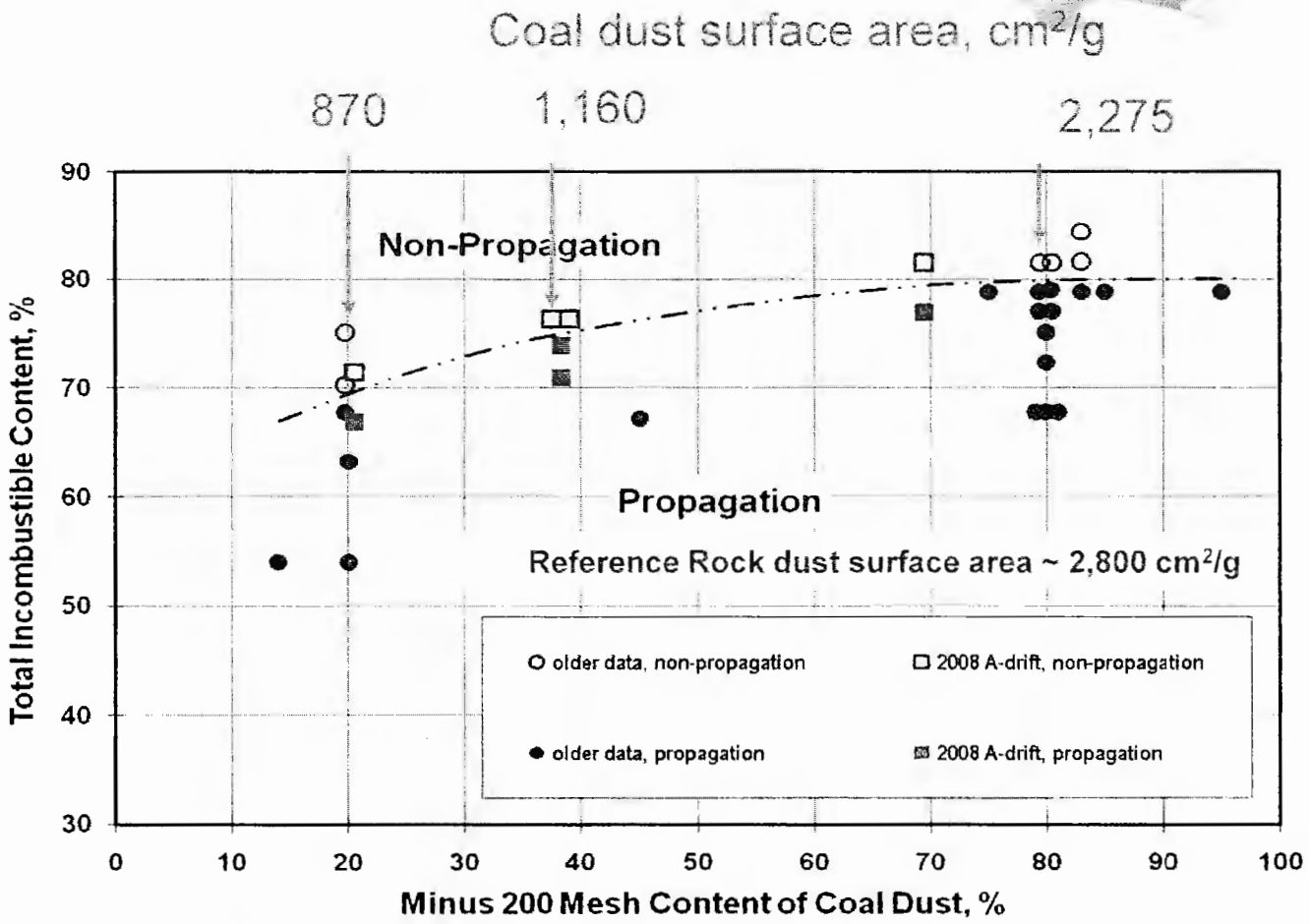
# Particle Size

100% <20 mesh, 70% <200 mesh

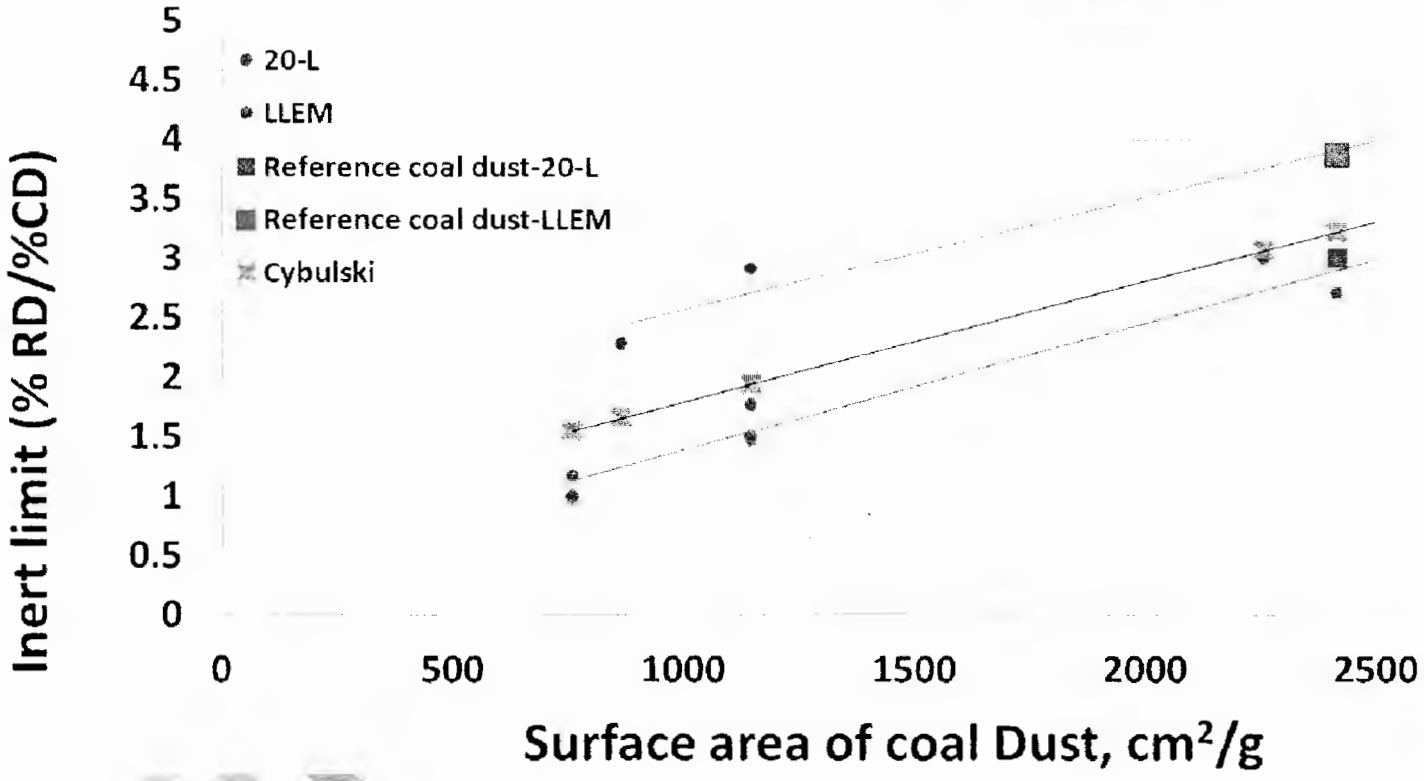




# Lake Lynn Experimental Mine Inerting Limits




# Inerting Requirement as a Function of Coal Dust Surface Area



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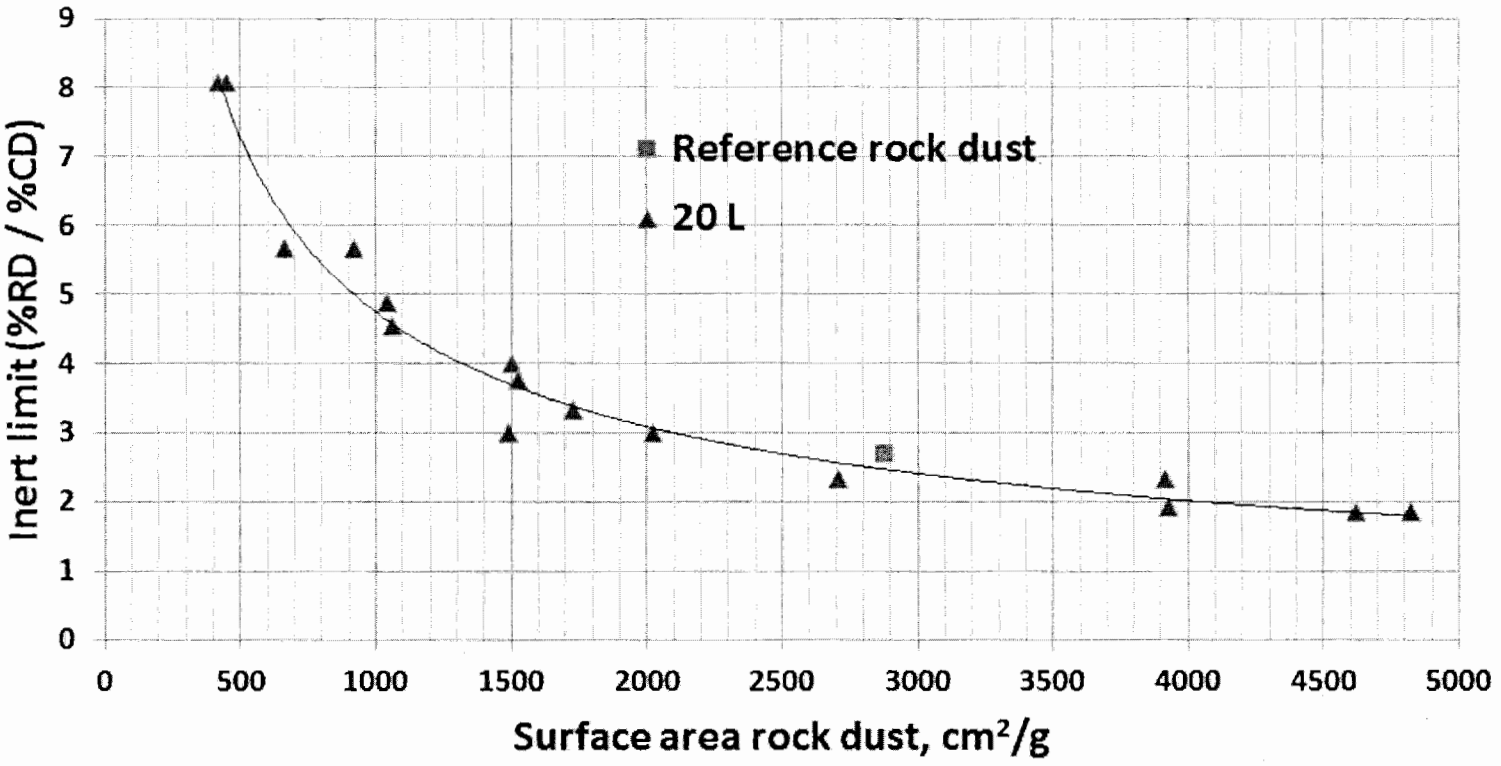
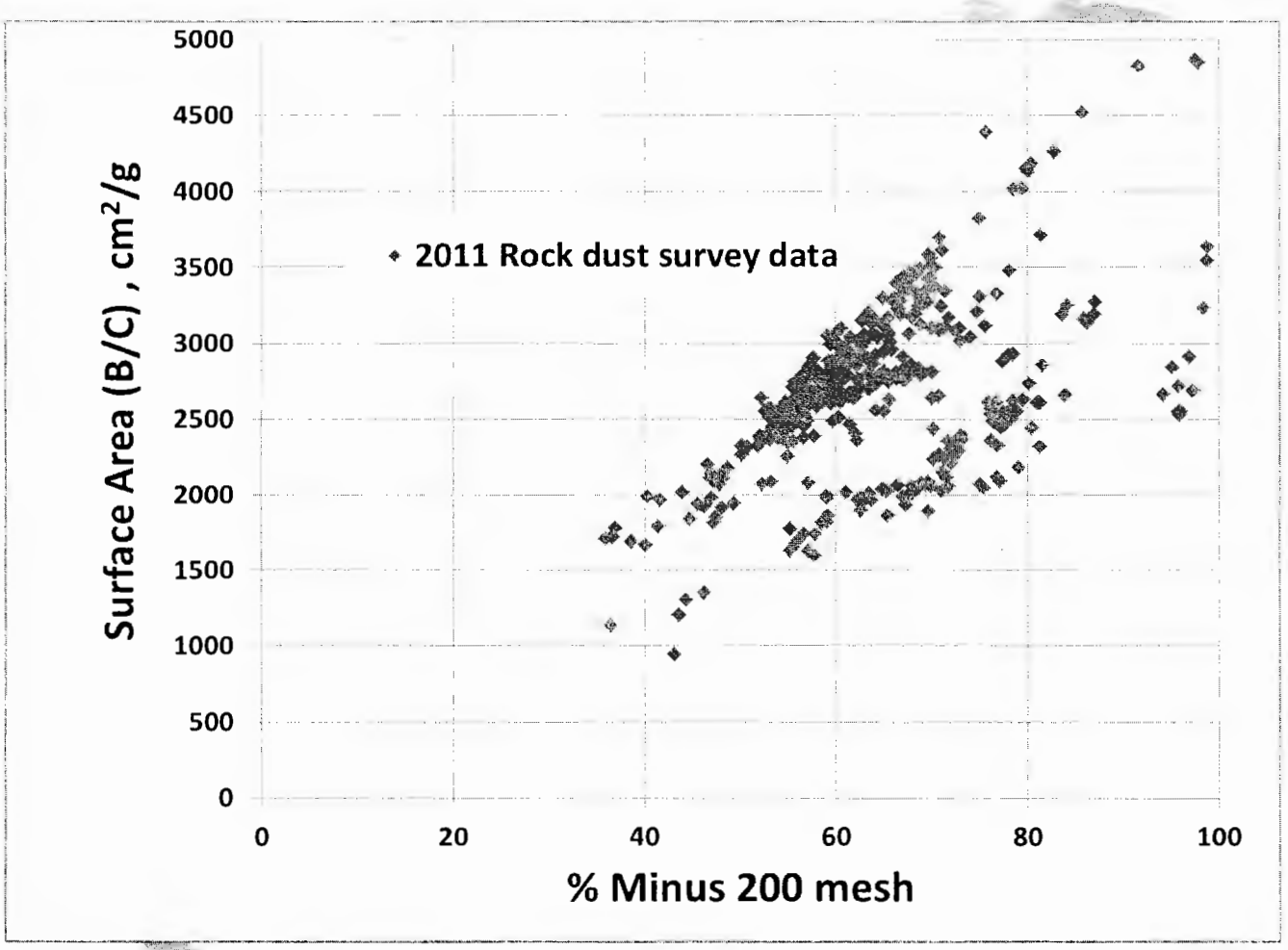
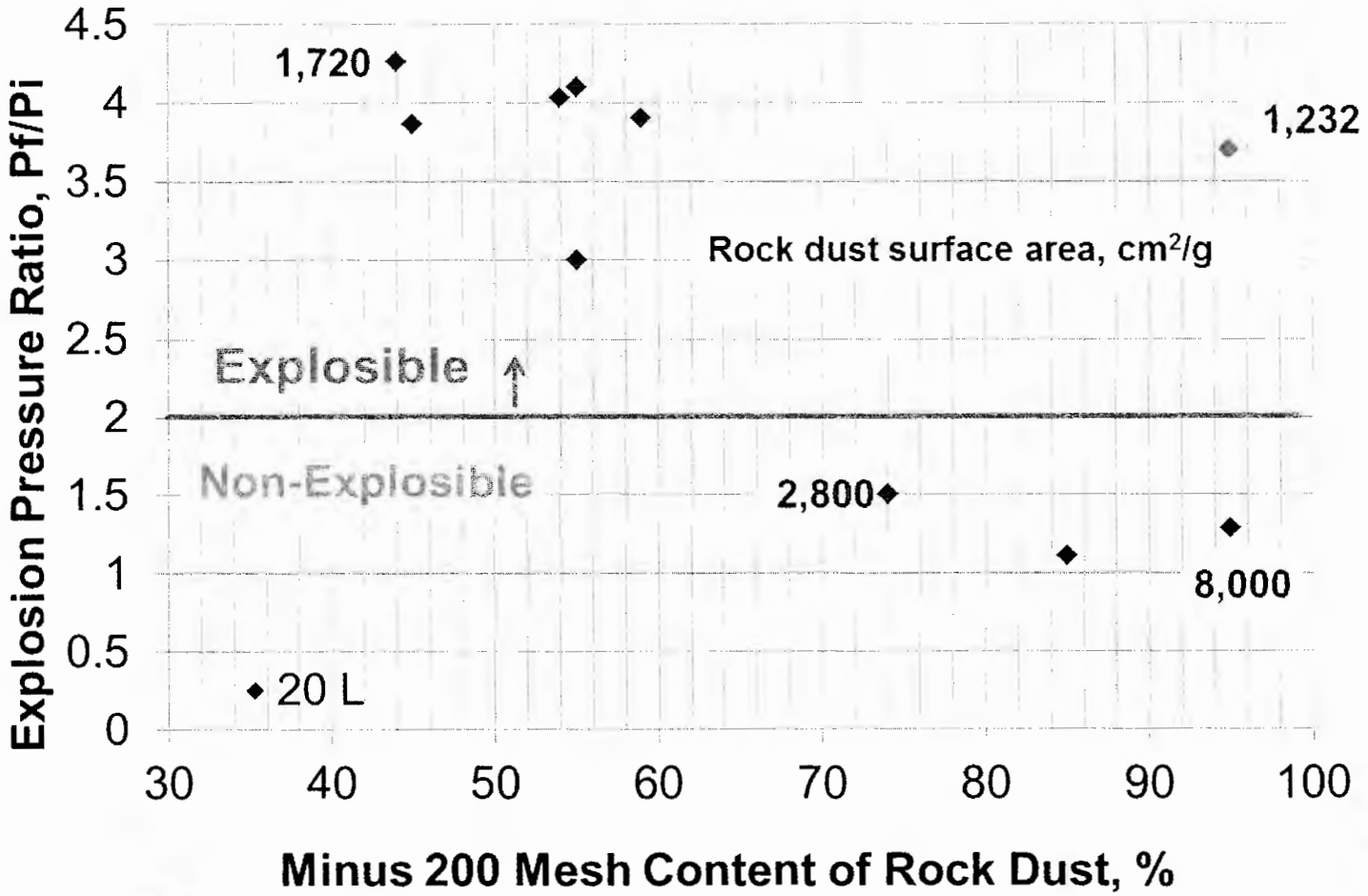


# Surface Area of Rock Dust Survey






# 20-L Chamber Inerting Limits




# Experimental Observations

- A dispersible rock dust must have a minimum surface area of ~ 2,800 $cm^2/g$ to inert an average sized coal dust at the current 80% level in the absence of methane (LLEM testing)

- Rock dust particles >200 mesh (>75 µm) provided little benefit to coal dust inerting (20-L chamber testing)

- Coal dust particles >60 mesh (>250 µm) do not contribute to explosion propagation (20-L chamber testing)





# Must be of fine enough size...

Proposed change

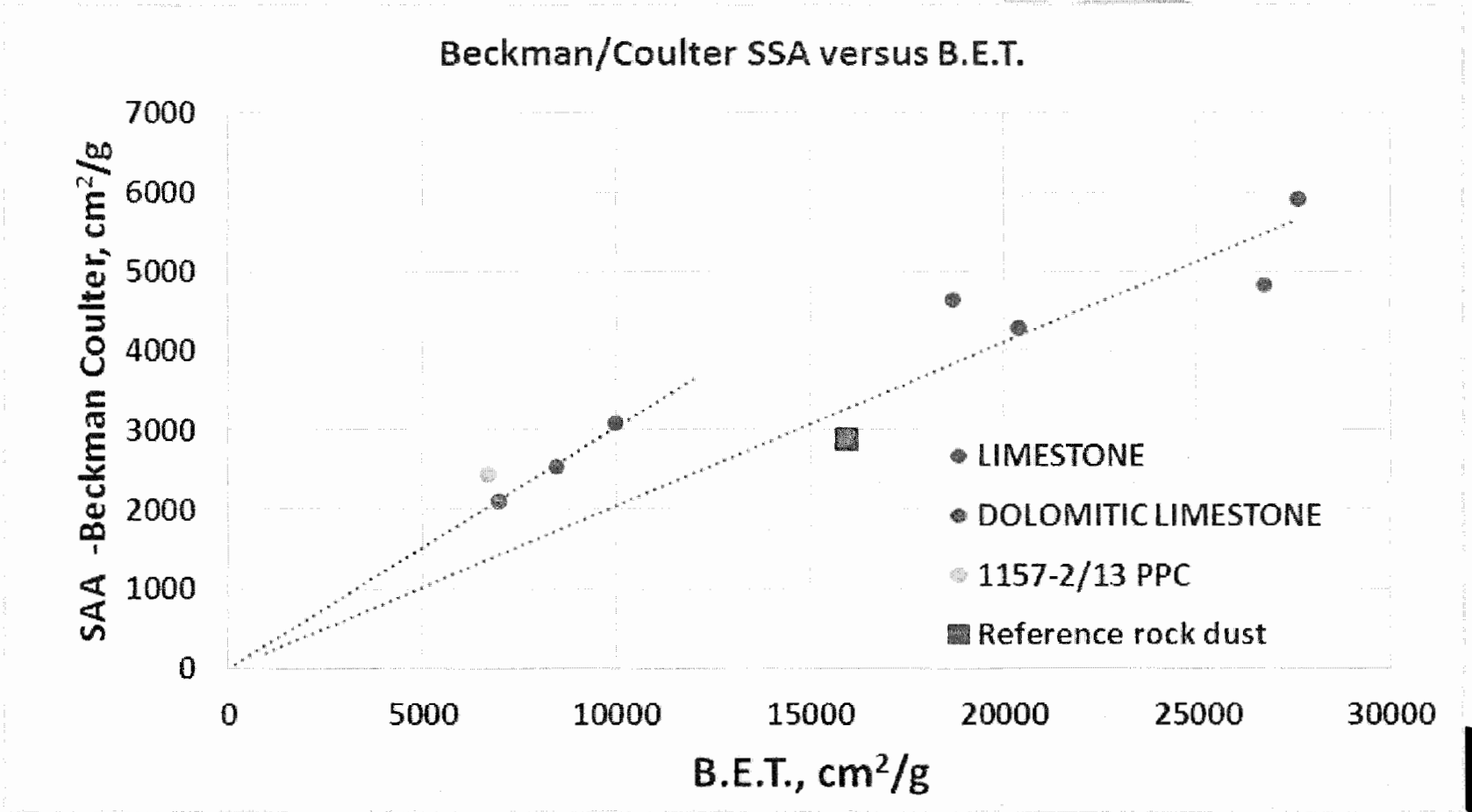
- From
  - *..., 100 percent of which will pass through a sieve having 20 meshes per linear inch and 70 percent or more of which will pass through a sieve having 200 meshes per linear inch;...*
- To
  - *..., 100 percent of which will pass through a sieve having 60 meshes per linear inch, 95 percent or more of which will pass through a sieve having 200 meshes per linear inch, and with a minimum surface area of ~ 4,240 $cm^2/g$;...*

– Methods
  - Size analysis - Air jet sieve or equivalent
  - Surface area
    - laser diffraction particle size analyzer using dry dust (spherical)
    - B.E.T. gas adsorption – nitrogen (to be determined)
      - Issues with porous limestone





# Surface Area Determination



# Dispersibility

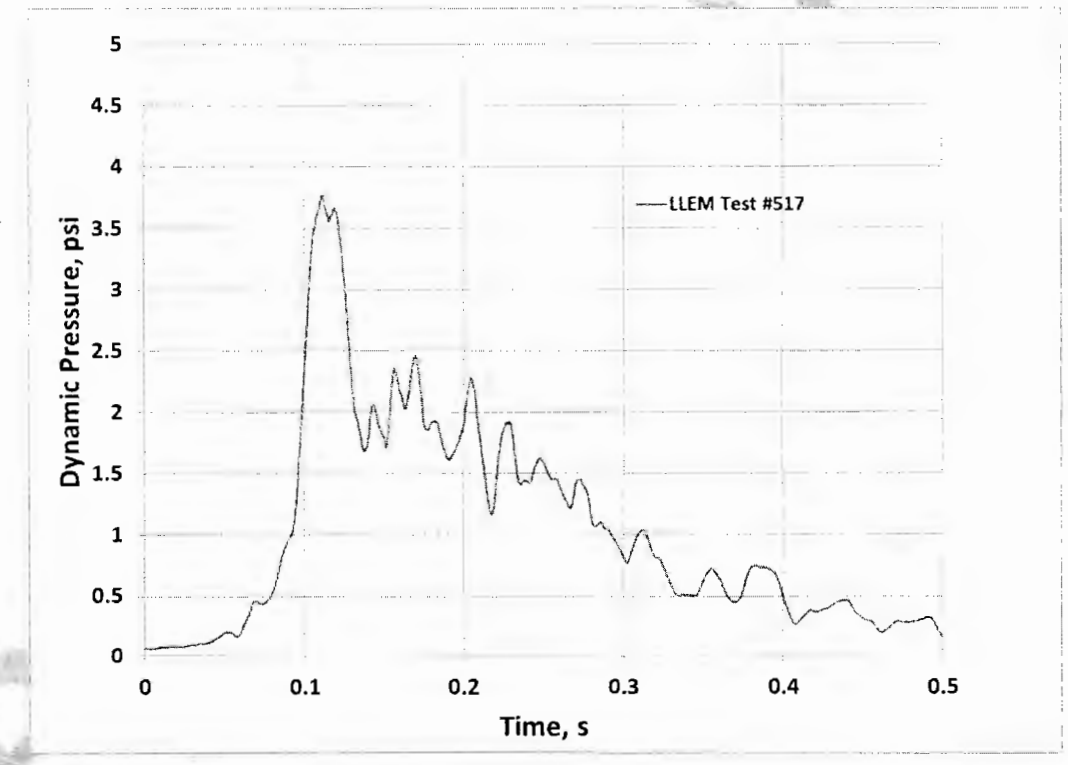
When wetted and dried will not cohere to form a cake which will not be dispersed into separate particles by a light blast of air





# Quantitative Assessment of Dispersibility

- *"light blast of air"*
  - Based on LLEM coal dust explosion data

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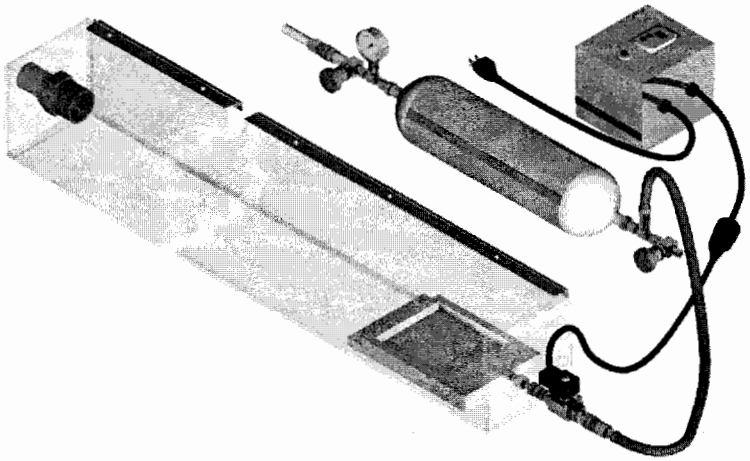

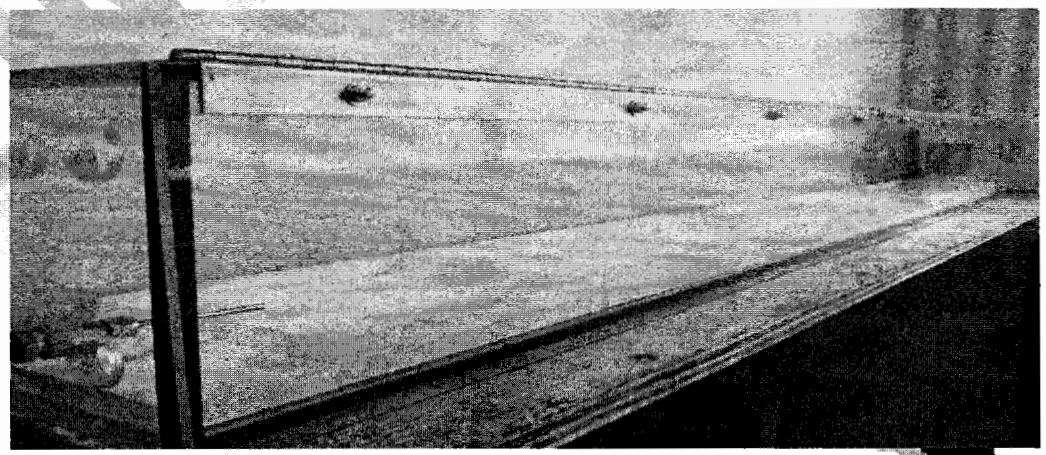



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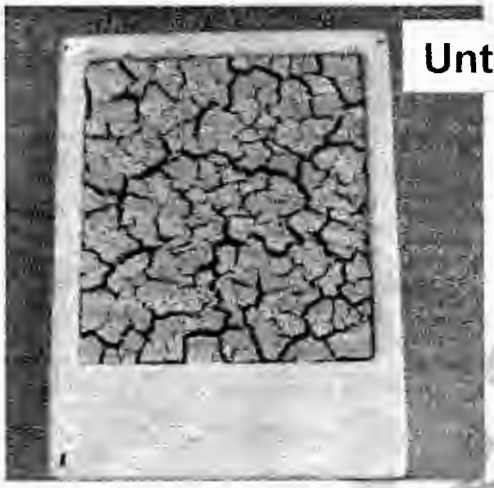
# Quantitative Assessment of Dispersibility

- Wicking
  - From the bottom
  - Exposure to long-term high humidity
- No degradation in dispersibility after moisture exposure



**Untreated rock dust exposed to water**

**Treated rock dust exposed to water**

**Treated rock dust with a layer of float coal dust exposed to water**

# Must be dispersible

- *…; the particles of which when wetted and dried will not cohere to form a cake and will disperse into separate particles by a defined pulse of air;*

– Methods for consideration
  - Cake tendency and strength
  - Dust dispersion chamber using wetted then dried dust
  - 20-L chamber testing (additives)
  - Manufacturer to define test method to verify additive concentration





# Combustible Matter

Does not contain more than 5 percent combustible matter





# Must not contain combustible matter that reduces inerting effectiveness

**20-L explosibility chamber**

| | |
|---|---|
| 0 | 75 |
| 2 | 75-80 |
| 5 | 85 |

# Must not contain combustible matter that reduces inerting effectiveness

Proposed change

- From
  - *…; and which does not contain more than 5 percent combustible matter…*
- To
  - *…; and which does not contain more than 1 percent combustible matter, …*
  - Method
    - Low temperature ashing test





# Must not exceed silica requirements

Proposed change

- From
  - *…[must not contain] more than a total of 4 percent free and combined silica ($SiO_2$), or, where the Secretary finds that such silica concentrations are not available, which does not contain more than 5 percent of free and combined silica.*
- To
  - *…[must not contain] more than a total of 4 percent free and combined silica.*

  – Methods
    - MSHA's gravimetric method (similar to ASTM C-25)
    - X-ray fluorescence analysis (free and combined silica)



# Initial Certification

Conducted by rock dust manufacturer

- Particle size (surface area determination)
- Dispersibility chamber
- Additive concentration (within acceptable tolerances)
- ASTM test methods for cake strength
- 20-L chamber
- Silica
- Health hazards (provide supporting data)





# Verification – Quality Control

Routinely - rock dust manufacturer/supplier

Spot check - mine operator and MSHA

- Particle size (surface area determination)
- Additive concentration (within acceptable tolerances)
  - Simple cake test (Mine)
  - Method as determined by manufacturer
- Silica – current acceptable method
- Low temperature ashing (to verify % combustible matter, 515°C)
- MSDS





# Parameters for a New Rock Dust Definition (30 CFR 75.2)

- Pulverized limestone, dolomite, or other inert material, preferably light colored;
- 100% <60 mesh, 95% <200 mesh, ~4,240 $cm^2/g$ surface area;
- When wetted and dried will not cohere to form a cake and will disperse into separate particles by a defined pulse of air;
- Must not contain more than 1 percent combustible matter; and
- Must not contain more than a total of 4 percent free and combined silica.





# Key Attributes of the New Definition



- Provides better protection against propagating dust explosions
- Eliminates up to 30% ineffectual rock dust particles (>200 mesh)
- Provides rock dust that will not cake and remains dispersible





# Key Attributes of the New Definition

- Provides for better size balance between the airborne distribution and deposition of coal and rock dust
- Provides performance criteria and methods for certification that the rock dust meets the new 30 CFR 75.2
- Provides quality control methods that MSHA and mine operators can use to spot check the compliance of the rock dust supply





Overarching concern is to provide effective rock dust to prevent a propagating coal dust explosion





# Action Items

- Keep partnership updated
- Next meeting – March/April 2014
- Surface area determination
- Minus 200 mesh tolerance
- Follow-up on compliance survey (particle size)





# Closing Remarks

- IMA-NA
- NSSGA
- NLA
- MSHA
- OMSHR





# Thank You