Ensuring Adequate Process Safety Information for Conducting PHAs

Amy E. Theis, PE
AcuTech Group, Inc.

AcuTech
PROCESS RISK MANAGEMENT

Amy E Theis, PE (she/her)

- B.S. Chemical Engineering, University of Iowa
- AcuTech, Group Inc. - Central Business Unit Leader and Principal Engineer
- 25+ years in Process Safety Consulting
- PHA/HAZOP/LOPA facilitator, NFPA code compliance, PSM/RMP audits & PSM program development
- Specialty experience in reactive chemical hazards, combustible dust, flammable liquids, UN/DOT transportation of dangerous goods and emergency relief system design for reactive systems

Agenda

- PSM Requirements for PSI and PHA
- Common deficiencies
- Special considerations
- Key Takeaways

PSM Requirements for PSI: Hazards

Hazards

- Toxicity
- Permissilbe exposure limits
- Physical data
- Reactivity data
- Corrosivity data
- Thermal and chemical stability data
- Hazardous effects of inadvertently mixing

PSM Requirements for PSI: Technology

Technology

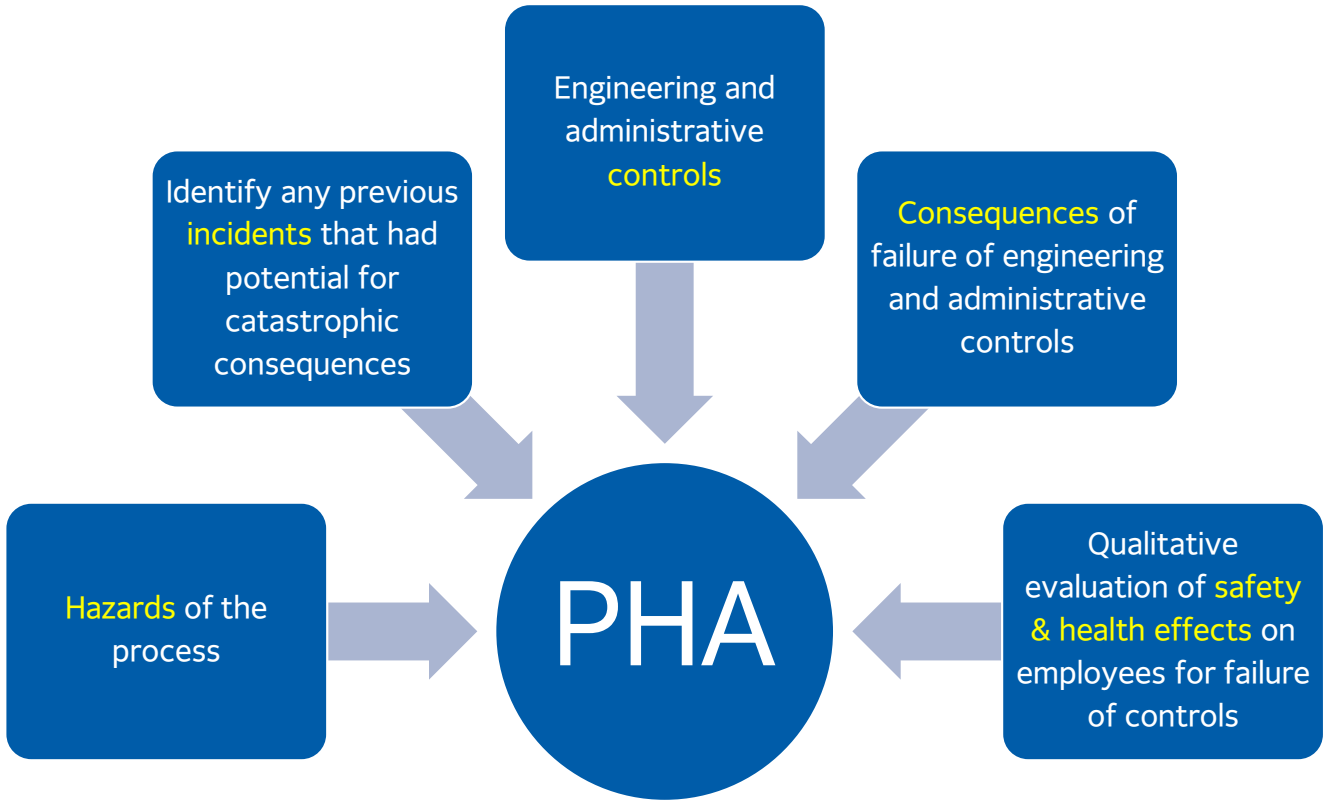
- Block flow diagram
- Process chemistry
- Maximum intended inventory
- Safe upper and lower limits for parameters such as temperature, pressure, flow or composition
- Evaluation of consequences of deviation
- Develop information as needed in conjunction with the PHA

PSM Requirements for PSI: Equipment

Equipment

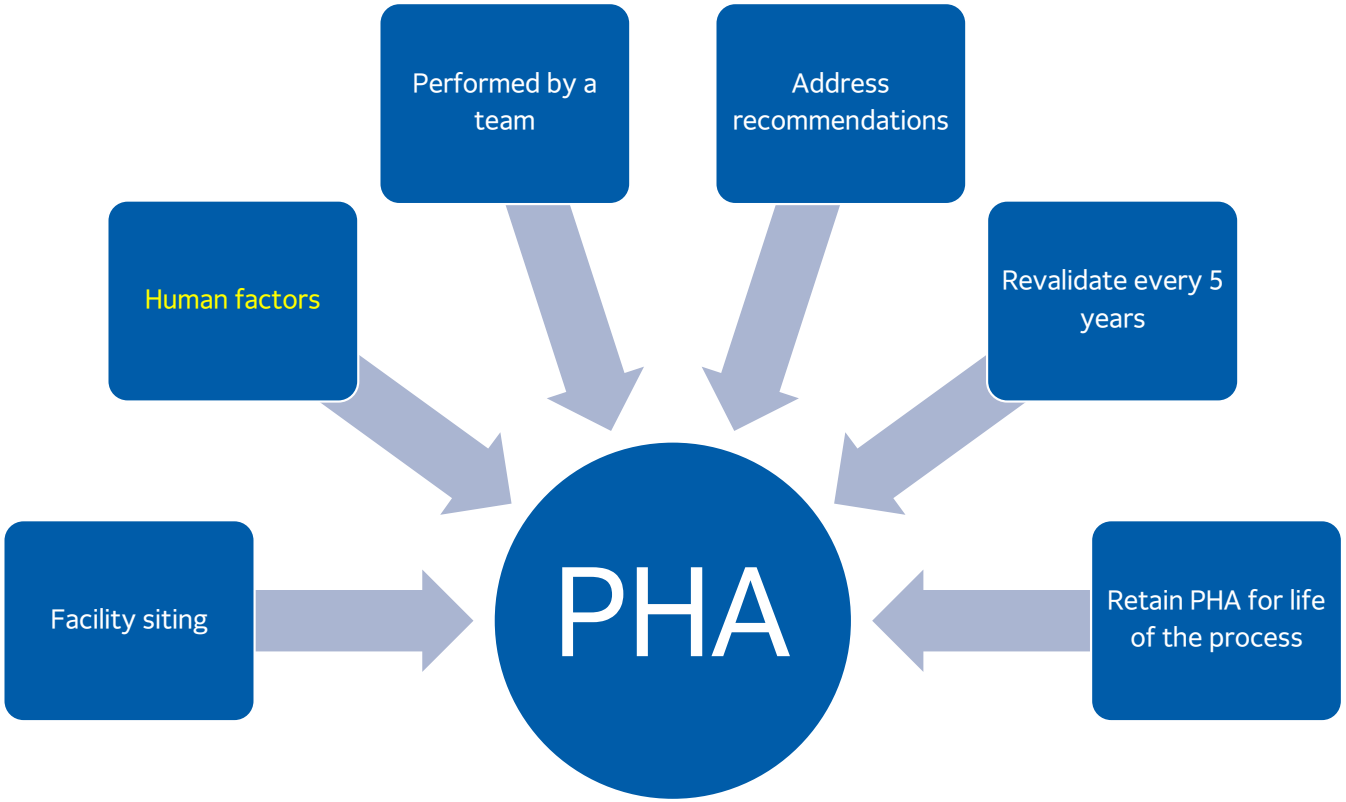
- Materials of construction
- Piping & instrumentation diagrams (P&IDs)
- Electrical area classification
- Relief system design and design basis
- Ventilation system design
- Design codes and standards employed
- Material and energy balances
- Safety systems (interlocks, detection, controls)
- Evidence of RAGAGEP compliance

PSM Requirements for PHA



AcuTech PROCESS RISK MANAGEMENT

PSM Requirements for PHA



AcuTech
PROCESS RISK MANAGEMENT

Common Deficiencies

PSI

- Safe operating limits
- Consequences of deviation
- Reactivity information
- Thermal & chemical stability

PHA

- Evaluate consequences with safeguards
- Omit human factors
- Omit previous incident review

PSI Best Practice Recommendations

- Safe operating parameters
- Flow rates/speed
- Operating manuals
- Documented design basis emergency vent system design
  - Explain each ASME overpressure scenario with justification
- Summarize hazard information for all chemicals

PSI Recommended Best Practices

- Compare thermal stability to safe operating limits
  - Maximum temperature to avoid decomposition
  - Temperature of no return
  - 24-hour time to maximum rate
- Characterize chemical reactivity due to upset conditions or inadvertent mixing

Chemical Interactivity Hazards

- Chemical Reactivity Worksheet/CAMEO
- Results can be conservative
- Create for each scope
- Limited to 1:1 interactions
- Use as first pass screening

Print Chart | Export Chart Data | Chemical Pairs

NFPA Health	NFPA Flammability	NFPA Instability	NFPA Special	MPGI Compatibility Chart	ACETIC ANHYDRIDE	PROPYLENE OXIDE	SODIUM HYDROXIDE SOLUTION	SODIUM HYPOCHLORITE	SULFURIC ACID
3	2	1		ACETIC ANHYDRIDE					
3	4	2		PROPYLENE OXIDE	N	SR			
3	0	1		SODIUM HYDROXIDE SOLUTION	N	N			
				SODIUM HYPOCHLORITE	N	N	N		
3	0	2	No	SULFURIC ACID	N	N	N	N	

Credit: Export from AIChE Chemical Reactivity Worksheet

AcuTech PROCESS RISK MANAGEMENT

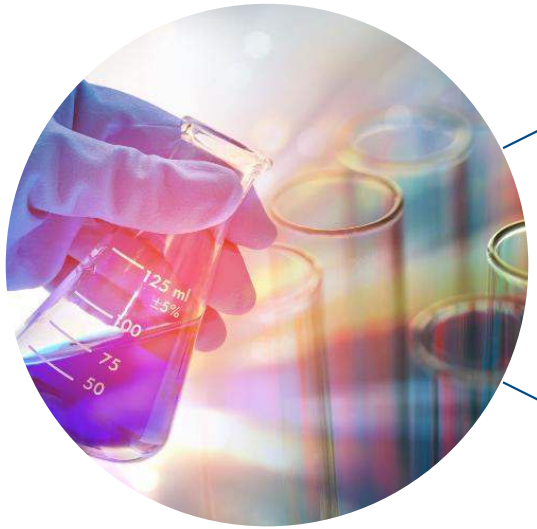
Develop Reactivity Scenarios

- Loss of utilities
- Process upset
- Energy input variation
- Mechanical failure
- Inadvertent mixing
- Human error
- Other

Reactive Hazards Data

- Rate and quantity of heat or gas generated
- Thermal stability of reactants, reaction mixtures, byproducts, waste streams, and products.
- Effect of variables such as charging rates, catalyst addition, and possible contaminants.
- Understand consequences of runaway reactions or toxic gas evolution.

Perform Testing to Characterize Reactivity



Gas production

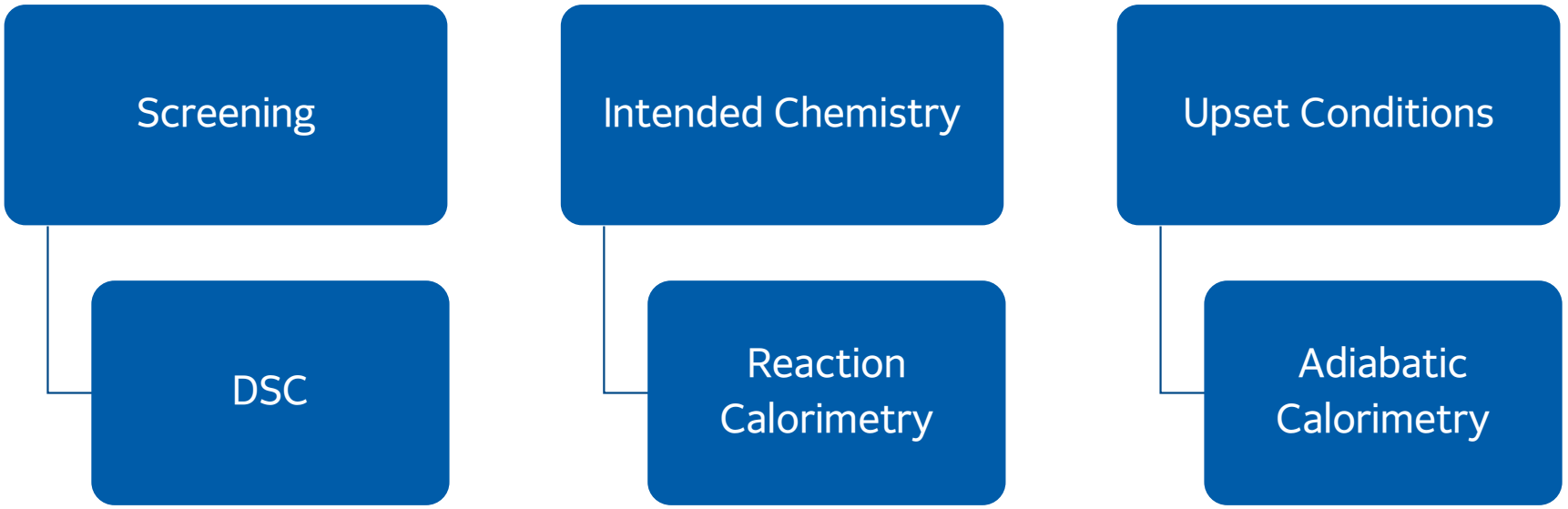
- Flammable or toxic gas
- How much
- How fast

Energy release

- How much
- How fast

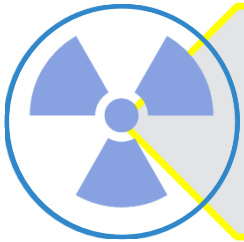
AcuTech PROCESS RISK MANAGEMENT

Testing Methodology



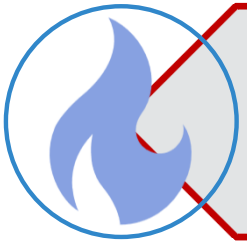
AcuTech PROCESS RISK MANAGEMENT

Evaluate Consequences



Toxic Gas Release

Flammable - Explosion

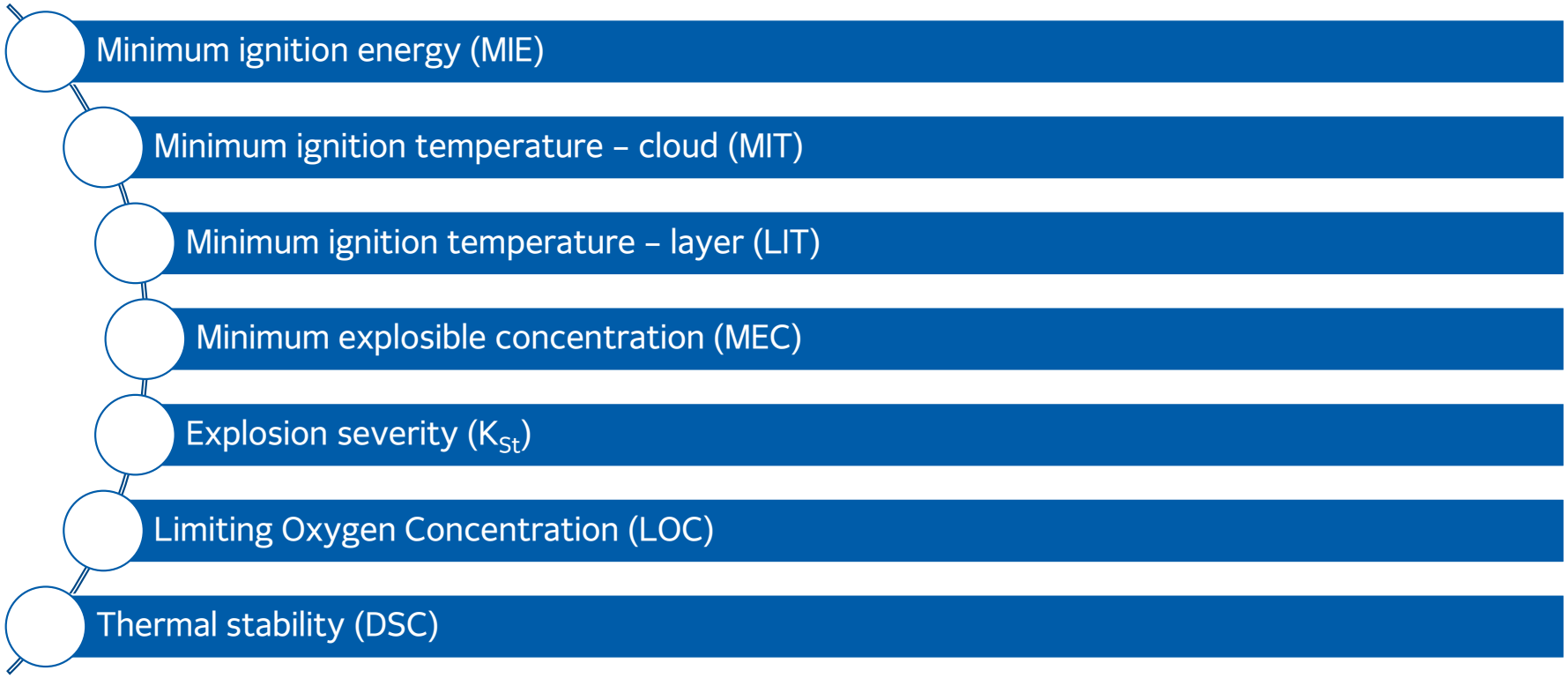


Flammable – Fire

Special Considerations

- Dryers – thermal stability
- Adding powders (combustible dust) to flammable liquids
- Batch operations with manual addition
- Loading/unloading operations
- Reactors
- Storage of self-reactive chemicals
- Extreme weather events

Combustible Dust (Powder) Data

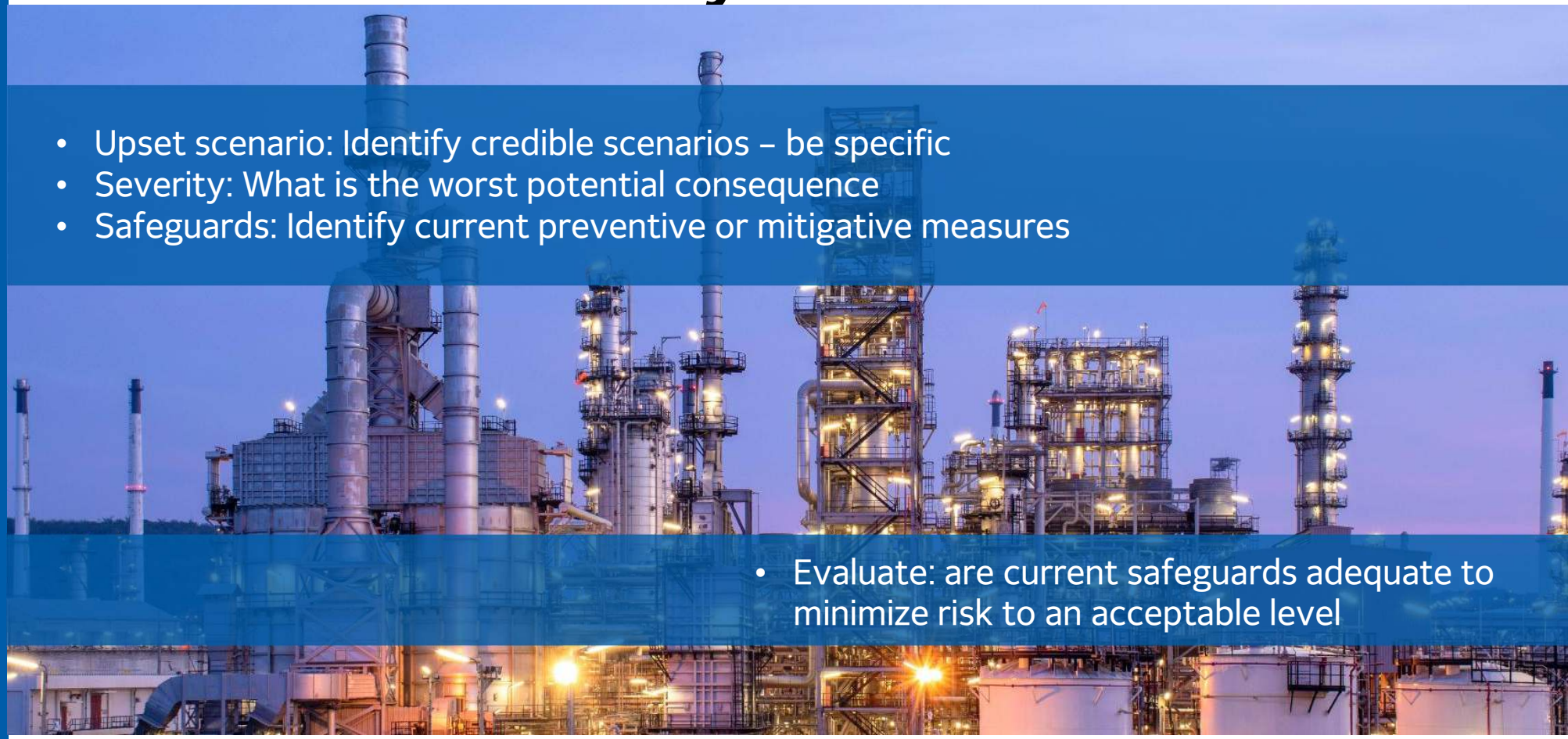


AcuTech PROCESS RISK MANAGEMENT

Thermal Stability Testing for Drying of Powders

Spray, Tray, Flash or Ring dryer	Fluid Bed or Rotating Drum dryer	Vacuum dryer
• Air over layer • Diffusion cell • DSC	• Aerated cell • Diffusion cell • DSC	• Diffusion cell • DSC

Process Hazard Analysis: Evaluate the Risk



- Upset scenario: Identify credible scenarios – be specific
- Severity: What is the worst potential consequence
- Safeguards: Identify current preventive or mitigative measures

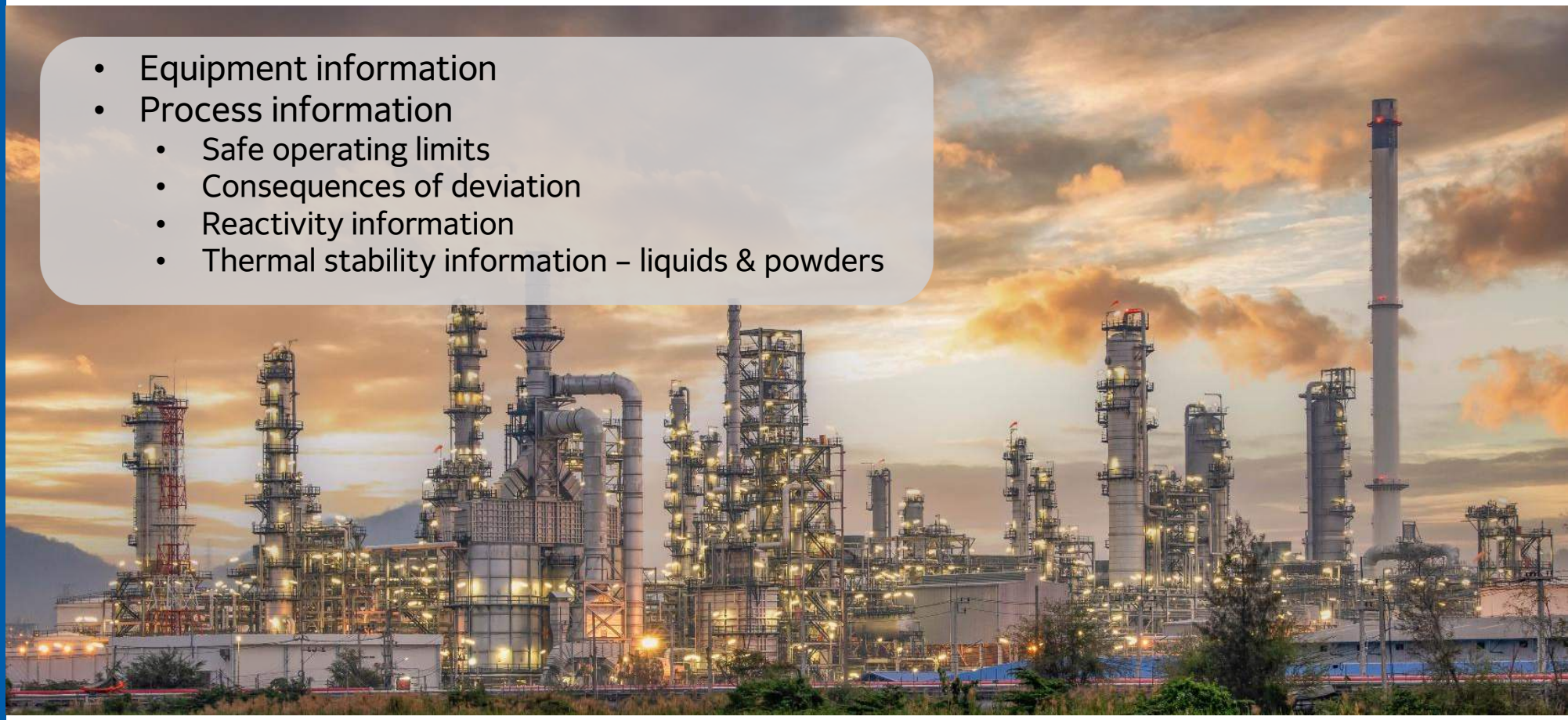
- Evaluate: are current safeguards adequate to minimize risk to an acceptable level

AcuTech
PROCESS RISK MANAGEMENT

Human Factors

Field	• Accessibility, clarity, layout
Control room	• Displays, alarms
Labeling	• Clear, consistent
Procedures	• Clear, consistent
Workload	• Regular & emergency operations

Summary of PSI for PHAs



- Equipment information
- Process information
  - Safe operating limits
  - Consequences of deviation
  - Reactivity information
  - Thermal stability information – liquids & powders

HEADQUARTERS

1750 Tysons Blvd, Suite 200
McLean, VA 22102
USA

EMAIL ADDRESS

atheis@acutech-consulting.com

WEBSITE

www.acutech-consulting.com