Respirator Workplace Protection Factor Studies

Stokes, D.W., Johnston, A.R., and Mullins, H.E.
3M Occupational Health and Safety Products Division

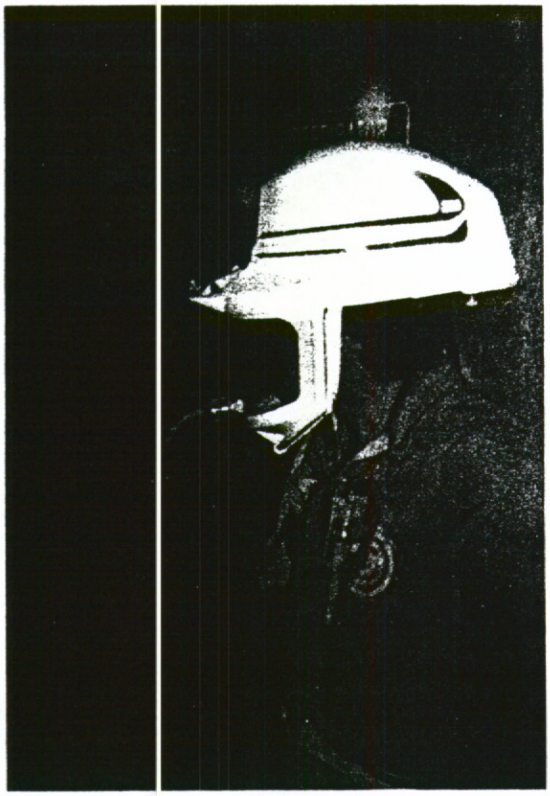
Powered Air Loose-Fitting Helmet

Study Objective

Determine a Workplace Protection Factor (WPF) for a powered air-purifier with a loose-fitting facepiece worn in a silica dust environment. The WPF is the protection provided by respirators actually worn in the workplace.

$$WPF = \frac{\text{Outside Sample}}{\text{Breathing Zone Sample}}$$

Five Powered air-purifiers were used during the cleanup of the silica dust byproduct from a roofing granule production plant. The tasks included sweeping, brushing walls, and shoveling.



Product Evaluated

Five NIOSH approved 3M Airhats® with either a dust/mist filter or high efficiency filter.

The airhats were also worn with and without a Tyvek® shroud.

Rechargeable NICAD battery.

Sample Set-Up

Each worker was equipped with two Spectrex sampling pumps (PAS 3000), tubing, filters, and cyclone.

Pump	Filter Size (mm)	Type (μm)	Placement	Sampling (LPM)
Total Dust	37	0.8 Polycarbonate	Lapel. Breathing Zone	2
Respirable Dust	37 (Placed in Cyclone)	0.8 Polycarbonate	Lapel. Breathing Zone	1.8
Inside Sample	25	0.8 Polycarbonate	Ben Liu Probe (Faceshields)	1.5

Sampling pumps were calibrated daily and checked for proper liter flow three times daily.

Calibration was performed using a TSI model 67 mass flow meter with a linear signal conditioner.

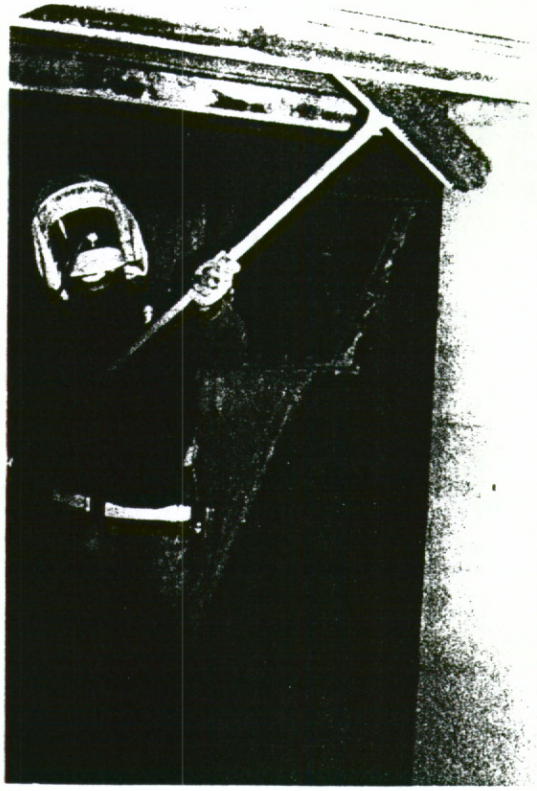
Sampling Procedure

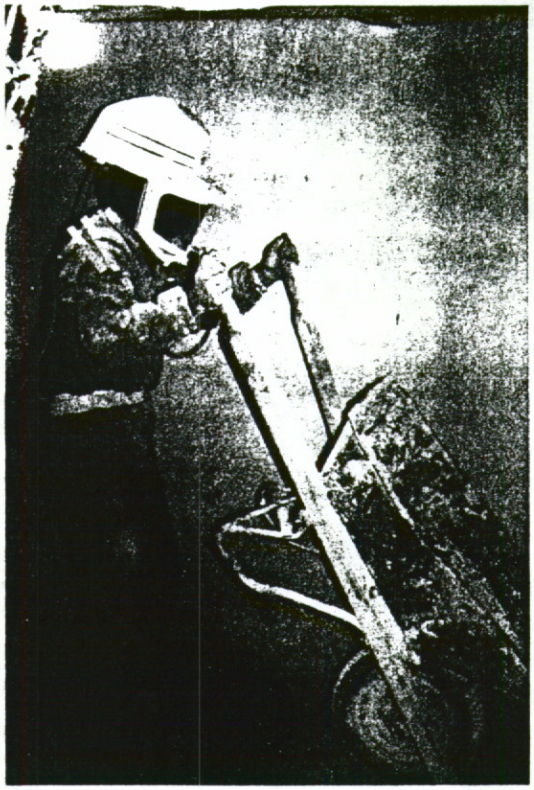
Five workers were assisted with the placement of the sampling equipment.

The flow into the airhat was verified to be greater than 6 cfm at the beginning and end of each sample set.

Sampling periods ranged from 30 min. to 1 hour for four days.

Each worker was observed to ensure proper use, wear time, and sample validity.





Sample Analysis

Sample analysis was done by proton induced X-ray emission (PIXE).

PIXE analysis is performed by bombarding protons onto the captured filter elements. An X-ray is emitted that will identify the composition and quantity of the substances.

Advantages:

Excellent sensitivity (10 to 100 μg).

Simultaneous analysis of multiple elements.

Nondestructive to the filter or elements.

Results include confidence levels.

Results

WPF results were derived by the following calculations.

1. Blank levels were determined by PIXE analysis.

2. Blank levels were averaged to determine the mean value.

3. The mean blank value was subtracted from all inside and outside samples.

4. All outside samples used in the final calculations were greater than 25 and 100 times the mean blank value.

5. $$\text{WPF} = \frac{\text{Outside value}}{\text{Inside value}}$$

Results

Respirable Dust
Values are 25X Above the Blank Level

	Sample Size	Geometric Mean	Geometric Std. Deviation	Fifth Percentile
Total D/M Samples	45	2480	7.0	95
D/M With Shroud	18	11,792	3.1	1615
D/M Without Shroud	27	877	5.2	53
Total HEPA Samples	12	5370	3.0	762

Values are 100X Above the Blank Level

	Sample Size	Geometric Mean	Geometric Std. Deviation	Fifth Percentile
Total D/M Samples	42	2404	6.9	92
D/M With Shroud	16	11,543	3.2	1484
D/M Without Shroud	26	915	5.3	54
Total HEPA Samples	11	5542	2.9	877

Summary

The ANSI Z88.2 Committee on Practices for Respiratory Protection has proposed a revised respirator protection factor of 25X the permissible exposure limit (PEL) for powered air purifier loose fitting facepieces (Airhat).

The workplace protection factor (WPF) for this study achieved a geometric mean of 2480 for dust/mist and 5370 for HEPA.

The fifth percentile achieved in this study was 95 for dust/mist and 762 for HEPA.