

# Exposure Assessment Strategies

Instructor note: The calculation tools I mentioned is available on the AIHA Exposure Assessment Strategies Committee website at <https://www.aiha.org/get-involved/VolunteerGroups/Pages/Exposure-Assessment-Strategies-Committee.aspx>

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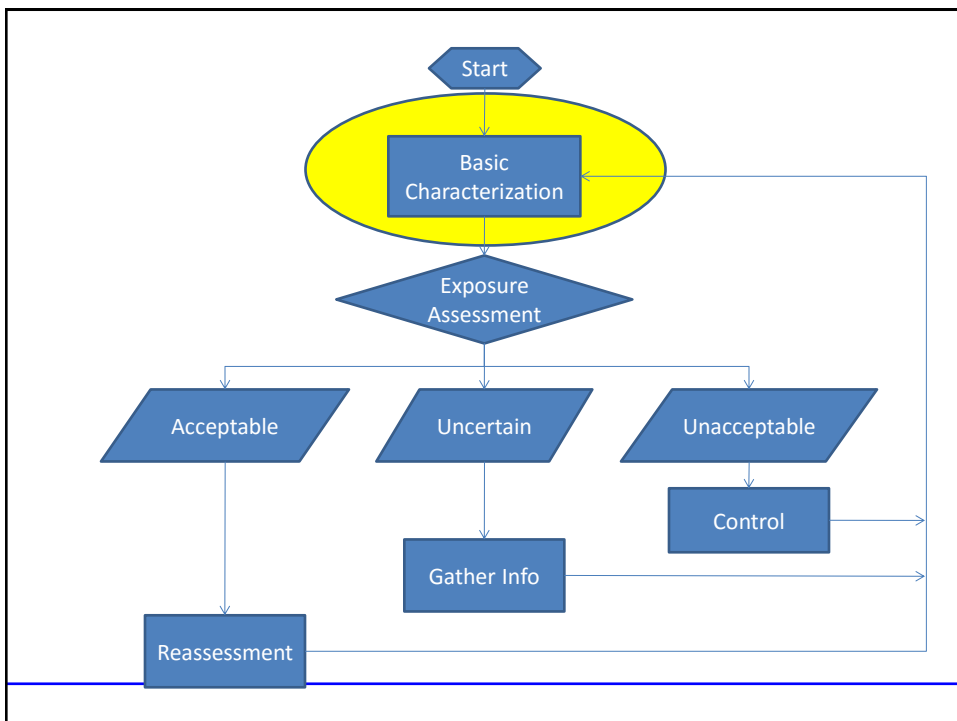
Recognized, methodical processes for developing an industrial hygiene exposure assessment strategy.

We'll discuss:

- Types of sampling;
- Selecting exposure criteria;
- Identifying recognized methods for measuring exposures;
- Characterizing exposure data; and,
- Making decisions for implementing controls.

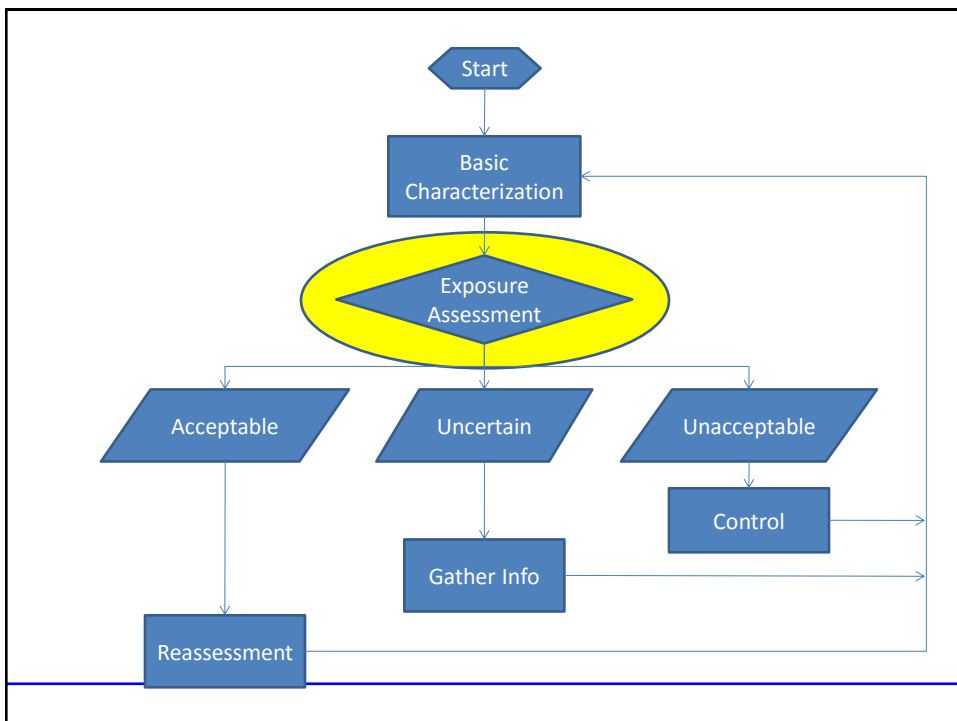
## Why Do Monitoring

- Baseline Monitoring
- Compliance Monitoring
- Evaluate Space and Time Distributions
- Evaluate Effectiveness of Engineering Controls



## Basic Characterization

- Summary of available essential information on:
  - employees
  - jobs and tasks
  - processes
  - agents
  - potential exposures
  - potential health effects



## Methods For Evaluating Exposures

- Exposure Assessment *Strategy*
  - What to sample
  - Who to sample
  - Where to sample
  - When to sample
- Sampling *Methodology*
  - HOW to sample

## Exposure Assessment

- List of Similar Exposure Groups (SEGs)
- Agents present
- Establish exposure criteria
- Strategy for assessing exposures
- Methods selected for measuring or estimating exposures
- Prioritized summary of exposure data based on risk

<b>Process</b>	<b>Job</b>	<b>Task</b>	<b>Agent</b>
Coil Coating	Coil Feed Operator	General	Noise
Coil Coating	Coil Feed Operator	General	2-Butoxyethanol
Coil Coating	Coil Feed Operator	Cleanup	MIBK
Coil Coating	Coil Feed Operator	Cleanup	Cyclohexanone
Coil Coating	Discharge Operator	General	Noise
Coil Coating	Discharge Operator	General	2-Butoxyethanol
Coil Coating	Discharge Operator	QC	MIBK
Coil Coating	Discharge Operator	Cleanup	MIBK
Coil Coating	Discharge Operator	Cleanup	Cyclohexanone
Casting	Helper	Fluxing	Cyclohexanone
Casting	Helper	Fluxing	Hexachloroethane
Casting	Helper	Fluxing	HCl
Casting	Helper	Fluxing	Hexachlorobenzene
Casting	Helper	Fluxing	Octostyrene
Casting	Helper	Fluxing	Heat

## Established Occupational Exposure Limits (OELs)

- OSHA Permissible Exposures Limit (PEL)
  - Enforceable
  - Based On Risk Of Exposure Over An 8-hour Day
  - TWA, ACTION LEVEL, STEL, CEILINGS
  
- NIOSH Recommended Exposure Limit (REL)
  - Based On Current Research And Risk Assessments
  - Generally Very Conservative
  
- ACGIH Threshold Limit Value (TLV)
  - Recommended Guidelines
  - Based On An 8-hour Exposure, 40-hour Work Week, Healthy Workforce
  - Reviewed Annually
  - Changes Published In “NIC” For Comment

## Established OELs

- NIOSH IDLH Values
- Manufacturer's Recommended Limits
- AIHA Workplace Environmental Exposure Limit (WEEL)
  - Developed For Compounds Without Established Limits
  - Based On Current Research And Comparative Assessments
- Internal Criteria

## Types of OELs

- TIME-WEIGHTED AVERAGES (TWA)
  - 8-HOUR EXPOSURE LIMIT
  - ASSUMES 16-HOUR RECOVERY
- SHORT-TERM EXPOSURE LIMITS (STEL)
  - GENERALLY, A 15-MINUTE EXPOSURE
- EXCURSION LIMITS
  - EXPOSURE TIME VARIES WITH AGENT
- CEILING
  - EXPOSURE TIME VARIES WITH AGENT
- IMMEDIATELY DANGEROUS TO LIFE AND HEALTH (IDLH)

## Estimating and Measuring Exposures

- Historical Data
- Predictive Modeling
- Direct Reading
  - Short-term / Instantaneous
  - Continuous Monitoring
- Personal Monitoring
  - Short-term
  - Length Of Activity
  - Full Shift
- Statistical Modeling
- Medical Monitoring / Surveillance

## Strategies for Measuring Exposures

- Area Monitoring
  - Determine concentration gradients
  - Leak detection
  - Time trend analysis
- Personal Monitoring
  - Estimate dose received by worker
- Considerations
  - Capture time variations – shift, day, changes in process
  - Capture inter-worker variations

## Exposure Method Selection

- Target Agent
- Occupational Exposure Limit
  - Length Of Exposure
  - Safety Factor
  - Limits of Detection / Method Sensitivity
- Recognized Methods
  - NIOSH or OSHA Validated
  - Consensus Standards
- Feasibility
  - Size Of Exposed Population
  - Frequency And Duration Of Activity
  - Turn-around Time
- Cost

## Sampling Strategies

- Number of Measurements Required

<i>Minimum sample size (n) for including (@ 90% confidence level) at least one high risk employee*</i>																			
Size of Employee Group (N):																			
1	2	3	4	5	6	7	8	9	10	11-12	13-14	15-17	18-20	21-24	25-29	30-37	39-49	50	>50
Minimum Number of Measured Employees (n):																			
1	2	3	4	5	6	7	7	8	9	10	11	12	13	14	15	16	17	18	22

\*Exposure in highest 10% of N.

Source: NMAM, Chapter D

- Rules of Thumb
  - ~ 6 samples required for valid estimate of confidence interval around the mean
  - >11 are required to estimate variance



## Frequency Distributions Measures of Central Location

- Arithmetic mean – the “average”
- Geometric mean – applies to skewed data; the average of a set of data measured on a logarithmic scale (occupational/environmental samples)
- Mode – the value that occurs most frequently
- Median – the mid-point of the distribution; preferred for skewed data

## Confidence Limits

- Upper Confidence Limit (UCL)
  - If  $UCL > 1$ , 95% confidence that the measurement  $> OEL$

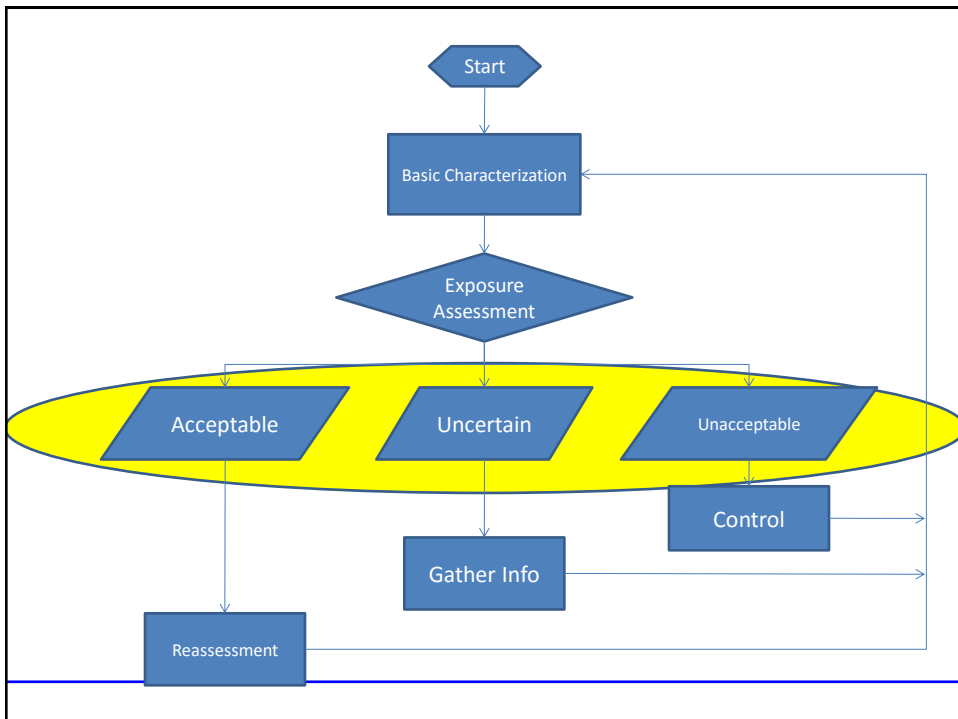
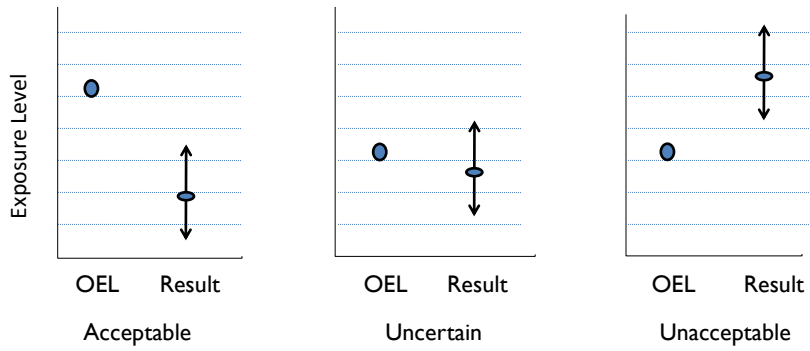
$$UCL = \frac{TWA}{OEL} + 1.645(CV)$$

- Lower Confidence Limit (LCL)
  - If  $LCL < 1$ , 95% confidence that the measurement  $< OEL$

$$LCL = \frac{TWA}{OEL} - 1.645(CV)$$

- If  $UCL \leq 1$  and  $LCL \geq 1$ , evaluate further

# Exposure Assessment: Judging Exposures



## Risk Characterization and Prioritization

- Where exposures are well controlled
- Where corrective actions need to be implemented
- Where additional data is needed to make decisions

## Risk Characterization

### Health Effects Rating (HER)

- 4 - Life threatening or disabling injury or illness
- 3 - Irreversible health effects
- 2 - Severe reversible health effects
- 1 - Reversible effects of little concern

# Risk Characterization

Exposure Rating (ER) Based on Arithmetic Mean Of Exposure Profile

- 4 - >OEL
- 3 - 50% to 100% OEL
- 2 - 10% to 50% OEL
- 1 - <10% OEL

# Risk Characterization

**HEALTH RISK RATING**

<b>HEALTH EFFECTS RATING</b>	<b>4</b>	4	8	12	16
	<b>3</b>	3	6	9	12
	<b>2</b>	2	4	6	8
	<b>1</b>	1	2	3	4
		<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
		<b>EXPOSURE RATING</b>			

## Further Information Gathering: Putting It All Together

Process	Job	Task	Agent	OEL	ER	HER	HRR	UR	IGPR	Info Needed
Coil Coating	Coil Feed Operator	General	Noise	85dBA	3	3	9	1	9	Noise Dosimetry
Coil Coating	Coil Feed Operator	General	2-Butoxy-ethanol	25 ppm	2	2	4	2	8	Air and/or bio monitoring
Coil Coating	Coil Feed Operator	Cleanup	MIBK	75 ppm	3	2	6	1	6	Air monitoring
Coil Coating	Coil Feed Operator	Cleanup	Cyclo-hexanone	35 ppm	3	2	6	1	6	Air monitoring
Coil Coating	Discharge Operator	QC	MIBK	75 ppm	4	2	8	2	16	Air monitoring
Casting	Helper	Fluxing	Hexachloro-ethane	9/7 mg/m3	1	2	2	1	2	Air monitoring
Casting	Helper	Fluxing	HCl	5 ppm	4	1	4	0	0	None
Casting	Helper	Fluxing	Hexachloro-benzene	25 ug/m3	3	4	12	1	12	
Casting	Helper	Fluxing	Octochloro-styrene	25 ug/m3	3	4	12	2	24	Toxicological Data
Casting	Helper	Fluxing	Heat	Varies	4	2	8	0	0	None

## Prioritization Based on Risk

### Information Gathering Priority

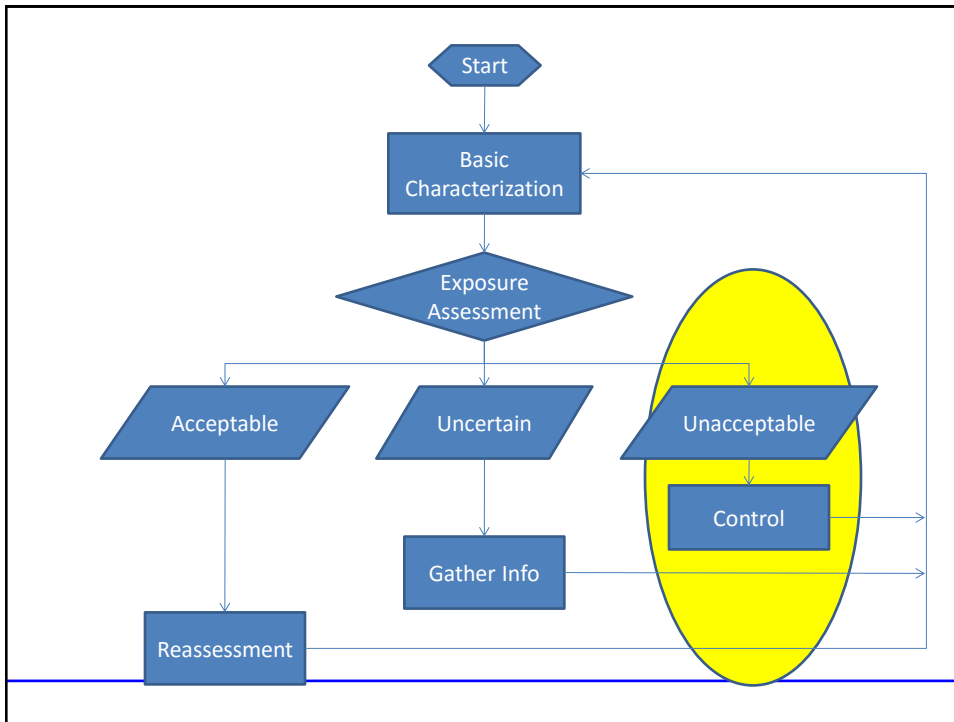
Control Needed	16	0	16	32
	12	0	12	24
	9	0	9	18
	8	0	8	16
	6	0	6	12
	4	0	4	8
	3	0	3	6
	2	0	2	4
	1	0	1	2
No Action		0 - Certain	1 - Uncertain	2 - Highly Uncertain

Health Risk Rating (rows)

Uncertainty Rating (columns)

Controls and Gather Information (rows 1-6)

Gather Information (rows 7-9)

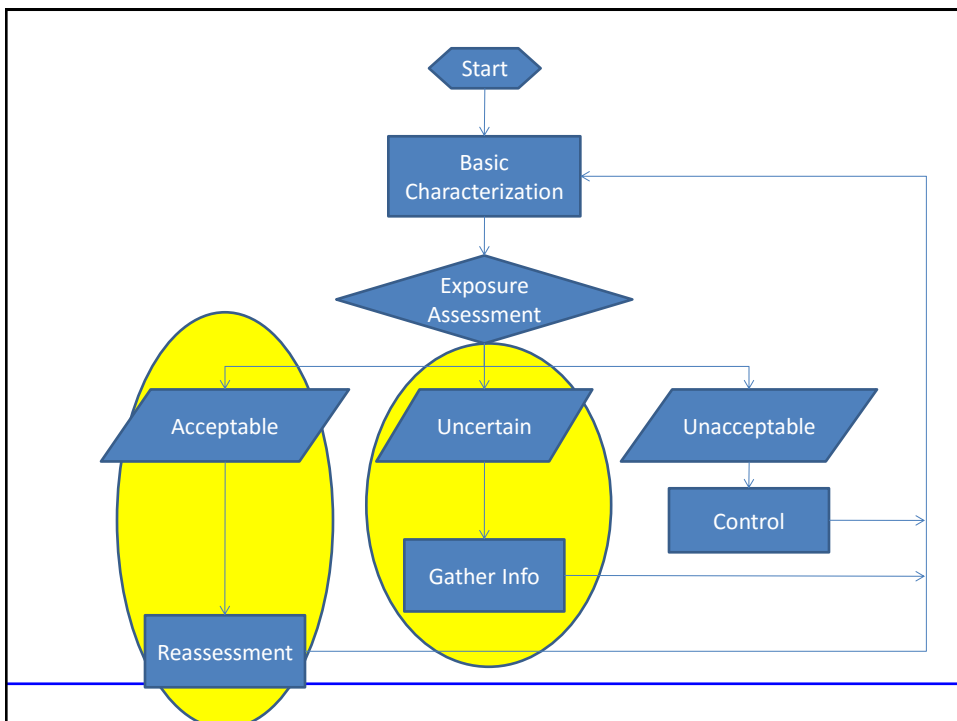


## Health Hazard Control

- Prioritized Control Plan
- Implementation of Short Term and Long Term Controls
- Verify Effectiveness of Exposure Controls

## Health Hazard Control: Hierarchy of Control

- Elimination
- Substitution
- Engineering Controls
- Work Practice Controls and Training
- Other Administrative Controls
- Personal Protective Equipment



## Reassessment

- Prioritized Schedule for Re-Evaluation
- Updated Basic Workplace Characterization
- Updated Exposure Groups and Exposure Profiles

**QUESTIONS?**