

# A Simple Air Monitoring Plan for Respirator Selection & Use

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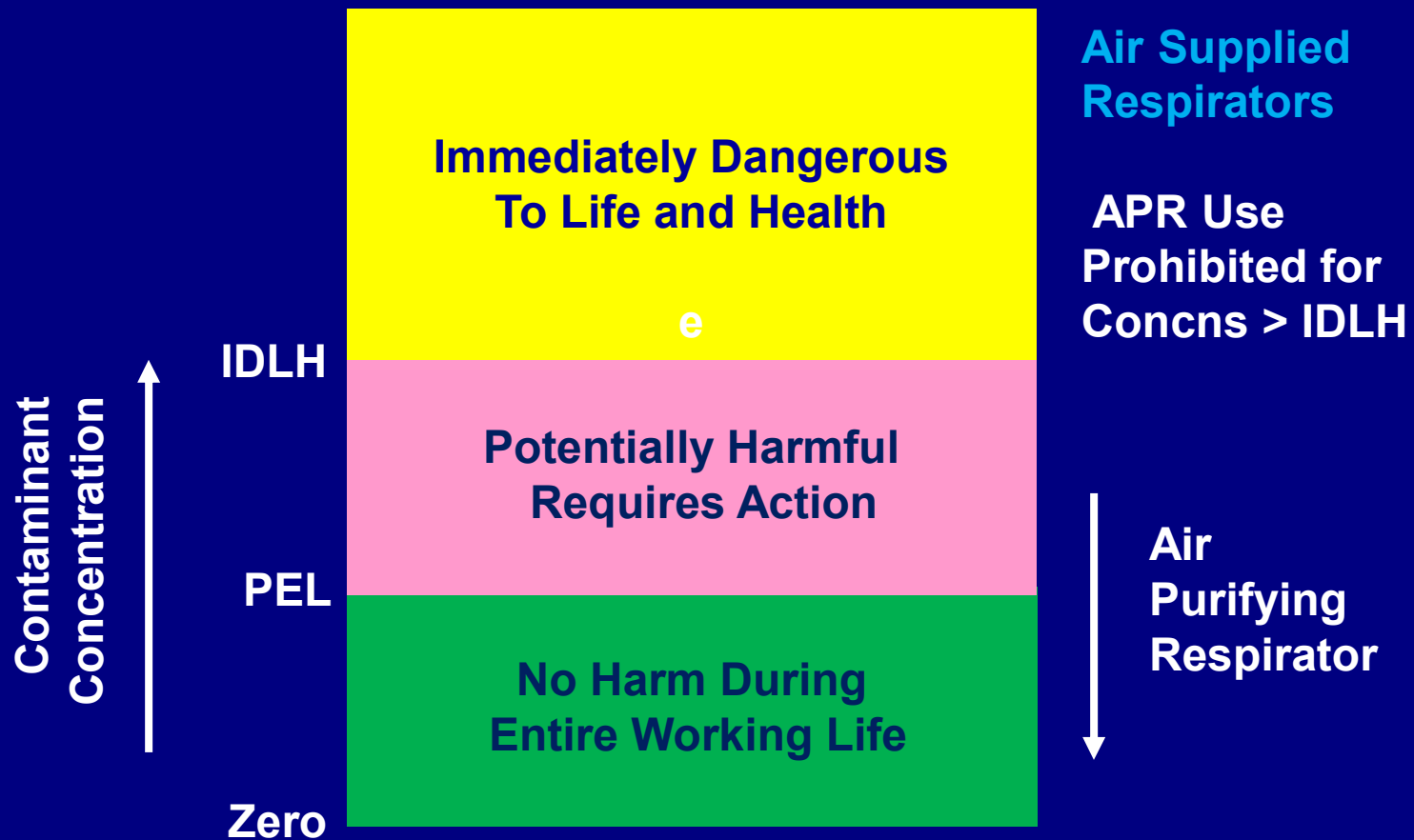
Chief Technical Officer

**M.D.R. Peralta, PhD**

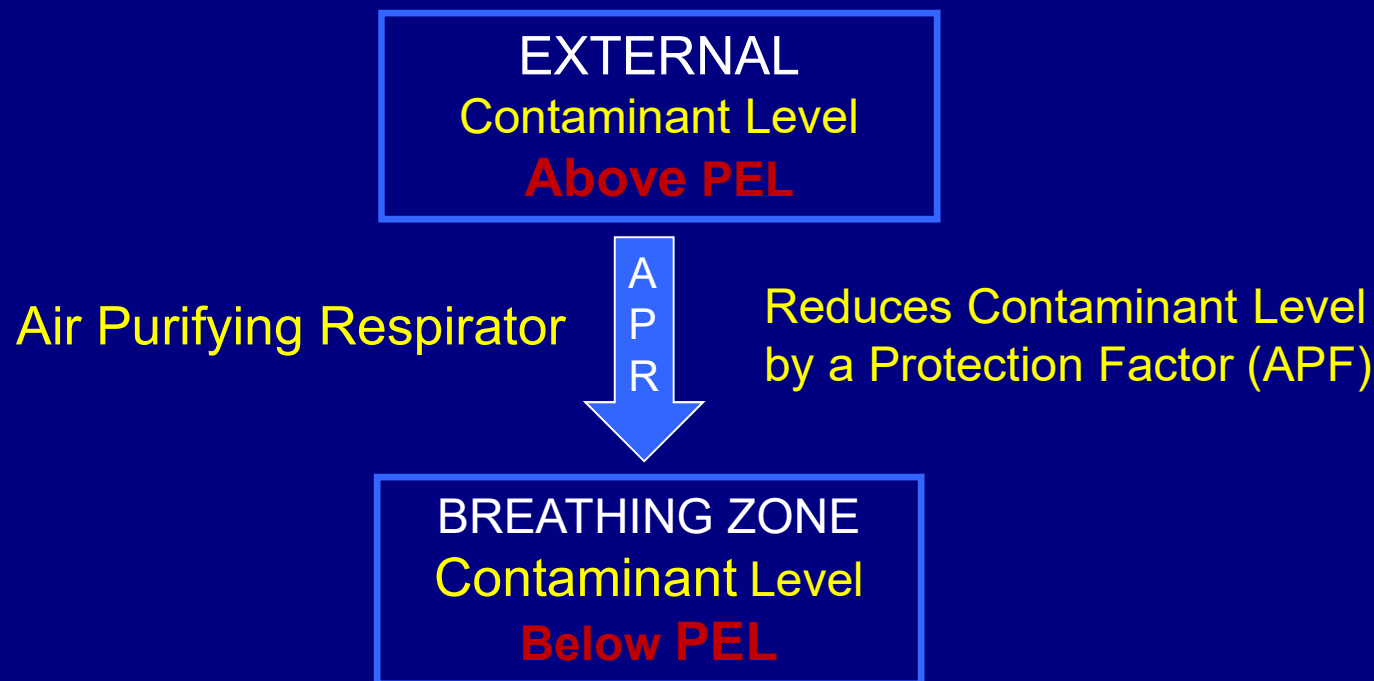
Technical Director

Assay Technology operates accredited testing labs and  
manufactures personal monitoring badges

# Respirators Reduce Exposure but Don't Remove All Contaminants



# What is Happening when you wear an Air Purifying Respirator



APR = Air Purifying Respirator;  
IDLH = immediately dangerous to life & health;

APF = Assigned Protection Factor  
PEL = OSHA Permissible Exposure Limit

# Assigned Protection Factor

(assigned by OSHA)

$$APF = C_o / C_i = 10, 25, 50, 1000, \text{ etc.}$$

$C_o$  = Concentration Outside Mask

$C_i$  = Contaminant Concentration Inside Mask

A Protection Factor is an estimated contaminant Reduction Factor assigned by OSHA as a “worst case”.

It is the ratio of the contaminant level **outside** the mask, compared to the contaminant level **inside** the mask.

# Respirator Selection

(OSHA Rules)

## Maximum Use Concentration (MUC)

$$\text{MUC} = \text{PEL} \times \text{APF}$$

Where:

PEL = OSHA Permissible Exposure Limit (ppm)

APF = Assigned Protection Factor

Except:

MUC can never exceed the NIOSH IDLH (in ppm)

IDLH = Immediately Dangerous to Life and Health

# Respirators You Can Use

<b>Respirator Type</b>	<b>APF</b>	<b>MUC</b>
Half Mask APR	10	$\leq 10 \times \text{PEL}$
PAPR	25	$\leq 25 \times \text{PEL}$
Full Face Piece APR	50	$\leq 50 \times \text{PEL}$
Air Supplied Respirator	1000	$\leq 1000 \times \text{PEL}$

APR = Air Purifying Respirator;  
PAPR = Powered Air Purifying Respirator

APF = Assigned Protection Factor  
PEL = OSHA Permissible Exposure Limit

# Performance and Cost

<b>Respirator Type</b>	<b>APF</b>	<b>Cost/Emp/Mo</b>
Half Mask APR	10	\$450
PAPR	25	\$3,000
Full Face Piece APR	50	\$ 500
Air Supplied Respirator	1000	\$5,000

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



# Air Monitors & Respirators are closely connected

- Air Purifying Respirators

- Reduce Air Contaminants

- by a REDUCTION FACTOR

- Air Monitors

- Identify Air Contaminants

- Measure Contaminant Levels

# Exposure Assessment

(required by OSHA)

## 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<sub>2</sub>, SO<sub>2</sub>, NH<sub>3</sub>, Hg,

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

# Air Monitoring Value Proposition A

## ■ 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

# Value Prop A Case 1

- 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  $5 \pm 3$  ppm of benzene
  - Half-Mask APR may now be used

# 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

## Value Prop A Case 2

- 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  $200 \pm 100$  ppm.
  - Half-Mask APRs may now be used.



# Maximum Use Concentrations for Several Respirators & Solvents

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	Assigned Protection Factor (APF)	Benzene	2-Butanone	Xylene
Exposure Limit (PEL) (ppm)		1	200	100
Half-Mask APR	10	10	2,000	1,000
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APR = Air Purifying Respirator  
MUC = APR x PEL

# 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 ... 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.

# Service Life Calculators

## ■ Available from Mfr On-Line

– You Enter Data

- Respirator ID, Temp, %RH, Breathing Rate
- Expected Contaminant and Its Concentration

## ■ Calculator Predicts Service Life

– 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

# Air Monitoring Value Proposition B

## ■ Air Monitoring Data

- Predicts Respirator Service Life

- Finding Lower Contaminant Levels Justifies Longer Service Life

  - Conserving Respiratory Protection resources.

# Value Prop B Case 1

- 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  $150 \pm 50$  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
25	62		
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Typical Air Purifying Respirator  
e.g., 3M 6001 Org Vapor Cartridge

## Value Prop B Case 2

- 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  $100 \pm 50$  ppm of benzene
  - Based on the Calculator, respirator cartridges *now need only be changed daily.*



# Personal Air Monitors



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



# Conclusion

- Personal Air Monitoring provides 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.

# Finis

- Thanks for attending. Feel free to contact either of us with any questions.
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**CM1**

Charles Manning, 5/8/2020