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Miniaturized Blown
Sand Abrader for
Eyewear Coating
Evaluation

**Advanced Planning Brief to
Industry, May 8, 2008**

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UNCLASSIFIED

- Arid, desert environments have blowing sand of differing size and shape that can significantly degrade equipment performance.
- Materials that pass slow time-scale rubbing abrasion tests can shatter upon sand impact or other kinetic events.
- Expensive lenses need better coating materials to improve useful lifetimes.
- Popular abrasion tests have geometry constraints that prevent use with actual lenses.

Taber Abrader (ASTM D4060-5) - Sand imbedded in rubber wheel, rolled across surface.

Test velocity ~ 0.2 m/s

Bayer Table (ASTM F735-94) - Bed of sand is shaken while on top of lens, compared to standard (uncoated) lens.

Sand velocity ~ 0.5 m/s

Falling Sand Test (ASTM D 968-93) - Sand dropped from 36 inches.

Velocity ~ 2.0 m/s

Eraser Test - Spring-loaded pumice-rubber eraser rubbed on lens.

Velocity ~ 0.05 m/s

Various Steel Wool Tests – Steel wool rubbed on lens.

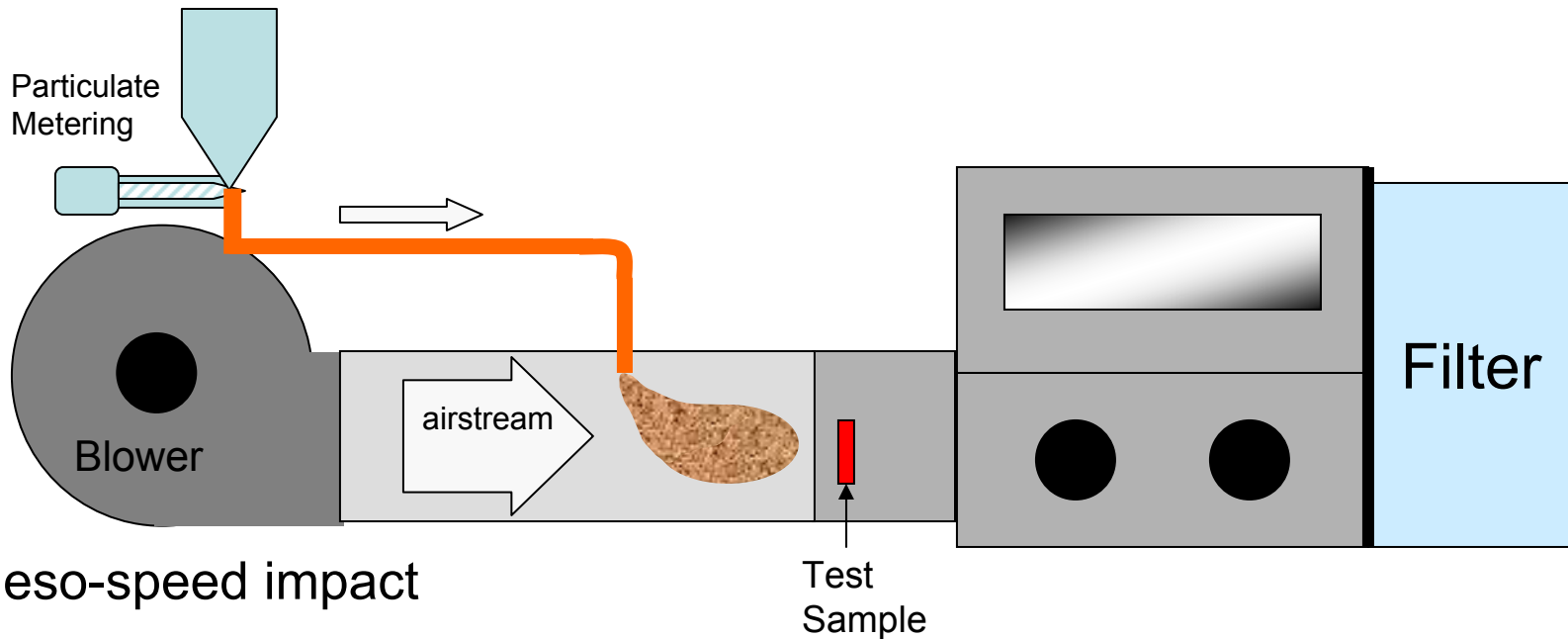
Test velocity ~ 0.05 m/s

- Blowing sand can range from **4-17m/s**
- Dropping lens from standing (2m height) ~ **6 m/s**
- Dropping lens from elevated position (4m), e.g. tank, truck, velocity ~ **9 m/s**
- Running, velocity ~ **3-4 m/s**

Faster velocities tend to induce brittle failure in most materials.

A new Blown Sand Abrader was developed at NSRDEC to simulate real-world blowing sand conditions in the laboratory.

- Blown sand test air velocity: 16.5 m/s
- First-generation model
- Second-generation (miniaturized) model

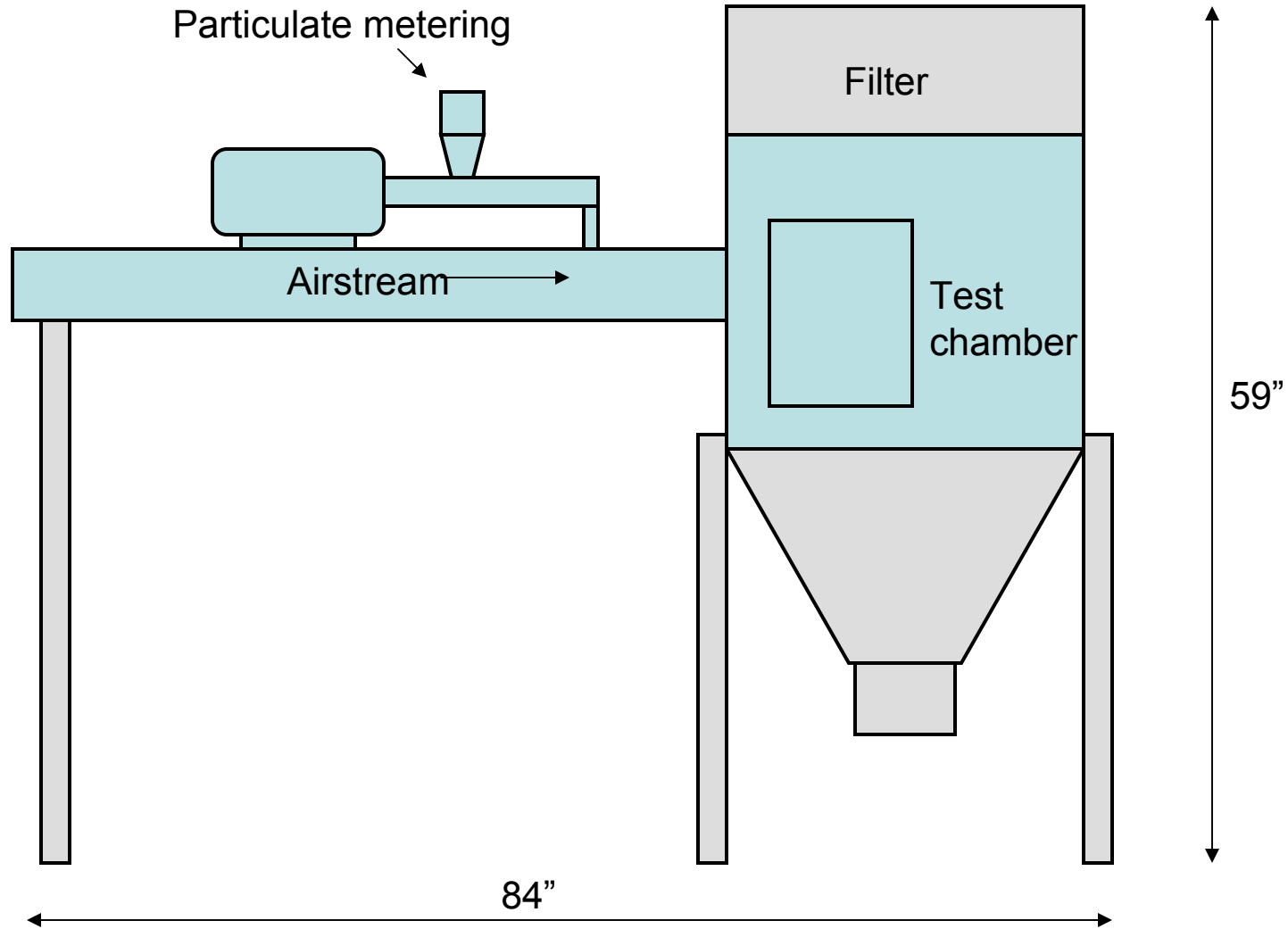


- Meso-speed impact
- No sample geometry constraints
- Variable-
air speed, particle density, sand type, sample orientation

Standard Test Conditions:

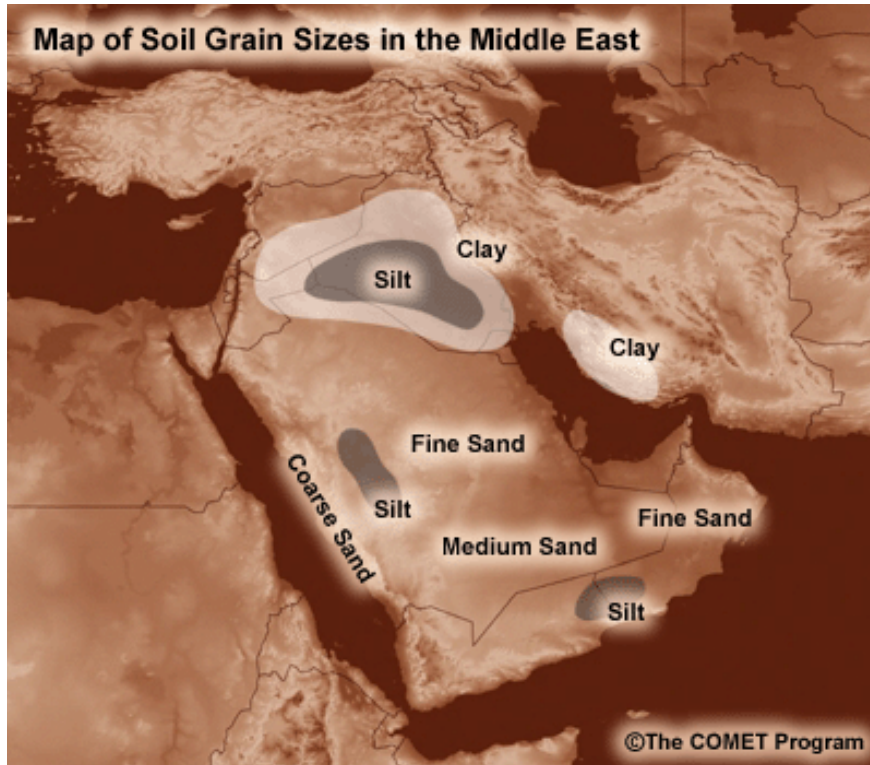
- 10 minutes
- 16.5 m/s (38mph)
- 400 μm diameter quartz sand
- 6.0 g/m^3 sand density in air
- Lens perpendicular to air stream

- More space-efficient
- Reduced quantity of sand
- More efficient post-test sand removal
- Continuous monitoring of air speed





- Sample is mounted perpendicular to direction of blowing sand
- Eyewear can be mounted on headform



Geological Classifications

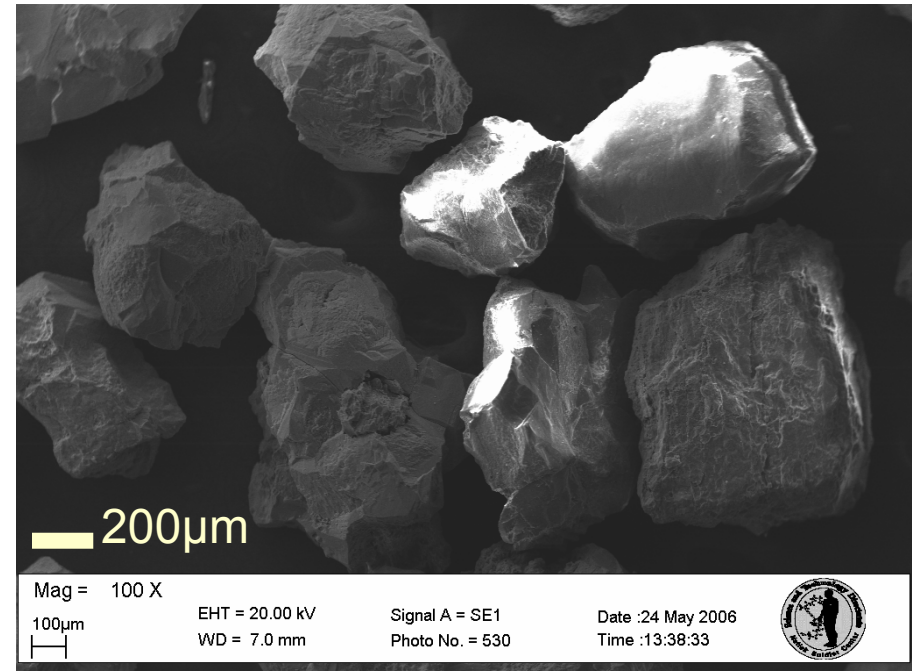
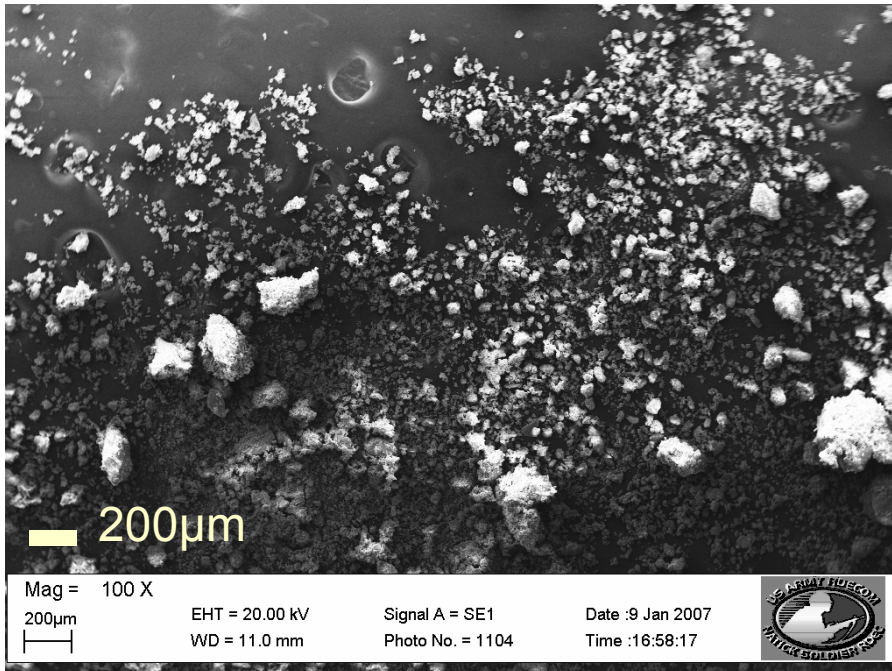
Coarse Sand:	0.2 - 2.0 mm
Fine Sand:	0.02 - 0.2 mm
Silt:	0.002 - 0.02 mm
Clay:	< 0.002 mm

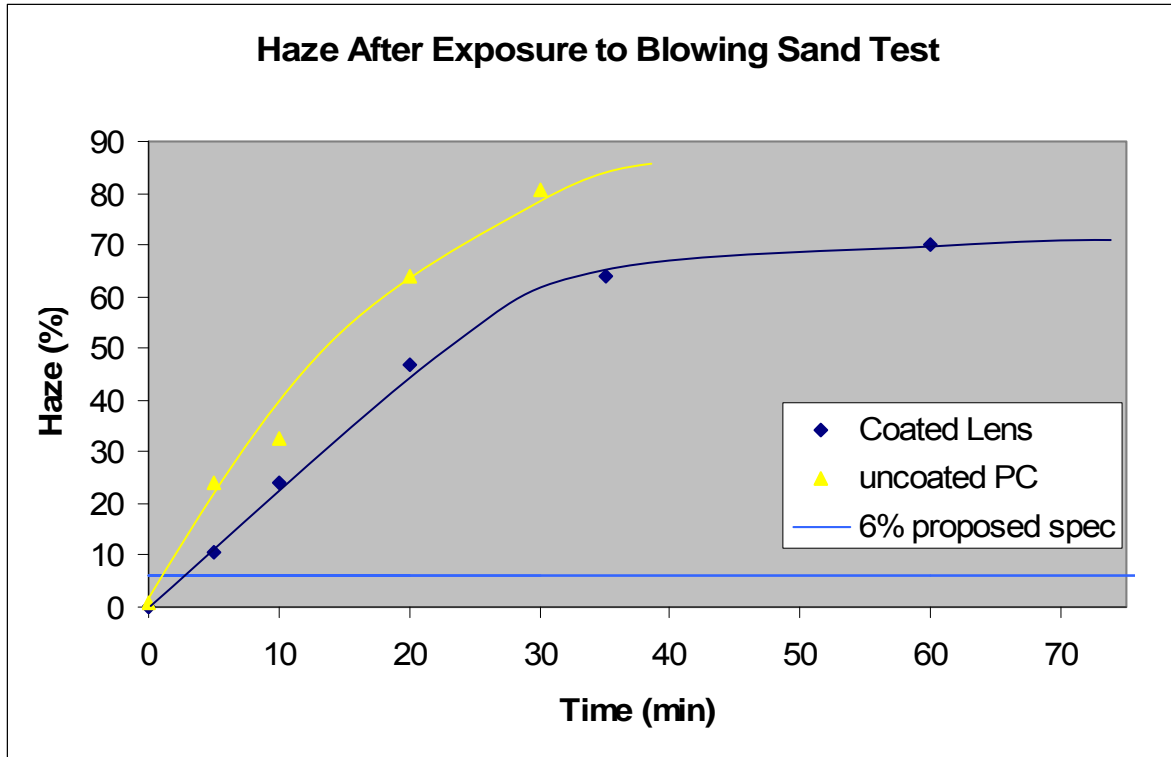
Sand size and composition vary throughout the world. Smaller particles tend to adhere into larger aggregates.

- Test sand was chosen as most abrasive case.
- Damage from fine sand and coarse sand similar.
 - Both will cause damage to lens surface.
 - Rate of damage development is faster with larger particles.
 - Aggregates of smaller sand particles can have similar kinetic energy to large particles.

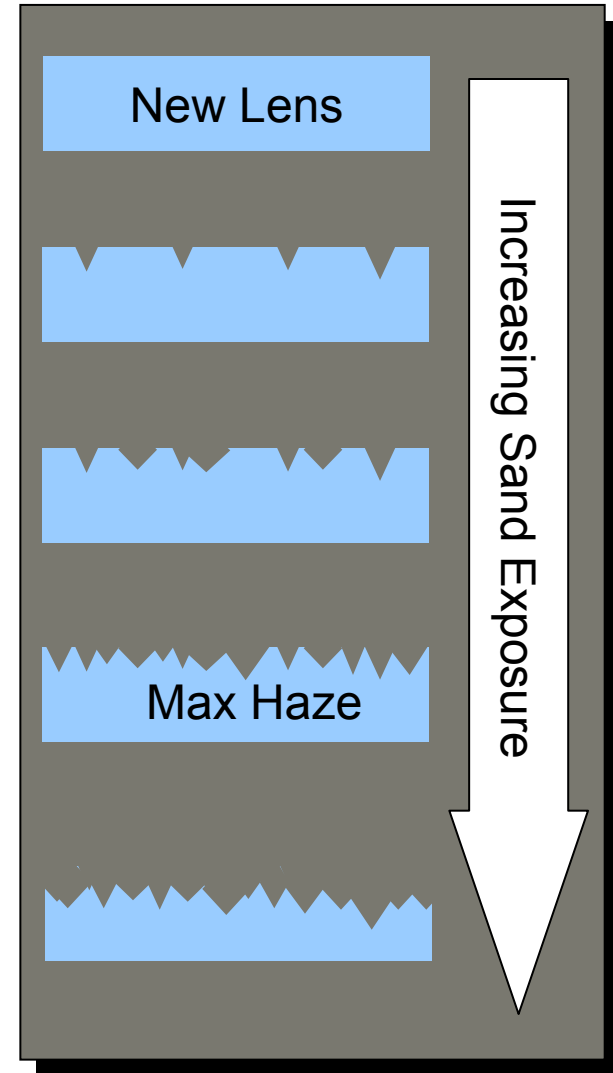
SWA Sand-
 Al, Ca, Fe, Mg, Na, K, Ti (oxides)
 Hardness: ~4 Moh
 Mean diameter: 10 μm
 Aggregate size: 3+ mm
 Mean mass 1x10⁻⁸ mg

Test Sand-
 100% Quartz Silica
 Hardness: 7 Moh
 Mean diameter: 400 μm
 Mean mass: 0.09 mg

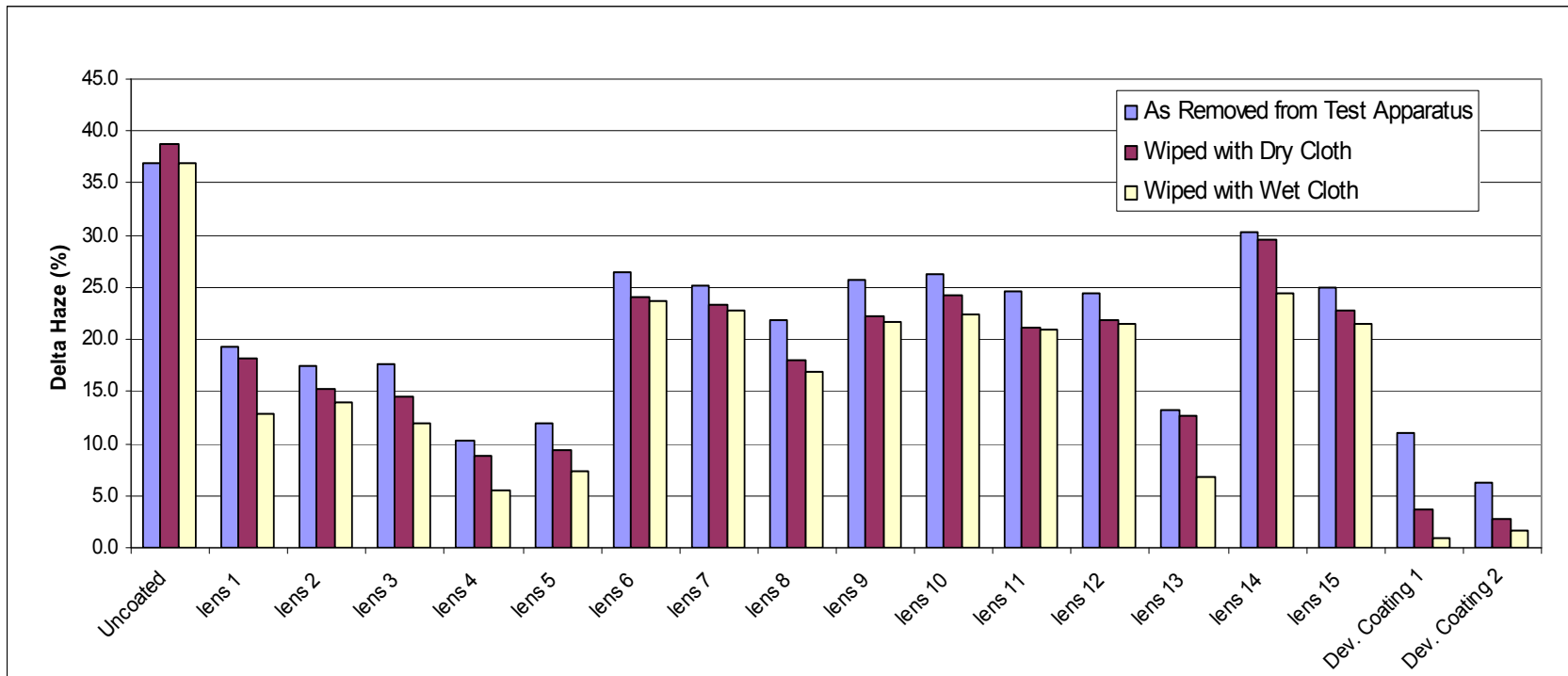




As the lens surface becomes damaged, haze increases until the surface is completely roughened. Further exposure erodes the surface but roughness remains constant.



Haze after 10 minute Exposure in Sand Blower



- Blown Sand Abrader has been developed for simulation of sandstorm conditions in a laboratory environment
 - Baseline
 - New coating development
- Miniaturized version has been developed and is in use
- Advantages:
 - Better predictor of wear under field conditions
 - Can test actual eyewear lens
 - Better direct coating research: Government and private
- New standard test method for resistance to abrasion by blowing sand is being developed
- Looking for industry participation