

Evaluating Employee Inhalation Exposures to Metals

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[Objectives]

- Select OEL
- Document exposures
- Basics of qualitative assessment
- Process of exposure monitoring
- Interpret results

[Who Are Our Clients?]

“We are obligated to protect the health and well-being of people.”



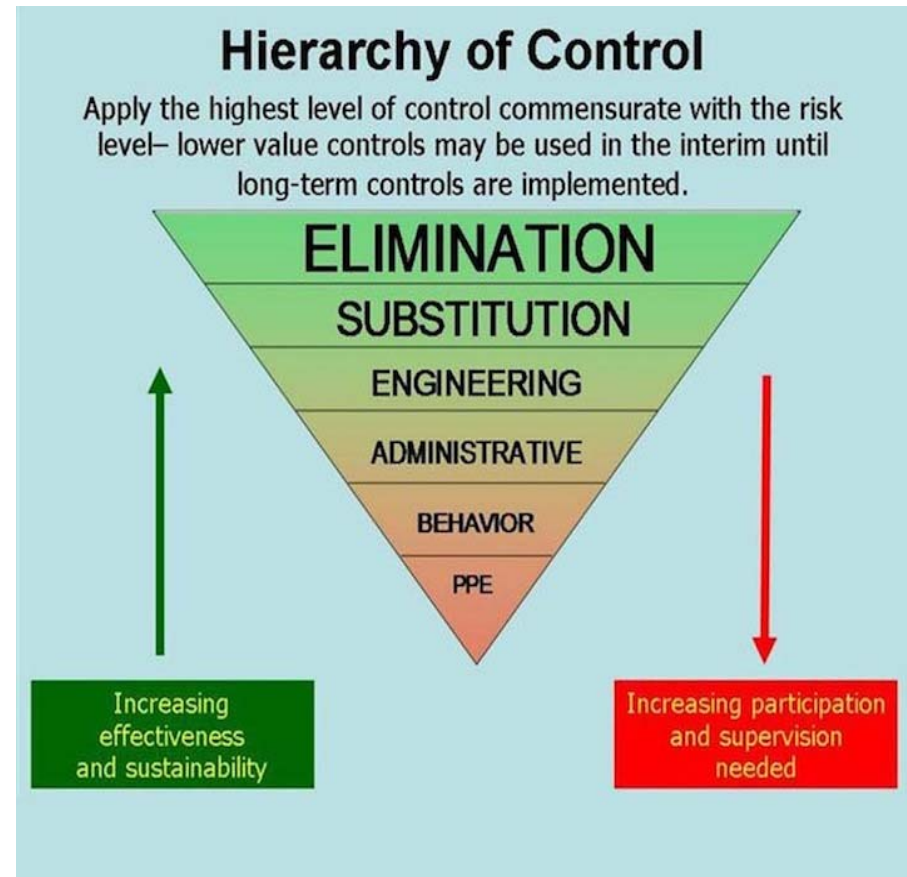
Primary Responsibilities of the Occupational Hygienist

- Anticipation
- Recognition
- Evaluation
- Control



The Hierarchy of Control

- Elimination
- Substitution
- Engineering Controls
- Work Practices/Administrative Controls
- Personal Protective Equipment





Occupational Exposure Limits

PEL, TLV, REL, WEEL, etc.

[Occupational Exposure Limits - Goals]

- Refers to all established limits
- Protect workers over working lifetime without adverse health effects
- Applies to the working conditions of the country where developed
- Basis varies with chemical
- Not applicable to general public

[Sources of OELs]


- OSHA PEL Standards
 - Permissible Exposure Limits
 - Regulatory
 - TWA/ Action Limits/Ceiling
 - <https://www.osha.gov/dsg/annotated-pels/tablez-1.html>
- NIOSH REL
 - Recommended Exposure Limit
 - Precursor to TLV (10-hr days)
- ACGIH TLV
 - Threshold Limit Values
 - TWA/STEL/C
- TERA WEEL Guidelines (formerly AIHA)
 - Workplace Environmental Exposure Level
- EPA - NCEL (TSCA)
 - New Chemical Exposure Limit
 - <http://www.epa.gov/oppt/newchemicals/pubs/ncelmain.htm>

[Other Exposure Limits]

- MAK - Germany
- MEL & OES - Britain
- DNEL – European Union REACH
- GESTIS International Limit Values
- ERPG - AIHA Emergency Response Planning Guidelines (community)
- RfC - EPA Reference Concentrations (community)

[OEL Terms]

- TWA - Time-weighted average (ppm or mg/m³)
 - Full shift
- STEL - Short-term exposure limit (ppm or mg/m³)
 - 15 minute short term
- C - Ceiling value (ppm or mg/m³)
 - Instantaneous maximum concentration
- Skin - skin notation
- SEN – Sensitizer (DSEN, RSEN)



Managing Exposures

Qualitative Exposure
Assessments

[The Occupational Hygiene Survey]

- Determination of purpose and scope
- Familiarization with process
- Qualitative survey
- Quantitative survey



Picture from the University of Pennsylvania

Familiarization with Process

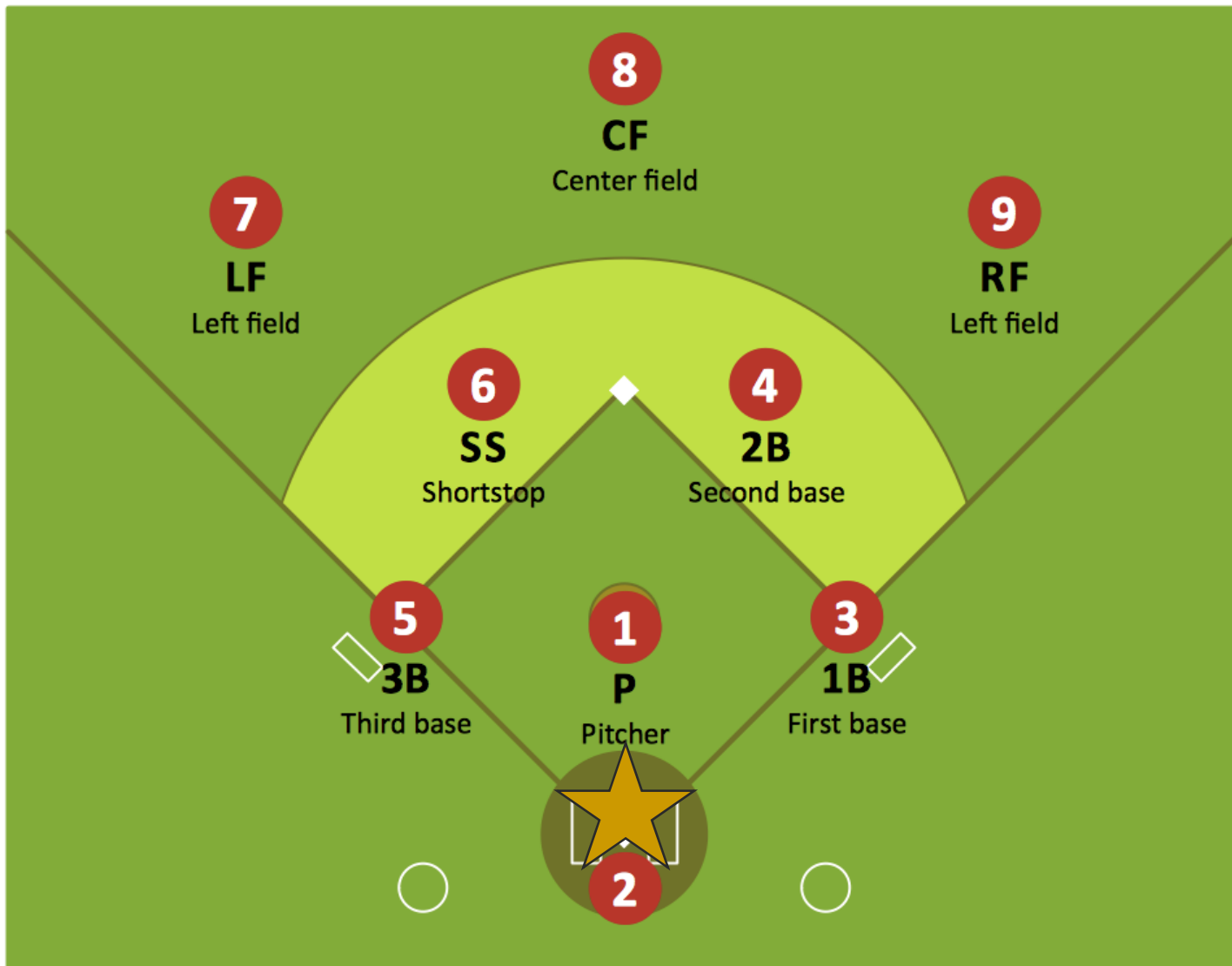
- Physical site layout
- Understanding the process
- Inventory: raw materials, intermediates, by-products, and products
- Job classifications
 - SEG



[Similar Exposure Groups (SEGs)]

- A group of workers having the same general exposure profile for an agent because of the:
 - Similarity and frequency of the task(s) they perform,
 - Similarity of materials and process
 - Similarity of the way they perform the task

[SEG in Baseball]



[Qualitative Assessment Process]

1. Establish Similar Exposure Groups (SEGs)
2. Conduct assessment per SEG
3. Determine if assessment is:
 - a. Acceptable
 - b. Uncertain
 - c. Unacceptable

Judging Exposures

- Acceptable
 - Exposure variability low and risk is low
- Uncertain
 - Need additional data to make determination
 - Too close to call
- Unacceptable
 - Controls should be implemented
 - May conduct a quantitative assessment to gather actual data

Group Discussion

- Conduct qualitative assessment for given scenario
 - Limited sampling budget, prioritize sampling
- Determine SEG
 - Torch cutting, supervisor, equipment operator, maintenance
- Identify potential metal exposures
- Determine frequency and probability of exposure

Recycling





Managing Exposures

Quantitative Assessment

[Exposure Assessment]

- Develop a plan prior to beginning any monitoring
- Describe the basic tenets of monitoring
 - who, what, when and how
- Understand the instrument selection process

[Steps in a Quantitative Survey]

- Review SDS - Select contaminants
- Review available sampling and analytical methods
- Select sampling equipment
- Select personal protective equipment

[Common Metals]

- Lead
 - OSHA lead standard)
- Iron oxide
- Chromium
 - Hexavalent Chromium – Stainless steel
- Manganese

[Exotic Metals]

- Tungsten
- Vanadium
- Molybdenum
- Etc.

Conducting a Quantitative Assessment

- Questions requiring answers include:
 - Who to sample
 - When to sample
 - How long to sample
 - How many samples to collect
 - What to sample
 - How should samples be obtained

[Who and When]

- Who
 - SEGs - unacceptable or uncertain
 - Highest or lowest exposed employee
- When
 - Routine
 - During specific task
 - Over all shifts
 - Random
 - Non-routine tasks

[How Many]

- Representative number
- Statistically significant/ random
 - *A Strategy for Assessing and Managing Occupational Exposures*
– AIHA Press

[Sample Duration]

- Purpose of the sampling
 - OEL comparison
 - TWA
 - STEL/ Ceiling
 - Excursion Values
 - Task analysis
- Never collect sample if you don't know what you will do with the results!

[What to Monitor]

- Gases or vapors
- **Particulates or fumes**
- Fibers
- Consider by-products or intermediates

As identified during the qualitative assessment

[Sampling Methods]

- NIOSH Sampling Methods
- OSHA Sampling Methods
- Review NIOSH 7300
 - Individual metals
 - 9 metal scan
 - 30 metal scan

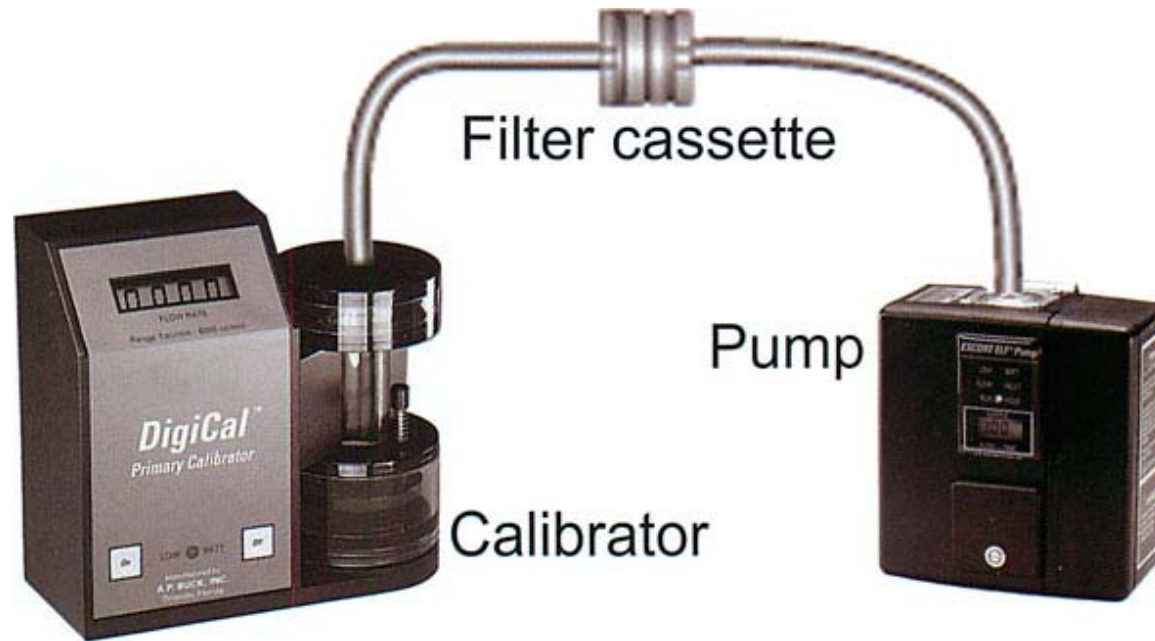
[Sampling]

- Select pump and media
- Determine duration of sample
- Calibrate pump
- Sample
- Ship sample to lab
- Receive results

NIOSH 7300 Equipment



[CALIBRATE]

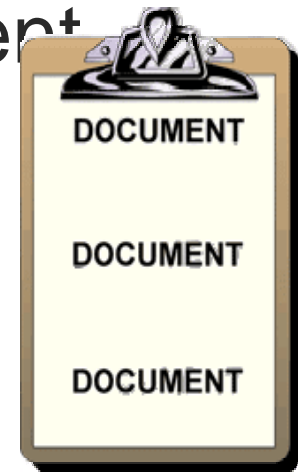


[SAMPLE]



[The Field Survey]

- Observe workers and record activities
- Do not interfere
- Note duration and location of tasks and operations as well as other pertinent factors
- Label samples
- Establish chain-of-custody



[Chain of Custody]

- Determine Sample Volume
 - $\text{Lpm} \times \text{minutes} = \text{liters}$
- Indicate Sampling Method
 - NIOSH 7300
- Indicate contaminant/analysis
- Sign and date

Interpretation of Monitoring Results

- Time-weighted average limits
- Short-Term Exposures/ Ceiling Values
- Comparison with appropriate standards
- Comparison to previous data



Interpreting Exposure Data

[TWA Calculation]

$$\text{TWA} = \frac{C_1 T_1 + C_2 T_2 + C_3 T_3 \dots \dots \dots}{\text{Total Time}^*}$$

** Total time can be either in hours or minutes. You may choose to use 8 hours or 480 minutes, but this will assume that unsampled time is zero exposure.*

[Example: TWA Calculation]

- If three benzene samples collected on a refinery worker over an 8-hour workday revealed the following exposures, what would the 8-hour TWA be?
 - 0.5 ppm for 4.5 hours
 - 1.5 ppm for 1.0 hours
 - 0.8 ppm for 2.5 hours

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OTHER CONSIDERATIONS

[Non-Traditional Work Schedules]

- OSHA Method
- AIHA - article AIHA Journal May/June 00
- Brief and Scala method

[Non-Traditional Work Schedules]

OSHA Method

Day

$$\text{Equivalent PEL} = 8 \text{ hour PEL} \left(\frac{8 \text{ hours}}{\text{Hours of exposure}} \right)$$

Week

$$\text{Equivalent PEL} = 8 \text{ hour PEL} \left(\frac{40 \text{ hours}}{\text{Hours of exposure}} \right)$$

[Lead Example]

$$\text{Equivalent PEL} = 8 \text{ hour PEL} \left(\frac{8 \text{ hours}}{\text{Hours of exposure}} \right)$$

$$\text{Equivalent PEL} = .05 \text{ mg/m}^3 (8 \text{ hours} / 12 \text{ hours})$$

$$\text{Equivalent PEL} = .05 (.66)$$

$$\text{Equivalent PEL} = .0333 \text{ mg/m}^3$$

[Non-Traditional Work Schedules]

Brief and Scala Method

$$\text{OEL Reduction Factor (RF)} = \left(\frac{8 \text{ hours}}{\text{Hours worked}} \right) \left(\frac{24 - \text{hours worked}}{16 \text{ hours}} \right)$$

$$\text{Equivalent OEL} = (\text{OEL}) (\text{RF})$$

[Brief and Scala Example]

$$\text{OEL Reduction Factor (RF)} = \left(\frac{8 \text{ hours}}{\text{Hours worked}} \right) \left(\frac{24 - \text{hrs. worked}}{16 \text{ hours}} \right)$$

$$\text{OEL RF} = (8\text{hrs}/ 12 \text{ hours}) [(24 - 12)/16]$$

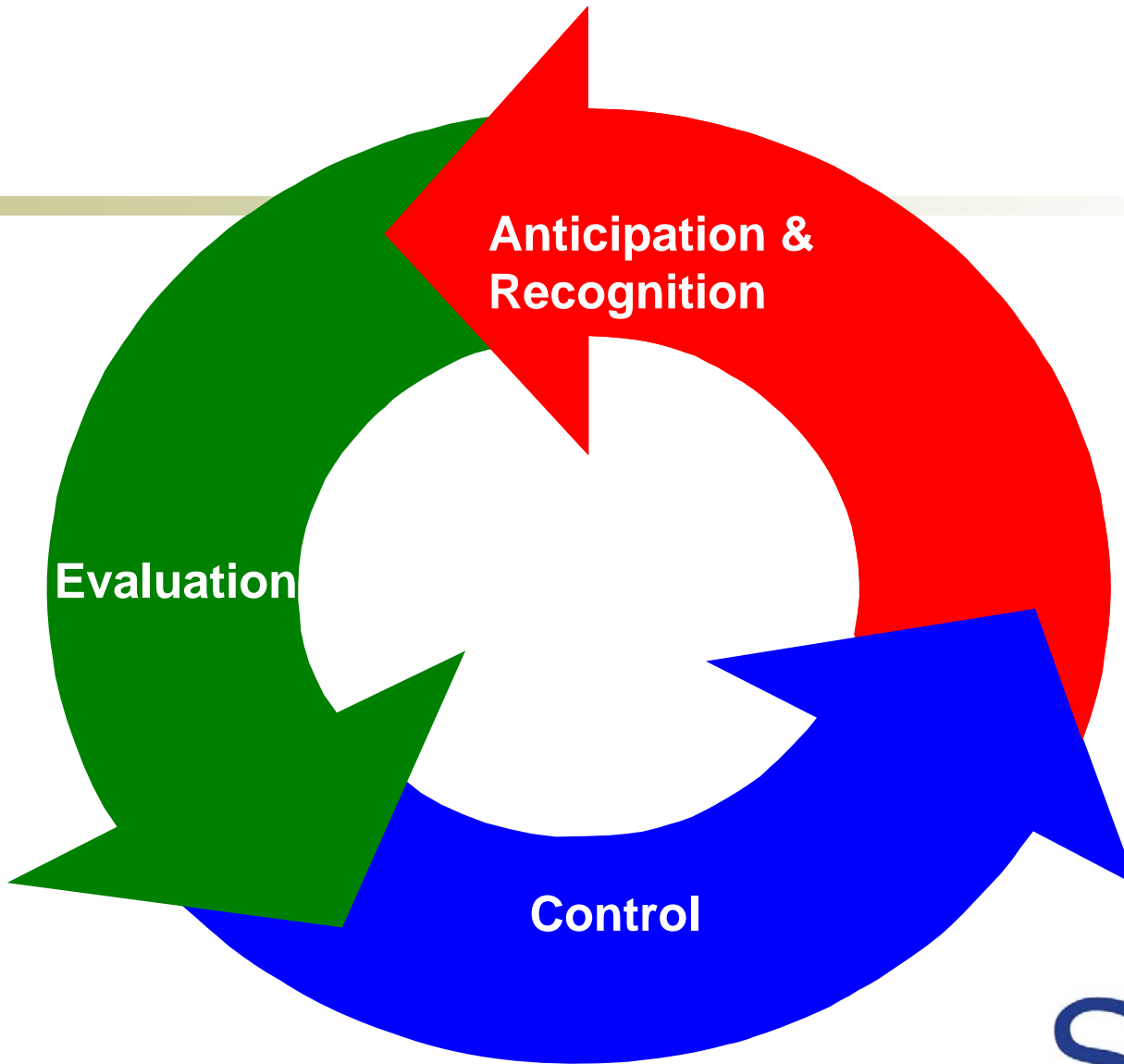
$$\text{OEL RF} = (.67) (12/16)$$

$$\text{OEL RF} = (.67) (.75)$$

$$\text{OEL RF} = .50$$

$$\text{Adjusted OEL} = \text{OEL} \times \text{OEL RF}$$

$$\text{Adjusted OEL} = .05 \text{ mg/m}^3 \times .5 = .025 \text{ mg/m}^3$$





Questions?

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