

BASELINE RISK ASSESSMENT OVERVIEW

Dawn A. Ioven
Senior Toxicologist
U.S. EPA – Region III



WHAT IS RISK?

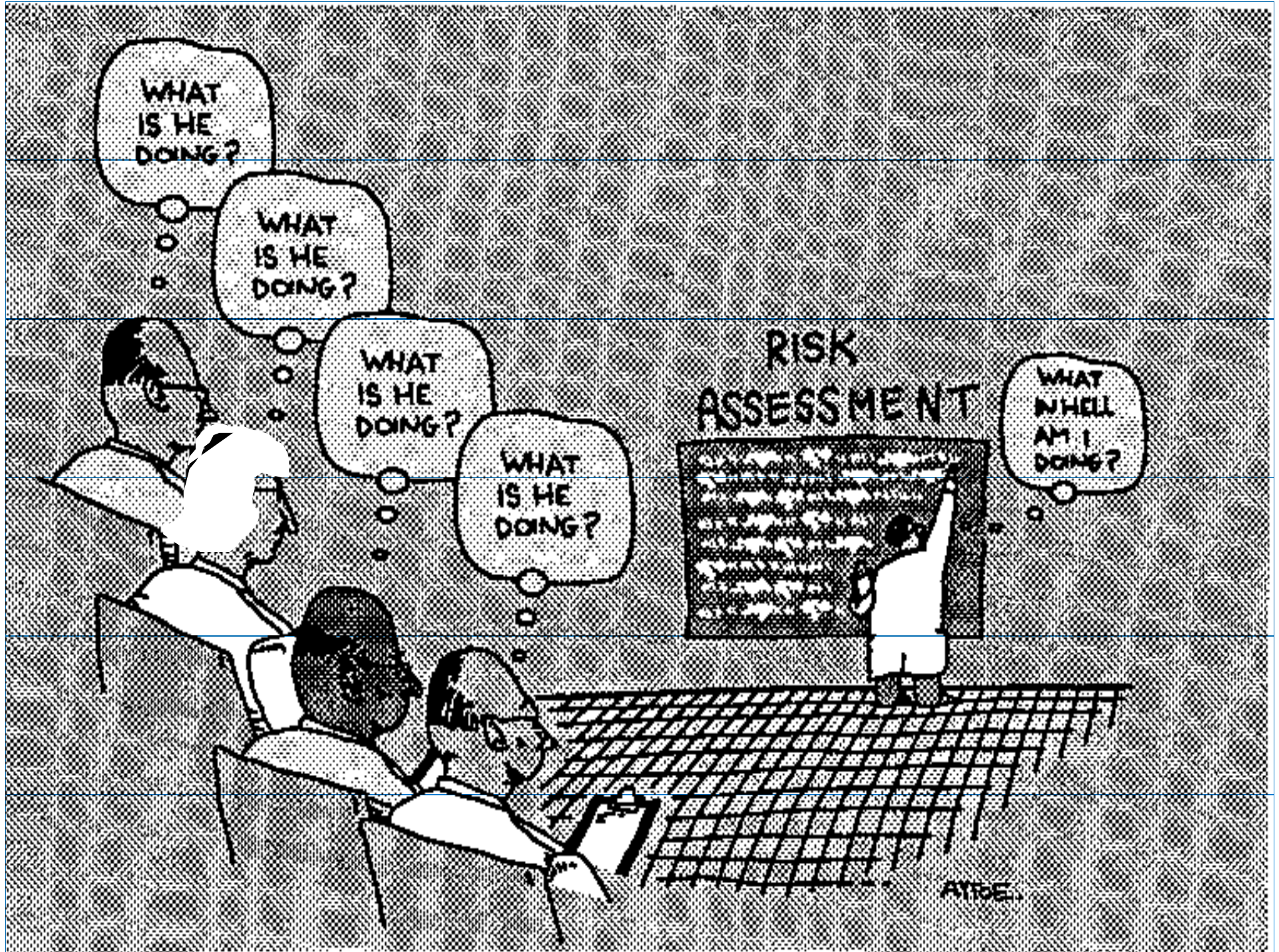
- Definition: probability of harm or loss
- Risk = Hazard x Exposure
- Risk can be voluntary or involuntary
- Interpretation of risk differs for each of us
- Predictive risk assessment (U.S. EPA) vs. health study (ATSDR, Health Department)



PURPOSE OF BASELINE RISK ASSESSMENT

- Characterize current *and* potential future risks to human health and the environment
- Determine the need for remedial action
- Aid stakeholders in understanding potential site-related risks
- Satisfy Federal regulations requiring the assessment of risk at Superfund sites





WHAT IS HE DOING?

WHAT IS HE DOING?

WHAT IS HE DOING?

WHAT IS HE DOING?

RISK ASSESSMENT

WHAT IN HELL AM I DOING?

AT&E

BASELINE RISK ASSESSMENT PROCESS

- Hazard Identification
- Exposure Assessment
- Toxicity Assessment
- Risk Characterization
- Uncertainty Analysis



HAZARD IDENTIFICATION

- Gather and analyze relevant site data
- Identify Chemicals of Potential Concern (CoPCs)
 - CoPCs are chemicals that may contribute significantly to site-related risks
 - Determined by comparison to generic risk-based screening levels or regulatory criteria
 - Identification process also considers essentiality, frequency of detection, and background conditions



EXPOSURE ASSESSMENT

- Analyze contaminant releases
- Identify potentially-exposed populations (current and future)
- Identify potential exposure pathways
- Estimate exposure point concentrations for CoPCs
- Estimate contaminant intakes for CoPCs (dose or exposure concentration)



EXPOSURE ASSESSMENT (cont.)

Common Land-Use Scenarios

- Residential
- Occupational
 - Commercial / Industrial
 - Construction
- Recreational
- Other
 - Agricultural
 - Trespassing
 - Maintenance (Landscaping)



EXPOSURE ASSESSMENT (cont.)

Common Exposure Pathways

- Surface soil
- Subsurface soil
- Ground water
- Air
- Surface water
- Sediment



EXPOSURE ASSESSMENT (cont.)

Common Exposure Routes

- Ingestion
 - Soil
 - Ground water
 - Surface water
 - Sediment
- Dermal contact
 - Soil
 - Ground water (bathing)
 - Surface water
 - Sediment
- Inhalation
 - Soil (outdoor vapors, airborne particulate, vapor intrusion)
 - Ground water (showering, vapor intrusion)
 - Air



EXPOSURE ASSESSMENT (cont.)

Generic Dose Equation - Ingestion

$$\text{Dose} = (\text{C} \times \text{CR} \times \text{EF} \times \text{ED}) / (\text{BW} \times \text{AT})$$

where:

- C = contaminant concentration, media-dependent
- CR = contact rate, media-dependent
- EF (days/yr) = exposure frequency
- ED (yrs) = exposure duration
- BW (kg) = body weight
- AT (days) = averaging time

Generic Dose Equation - Inhalation

$$\text{Exposure Concentration} = (\text{CA} \times \text{ET} \times \text{EF} \times \text{ED} \times \text{CF}) / \text{AT}$$

where:

- CA ($\mu\text{g}/\text{m}^3$) = contaminant concentration in air
- ET (hrs/day) = exposure time
- EF (days/yr) = exposure frequency
- ED (yrs) = exposure duration
- CF (1 day/24 hrs) = conversion factor
- AT (days) = averaging time



TOXICITY ASSESSMENT

- Collect qualitative and quantitative toxicity information for CoPCs
- Determine appropriate toxicity values for CoPCs to estimate risks
 - Reference Dose (RfD)
 - Inhalation Reference Concentration (RfC)
 - Carcinogenic Slope Factor (CSF)
 - Inhalation Unit Risk (IUR)



RISK CHARACTERIZATION

- Combine Exposure Assessment with Toxicity Assessment to describe potential for adverse health effects



RISK CHARACTERIZATION (cont.)

Cancer Risks

$$\text{Risk} = \text{CSF} \times \text{Dose}$$

where: CSF (mg/kg/day)⁻¹ = Carcinogenic Slope Factor

$$\text{Risk} = \text{IUR} \times \text{EC}$$

where: IUR (ug/m³)⁻¹ = Inhalation Unit Risk, chemical-specific
EC (ug/m³) = exposure concentration

Non-Cancer Risks

$$\text{HQ} = \text{Dose} / \text{RfD}$$

where: HQ (unitless) = Hazard Quotient
RfD (mg/kg/day) = Reference Dose

$$\text{HQ} = \text{EC} / (\text{RfC} \times 1000 \text{ ug/mg})$$

where: HQ (unitless) = Hazard Quotient
EC (ug/m³) = exposure concentration
RfC (mg/m³) = Reference Concentration, chemical-specific



RISK CHARACTERIZATION (cont.)

➤ Unacceptable Risk

- Excess cancer risk greater than $1E-04$
 - probability of developing cancer from defined exposure is greater than 1 in 10,000
- For non-cancer impacts, sum of HQs for similar target organs is greater than 1
 - “safe” dose is exceeded



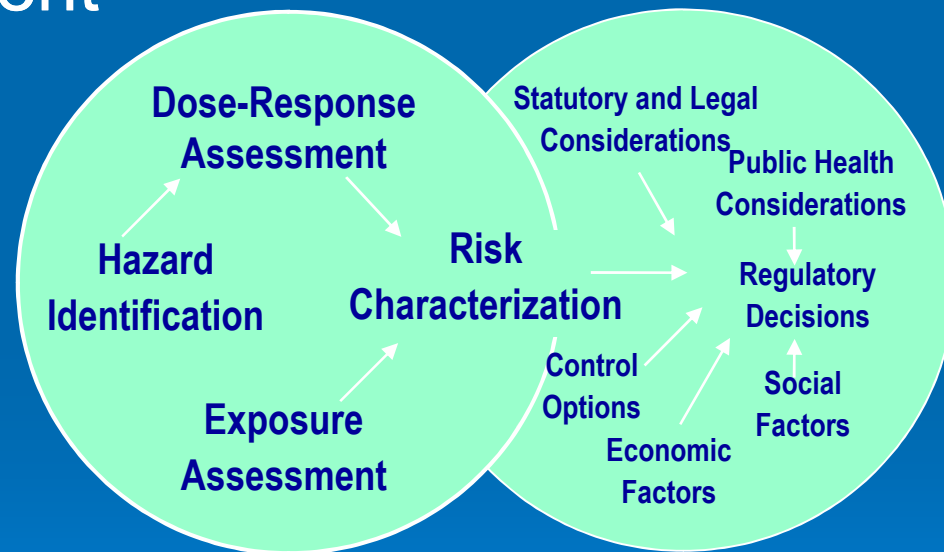
UNCERTAINTY ANALYSIS

- Describe assumptions and significant unknowns associated with risk assessment process
- Quantitative measure of variability and sensitivity of each input parameter can be performed via Monte Carlo Analysis



NATIONAL RESEARCH COUNCIL RISK ASSESSMENT PARADIGM

Risk Assessment



Risk Management

National Research Council, 1983