# Assessing Exposure to Particles and Vapors

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# Sampling Data Considerations

- Why was the measurement made?
- What is the underlying distribution?
- What was the sampling duration?
- How to deal with detection limits?
- How to manage partial-shift data?





## Why were these samples collected?

Reason for Sampling	Objective	Sampling Strategy
Employer	95% UCL < OEL	All areas
Compliance Officer	95% LCL > OEL	High-risk worker
Dose–Response Research	Mean = $\sum C x t$	Representative sampling
Control Evaluation	Range	Task-based

OEL = Occupational Exposure Limit UCL = Upper Confidence Limit LCL = Lower Confidence Limit



Source: Occupational Exposure Sampling Strategy Manual (77-173) | NIOSH | CDC

AIHA Exposure Category Rating

	Category	Description	Exposure 95% of the time	Action
	1	Highly controlled, minimal exposure	<10 % of OEL	No action, hazard communication
	2	Well controlled, frequent contact at low exposure, rare contact at high exposure	10-50% of OEL	Chemical specific hazard communication
	3	Controlled exposure, frequent contact at low exposure, infrequent contact at high exposure	50-100% of OEL	Exposure surveillance, medical surveillance and work practice evaluation
	4	Poorly controlled, contact at high or very high concentrations.	> 100% of OEL	Respiratory Protection with Engineering Controls

Source: https://doi.org/10.1080/15459620600914641

## **Statistical Considerations**

- Occupational exposure data usually *log-normal*
- Skewed with tail to high concentrations
  - UCL = GM x GSD $^{\alpha}$
  - LCL = GM / GSD $^{\alpha}$

 $\alpha = t/\sqrt{n}$ 



## Sampling Duration for OELs

- Ceiling Limit (C) never to be exceeded
- Short Term Exposure Limit (STEL) Usually a 15-minute TWA
- Daily Limit full shift, 8-hour, or 10-hour TWA
- Monthly Limit average or cumulative maximum

TWA = Time-Weighed Average

# Types of Sampling

- Personal
- Area
- Task-based
- Direct-reading monitors
  - Alarms!





# Evolution of Dust Sampling: Greenburg-Smith Impinger – 1932



For sale by the Superintendent of Documents, Washington, D. C. - - - Price 5 cent Subscription price, \$1.50 per year





https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1996240/

#### Advances in Personal Dust Sampling







#### **Continuous Personal Dust Monitor**



Sensor: Tapered-element Oscillating Microprobe

Source: <a href="https://www.cdc.gov/niosh/mining/features/CPDMhelpsminersavoiddust.html">https://www.cdc.gov/niosh/mining/features/CPDMhelpsminersavoiddust.html</a>

#### Gases & Vapors



- Collection method (e.g., charcoal tube)
- Flow Rate
- Sampling time
- Sample Volume
- Limit of Detection (LOD)
- Limit of Quantitation (LOQ)
- Interferences

NIOSH Manual of Analytical Methods (2014-151) NIOSH CDC

## Range-finding Exposure Sampling





#### **Spot & Partial-period Sampling**



Source: Occupational Exposure Sampling Strategy Manual (77-173) | NIOSH | CDC

## Summary

- Understand biases from sampling strategies, by purpose
- Recognize underlying statistical distribution
- Compensate for evolving methods in historical data
- Understand the limits for reliable quantification
- Plan for dealing with data gaps