Discussion Topics

- Full-scale explosions
- Need for laboratory testing
- Testing at Polish Central Mining Institute
- Particle size analyses
- Tests for inerting potential
- Assessing dispersibility
- In-mine assessments

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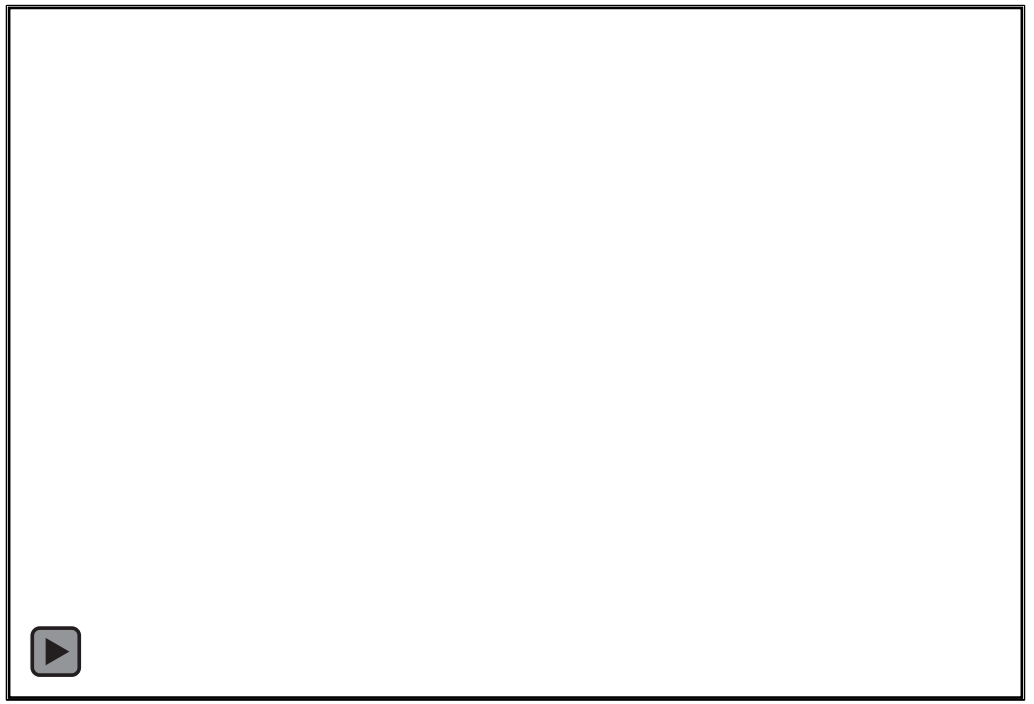
Full-scale Explosion Tests

- Processes are physical and chemical in nature
  - Dynamic
  - Multi-step
- Can only be systematically evaluated and decisively confirmed through large-scale explosion tests
- Approach followed by major coal producing countries



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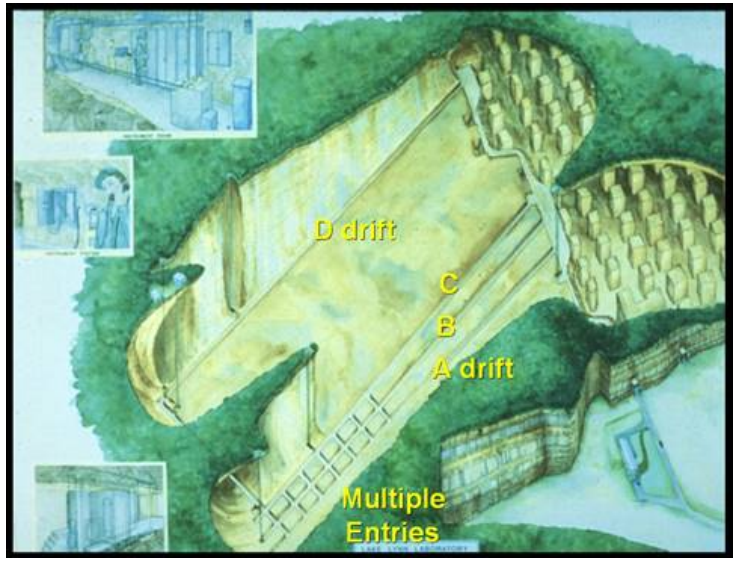
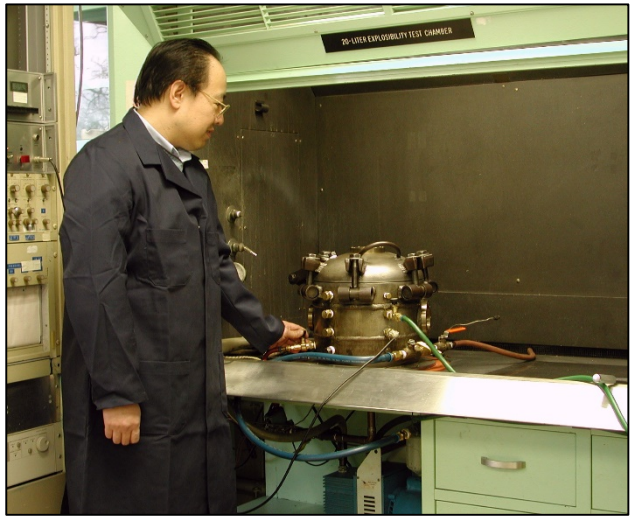
Laboratory-Scale Test Method Development

- Key explosion properties, identified through large-scale tests, served as the basis for developing lab-scale test methods, using common reference materials
- Parallel lab-scale tests allowed researchers to identify relevant parameters for testing rock dust





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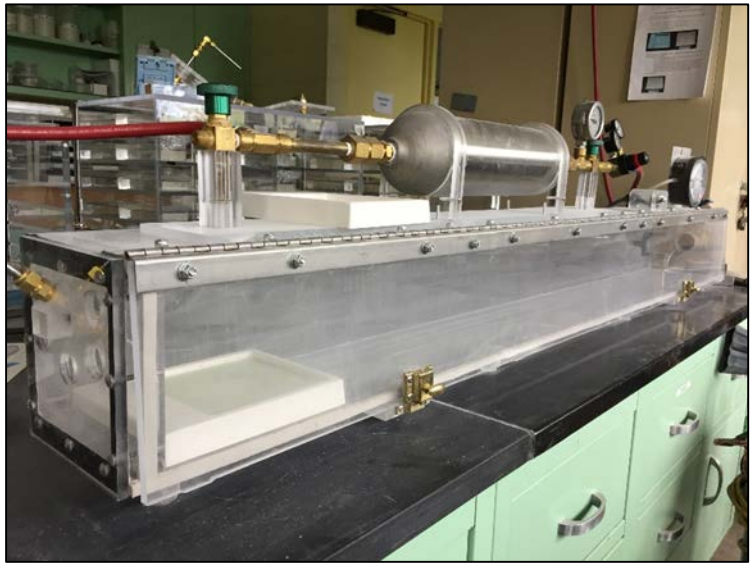
Laboratory-Scale Evaluations

Rock dust samples are evaluated in the lab to determine if they meet the criteria for full-scale testing

Tests include:

- Beckman-Coulter particle size analyzer
- 20-L explosibility test chamber
- Dust dispersion chamber
- Field dispersibility

The performance of a rock dust is compared to a reference rock dust already found to be effective in large-scale explosion tests



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Testing at Polish Central Mining Institute

- Rich history of collaboration between the Bureau of Mines/NIOSH and Central Mining Institute scientists
- Polish mine geometry very similar to Bruceton
- Reference rock dust and coal dust used is similar to Poland
- Very little variability in interior surface temperatures of underground galleries
- Similar-sized stearate treated and untreated rock dust readily available at Poland
- Barbara coal dust similar to Pittsburgh coal dust (volatility and heating value)

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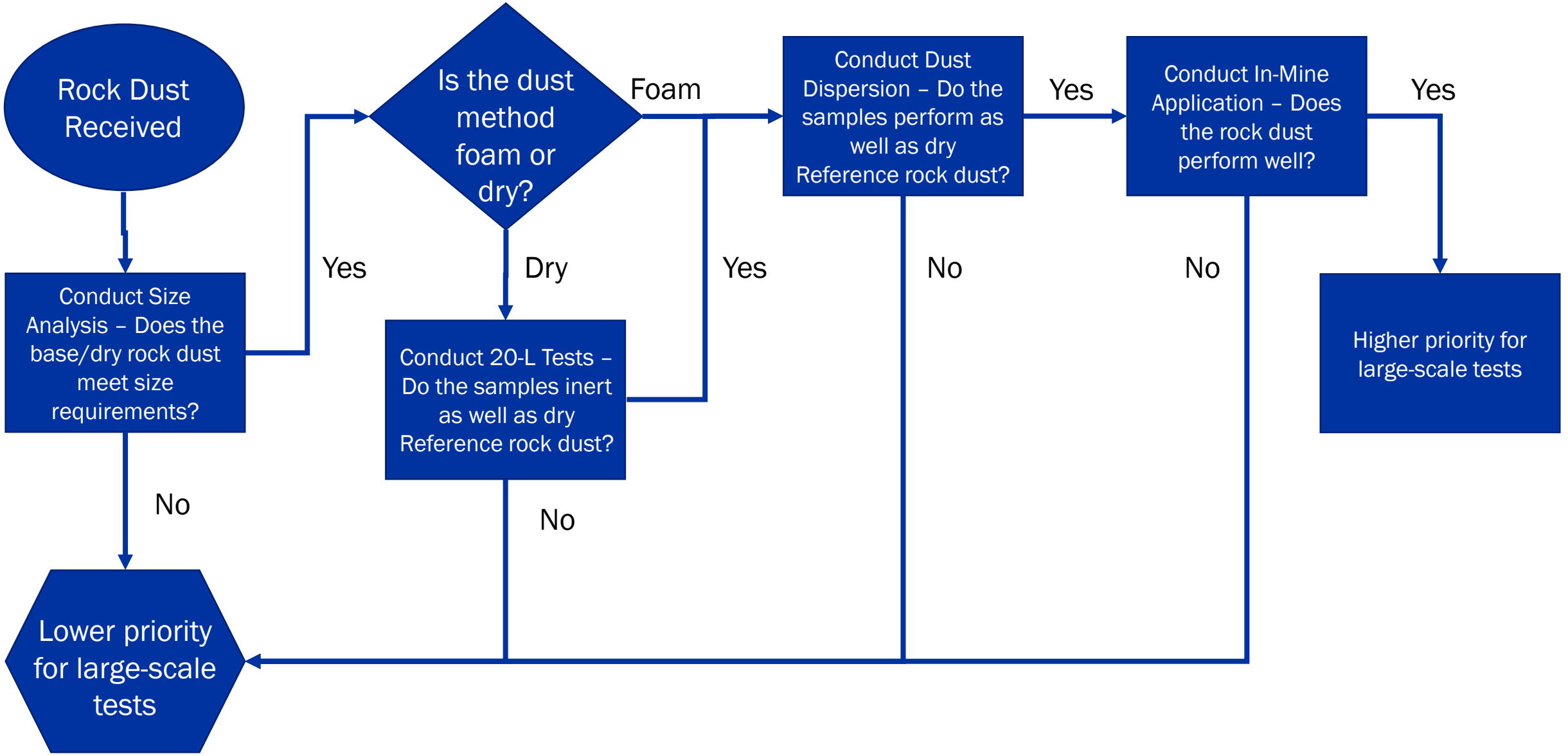
Rock Dust Assessment



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Laboratory-Scale Evaluations

Dry Rock Dust	Foam Rock Dust
Size analysis	Size analysis
20-L chamber	Dispersion chamber
Dispersion chamber	In-mine evaluation
In-mine evaluation	

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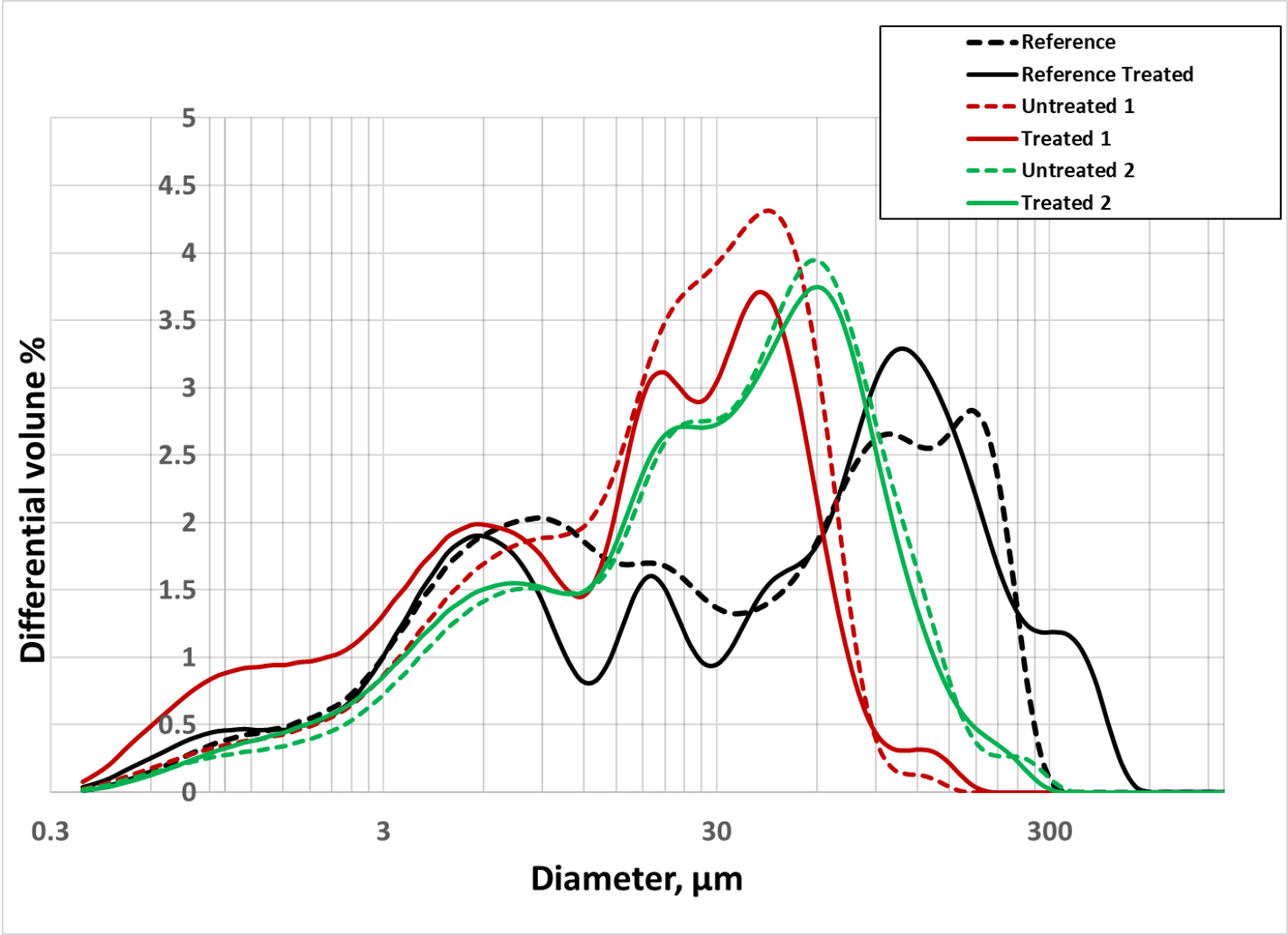
Particle Sizing Beckman-Coulter Device

- Air-jet sieve
- Beckman-Coulter



Harris, M.L., Sapko, M.J., Zlochower, I.A., Perera, I.E., Weiss, E.S. ***"Particle Size and Surface Area Effects on Explosibility Using a 20-L Chamber,"*** *Journal of Loss Prevention in the Process Industries, 2015, DOI: 10.1016/j.jlp.2015.06.009*

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Inerting Potential of Rock Dusts using 20-Liter Chamber

- Reference rock dust and pulverized Pittsburgh coal dust
  - Large-scale tests - Inert at 80% total incombustible
  - Bureau of Mines 20-L chamber - Inert at 75% rock dust

- Inert if pressure ratio ≤ 2

Cashdollar, K., 1996. Coal dust explosibility. J. Loss Prev. Process Ind. 9, 65-76.

Cashdollar, K.L., 2000. Overview of dust explosibility characteristics. J. Loss Prev. Process Ind. 13, 183-199.

Cashdollar, K.L., Hertzberg, M., 1989. Laboratory study of rock dust inerting requirements: effects of coal volatility, particle size, and methane addition. In: Proceedings of the 23rd International Conference of Safety in Mines Research Institutes, September 11-15, 1989. U.S. Department of the Interior, Bureau of Mines, Washington, DC, pp. 965-977.

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Preliminary Inerting Results from 20-Liter Tests

Rock dust	% Rock Dust Concentration		
	70%	75%	80%
Reference Rock Dust	Explosion	Inert	
Untreated 1	Explosion	Inert	
Untreated 2	Explosion	Inert	
Treated Reference Rock Dust	Explosion	Inert	
Treated 1	Explosion	Inert	
Treated 2		Explosion	Inert

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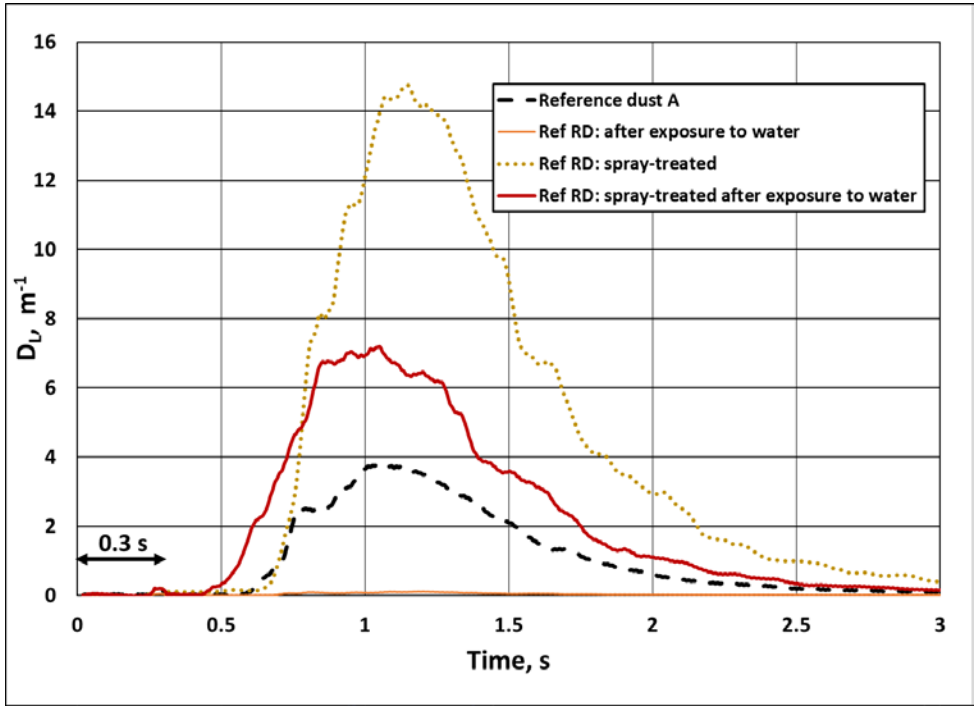
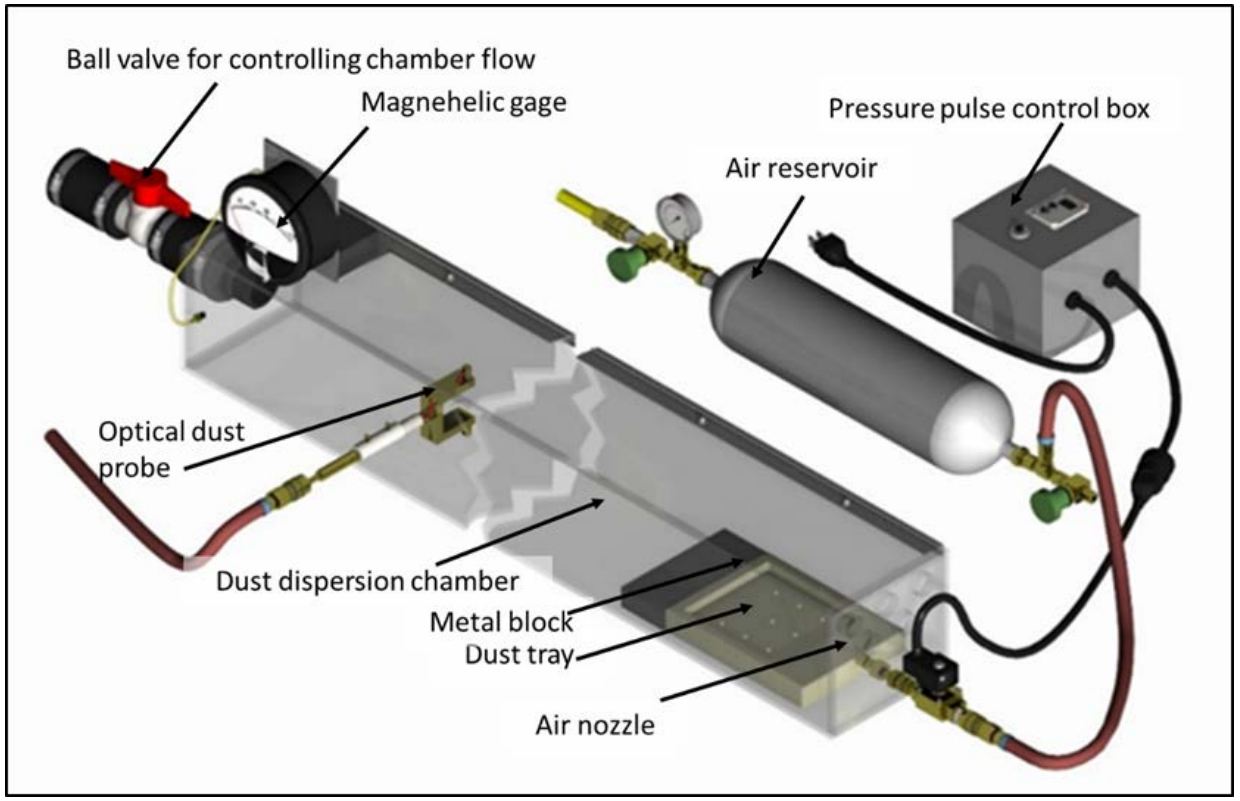
Quantitative Dispersion Assessment

Based on large-scale coal dust explosion data

Generates a reproducible air pulse

4.2 psi for 0.3 sec





Perera IE, Sapko MJ, Harris ML, Zlochower IA, Weiss ES (2016). *Design and development of a dust dispersion chamber to quantify the dispersibility of rock dust*, Journal of Loss Prevention in the Process Industries, Vol. 39, pp 7-16, January 2016.

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Preliminary Dispersion Results of Foam Dusts

Before Dispersion

After Dispersion

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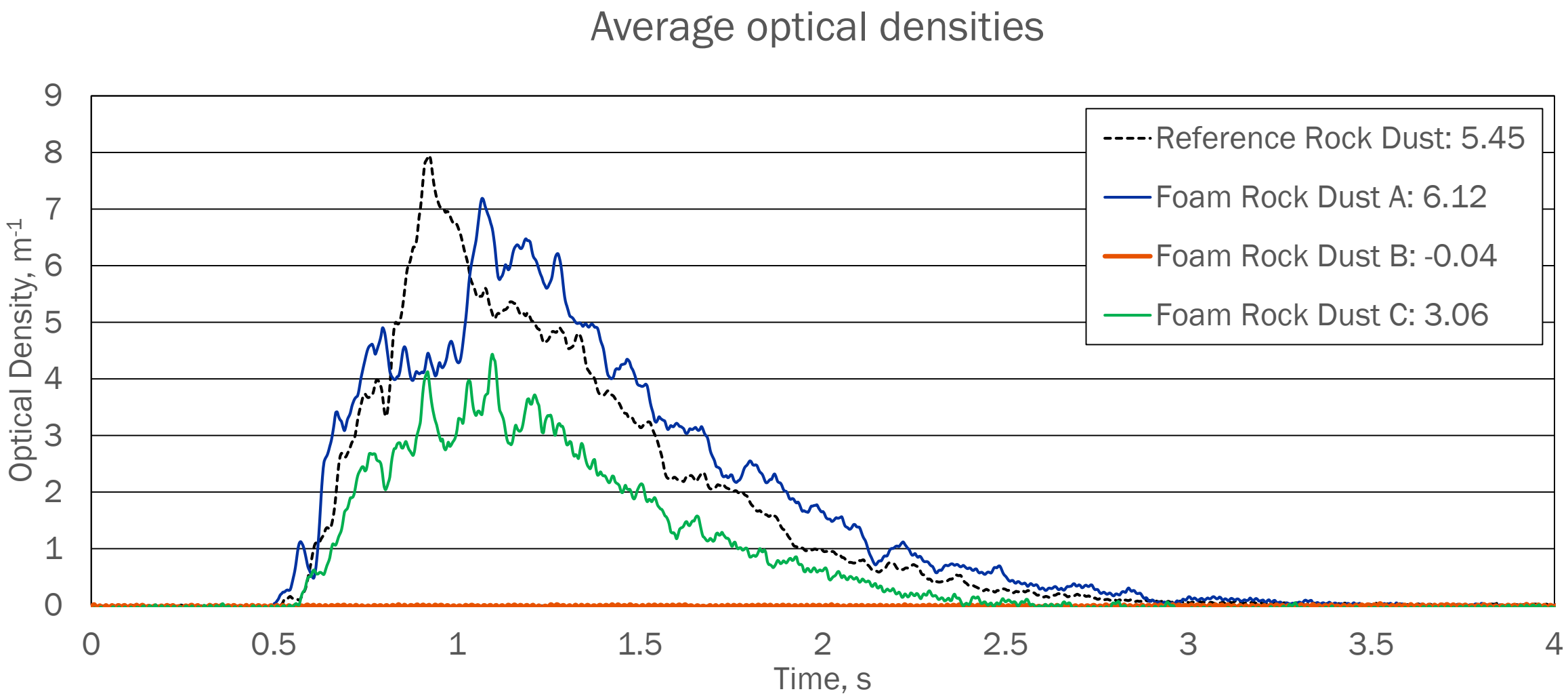
Preliminary Dispersion Results of Foam Dusts



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Preliminary Qualitative Dispersibility Assessment at a Mine Site

Example of a dispersible rock dust

Example of a non-dispersible rock dust

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Preliminary Qualitative Dispersion Test Results

Treated rock dust products showed promising dispersion in humid conditions

Untreated rock dust products showed little dispersion in humid conditions

Some foams showed an appearance of a thin crust

Some foams showed little visible dust exposed to the can of air

Adhesion and stability of the foams varied

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Preliminary Rock Dust Test Results

- Not practical or cost effective to conduct large-scale testing on all rock dusts
- Screening tests developed to select best candidates for large-scale testing
- Dry/base rock dust
  - Meet particle size requirements
  - Inert as well as or better than Reference rock dust
  - Disperse as well as or better than Reference rock dust
  - In-mine performance assessment
- Foam rock dust
  - Disperse as well as or better than Reference rock dust
  - In-mine performance assessment
  - Consistency in product
- Based upon the screening results, rock dusts that pass the lab scale criteria move to large-scale testing

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Thank you

Mike Sapko msapko@cdc.gov

Dr. Eranda Perera eperera@cdc.gov

Connor B. Brown cbrown@cdc.gov

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