Exposure Assessment Associated with the Use of Respirators

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Exposure Assessment

(from OSHA web-site)

- When must an employer conduct an exposure assessment?
  - When you expose your employees to a respiratory hazard and/or require them to wear respirators.

Respirator Selection

(from OSHA web-site)

Which respirator is right for you?

In order to select an appropriate respirator you must:

Conduct an Exposure Assessment to determine the type and amount of hazardous exposure

Respirator Change Schedules

(from OSHA web-site)

Did you know that employers are now required to provide a respirator cartridge change schedule?

Respirator cartridges don't last forever!

A change schedule is the part of the written respirator program which says how often cartridges should be replaced and what information was relied upon to make this judgment. A cartridge's useful service life is how long it provides adequate protection from harmful chemicals in the air. The service life of a cartridge depends upon many factors, including environmental conditions, breathing rate, cartridge filtering capacity, and the amount of contaminants in the air.

Exposure Assessment

(from OSHA web-site)

- Employers must characterize the nature and magnitude of employee exposures to respiratory hazards before selecting respiratory protection equipment. Paragraph (d)(1)(iii) of the final rule requires the employer to identify and evaluate the respiratory hazard(s) in the workplace.
- Employers must make a "reasonable estimate" of the employee exposures anticipated to occur as a result of those hazards, including those likely to be encountered in reasonably foreseeable emergency situations, and must also identify the physical state and chemical form of such contaminant(s).
- The final rule does not specify how the employer is to make reasonable estimates of employee exposures for the purposes of selecting respirators

Respirator Selection

- Selection of a Respirator require Knowledge of the Nature and Quantity of Contaminants in a workers' breathing zone.
- Establishing a Respirator Change Schedule requires the same type of Knowledge.
- Such Knowledge can arise from an Exposure Assessment.

Exposure Assessment

is necessary because …

- ***A Respirator does not remove all contamination.***
- It reduces contamination in accordance with a “Protection Factor”
  - **APF, WPF, EPF, SWPF, PPF,** etc.

For example… APF = $\mathbf{C_o}$ / $\mathbf{C_i}$ = 10

$\mathbf{C_o}$ = Concentration Outside Mask
$\mathbf{C_i}$ = Contaminant Concentration Inside Mask

Protection Factors

$$\mathbf{APF = C_o / C_i = 10}$$

$\mathbf{C_o}$ = Concentration Outside Mask
$\mathbf{C_i}$ = Contaminant Concentration Inside Mask

$$\mathbf{C_i = C_o / 10}$$

A Protection Factor is really an estimated Reduction Factor for contaminant.

To control the concentration inside the mask,
you need to know the concentration outside the mask.

Exposure Assessment

is necessary because …

- OSHA says you need to do it.
- Exposure Assessment is going to tell you what kind of Respirator you must use.
  - one with a Protection Factor that will get you below the PEL

Respirator Selection

(OSHA Rules)

Maximum Use Concentration (MUC)

MUC = APF x PEL

Where:

PEL = OSHA Permissible Exposure Limit (ppm)
APF = Assigned Protection Factor (designated by OSHA)

Except:

MUC can never exceed the NIOSH IDLH (in ppm)
IDLH = Immediately Dangerous to Life and Health

Ways to Do Exposure Assessment

(from OSHA web-site)

- Sampling
  - Personal exposure monitoring is the "gold standard" for determining employee exposures because it is the most reliable approach for assessing how much and what type of respiratory protection is required in a given circumstance.
- Objective Information
  - You may rely on information and data that indicate that use or handling of a product or material cannot, under worst-case conditions, release concentrations of a respiratory hazard above a level that would trigger the need for respirator use or require use of a more protective respirator.
- Data from industry-wide surveys
  - by trade associations for use by their members, as well as from stewardship programs operated by manufacturers for their customers, are often useful in assisting employers, particularly small-business owners, to obtain information on employee exposures in their workplaces.

Ways to Do Exposure Assessment

- Monitoring
  - Sampling and Measuring Contaminant Concentrations
- Modeling
  - Estimating Contaminant Concentrations Based on
    - **Worst Case Assumptions**
    - **Industry Data for Similar Operations**

Monitoring & Modeling

Pros & Cons

Monitoring

PRO – Accurate & Easy-to-Defend
CON – Can be complex & expensive

Modeling

PRO – Requires only Documents & Computers
CON – Assumptions may be inaccurate

Modeling – Example #1

Contaminant Concentrations

(worst case)

From Production Records:

- 880 L. Cyclohexanone + 975 L. Toluene used (lost) each day in a workplace.
- Workplace believed to have one complete air change per hour.
- Workplace has a Volume of 453 M^3 (40’ x 20’ x 20’).

$$\frac{880{,}000\text{mL}}{8 \times 453\ \text{M3}} = 243\ \text{ppm}$$ Cyclohexanone

PEL = 50 ppm
IDLH= 700 ppm

$$\frac{975{,}000\text{mL}}{8 \times 453\ \text{M3}} = 269\ \text{ppm}$$ Toluene

PEL = 200 ppm
IDLH= 500 ppm

Respirator Selection

(OSHA Rules)

Maximum Use Concentration (MUC)

MUC = PEL x APF

Where:

PEL = OSHA Permissible Exposure Limit (ppm)
APF = Assigned Protection Factor (designated by OSHA)

Except:

MUC can never exceed the NIOSH IDLH (in ppm)
IDLH = Immediately Dangerous to Life and Health

Conclusions from Example #1

Model Estimating Contaminant Concentrations

(worst case)

243 ppm Cyclohexanone

PEL = 50 ppm IDLH= 700 ppm

4.9 x PEL; 35% of IDLH

269 ppm Toluene

PEL = 200 ppm IDLH= 500 ppm

1.4 x PEL; 54% of IDLH

CONCLUSIONS (based on MUC):

1. You could use Air Purifying OV Half Mask (APF=10).
2. You could use OSHA On-Line :"Advisor Genius" to predict Service Life

Modeling – Example #2
More Toxic Contaminants
(worst case)

243 ppm Pyridine

PEL = 5 ppm IDLH= 1000 ppm

49 x PEL; 35% of IDLH

269 ppm Methylene Chloride

PEL = 25 ppm IDLH= 2300 ppm

11 x PEL; 12% of IDLH

CONCLUSIONS (based on MUC):

1. Use Full Facepiece APR (APF=50) or PAPR (APF=25) for Methylene Chloride.
2. Use Full Face Piece APR (APF=50) or Air Supplied Respirator (APF=1000) for Pyridine. (Can still use OSHA Advisor Genius for Service Life.)

Accuracy of Modeling

- Maybe you don't like the Conclusions
  - e.g. that you must use APR or PAPR
    or Air Supplied Respirators
- Actual contaminant concentrations may be significantly lower than the ones estimated using "worst case models".
- Monitoring could demonstrate that a lesser degree of Respiratory Protection is required.

Monitoring (Air Sampling)

- Breathing Zone Measurements
  - Personal Monitoring to measure TWA
- Active (Pump and Tube)
  - Requires Air Sampling Pump
  - Requires air sampling expertise
- Diffusive (Personal Montoring Badge)
  - Cost Effective & Convenient

Air Sampling Methods

- Active (Pump and Tube)
  - Air Sampling Pump = >$15 (amortize or rent) per use
  - In-House Expertise + Labor (hard to value)
  - Lab Fees = $40-60/sample
  - Overall Cost per 10 samples < $1,000
- Diffusive (Personal Montoring Badge)
  - Personal Monitoring Badge = $15 each use
  - Lab Fees = $40-60/sample
  - Overall Cost per 10 samples < $1,000

Cost Comparisons

- Respirator Program (Air Purifying)
  - greater than $1,000 per employee per year
- Respirator Program (Air Supplied)
  - maybe $10,000 per employee per year
- Air Sampling
  - approx. $200 per employee per year

Conclusion

- It may be a good business decision to do periodic Air Sampling to accurately measure the Nature and Quantity of contaminants in workers' breathing zones

- ….. before spending too much money establishing and maintaining a Respirator Program that is inappropriate.