DIESEL PARTICULATE MATTER (DPM) SAMPLING

United States Department of Labor
MSHA
Mine Safety and Health Adminstration

OBJECTIVES

DPM Sampling Only - Not Intended To Be Comprehensive IH Training

- **DPM Sampling Requirements - §57.5071**
- **MSHA Compliance Sampling Procedures**
- **DPM Sampling Equipment**
- **Sample Analysis & Interpretation**

§57.5071 *Environmental Monitoring* does not specify sampling or analytical method

Must identify overexposures to PEL

DPM Sampling Per §57.5071

- Sample as often as necessary to determine whether exposures exceed the applicable PEL
- Miners have option of observing sampling
- If exposure exceeds PEL, operator must
  - Post corrective action
  - Initiate corrective action by next work shift, and
  - Promptly complete corrective action
- All sampling results must be posted and copy provided to miner's representative
- Records of sampling method and sampling results must be retained for 5 years

DPM Sampling & Analytic Methods

- Gravimetric (weight)
- Submicron dust (size selective + weight)
- Respirable combustible dust (weigh, burn off combustibles, then re-weigh)
- Weighing-based systems not accurate enough at low DPM concentrations
- Submicron sampling + carbon analysis
  - NIOSH method 5040
- This presentation focuses on MSHA compliance sampling

DPM Sampling Compliance Sampling

- Equipment and procedures used by MSHA for DPM compliance sampling are fully described in the MSHA MNM Health Inspection Procedures Handbook – Chapter 22
- Handbook accessible on-line at:
  http://www.msha.gov/READROOM/HANDBOOK/PH06-IV-1(1)MNMHealthInspectionProc.pdf

DPM SAMPLING OVERVIEW

- Use sampling pump to draw air through tandem quartz fiber filters
- Filters captures DPM, which is analyzed for organic and elemental carbon (OC & EC)
- OC on dynamic blank subtracted from OC on sample filter
- Net carbon mass divided by volume of air drawn by pump is carbon concentration

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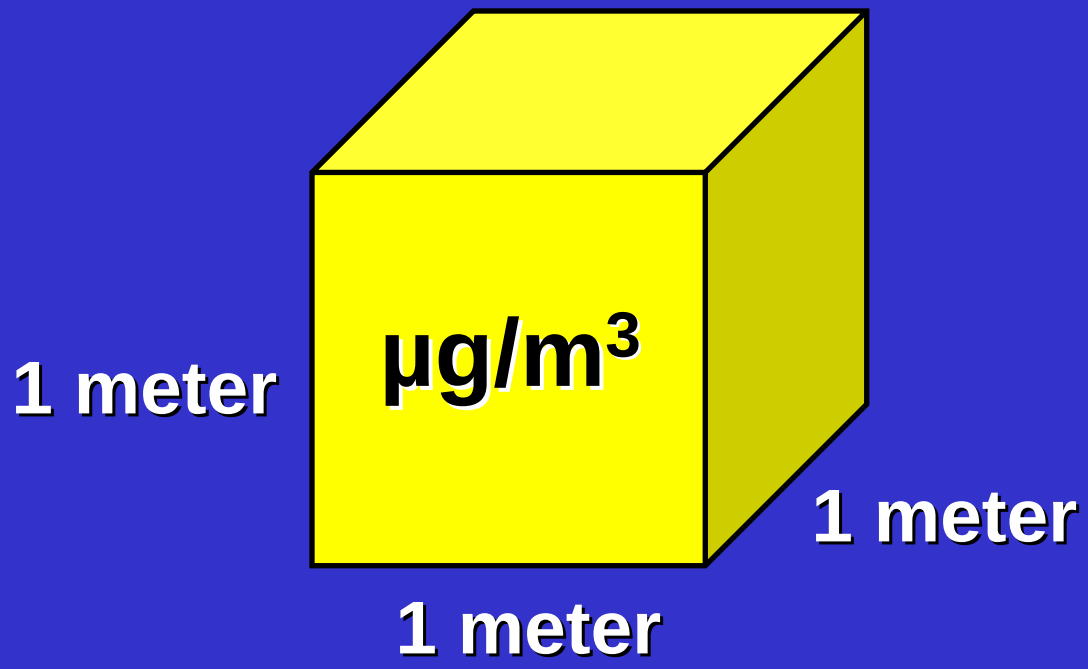
$$\frac{\text{carbon mass } (\mu g)}{\text{volume of air } (m^3)} = \text{carbon concentration } (\mu g/m^3)$$

Units of Measurement

Micrograms per cubic meter of air



$$1 \text{ microgram} = \frac{1}{\text{millionth}} \text{ gram} = \frac{35}{\text{billionth}} \text{ oz}$$

DPM Sampling

Collect only Submicron particulates to eliminate mineral dust interference

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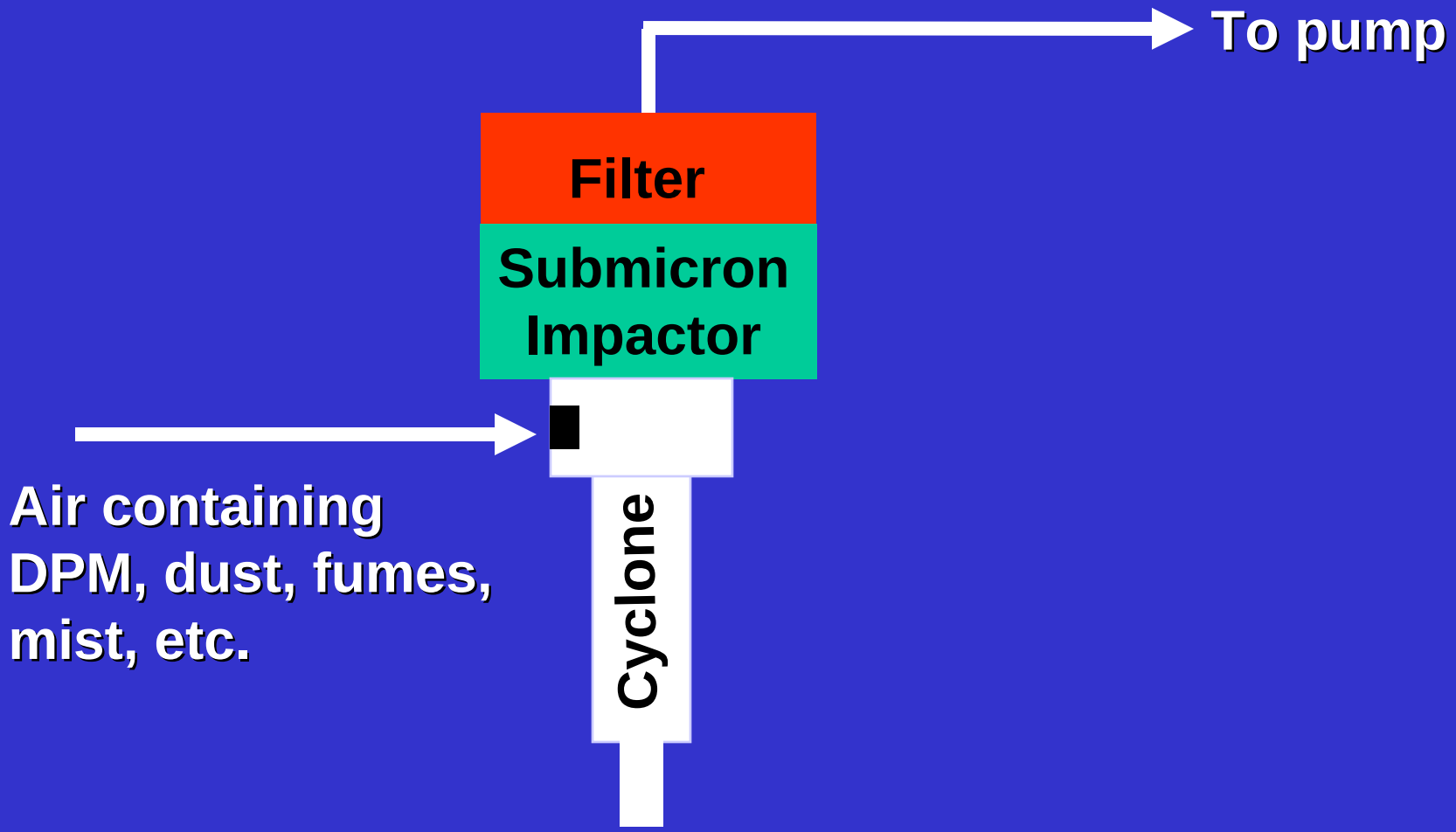

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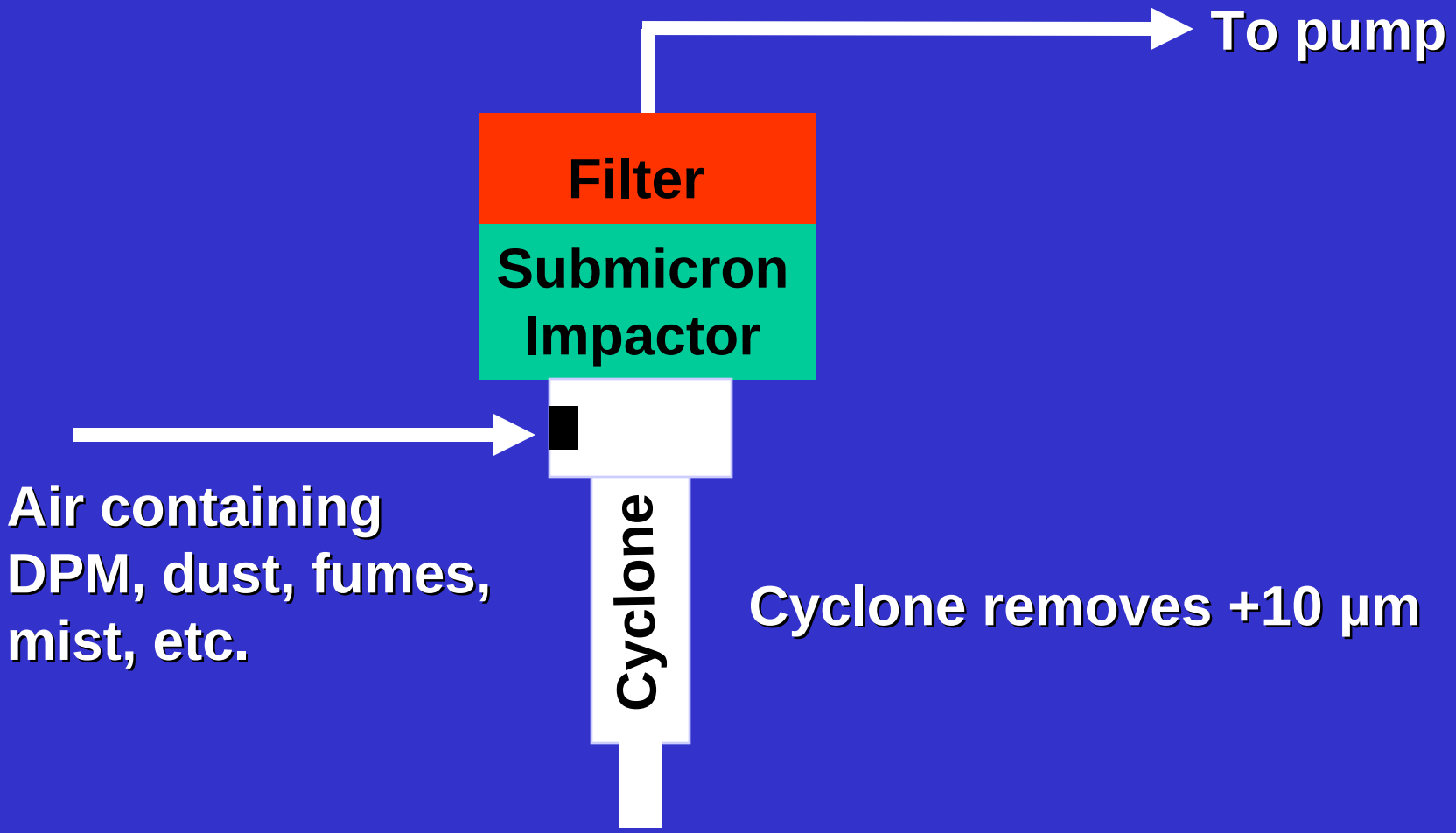

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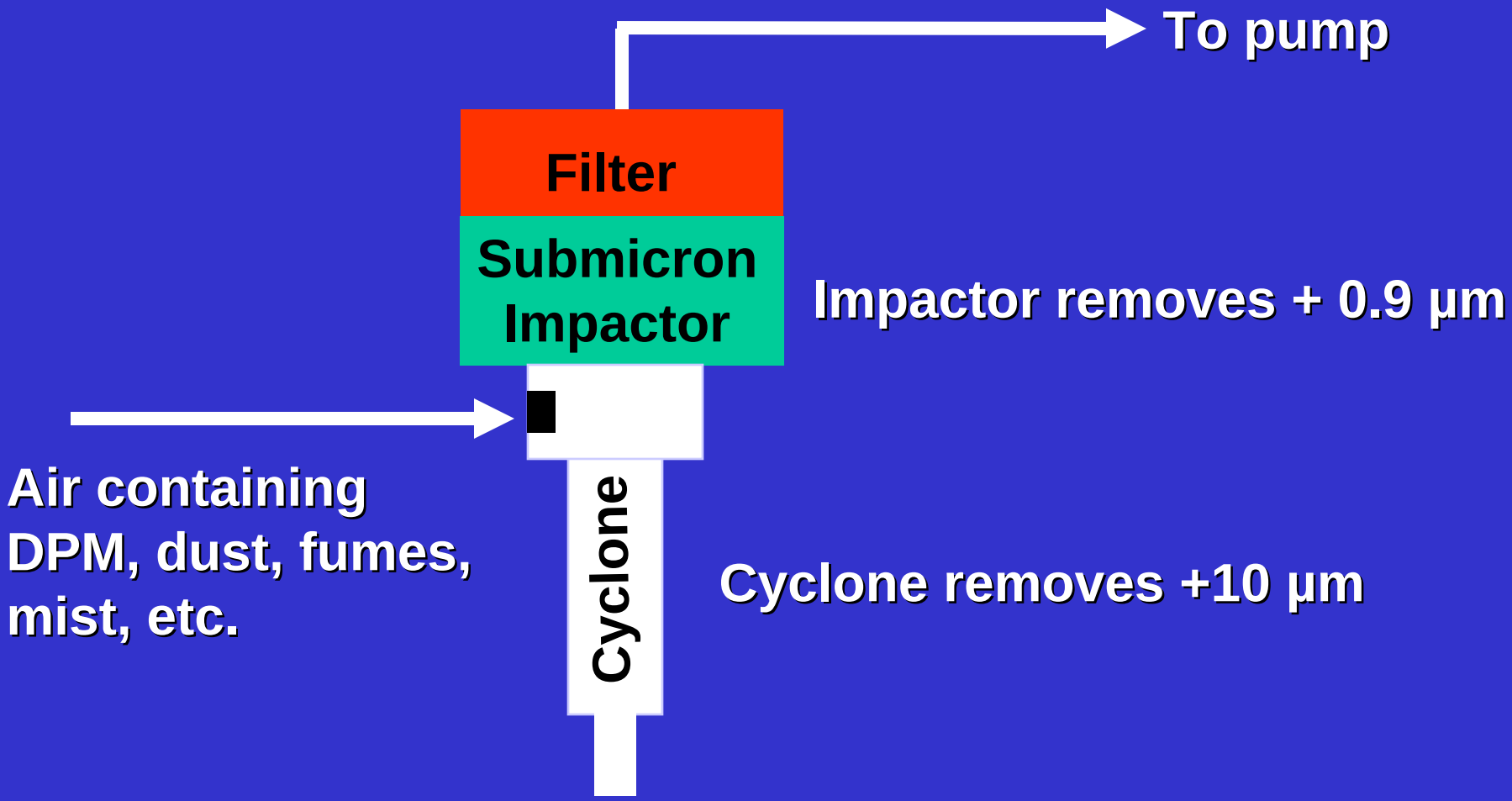

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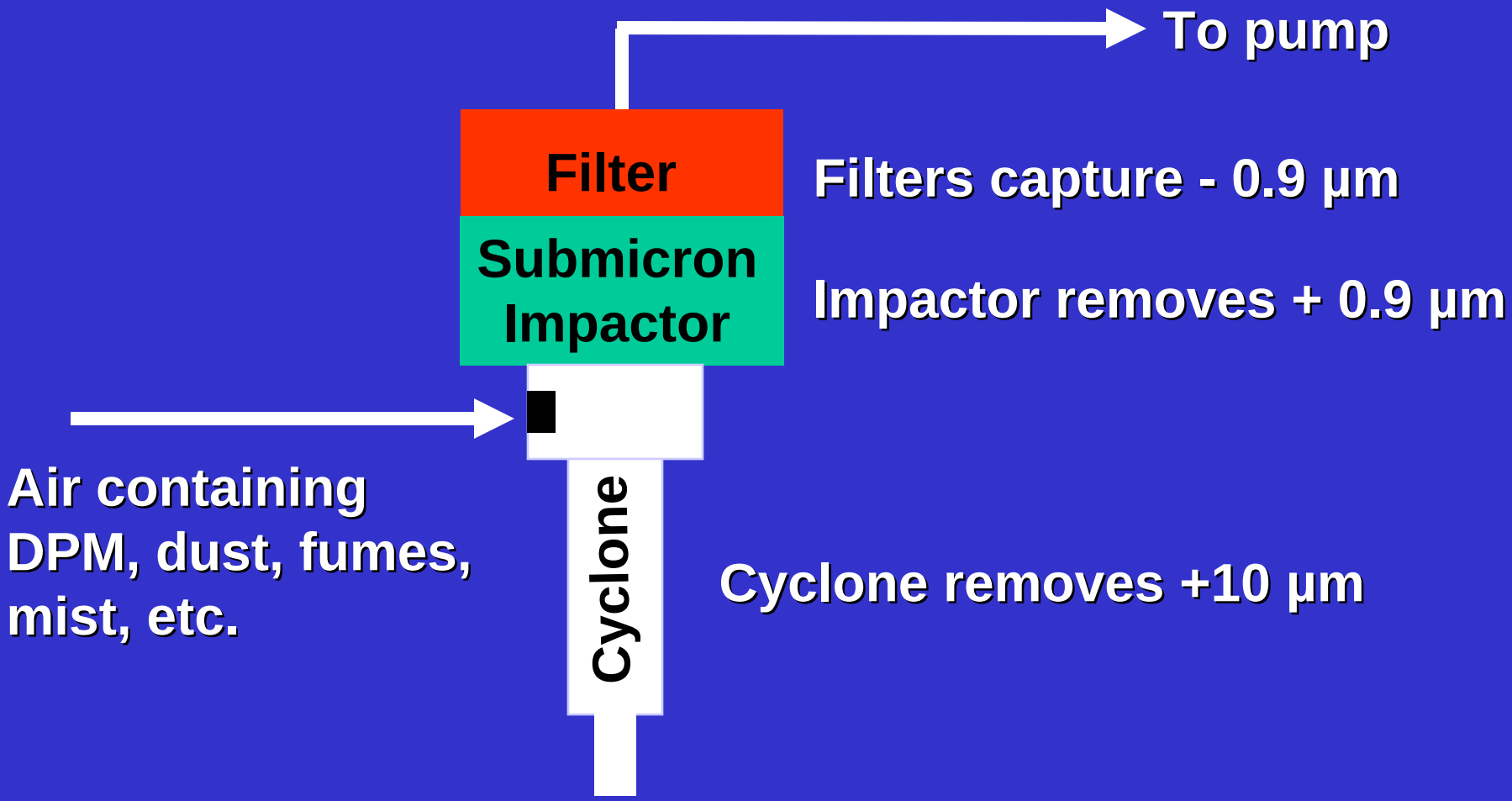

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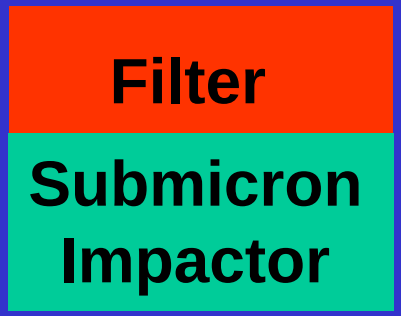

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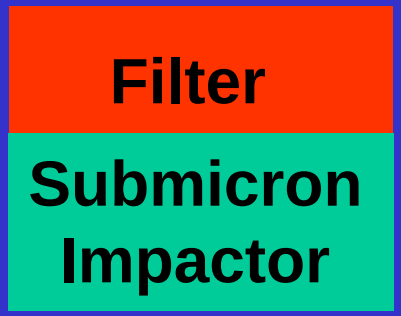

Send filter to lab for analysis

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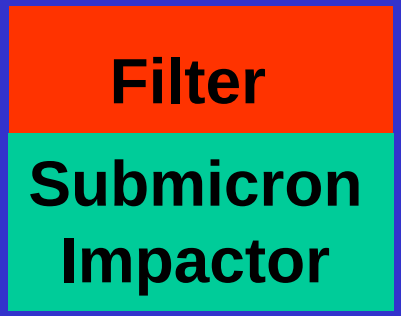

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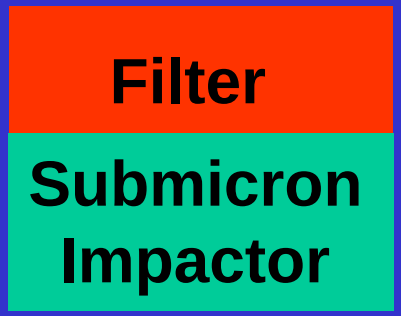


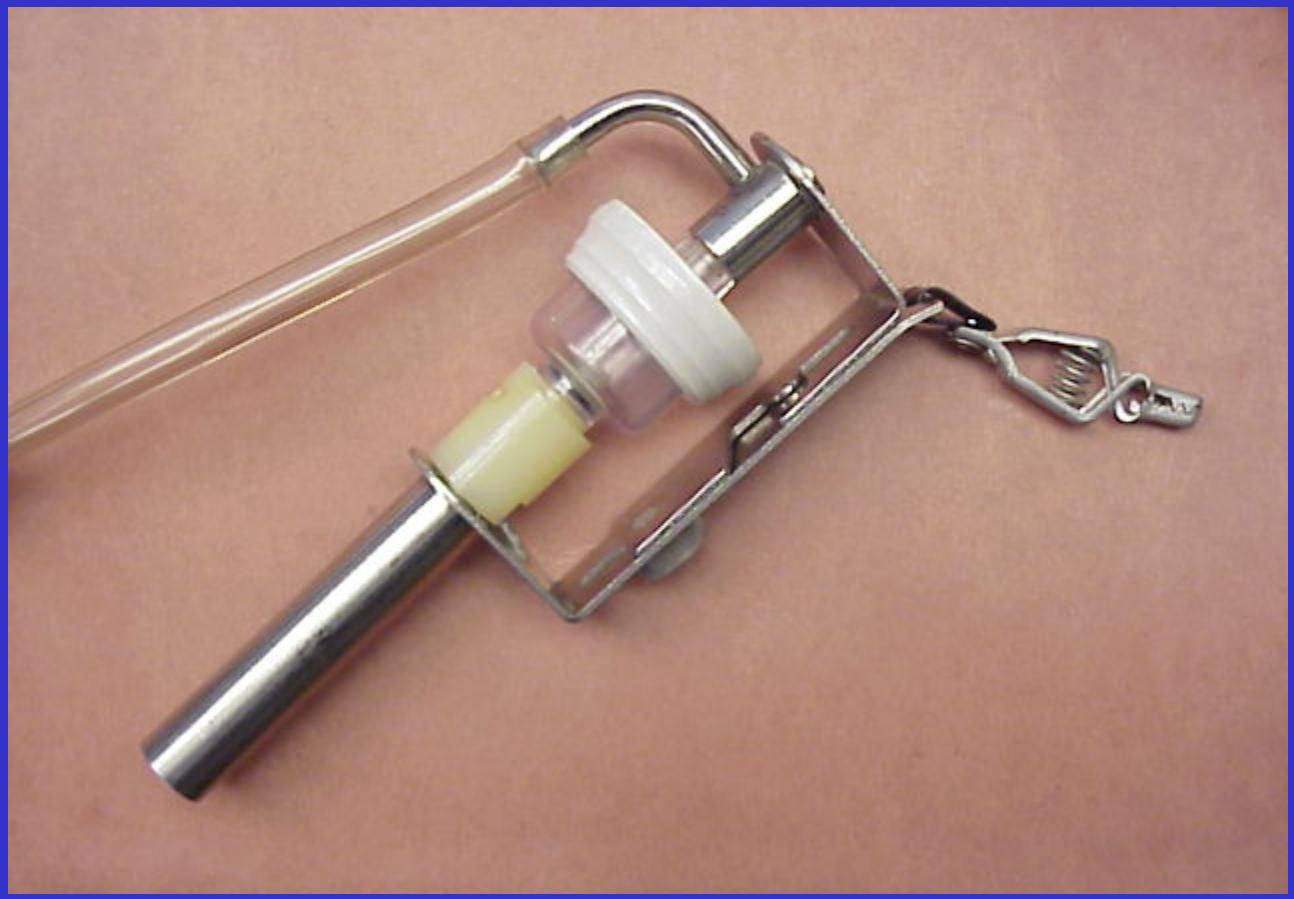
Send filter to lab for analysis

Lab analyzes filter for OC & EC

Lab reports OC, EC, TC concentration

DPM Filter Cassette

DPM filter cassette and cyclone components



DPM filter cassette mounted on cyclone in lapel holder

DPM sampling train connected to sampling pump

Personal DPM sampler

Area DPM Sampler

Sampling Train

- Sampling train is the hose, filter, and cyclone assembly attached to the pump
- When assembling and attaching, insure:
  - Connections tight
  - Proper components are included (cyclone, DPM cassette)
  - Filter is new (not used for calibration), properly labeled, plugs removed, in correct direction (will only fit properly if correctly installed)
  - Cyclone and hoses are clean

Conduct Sampling

- Always follow manufacturer instructions
  - Sampling equipment
  - Accessories
  - Use and environmental limitations (duration, temperature, humidity)
- Pre-calibrate
- Sample
- Post-calibrate

Why Calibrate Pumps ?

- Must calibrate pump so exact volume of air drawn across filter can be determined

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- For DPM sampling, cyclone and submicron impactor function properly ***ONLY IF*** pump operates at 1.7 liters/min

Pump Calibration

- Connect sampling train to pump and calibration device
  - Air must be drawn through calibration device, then through sampling train, then into pump (must be in this order)
- Turn on pump (let run for 10 minutes)
- Adjust pump speed until desired flow rate is achieved
  - 1.7 liters/minute for DPM

DPM Sampling Priorities

- Sample the underground occupation(s), miner(s), and shift(s) where the greatest DPM exposures are most likely to be experienced
- Take as many samples as necessary to document “worst case” conditions

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If these conditions are controlled to acceptable levels, all other exposures will be at least as well controlled

Documentation of Sampling

- All sampling must be documented
  - Observations of employee work activities
  - PPE (respirator type, is it being used?)
  - Sampling information (type of sampling, calibration data, pump type and serial number, filter number, etc.)
  - Environmental conditions
  - Sources of DPM and DPM controls in use
  - Periodic sampling equipment checks
- Helps to use a form or checklist
- MSHA DPM Field Notes form is available

Labs and Filters

- Need a lab to process samples
  - Thermo-Optical Analysis for DPM
- Many analytical labs to choose from:

Data Chem, Salt Lake City, UT
Clayton Group Services, Novi, MI
Mine Ventilation Services, Fresno, CA
Sunset Laboratory, Forest Grove, OR
Galson Laboratories, E. Syracuse, NY
LA Testing, Los Alamitos, CA
EMSL Analytical, Westmont, NJ
Galson Laboratories, E. Syracuse, NY
NATLSCO, Long Grove, IL
RJ Lee Group, Monroeville, PA
Wisconsin Occupational Health Laboratory, Madison, WI
Environmental Diagnostics Laboratory, Clearwater, FL

(We regret any inadvertent omissions. MSHA does not endorse these laboratories nor does it take responsibility for, or exercise control over these organizations.)

- Filter options
  - SKC disposable DPM filter (tandem quartz fiber)

Shift Weighted Average

- **Problem: PEL based on 8 hr exposure**
- **What happens when exposure is longer than 8 hrs?**
- **Solution: Adjust exposure concentration to compensate for longer exposure time**
- ***SHIFT WEIGHTED AVERAGE***

Shift Weighted Average

- SWA is determined by adjusting measured DPM concentration

$$\text{DPM conc.} = \frac{\text{Weight of DPM}}{\text{Pump Flow Rate x Sample Time x 0.001}}$$

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Shift Weighted Average

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All MSHA compliance determinations based on SWA

What Do I Do With My Sample Results?

- Compare SWA to PEL
  - SWA Below Limit - OK
  - SWA Above Limit - Overexposure
- If SWA Exceeds PEL:
  - Provide respiratory protection per §57.5060
  - Implement additional engineering and/or work practice controls
  - Conduct additional sampling to verify effectiveness of new controls (SWA<PEL)
- Maintain records of sampling method and 5-yr sampling history

Sampling and Analytic Error

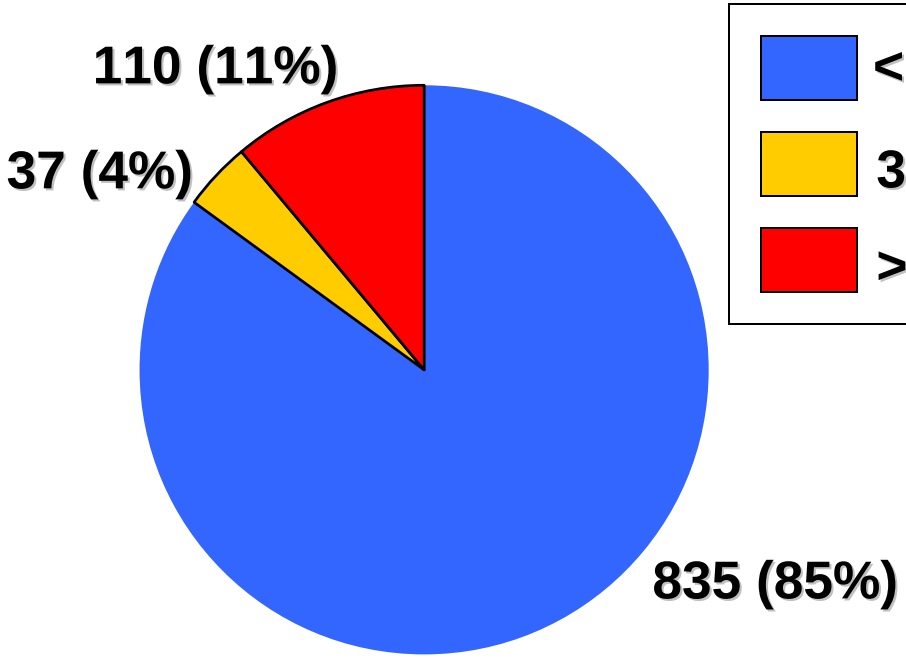
- Every measurement involves error
  - Sampling (pump flow rate, air density)
  - Laboratory (chemical analysis)
- Laboratory results incorporate uncertainty range (Error Factor)
- Example:
  - PEL = 308 µg/m^3
  - SWA = 335 µg/m^3 ± 12%
  - Actual concentration is somewhere between 295 µg/m^3 and 375 µg/m^3
- ***Actual SWA Could Be Less Than Limit***

What Do I Need To Do So I Will Be In Compliance With § 57.5071

- Review all available DPM sampling information on your mine
  - Company records
  - MSHA sampling history
- Develop and implement DPM sampling strategy
  - Is sampling necessary ? If so, who, where, when ?
  - Do we perform sampling, or hire contractor ?
  - Sampling equipment (buy, borrow, rent) ?
  - Line up an analytical laboratory
  - Conduct sampling, analyze results, take action
  - Insure all requirements of §57.5071 satisfied
- Develop a good recordkeeping system

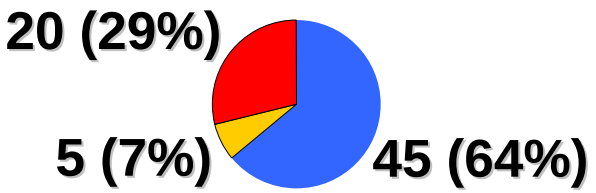
DPM Compliance Sampling Results Since June 6, 2005

Entire U.S.



982 samples total
147 > 308 µg/m³ (15%)
91 citations (9%)

Nevada



70 samples total
25 > 308 µg/m3 (36%)
8 citations (11%)

DPM Citations Issued Since 6/6/2005

(Includes a few citations that were later vacated)

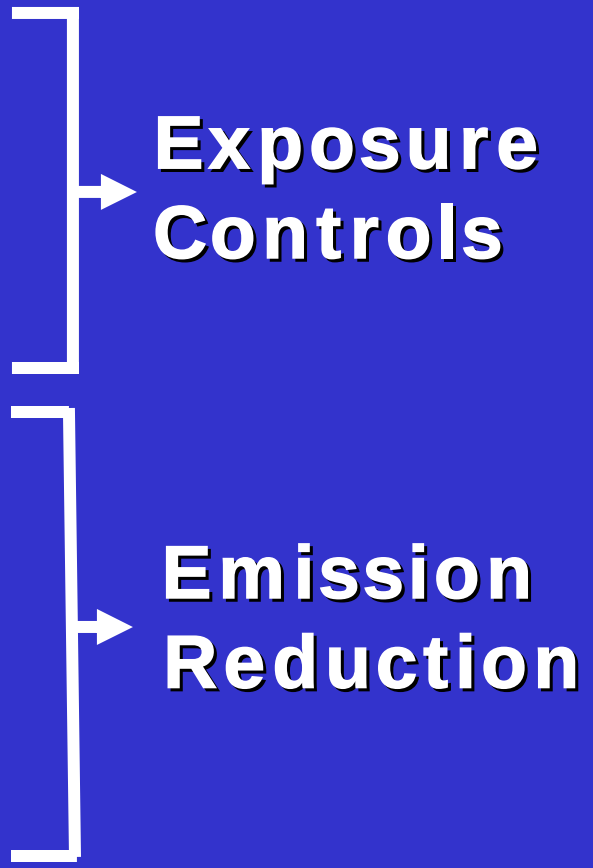
Missouri	16	New York	3
Iowa	12	Pennsylvania	3
Indiana	10	Illinois	2
Montana	10	West Virginia	2
Nevada	8	Kansas, Michigan,	
Alaska	5	Ohio, Oklahoma,	
Kentucky	5	New Mexico,	
Colorado	4	Tennessee,	
Nebraska	4	Utah…….1 each	

MNM Citation Rates Since 6/6/2005
Resp. Quartz vs. Noise vs. DPM
(Includes a few citations that were later vacated)

	Samples	Citations	Citation Rate
Resp. Quartz	4021	229	5.7%
Noise	2453	171	7.0%
DPM	982	91	9.3%

Available Control Strategies

1. Ventilation
2. Environmental Cabs
3. Administrative Controls
4. Diesel Engines
5. Engine Maintenance
6. Biodiesel Fuel
7. DPM Exhaust Filters



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Most mines have been able to attain consistent compliance with Interim DPM PEL

6. Biodiesel Fuel
7. DPM Exhaust Filters

Additional controls will be needed at most mines to meet Final DPM PEL

Bill Pomroy
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515 W. First St.
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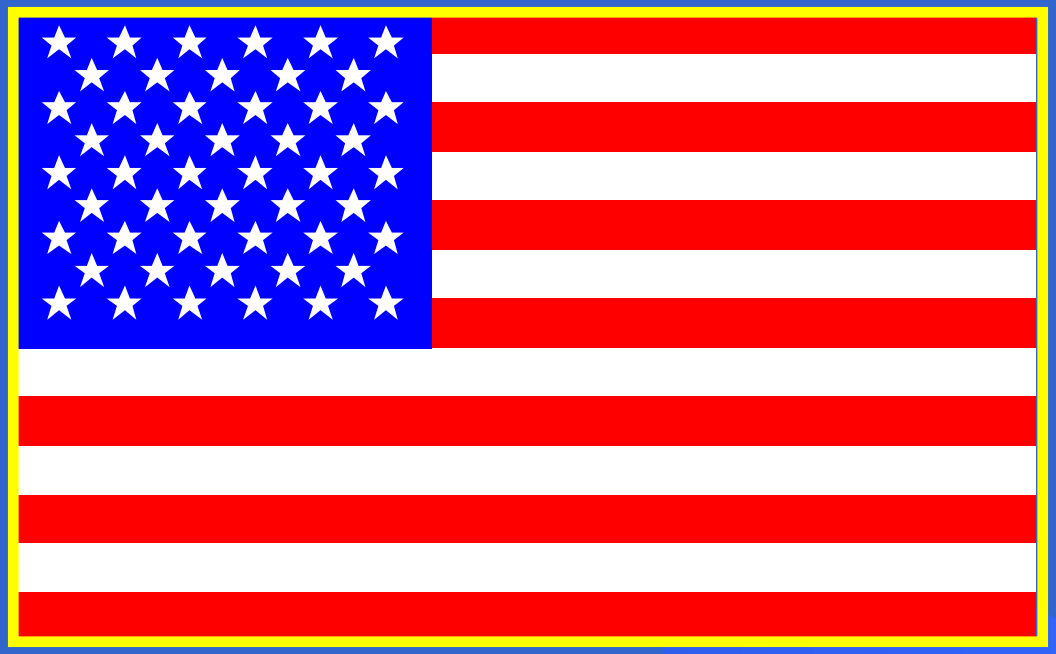
Thank You



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