

IH&S 725

Overview of IH Sampling Strategies

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Measurement Vs Sampling Vs Survey

- **Measurement relevant only if it is a sample of something relevant**
- **Sampling is relevant only if the mean of the samples is representative of the duration and condition sampled.**
- **Sampling is a tool of a survey, which seeks to answer questions (is anyone overexposed?) or fill some other need (e.g., documentation)**
- **Survey includes:**
 - study of the process and records
 - interviews with employees, supervisors, engineers, etc.
 - walkthrough, using senses and all of the above to make preliminary decisions
 - sampling of priority areas

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Purpose of Sampling

- **Historical documentation**
 - later medical diagnosis
 - defense against unjustified claims
 - epidemiological research
- **Determine need for action**
 - engineering controls
 - require/select personal protective equipment
 - remove vulnerable workers from exposures
 - further, more intensive sampling
- **Regulatory compliance**
 - voluntary: assure within PELs, TLVs
 - required: document exposures
- **Engineering controls**
 - determine most important sources
 - assure working effectively

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Sampling Procedures

- **Focus**
 - Personal sampling
determine acceptability of air concentrations
 - Area sampling
evaluate engineering controls
source apportionment
- **Duration**
 - grab (instantaneous):
spot checks
see instantaneous below
 - time-weighted, short-term (STEL)
 - time-weighted, 8 hr (PEL)
 - use of instantaneous to estimated time-weighted
must take many to have confidence in mean value

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Comparing time-weighted exposures to standards

$$TWA = \left(\frac{\sum_{i=1}^n C_i \Delta t_i}{\sum_{i=1}^n \Delta t_i} \right)$$

$$8hr TWA = \left(\frac{\sum_{i=1}^n C_i \Delta t_i}{8} \right)$$

STEL = highest 15 minute running average

Standards for mixtures:

independent: consider each separately

additive ---->

$$FractionOfPEL = \frac{1}{8} \sum_{j=1}^m \left(\frac{\bar{C}_j \Delta t_j}{PEL_j} \right)$$

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Homework, No. 1

Time	Time	Cont.	Cont.
Start	Stop	Xylene	Toluene
8	9	45	67
9	12	121	175
12	1	0	0
1	3	75	115
3	5	100	150

8-hrTWA=
STEL=
PEL=
TLV=
%STEL=
%Allowed=

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Random & Systematic Errors Due to Measurement Technique - I

- Pump flow fluctuations
- Drops in pump battery voltage
- Failure to correct for:
 - effects of temp. and pressure on calibration
 - collection efficiency of the sampling medium
 - desorption efficiency
- Variation in:
 - electrical current to analytic instrument
 - supply of fuel to analytic instrument (e.g., flame ionization detector)

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Random & Systematic Errors Due to Measurement Technique-II

- Varying climatic factors (temp., pressure, humidity)
- Pump calibration errors
- Sample degradation during shipping and storage
- Humidity effects on air sample collection
- Interferences
- Lab errors

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- Factors causing variation in worker exposures**
- **Process factors**
 - type and operation
 - chemical composition
 - physical state and prop. (e.g., vap. press.)
 - rate of operation
 - airflow patterns
 - ventilation
 - **Environmental variables**
 - weather
 - age, size, layout of plant
 - job category (time doing what, where)
 - **Time Variables**
 - buildup during day
 - flushing when not generating contaminant
 - cyclical operations
 - work shift, day of week, season, year, decade
 - **Behavioral**
 - worker practices, training, attitudes
 - management attitudes
 - **Incidental** - accidents, maintenance, failures, errors, etc.

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Some Sampling Strategies

- **Professional judgment checklist**
- **Worst case sampling**
- **OSHA strategy**
- **AIHA strategy**
- **Simple strategy (Perkins)**
 - acute toxicants
 - chronic toxicants
- **Rappaport strategy**
- **Quality control strategy**
- **Guffey**

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Estimating Exposures by Professional Judgment

- **Could be > action limit?**
 - vapor pressure of the chemical
 - duration time of exposure
 - process temperature
 - work practices exacerbate
 - level of the action limit
- **Exceeds how frequently?**
 - variability says will occasionally exceed
 - how often is too often?
- **Which are worst cases?**
 - contrived (worst part of task)
 - most exposed individuals *that day*
 - » Is top 10% “worst case”?
 - » can't extrapolate to other days
 - loop: monthly sampling will reveal at least one over-exposed employee
 - » acceptable risk: 5% overexposures acceptable?
 - » okay for chronic, not acute

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AIHA Strategy

- Random sampling of *homogeneous exposure groups* (HEGs)
- Individual monitoring events staged on random days for single workers within HEGs
- Minimum sample number of 6
- 30 often needed

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NIOSH Sampling Strategy

1. Is the chemical released into the workplace?
 - a. If no, discontinue sampling strategy.
 - b. If yes, go to item 2
2. Determine which employees may be exposed > than action level (AL)
3. If exposure may be > AL, identify and measure worst-case employees
 - a. <AL, discontinue sampling
 - b. >AL, measure ALL employees who may be >AL
4. If exposures in 3 are:
 - a. <AL, discontinue sampling
 - b. >AL and <PEL, re-measure every 2 months. If two consecutive <AL, discontinue for that employee.
 - c. >PEL, notify employees, institute controls, re-measure at least monthly until <PEL

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Rappaport

- Day to day and worker variability huge
- Homogeneous work groups are a myth
- Professional judgment is poor
- Highly precise sampling method therefore pointless if consider error propagation
- Solution:
 - Sample frequently
 - Use low-cost sampling even if poor precision
 - Change assumption of risk: make employers prove workers are NOT over-exposed.

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Guffey Approach

- **Sample to make decisions**
 - Thus sample more if close to decision point
 - Sample little if very high or very low
- **Sample at every opportunity**
 - Low quality samples during walk around to rule out areas of very low exposures
 - High quality samples when an important decision is in doubt
 - Additional low-quality samples to back up small number of costly high-quality samples
- **Sample the heck out of it**
 - As many samples as possible
 - As diverse as possible: different workers, different days, different conditions
 - Sample every SHIFT
 - Take personal and area samples
- **Rely heavily on task sampling to back up decisions**
- **Talk to workers; watch workers; watch person being sampled**

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Other assessment problems

- **Multiple exposure limits**
- **Temporal and spatial correlation (non-independence of samples)**
- **Exposure groups not homogenous**
- **>40 hour workweeks**
- **>8 hour days**
- **Multiple jobs**
- **Exposures after work**

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Questions?

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