Hindsight is 20/20:

Lessons Learned from Reactive Chemical Incidents

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AcuTech
PROCESS RISK MANAGEMENT

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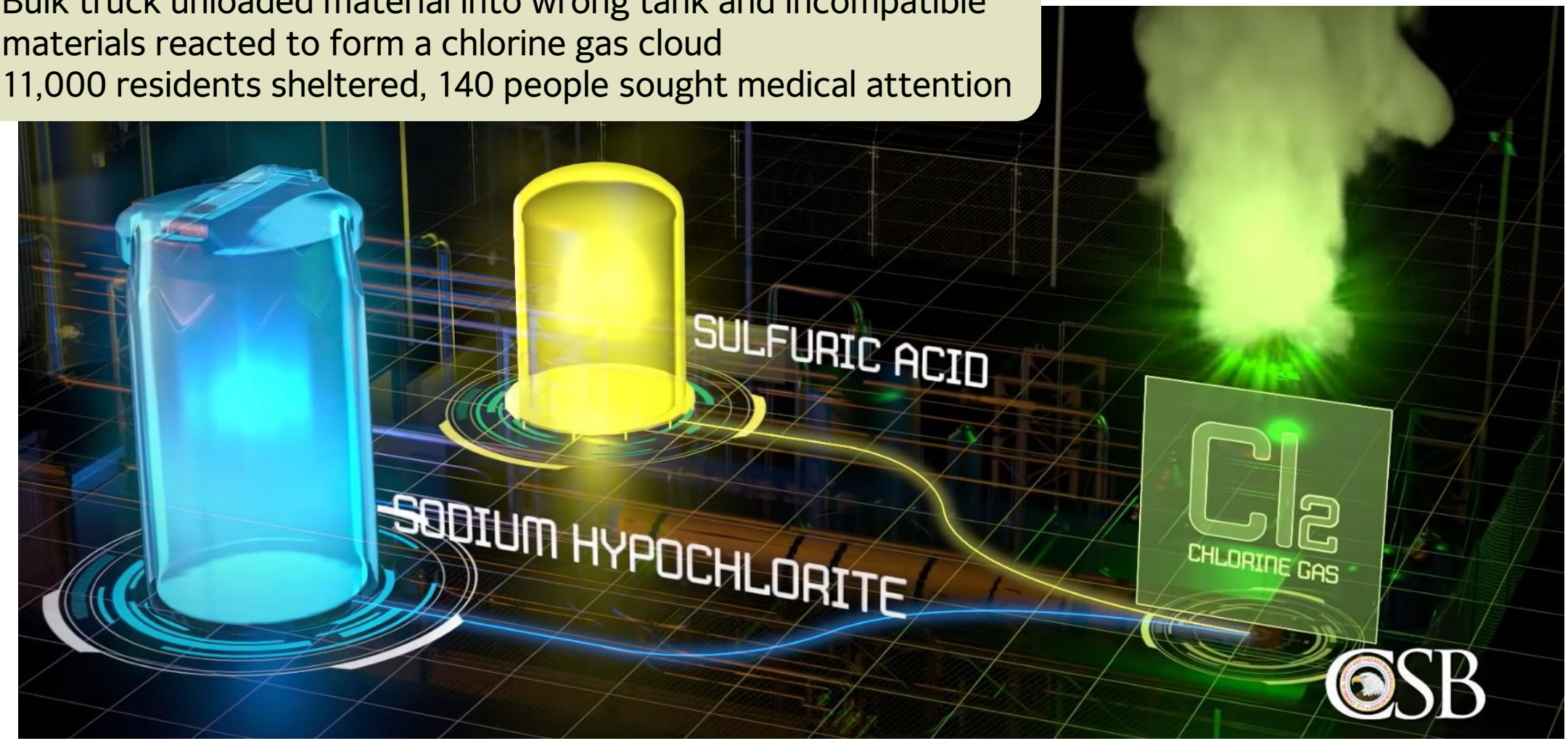
- B.S. Chemical Engineering, University of Iowa
- AcuTech, Group Inc. - Central Business Unit Leader and Principal Engineer
- 25+ years in Process Safety Consulting
- PHA/HAZOP/LOPA facilitator, NFPA code compliance, PSM/RMP audits & PSM program development
- Specialty experience in reactive chemical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

Agenda

- Incident Reviews
- Common Causes
- Reactivity Management Strategy
- Key Takeaways

Storage Incident at MGPI

- Bulk truck unloaded material into wrong tank and incompatible materials reacted to form a chlorine gas cloud
- 11,000 residents sheltered, 140 people sought medical attention



Credit: US CSB Video MGPI

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Storage Incident at MGPI

Human Factors
- Labeling
- Proximity

Equipment
- No automated or remote shut off valves
- Design of chemical transfer equipment

Training
- Chemical unloading procedures
- Emergency planning

Process Incident at AB Specialty Silicones

- Incorrect material loaded into tank and incompatible materials reacted to form hydrogen which was ignited, resulting in an explosion and fire

- 4 employees were fatally injured, significant damage to production area

Credit: US CSB Video AB Specialty Silicones

Process Incident at AB Specialty Silicones

Policies & Procedures

- Hazard analysis program was not well implemented
- Inadequate methods for storage and handling of incompatible materials
- Process safety culture weakness

Equipment

- Inadequate ventilation system design
- Lack of gas detection and alarm system

Common Issues

Did not involve chemicals covered by OSHA PSM or EPA RMP

Failure to identify hazards and consequences for chemical reactivity

Procedures and training

Evaluation and design of safeguards

Equipment and building design concerns

Emergency preparedness

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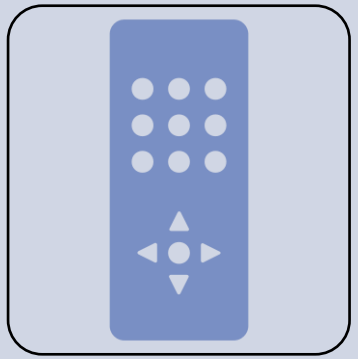
Reactivity Management Strategy

Identify

- Collect reactivity hazard information
- Identify chemical reactivity hazards

Evaluate

- Test for chemical reactivity
- Assess chemical reactivity risks



Control

- Identify process controls and safeguards
- Document chemical reactivity risks
- Communicate and train

Maintain

- Investigate incidents
- Review
- Audit
- Manage change
- Continuous improvement

Identify Reactivity – Define the Scope

Process Vessels

- Intentional Chemistry
- Batch Additions
- Blending

Storage Tanks

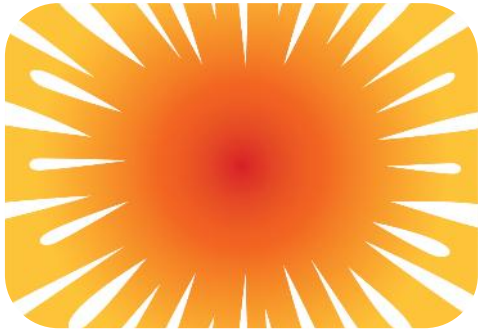
- Tank Farms
- Loading/Unloading
- Manifolds

Collect Reactivity Information

- SDS review
- Manufacturer technical information
- Wiley's Guide to Chemical Incompatibilities
- Chemical reactivity worksheet/CAMEO
- Bretherick's, Handbook of Reactive Chemical Hazards
- Sax, Dangerous Properties of Industrial Materials

Single Component Hazards

Flammability



Polymerizable (self-reactive)

Strong Oxidizing Agent

Water-Reactive

Pyrophoric

Peroxidizable Compound

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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

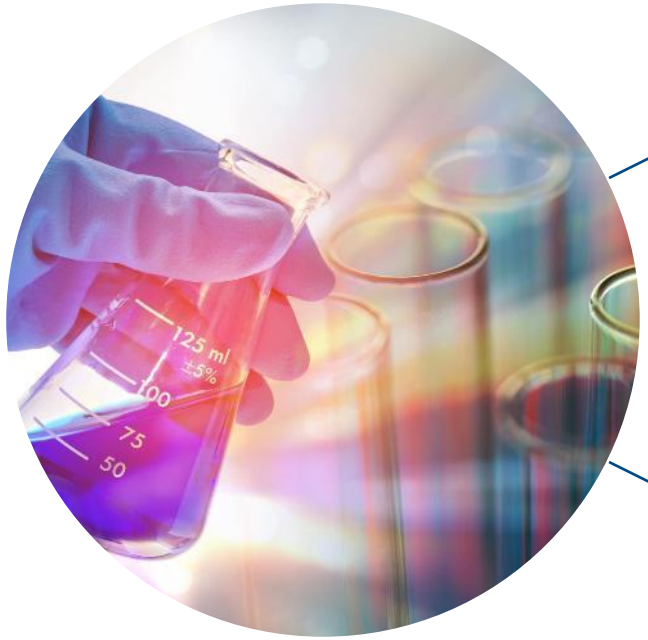
NFPA Health	NFPA Flammability	NFPA Instability	NFPA Special	MPGI Compatibility Chart	ACETIC ANHYDRIDE	PROPYLENE OXIDE	SODIUM HYDROXIDE SOLUTION	SODIUM HYPOCHLORITE	SULFURIC ACID
3	2	1		ACETIC ANHYDRIDE					
3	4	2		PROPYLENE OXIDE	N	SR			
3	0	1		SODIUM HYDROXIDE SOLUTION	N	N			
				SODIUM HYPOCHLORITE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

Credit: Export from AIChE Chemical Reactivity Worksheet

Develop Reactivity Scenarios

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

Perform Testing to Characterize Reactivity



Gas production

- Flammable or toxic gas
- How much
- How fast

Energy release

- How much
- How fast

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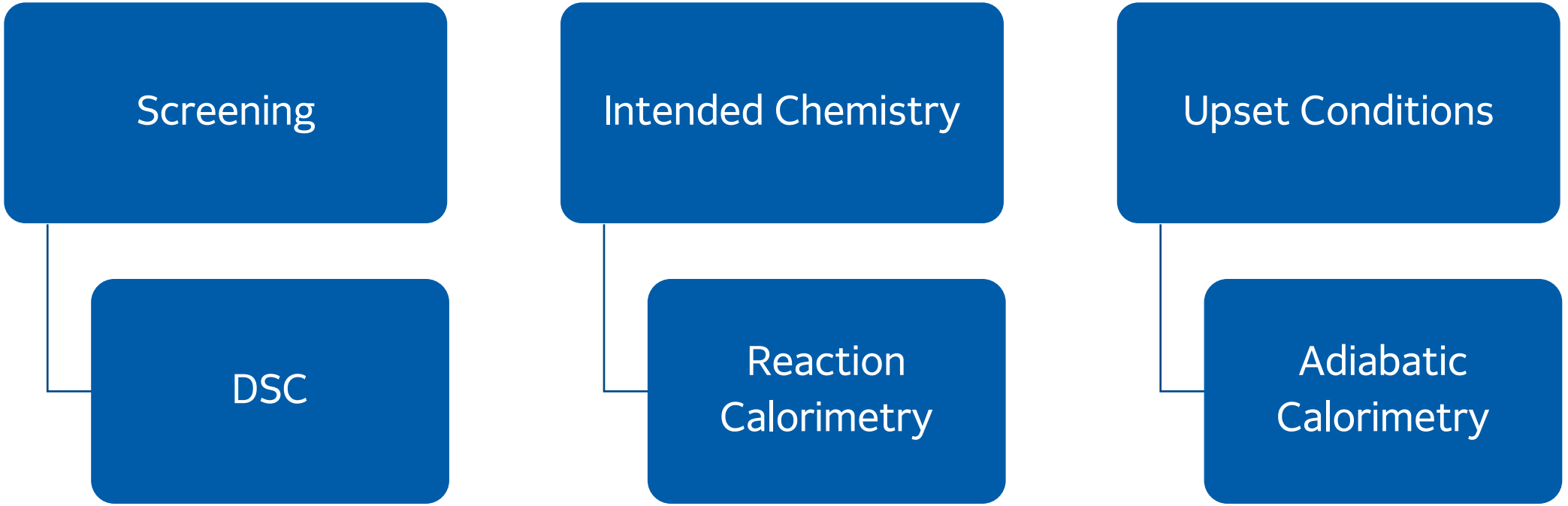
Testing Methodology



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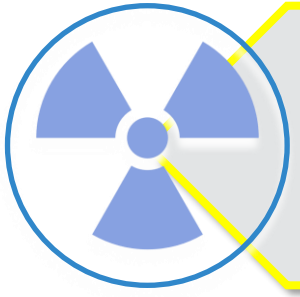
Evaluate Consequences

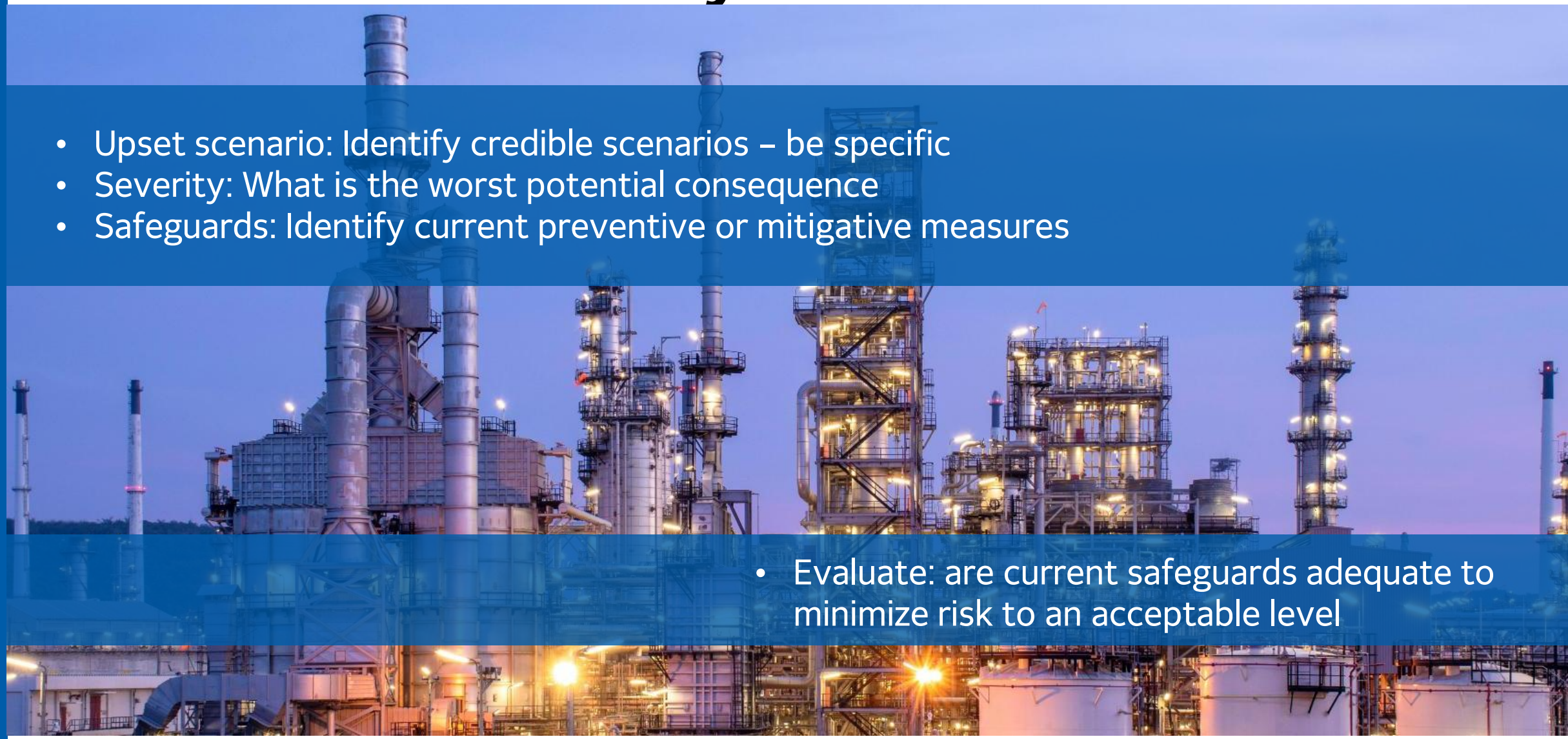


Toxic Gas Release

Flammable - Explosion

Flammable – Fire

Process Hazard Analysis: Evaluate the Risk

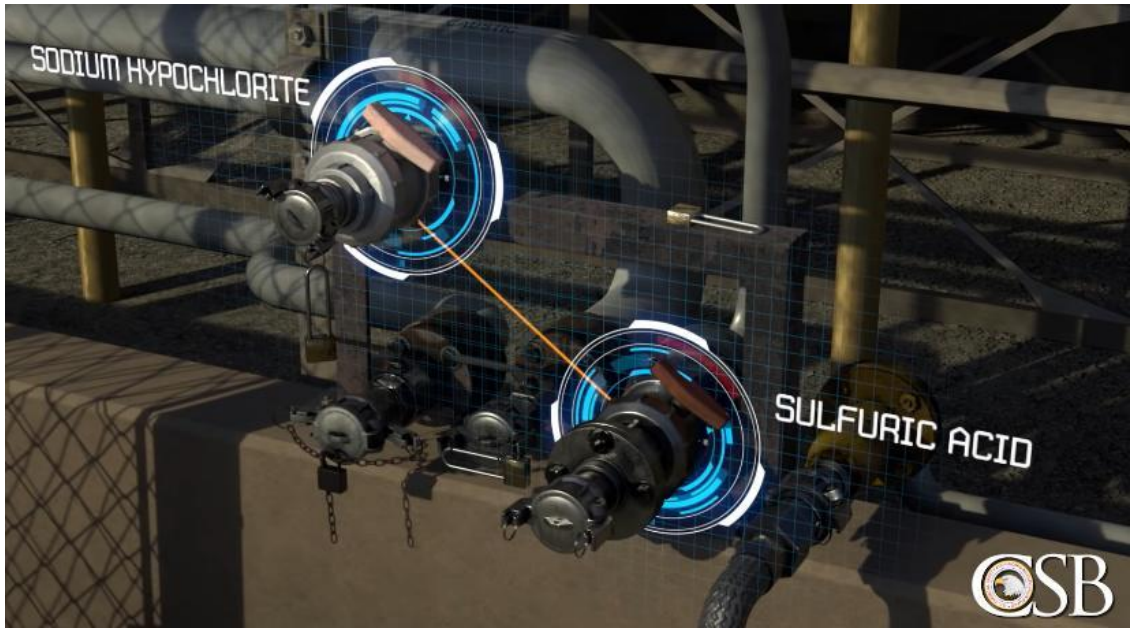


- Upset scenario: Identify credible scenarios – be specific
- Severity: What is the worst potential consequence
- Safeguards: Identify current preventive or mitigative measures

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

Human Factors

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



Credit: US CSB Video MGPI

Weather Extremes

- Flooding
- Tornado
- Hurricane
- Earthquake
- Cold Weather
- Hot Weather

Identify and Implement Safeguards

- Interlocks
- Gas Detection/Alarm
- Emergency Relief System Design
- Equipment Design Considerations
- Procedures

Maintain the Reactivity Program

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Reactivity Hazard Management Summary

- Identify reactivity hazards
- Evaluate consequences
- Control with safeguards
- Maintain the reactivity program

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