Using Personal Monitors to Enhance Air Purifying Respirator Use

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Our Hypothesis

- Regulatory guidelines advise employers in chemically-exposed facilities to perform exposure assessment to decide if a respirator is needed.

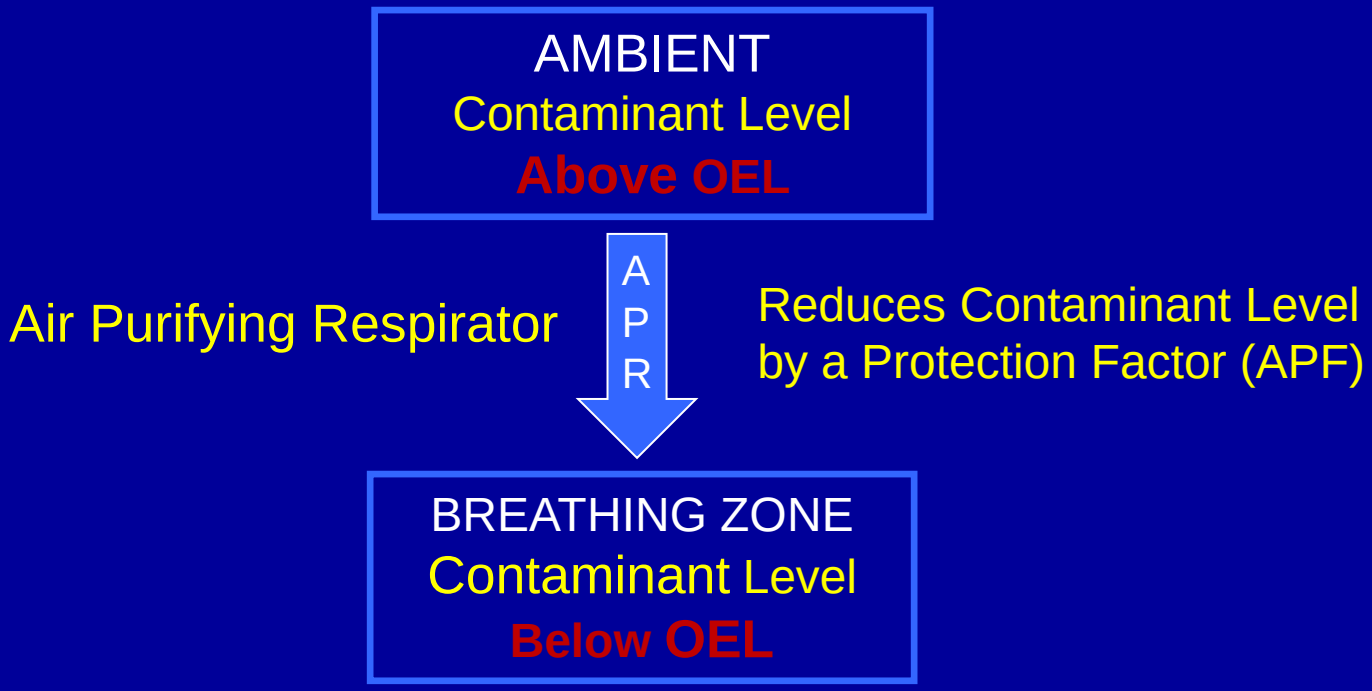
- Exposure assessment will also assist in respirator selection, and will inform APR users in establishing a respirator change schedule.

- Assessment = Monitoring … not guessing

Air Purifying Respirators

- Do Not Remove All Contaminants
- What APRs DO
  - Substantially Reduce Contaminant Levels
- To Correctly Use APR
  - You Need to Know Exposure Levels

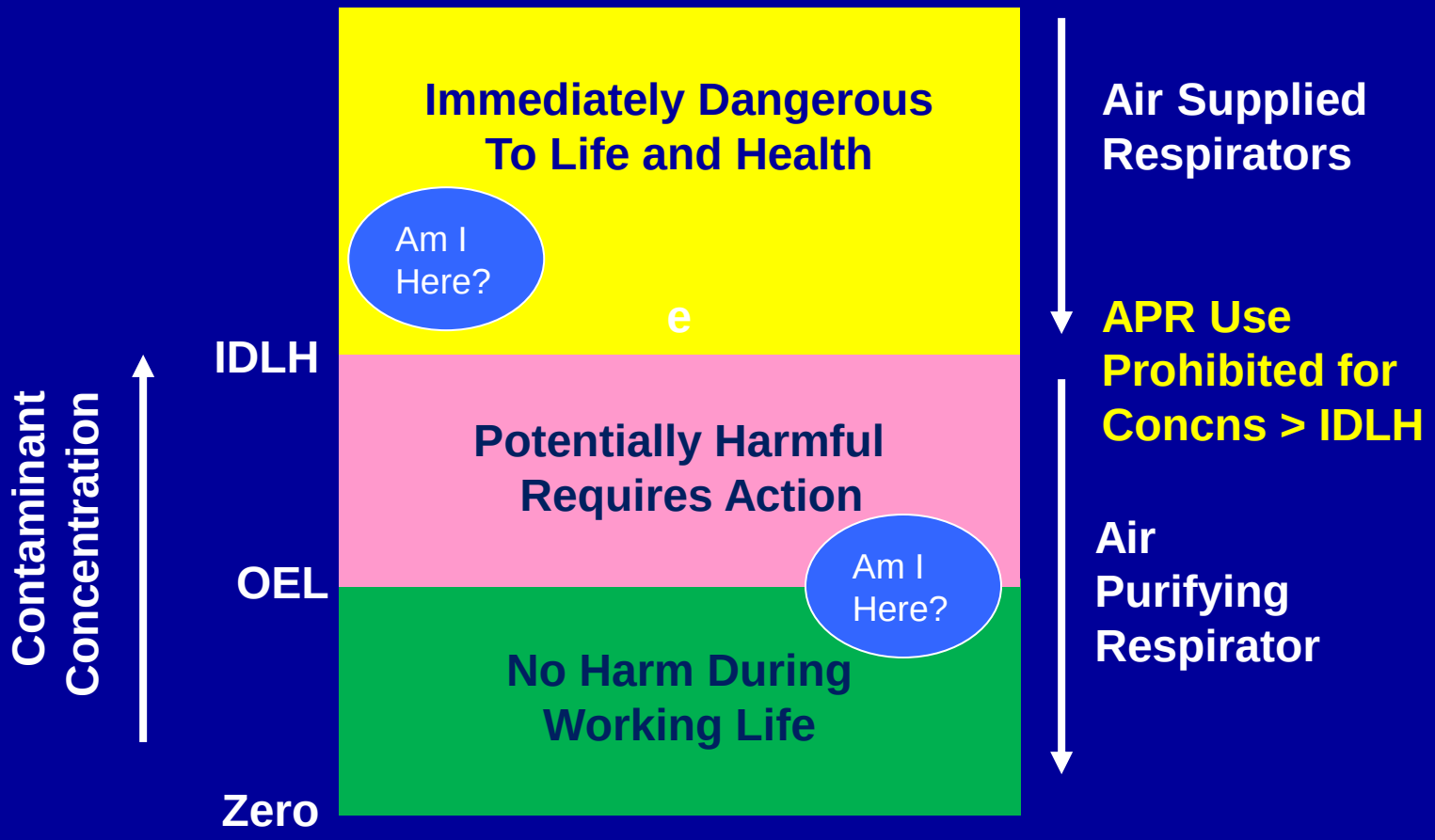
What is Happening when you wear an Air Purifying Respirator



APR = Air Purifying Respirator;
IDLH = immediately dangerous to life & health;
WPF, APF = Protection Factor
OEL = Occupational Exposure Limit

Domains of Respirator Use

Based on Ambient Contaminant Level



Respirator Selection

(USA)

Maximum Use Concentration (MUC)

MUC = OEL x APF

Where:

OEL = Occupational Exposure Limit (ppm)
APF = Assigned Protection Factor

Except:

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

Assigned Protection Factors
(USA)

$APF = C_o / C_i$ = 10, 25, 50, 1000, etc.

C_o = Concentration Outside Mask
C_i = Contaminant Concentration Inside Mask

Assigned Protection Factor is a
"worst case" contaminant Reduction Factor

Ratio of the contaminant level outside / inside the mask.

Respirators You Can Use
(USA)

Respirator Type	APF	MUC
Half Mask APR	10	≤ 10 x OEL
PAPR	25	≤ 25 x OEL
Full Face Piece APR	50	≤ 50 x OEL
Air Supplied Respirator	1000	≤ 1000 x OEL

APR = Air Purifying Respirator;
PAPR = Powered Air Purifying Respirator
APF = Assigned Protection Factor
PEL = OSHA Permissible Exposure Limit

Maximum Use Concentrations
for Several Respirators & Solvents

		Maximum Use Conc'n (MUC) in ppm		
	Assigned Protection Factor (APF)	Benzene	2-Butanone	Xylene
Exposure Limit (PEL) (ppm)		1	200	100
Half-Mask APR	10	10	2,000	1,000
PAPR	25	25	5,000	2,500
Full-Face Piece Mask APR	50	50	10,000	5,000
Air Supplied Respirator	1000	1,000	200,000	100,000

APR = Air Purifying Respirator

MUC = APR x PEL

Using an Air Monitor
in Respirator Selection

- Air Monitoring Data
  - – Tells you which Respirator you may use
  - – Finding of Lower Contaminant Levels justifies a less burdensome Respirator
    - More Cost-Effective & Convenient Respiratory Protection

Exposure Assessment

(Personal Monitoring)

Can Tell You 2 Things

- Which Respirator you May Use
- How Long you May Wear it

Exposure Assessment Methods

- Air Monitoring
- Math Models
- Guessing

Exposure Assessment Methods
(allowed by OSHA)

Exposure Assessment Methods

- Air Monitoring
- Math Models
- ~~Guessing~~

In Favor of Air Monitoring

- More Accurate Than Modeling/Guessing
- More Cost-Effective & Convenient

Part II

Personal Air Monitors

120+ Organic Vapors

Formaldehyde
& other Aldehydes

Amines, Anesthetics
EtO, Ozone, Acrolein,
NO_2, SO_2, NH_3, Hg,

The most cost-effective and convenient method for monitoring workers' chemical exposure.

Reasons for Not Monitoring

- Likely arise from one of the following beliefs
  - Users already know exposure levels
  - Exposure levels are constant
  - More data will not change respirator decisions
  - Monitoring is too expensive.

“Are exposure levels typically constant …”
probably not

- Studies of workplace exposures demonstrated that variations in workplace exposure are much higher than was believed when current practices and regulations were established.

- Respirator selections and change schedules based on minimal or old data with the assumption of constant exposures may often be incorrect.

Using an Air Monitor

in Respirator Selection

- Based on a Model, benzene exposure levels in a facility are estimated at 15-20 ppm.
  - The MUC for a Half-Mask APR is only 10 ppm, so a Full-Face Piece APR or PAPR must be used

- Subsequent Air Monitoring determines actual daily exposure levels of 5 ± 3 ppm of benzene
  - Half-Mask APR may now be used

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Maximum Use Concentrations
for Several Respirators & Solvents

		Maximum Use Conc'n (MUC) in ppm		
	Assigned Protection Factor (APF)	Benzene	2-Butanone	Xylene
Exposure Limit (PEL) (ppm)		1	200	100
Half-Mask APR	10	10	2,000	1,000
PAPR	25	25	5,000	2,500
Full-Face Piece Mask APR	50	50	10,000	5,000
Air Supplied Respirator	1000	1,000	200,000	100,000

APR = Air Purifying Respirator

MUC = APR x PEL

Using an Air Monitor

in Respirator Selection

- 2-butanone (MEK), an ingredient in ink jet printing, may be present at high levels where multiple printers are used. Due to a low odor threshold, its concentration is often overestimated.
  - Due to an exposure overestimate, cumbersome expensive PAPRs are in routine use.

- Air Monitoring establishes that daily exposure levels near printers are actually 200 ± 100 ppm.
  - Half-Mask APRs may now be used.

Maximum Use Concentrations
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Respirator Change Schedules

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 … 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.

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Service Life Calculators

- On-Line Calculator
  - You Must Enter Data
    - Respirator ID, Temp, %RH, Breathing Rate
    - *Expected Contaminant and Its Concentration*

- Service Life Estimation
  - Higher Contaminant Level
    - *Shorter Service Life*
  - Lower Contaminant Level
    - Longer Service Life

Effect of Air Concentration on Predicted Service Life

	Predicted Service Life (hours)			
	TWA Air Concentration	**Benzene**	**2-Butanone**	**Xylene**
Exposure Limit (PEL) (ppm)		**1**	**200**	**100**
	25	**62**		
	75	**26**		**46**
	100	**20**		**38**
	250	**9.0**	**9.0**	**16**
	500	**5.1**	**5.4**	**7.9**
	750	**3.6**	**3.9**	**5.3**

Typical Air Purifying Respirator
e.g.,3M 6001 Org Vapor Cartridge

Using an Air Monitor

to lengthen Change Schedule

- Air Monitoring Data
  - Predicts Respirator Service Life
  - Finding Lower Contaminant Levels Justifies Longer Service Life
    - Conserving Respiratory Protection resources.

Using an Air Monitor

to lengthen a Change Schedule

- Using a Model, xylene exposure levels in a facility have been estimated at 500+ ppm
  - Based on the 3M Service Life Calculator, a schedule of *changing cartridges each day* was adopted.

- Air Monitoring establishes that daily exposure levels are actually within 150 ± 50 ppm xylene.
  - Schedule can now be modified to *change every other day* using 3M Calculator.

Effect of Air Concentration on Predicted Service Life

	Predicted Service Life (hours)			
	TWA Air Concentration	**Benzene**	**2-Butanone**	**Xylene**
Exposure Limit (PEL) (ppm)		**1**	**200**	**100**
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Typical Air Purifying Respirator
e.g.,3M 6001 Org Vapor Cartridge

Using an Air Monitor

to lengthen a Change Schedule

- In a special refinery operation, benzene exposures have historically been 500 ppm or higher.
  - Based on the 3M Calculator, respirator cartridges must be changed every 4 hours.
- After engineering changes are made, subsequent Air Monitoring demonstrates that daily exposure levels are actually 100 ± 50 ppm of benzene
  - Based on the Calculator, respirator cartridges *now need only be changed daily*.

Personal Monitors

- Cost-effective and convenient personal monitors have become more versatile, reliable, and available than in the past, lowering the effective cost of data.
- Repeated exposure monitoring (assessment) generally leads to decreased exposures.
- Decreased exposures present economic opportunities to lengthen change schedules or to transition to simpler, less expensive respirators.

Personal Air Monitors

The most cost-effective and convenient method for monitoring workers' chemical exposure.

Conclusion

- Personal Air Monitors provide a more scientific approach to using Respirators
  - Air Monitoring data can justify selection of a more cost-effective & convenient respirator.
  - Air Monitoring data can justify change schedules that conserve respiratory protection resources.

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- Thanks for attending. Feel free to contact either of us with any questions.

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