# An Approach to Event-Specific Risk Assessment

*AFHSC/USUHS Symposium:*

*Assessing Potentially Hazardous Environmental Exposures among Military Populations*

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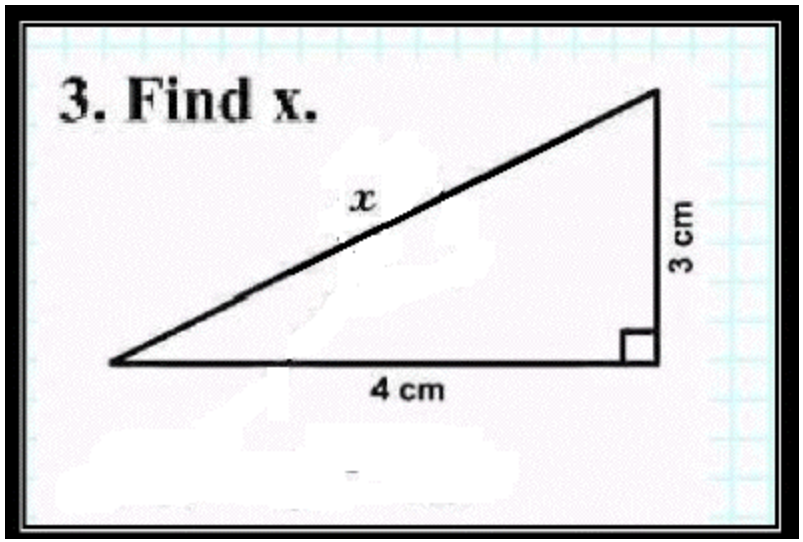
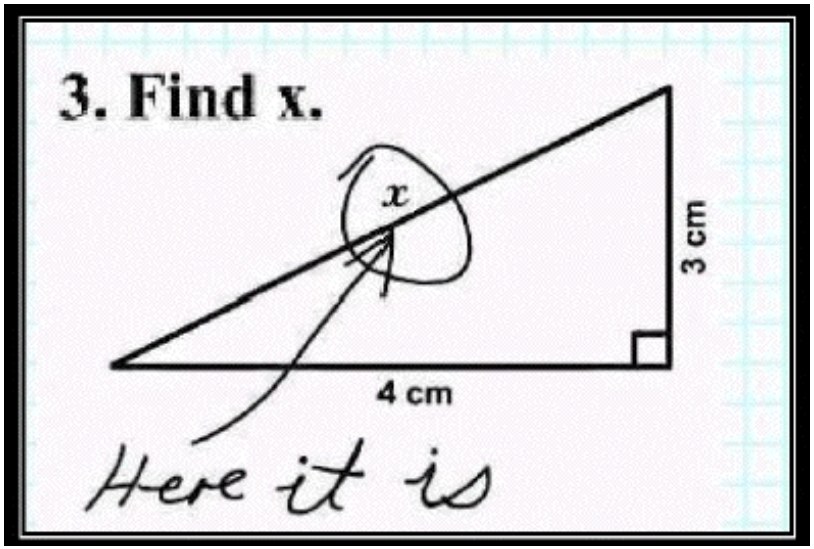
# Background

- This briefing is adapted from a workshop on enterprise-level risk assessment in the oil and gas industry.
- “Risk assessment” as a term is used in different ways. This is about hazard identification and assessment, not policy.
- Prefer robust approaches that do not require highly specialized technology or training.
- “Control banding” is one such approach.

# A Suggestion:

**Keep it simple, especially at first.**



# Definitions

**Hazard:**

1. anything that may cause harm
2. An intrinsic property

**Risk:** probability that somebody could be harmed and by how much

# One the Event-Level Risk Assessment System is in Place, What Does it Do?

- Identify specific workplace hazards:

  *Risk assessment*
- Share information on the problem and potential solutions:

  *Risk communication*
- Determine how best to deal with them:

  *Risk management*

This would be done on the level of the event or location, unit, and service.

# Categories of Hazard in the Workplace

- Traditional categories:
  - Chemical, emphasizing toxicity
  - Physical, emphasizing trauma
    - Mechanical
    - Radiation (specialized as radiation safety)
    - Other forms of energy
  - Biological, emphasizing infection
  - Psychogenic, emphasizing stress
- Limited usefulness except as a checklist.

- Chemical
- Physical
- Biological
- Psychogenic

# Limitations of Traditional Categories

- Chemical hazards may cause:
  - Toxic injury
  - Allergy
  - Safety hazard: fire, explosion, burns
- Physical hazards may cause:
  - Acute injury: mechanical
  - Stochastic outcomes: radiation, UV
  - Chronic conditions as well as acute disorder (e.g. RSI) - ergonomics


# Limitations of Traditional Categories

- Biological agents
  - Infection
  - Allergy
  - Biological products
    - really chemicals
    - May be toxic, allergenic
- Psychogenic and material stressors
  - Odor
  - Building-related issues

http://www.lifemaxsolutions.net/indoor_air_quality.jpg

# Hazards Matrix

Chronicity of Outcome

| Category of Hazard | Acute | Chronic | "Stochastic" |
|---|---|---|---|
| Chemical | Acute toxicity<br>Chemical safety | Chronic toxicity | Cancer<br>Allergy |
| Physical | Trauma<br>Acute effects | Delayed and chronic effects | Cancer |
| Biological | Infection | Infection | Infection<br>Allergy |
| Psychogenic | Workplace violence | Stress-related illness<br>Depression | Decompensation of mental illness |

# Another View

- Chemicals
  - That cause toxicity
  - That cause allergy
  - That release energy
- Forms of energy
  - Mechanical (safety)
  - Ergonomic
  - Electromagnetic
  - Ionizing radiation
  - Temperature extremes
  - Noise and vibration
- Biological agents
  - That cause infection
- Products of biological agents (also chemicals)
  - That cause allergy
  - That cause toxicity
- Stress indicators
  - Work organization
  - Interpersonal stressors
- Location

# How to Assess Risk Quickly

- Identify the hazards
- Determine quantity used or present
- Evaluate the risks and decide which are significant threats
- Decide who might be harmed and how
- Record your findings
- Determine best actions to control
- Implement actions
- Review the assessment, update as necessary

# Quantity

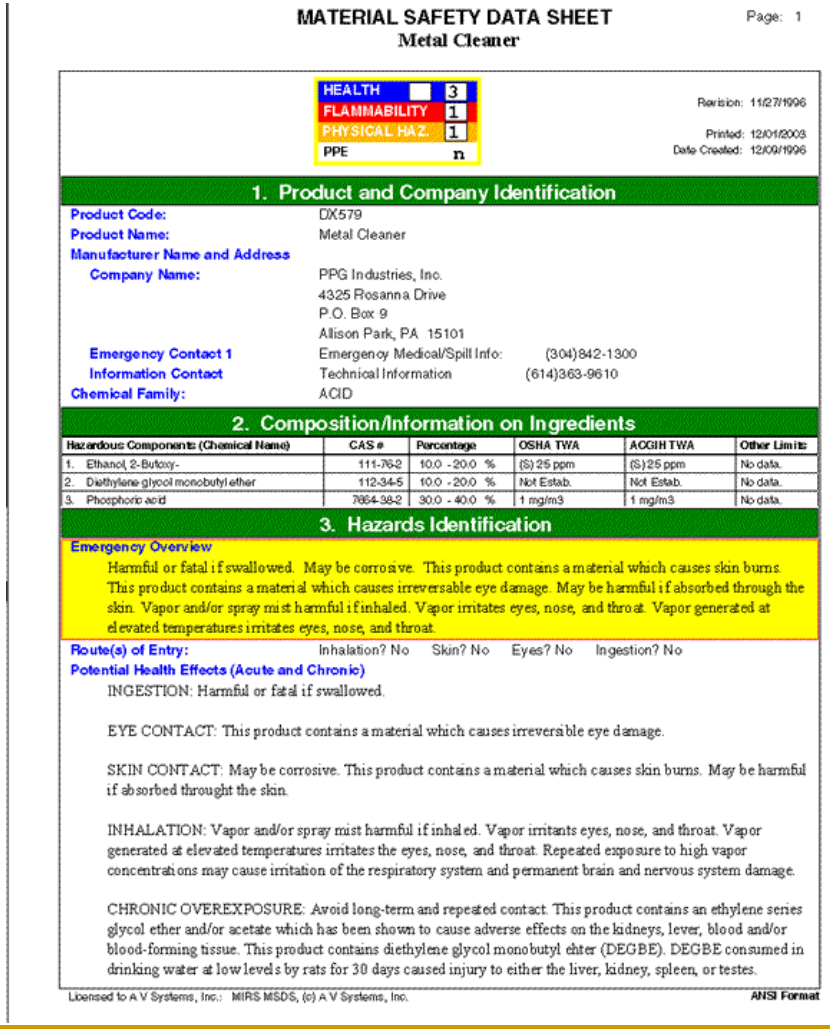
| | Solid *Weight* | Liquid *Volume* | Packaging |
|---|---|---|---|
| Small | g | ml | bottles |
| Medium | kg | l | drums |
| Large | tonnes | $m^3$ | bulk |

## Sources of Information

- Inventory
- Procurement
- Shipping manifests
- Vendors

Table adapted from Pavan Baichoo, SafeWork, ILO, Geneva

# Level of Hazard



MATERIAL SAFETY DATA SHEET
Metal Cleaner

Page: 1

HEALTH 3
FLAMMABILITY 1
PHYSICAL HAZ. 1
PPE n

Revision: 11/27/1996
Printed: 12/01/2003
Date Created: 12/09/1996

**1. Product and Company Identification**

**Product Code:** DX579
**Product Name:** Metal Cleaner
**Manufacturer Name and Address**
**Company Name:** PPG Industries, Inc.
4325 Rosanna Drive
P.O. Box 9
Allison Park, PA 15101
**Emergency Contact 1** Emergency Medical/Spill Info: (304)842-1300
**Information Contact** Technical Information (614)363-9610
**Chemical Family:** ACID

**2. Composition/Information on Ingredients**

| Hazardous Components (Chemical Name) | CAS # | Percentage | OSHA TWA | ACGIH TWA | Other Limits |
|---|---|---|---|---|---|
| 1. Ethanol, 2-Butoxy- | 111-76-2 | 10.0 - 20.0 % | (S) 25 ppm | (S) 25 ppm | No data. |
| 2. Diethylene glycol monobutyl ether | 112-34-5 | 10.0 - 20.0 % | Not Estab. | Not Estab. | No data. |
| 3. Phosphoric acid | 7664-38-2 | 30.0 - 40.0 % | 1 mg/m3 | 1 mg/m3 | No data. |

**3. Hazards Identification**

**Emergency Overview**

Harmful or fatal if swallowed. May be corrosive. This product contains a material which causes skin burns. This product contains a material which causes irreversable eye damage. May be harmful if absorbed through the skin. Vapor and/or spray mist harmful if inhaled. Vapor irritates eyes, nose, and throat. Vapor generated at elevated temperatures irritates eyes, nose, and throat.

**Route(s) of Entry:** Inhalation? No Skin? No Eyes? No Ingestion? No

**Potential Health Effects (Acute and Chronic)**

INGESTION: Harmful or fatal if swallowed.

EYE CONTACT: This product contains a material which causes irreversible eye damage.

SKIN CONTACT: May be corrosive. This product contains a material which causes skin burns. May be harmful if absorbed throught the skin.

INHALATION: Vapor and/or spray mist harmful if inhaled. Vapor irritants eyes, nose, and throat. Vapor generated at elevated temperatures irritates the eyes, nose, and throat. Repeated exposure to high vapor concentrations may cause irritation of the respiratory system and permanent brain and nervous system damage.

CHRONIC OVEREXPOSURE: Avoid long-term and repeated contact. This product contains an ethylene series glycol ether and/or acetate which has been shown to cause adverse effects on the kidneys, lever, blood and/or blood-forming tissue. This product contains diethylene glycol monobutyl ehter (DEGBE). DEGBE consumed in drinking water at low levels by rats for 30 days caused injury to either the liver, kidney, spleen, or testes.

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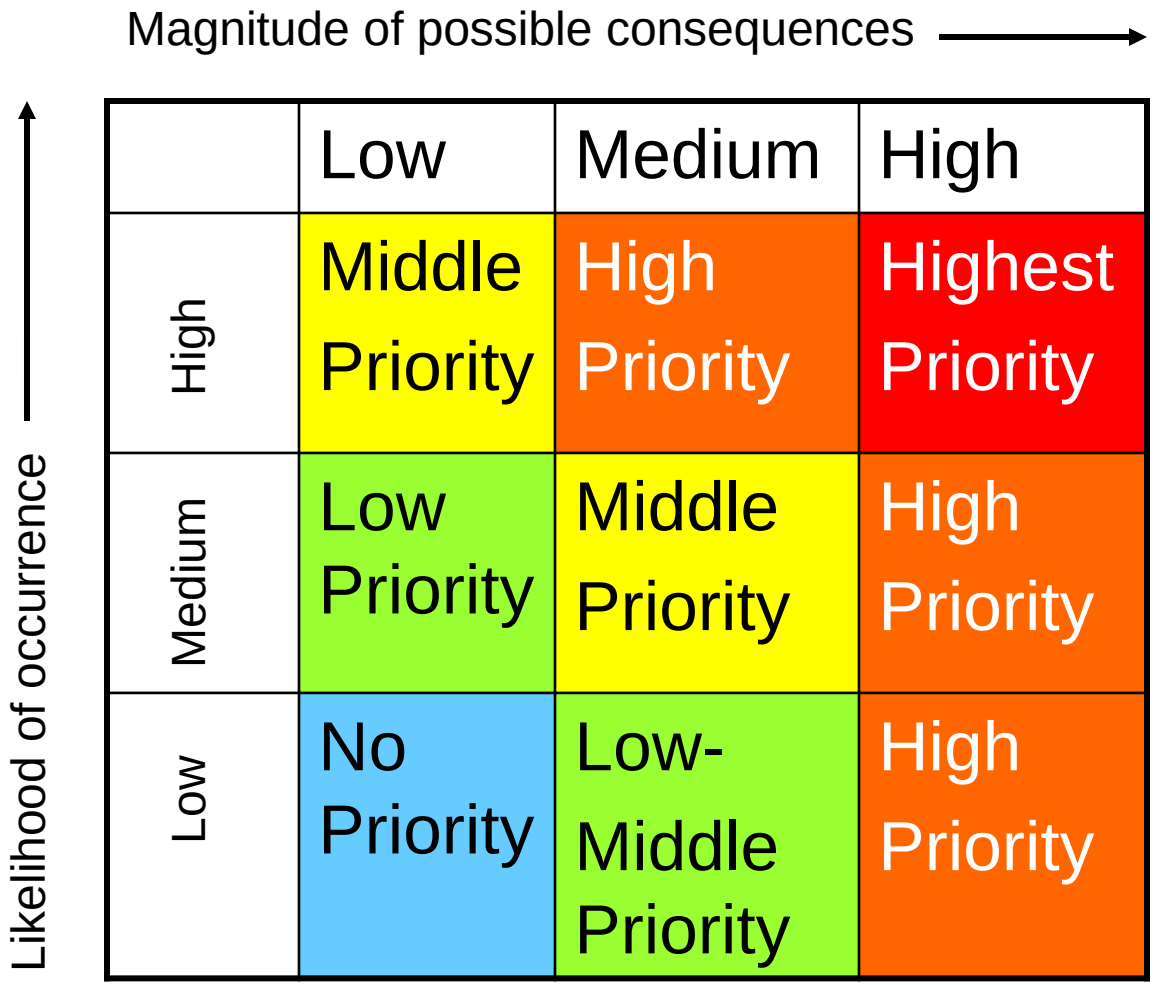
## Sources of Information

- MSDS
- Product safety information
- Label
- Standard references

# Risk Priorities



# Consequence Analysis Grid

| | People | Building | Equipment | Environment | Reputation | Relation-ships | Production | Revenues | Wastage |
|---|---|---|---|---|---|---|---|---|---|
| Fire | | | | | | | | | |
| Explosion | | | | | | | | | |
| Blowout | | | | | | | | | |
| Spill | | | | | | | | | |
| Gas release | | | | | | | | | |
| Structural failure | | | | | | | | | |
| Cable snapping | | | | | | | | | |
| Theft | | | | | | | | | |
| Etc. | | | | | | | | | |

**Estimate magnitude of consequence for each target for every plausible event.**

# Consequence Analysis Grid

Event Headings

- Motor vehicle collision
- Fire
- Explosion
- Blowout
- Spill
- Gas release
- Structural failure
- Cable snapping
- Theft
- Etc.


Target Headings

- People
- Buildings
- Equipment
- Environment
- Reputation
- Relationships
- Production
- Revenues
- Wastage
- Etc.

# Consequence Analysis Grid

- For each column, rate the worst case for risks by the following scale (10 for catastrophic risks, 1 to 5 for all other, using illustrations below for selected categories):
  - 10 = fatality, total loss of significant [illegible] hutdown in production
  - 5 = disabling inj[illegible] property loss, prolonged interruption in production
  - 4 = serious injury, significant [illegible] terruption in production
  - 3 = injury, re[illegible] damage, one-day interruption in production
  - 2 = minor inju[illegible], minor damage, brief interruption
  - 1 = any injury, damage, interruption to production
  - 0 = no impact whatever
- Note: this grid does not imply that the outcomes are comparable across rows, esp. comparing injury to people and property damage or production.

Use a reasonable scale of magnitude.

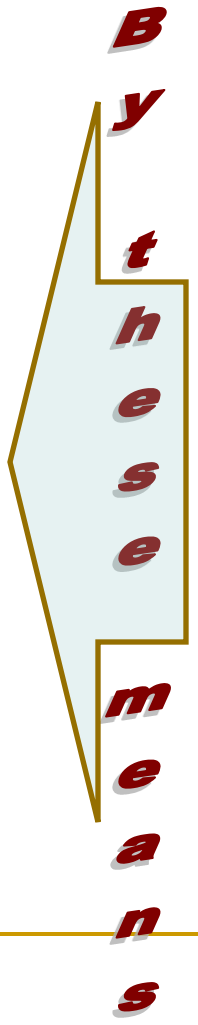
# Workplace-level Risk Management

Risk reduction, control

May be:

- Terminated
- Treated
- Tolerated
- Transferred

or best of all, Avoided!




Hierarchy of Controls

- Avoidance
- Substitution
- Isolation, containment
- Engineering
- Ventilation
- Housekeeping
- Personal Protection
- Administrative (e.g. limiting exposure)

# Control Banding

New Topic

- A way of viewing the problem.
- A simplified approach to risk assessment.
- A simplified approach to risk management.



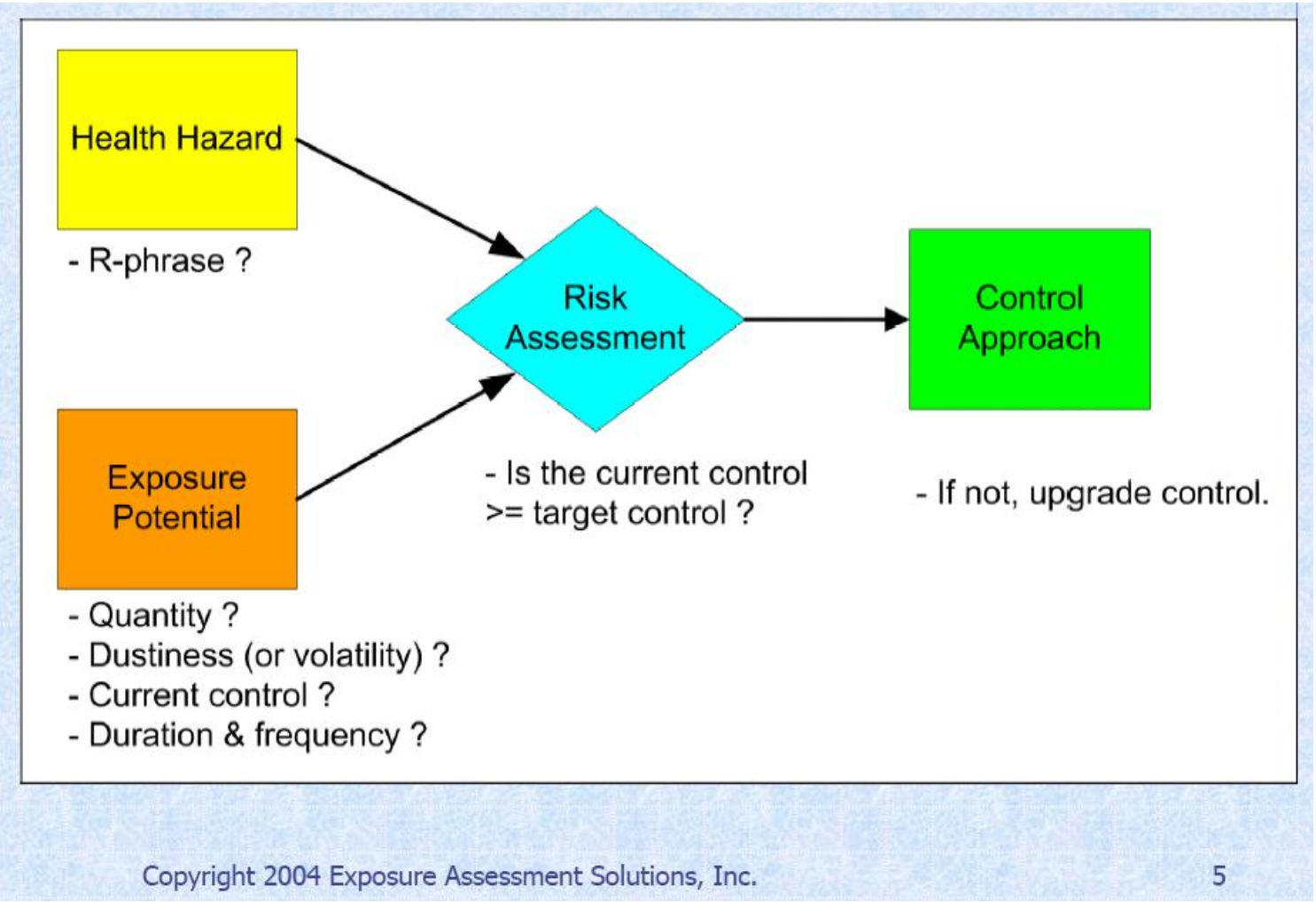

- Can be used as a system or as a way of thinking through hazard identification.

# Control Banding

- A systematic approach to risk management, popular in UK and EU
- Based on a simplified risk assessment
- Avoids expense of surveys and consultants for routine hazards

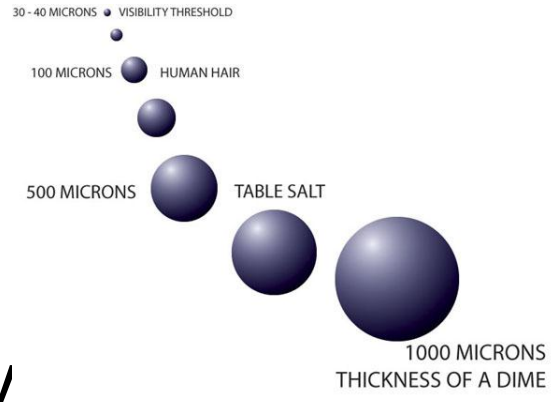
| Hazard Group (w/ examples) | Target airborne concentration range | |
|---|---|---|
| | Particulate | Vapors |
| A - Skin and eye irritants | >1-10 mg/m³ | >50-500 ppm |
| B - Harmful on single exposure | >0.1-1 mg/m³ | >5-50 ppm |
| C - Severely irritating & corrosive; skin sensitizers | >0.01-0.1 mg/m³ | >0.5-5 ppm |
| D - Very toxic on single exposure; reproductive hazard | <0.01 mg/m³ | <0.5 ppm |
| E - Carcinogens, asthmagens | Seek specialist advice | |

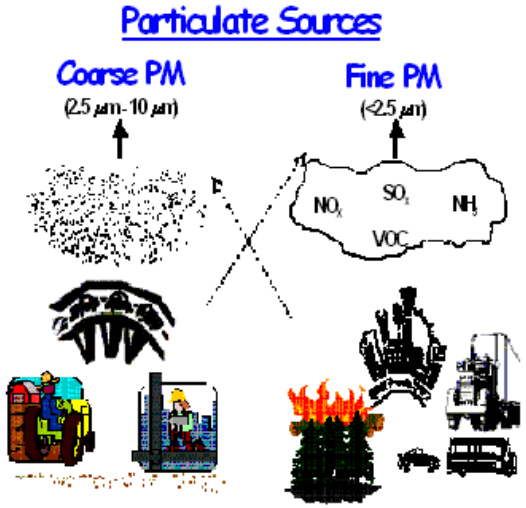
# Exposure Prediction Model



# Airborne Hazard

- Carried in air
  - *Dustiness* for a powder or solid
  - *Volatility* for a gas
- Aerosols: Determinant of toxicity
  - Large particles
  - Thoracic particles
  - Respirable range
  - Soluble particles



# Volatililty

## Predicted exposures - vapors

| Control Approach | Exposure Predictor Band (ppm) | | | |
|---|---|---|---|---|
| | ml – lo | ml – med,hi<br>L, $m^3$ – lo | $m^3$ – med<br>L – med,hi | $m^3$ – hi |
| General ventilation | <5 | 5-50 | 50-500 | >500 |
| Local Exhaust | <0.5 | 0.5-5 | 5-50 | 5-500 |
| Containment | <0.05 | 0.05-0.5 | 0.5-5 | 0.5-5 |

# Control Banding: Template

- Determine chemicals present and level of exposure
- Exposure potential has two terms:
  - Quantity/concentration
  - Physical properties (e.g. volatility), at three levels
- Group chemicals into one of five health hazard bands (A to E) by increasing severity of effect at exposure potential

# Toxicity

| Tier | Description |
|---|---|
| 1 | Minimal hazard; relatively harmless; practically non-toxic; no significant risk to health |
| 2 | Slight hazard; slightly toxic |
| 3 | Moderate hazard; moderately toxic |
| 4 | Serious hazard; highly (or very) toxic |
| 5 | Severe hazard; extremely toxic |

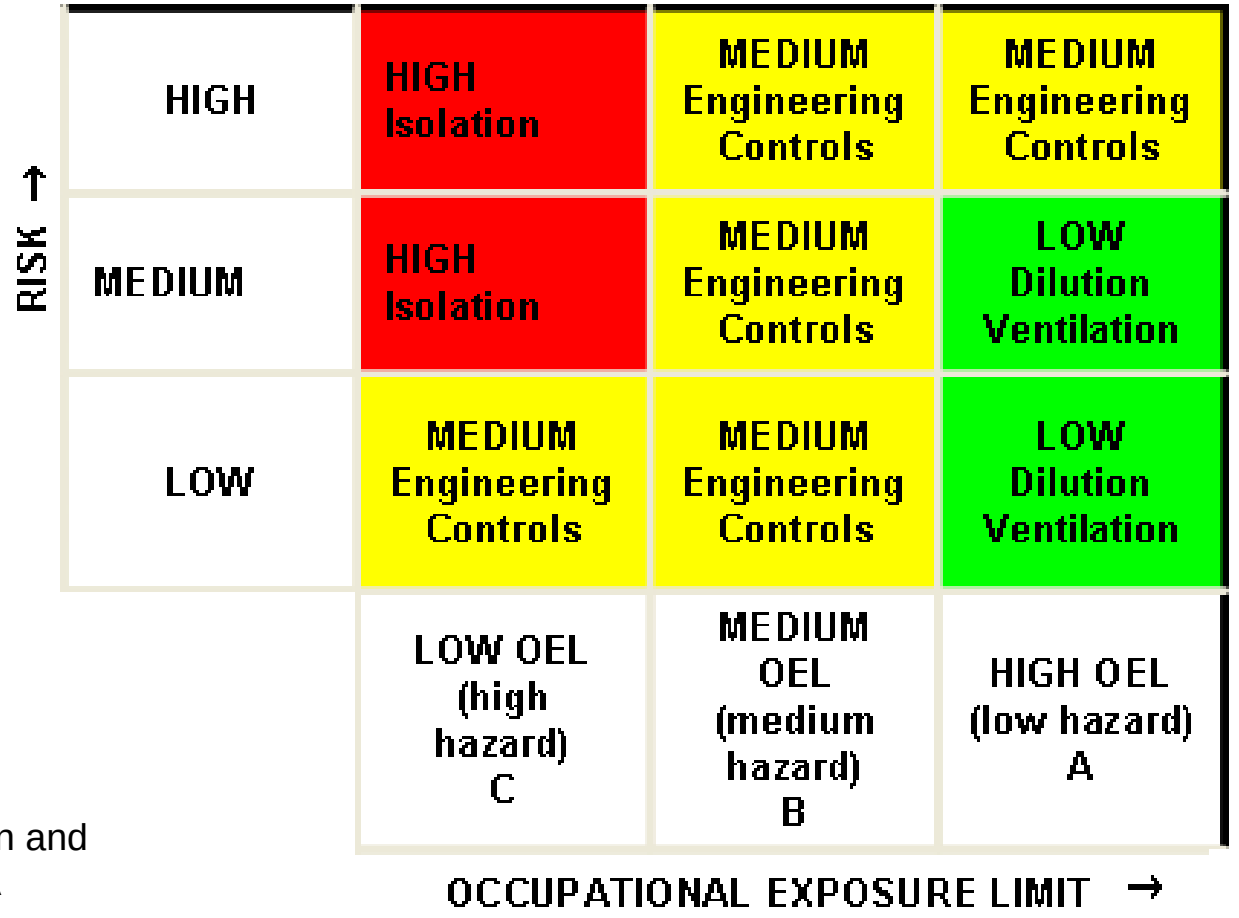
# Control Banding: Four Control Levels

- Level 1: General ventilation, basic industrial hygiene practice
- Level 2: Local exhaust ventilation (engineering controls)
- Level 3: Isolation, enclosure
- Level 4: Determined by specialist advice


Too complicated for general use.

# Decision Matrix for Control Selection

- Level 1
- Level 2
- Level 3
- Level 4




Prepared by E Sullivan and O Malik, 2007. ©AIHA

# Formal Assessment

- Safety professionals
  - Physical hazards
  - *Behavioral* management
- Occupational hygiene
  - Identification
  - Evaluation
  - Assessment
  - Control
- Engineering approaches (HAZOP, fault-tree analysis, etc.

# Going Deeper: Measurement

- Next step in sophistication is to measure:
  - Occupational hygienists, consultants
  - Proper equipment
  - Importance of calibration, quality assurance
  - Identify critical processes, work stations, conditions
- Measurement allows:
  - Prioritization
  - Compliance monitoring
  - Assessment of progress

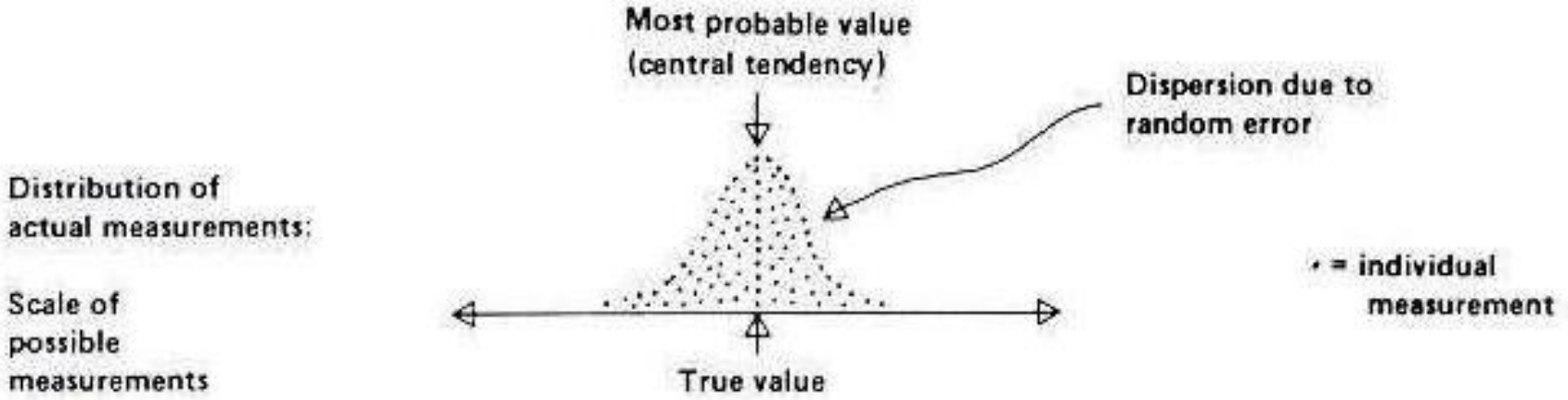
Look for:

- Quality assurance
- Certification
- Training
- Relevant experience

# Basic Strategies

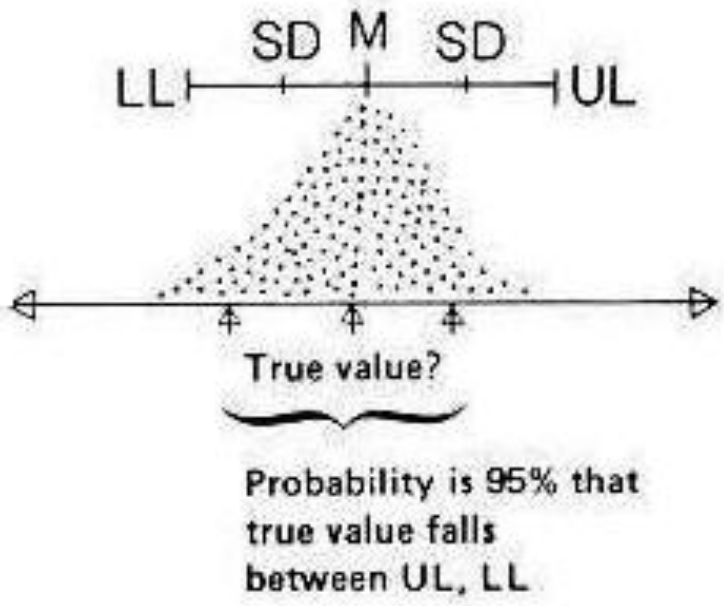
- Compliance monitoring
  - What is the worst case likely?
  - How does it compare with OEL?
- Exposure assessment
  - What is typical exposure level?
  - Which are the most exposed locations or tasks?
- Deployment setting
  - What is worst case possible?

# Measurement



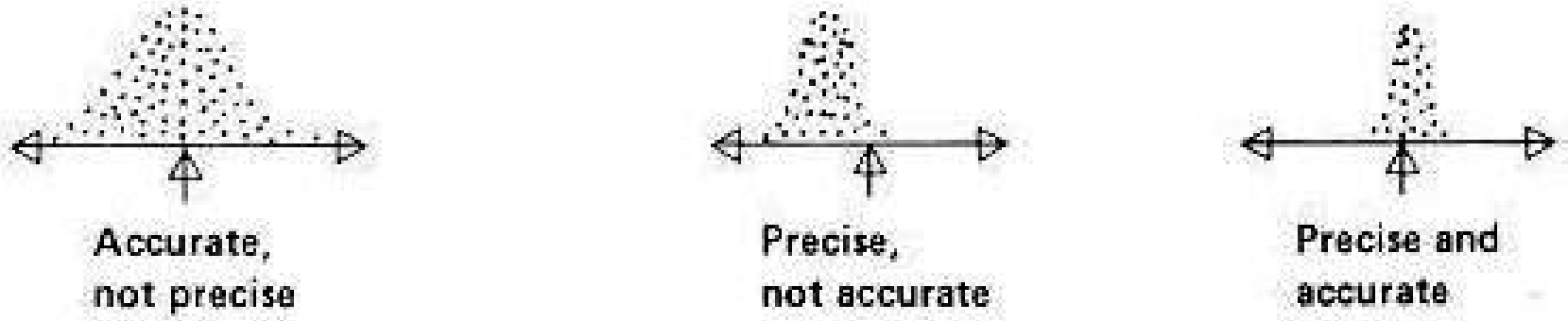
# Confidence Intervals

Application of confidence interval

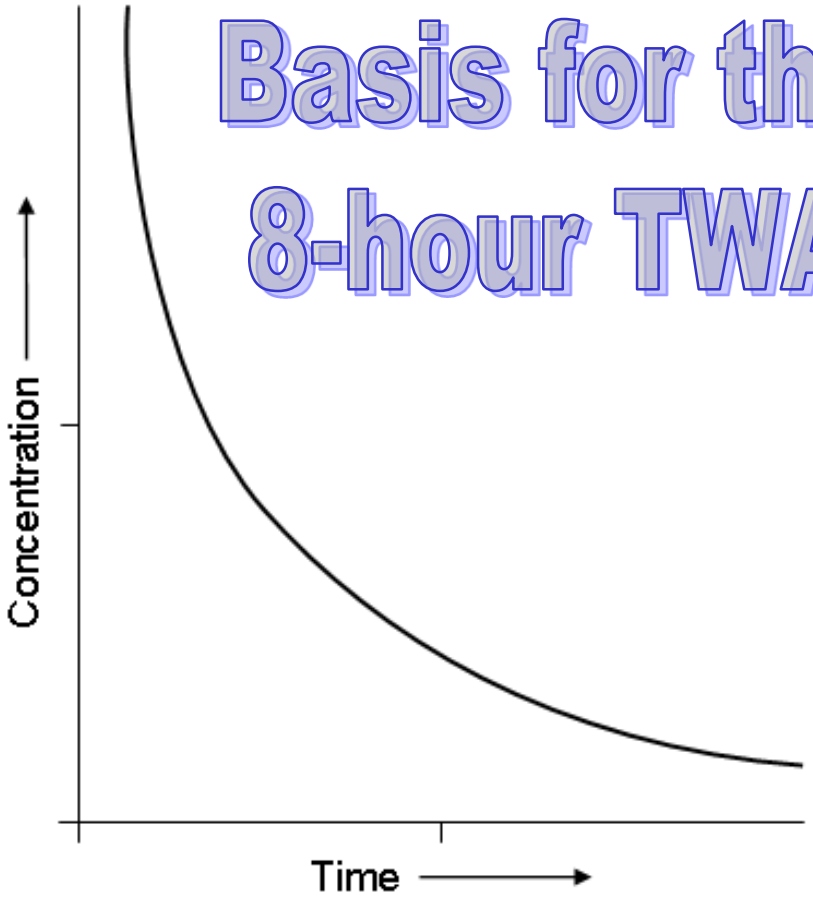



M = mean
UL = upper limit, 250
LL = lower limit, 250
SD = standard deviation

# Accuracy and Precision

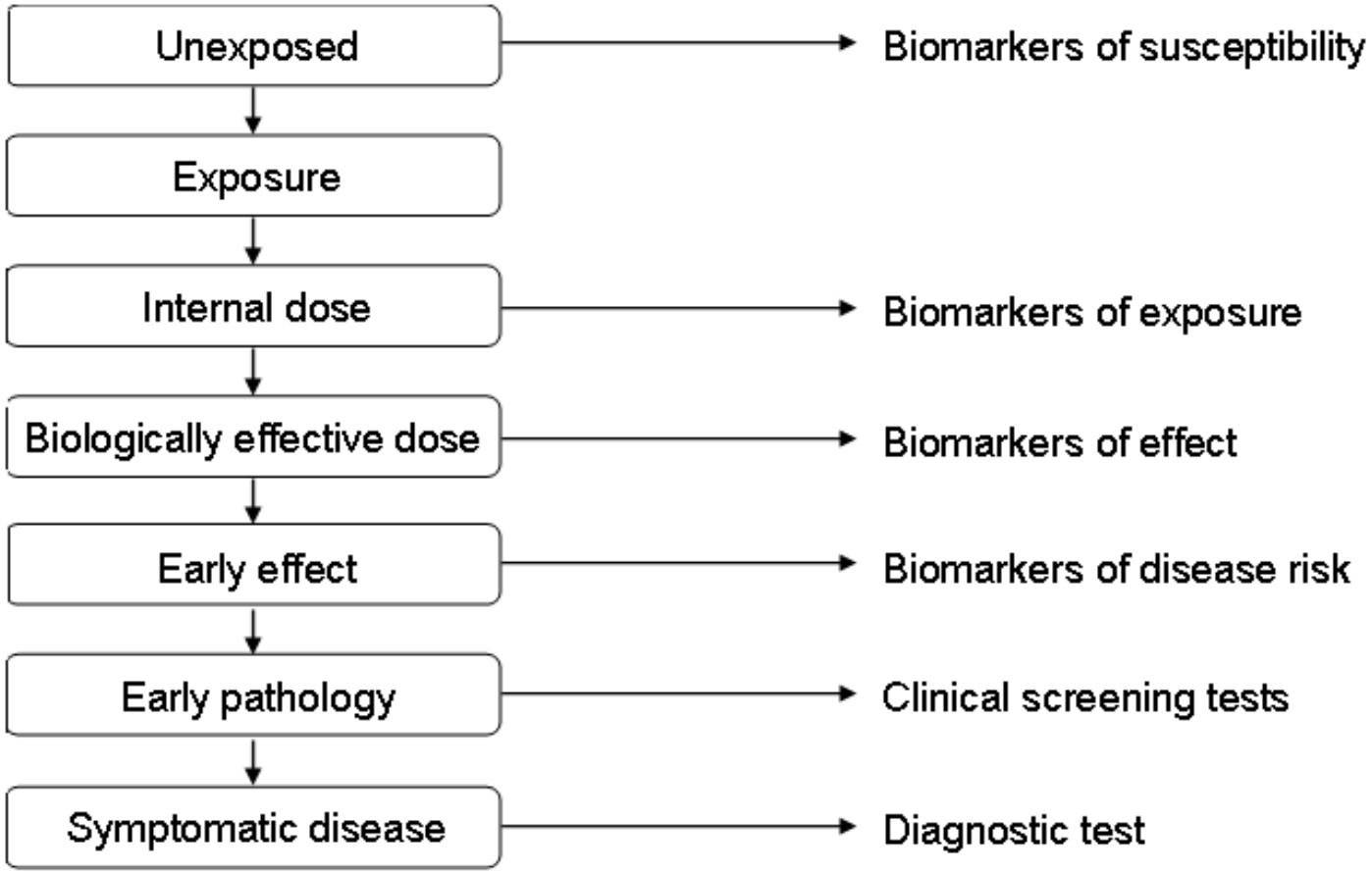


# Concentration × Time

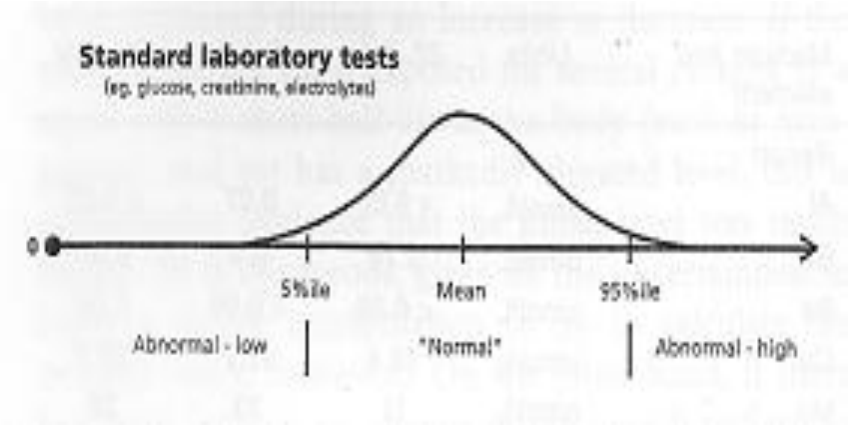


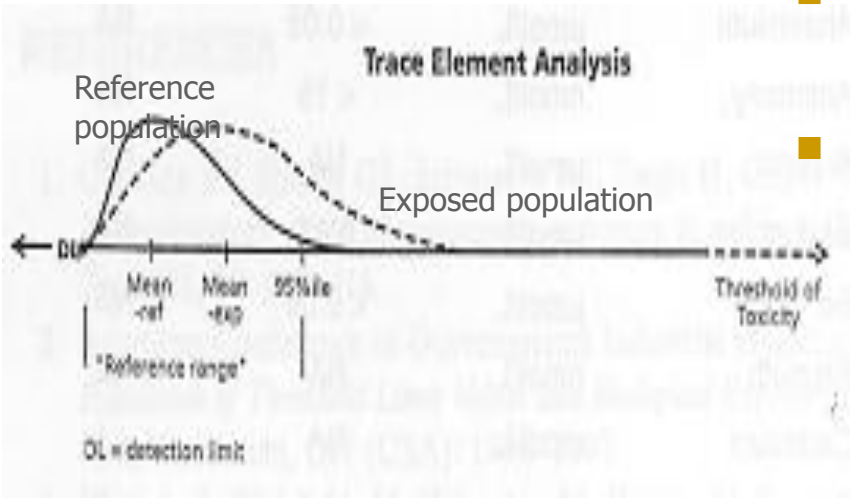

- Haber's Law for gases
- Cumulative exposure model
- Cumulative effects model
- Easily adjusted
- Doesn't really work

# Biomarkers


Unexposed
Exposure
Internal dose
Biologically effective dose
Early effect
Early pathology
Symptomatic disease
Biomarkers of susceptibility
Biomarkers of exposure
Biomarkers of effect
Biomarkers of disease risk
Clinical screening tests
Diagnostic test

# Interpreting Trace Element Studies




- Trace elements are not normally distributed
- Log-normal distribution
- Reference range ≠ normal range for lab studies
- Exposed populations show skewing of curve
- Requires knowledge of toxicity threshold, if known

# Communicating about Risk Before Deployment

- Deployed personnel
  - Inform, disclose, persuade, manage
- Peers
  - Share information, handover of responsibility, changes in command
- Leaders and decision-makers
  - Inform risk/risk analysis, communicate uncertainty, anticipate consequences, support planning
- Community
  - Esp. to obtain information

# Communicating About Risk

**Before Communicating**

- Gear the explanation to what people know
- Keep it simple and use simple language
- Ask questions to ensure comprehension
- Plan carefully
- Use lots of examples
- Anticipate likely questions

**While Communicating**

- Demonstrate respect for what others know
- Be honest, frank, and open
- Answer questions until other person is satisfied
- Do not exaggerate
- Look for reactions to what you say
- Admit it if you do now know