



One of These is Not Like the Other: Strategies to Manage Chemical Incompatibilities

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Agenda

Incident reviews

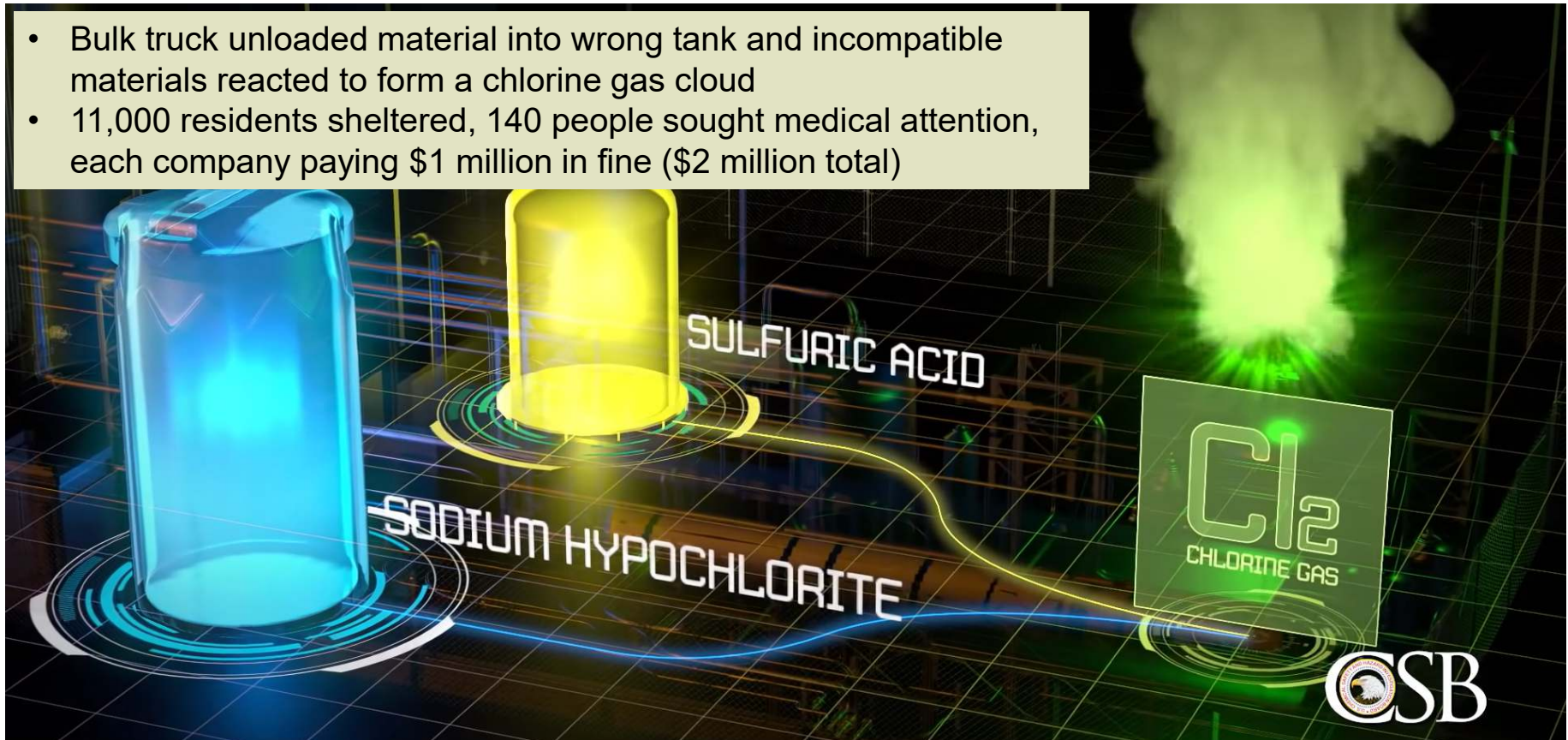
Common causes

Identification strategies

Safeguard design

Improper Mixing Incident: Harcros and 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, each company paying \$1 million in fine (\$2 million total)



Improper Mixing Incident: Harcros and MGPI

Human Factors

- Hose connections near each other, not labeled
- Accessibility of PPE for emergency evacuation

Equipment

- No automated or remote shut off valves
- Design of chemical transfer equipment
- Building design and ventilation

Training

- Chemical unloading procedures
- Hazard identification
- Emergency planning

Harcros and MPGI: Hose Connections

Fill line proximity

Identical connections and locks

Unclear labeling

Unloading procedures

- Not consistent
- Not performed as written

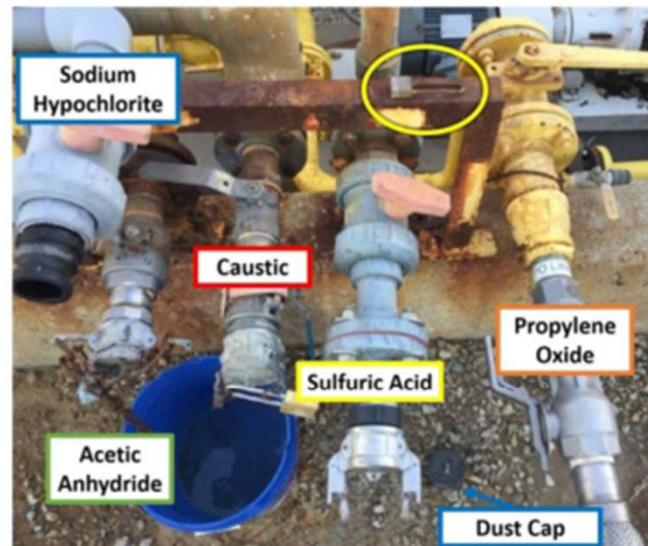
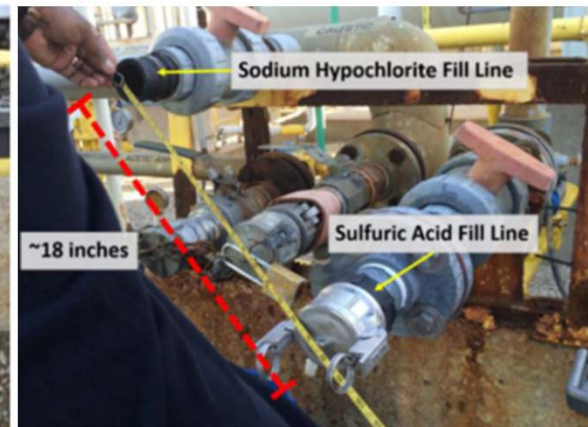
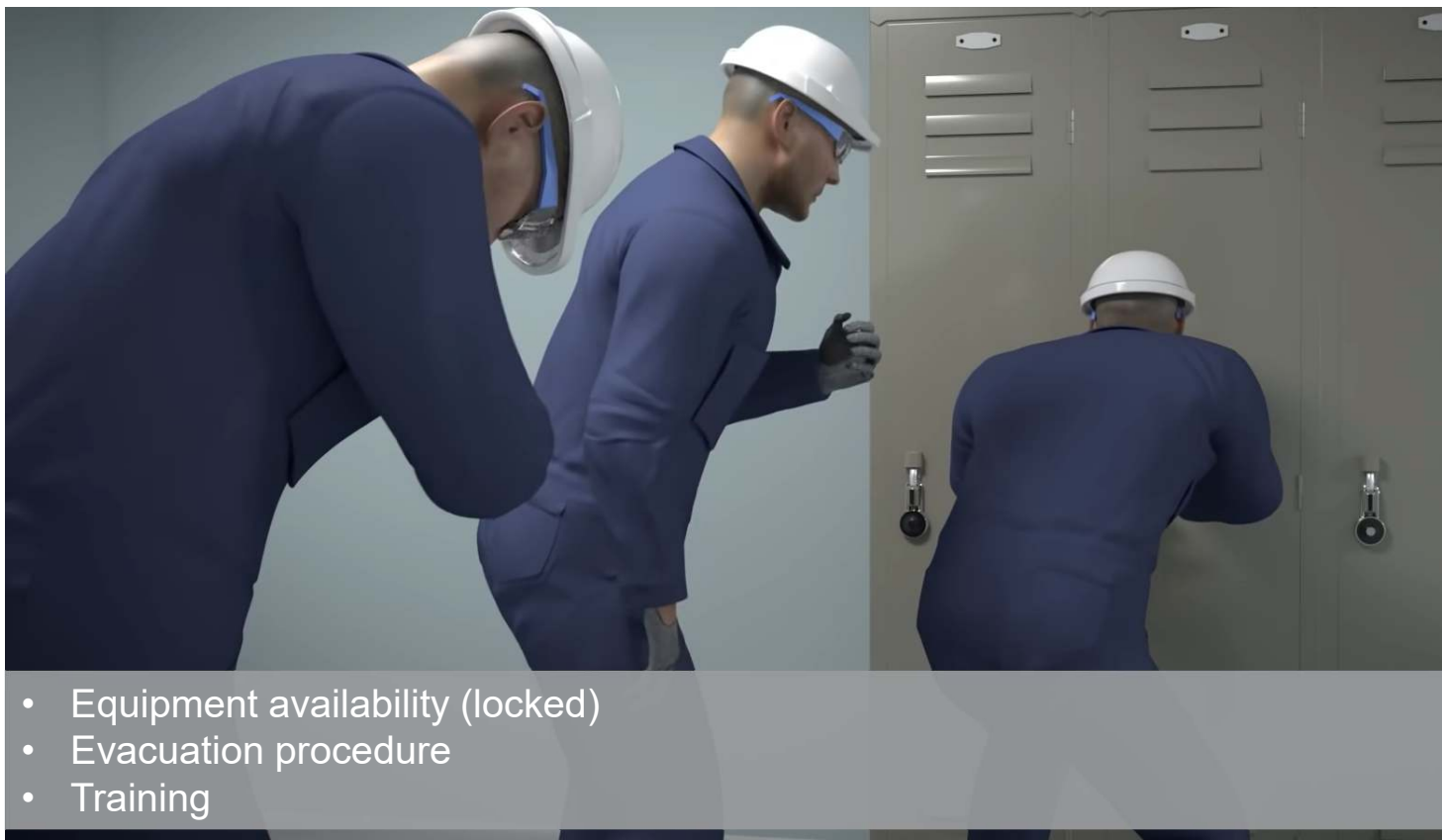


Figure 6. As-found state of connection area post-incident. Sulfuric acid fill line padlock (circled) placed on angle iron. Sodium hypochlorite dust cap on ground beneath fill lines (Source: CSB).



Pipe markings on transfer equipment and piping should be accurate and legible. Pipe markers should be placed as close to the fill line as possible

Harcros and MPGI: Emergency Planning & Evacuation



Harcros and MPGI: Equipment

- No remote shutoff valve available
- Building design allowed toxic gas to enter the control room



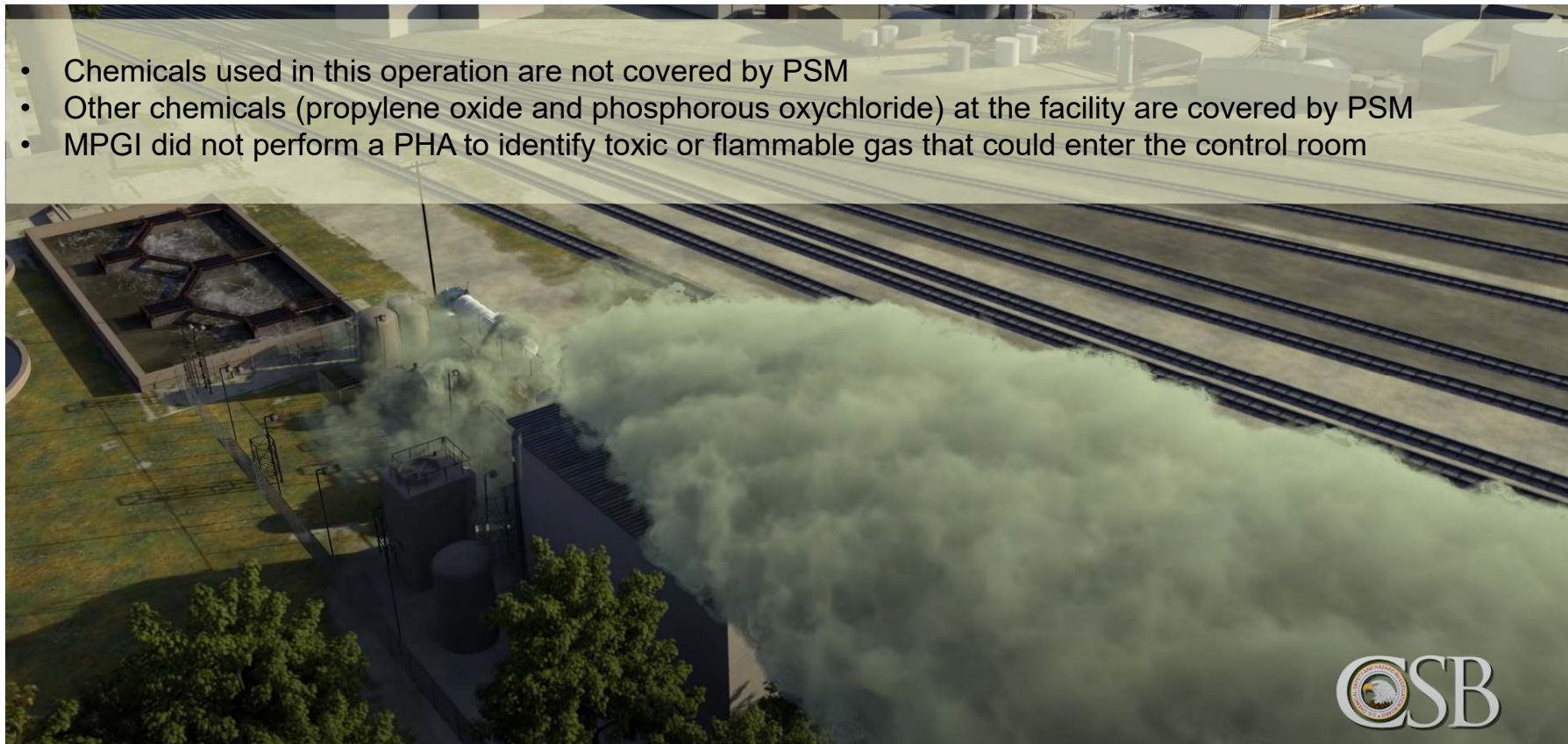
Harcros and MPGI: Training

- Hazard identification
- Unloading procedures
- Emergency evacuation



Harcros and MPGI: PSM Applicability

- Chemicals used in this operation are not covered by PSM
- Other chemicals (propylene oxide and phosphorous oxychloride) at the facility are covered by PSM
- MPGI did not perform a PHA to identify toxic or flammable gas that could enter the control room



Chemical Reaction Incident: AB Specialty Silicones

- ▶ Incorrect material loaded into tank and incompatible materials reacted to form hydrogen which was ignited, resulting in an explosion and fire
- ▶ 14 employees were fatally injured, destroyed facility's production area and forced facility to cease and relocate other operations

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

AB Specialty Silicones: Identified Safety Issues

- Mixing of Incompatible Materials
- Hazard Analysis Program
- Storage and Handling of Incompatible Materials
- Safety management system for process safety



AB Specialty Silicones: Identified Safety Issues

- Batch Equipment and Ventilation System Design
- Gas detection and alarm system
- Emergency preparedness
- Process safety culture



AB Specialty: Regulatory Coverage for Reactive Hazards



Common Issues



Reactivity hazards are not explicitly regulated other than the NJ TCPA.



Failure to identify consequences due to reactivity hazards



Inadequate procedures



Inadequate safeguards

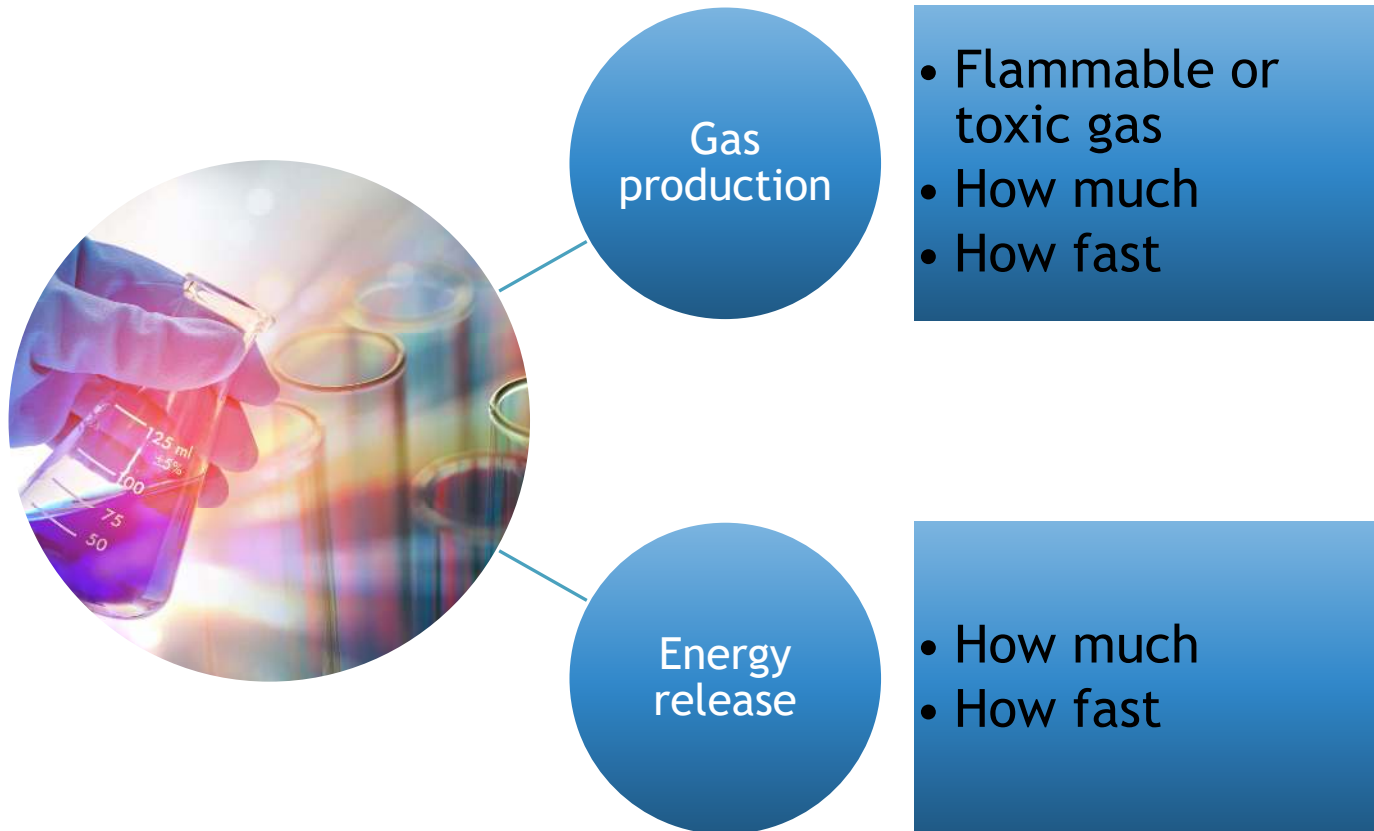


Equipment and building design concerns



Emergency preparedness

Identify Hazards of Incompatible Materials



Tools for Hazard Identification

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

Evaluate Reactivity

Process Vessels

Runaway reaction scenarios

Overpressure or
overtemperature scenarios

Lack of mixing

Storage Tanks

Contamination

Corrosion

Lack of mixing

Chemical Reactivity Worksheet/CAMEO

Results can be conservative

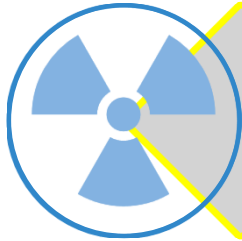
Review based on your operation

Limited to 1:1 interactions

Use as first pass screening

NFPA				Chemical Pairs	ACETIC ANHYDRIDE	PROPYLENE OXIDE	SODIUM HYDROXIDE SOLUTION	SODIUM HYPOCHLORITE	SULFURIC ACID
Health	Flammability	Instability	Special	MPGI Compatibility Chart					
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	

Consequences



Toxic release

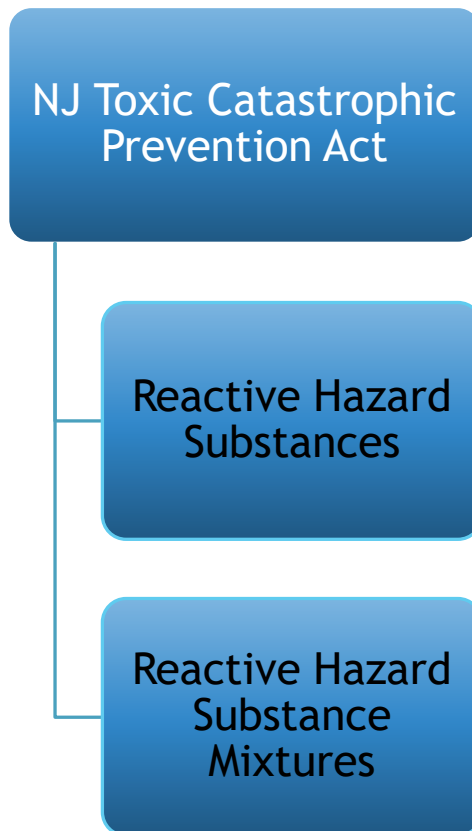


Flammable - explosion



Flammable - fire

Additional Hazard Identification Technique



NJ TCPA: Individual Reactive Hazard Substances – 30 listings

Peroxides

- Acetyl peroxide
- Cumene hydroperoxide
- Dibenzoyl peroxide
- Diethyl peroxide
- Di-tert-butyl peroxide

Nitromethane,
nitroglycerine
(alcohol solution)

O-dinitrobenzene,
p-dinitrobenzene,
1,3,5-trinitrobenzene

Peracetic acid (>56%)

Picric acid (wet, not less
than 10% water)

NJ TCPA: Reactive Hazard Substances Mixtures: 44 Functional Groups

Alkenes

Alkynes/acetylenes

Peroxides

Organic sulfoxides

Hydrazines

Diazo/diazonium

Azo/Azides

Organomettalics

Nitroso

Isocyanate

Nitro/n-Nitro

Acyl nitrates

Tools for Hazard Identification

NJ TCPA

Chemical reactivity worksheet/CAMEO

Bretherick's

SDS review

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Handling Considerations

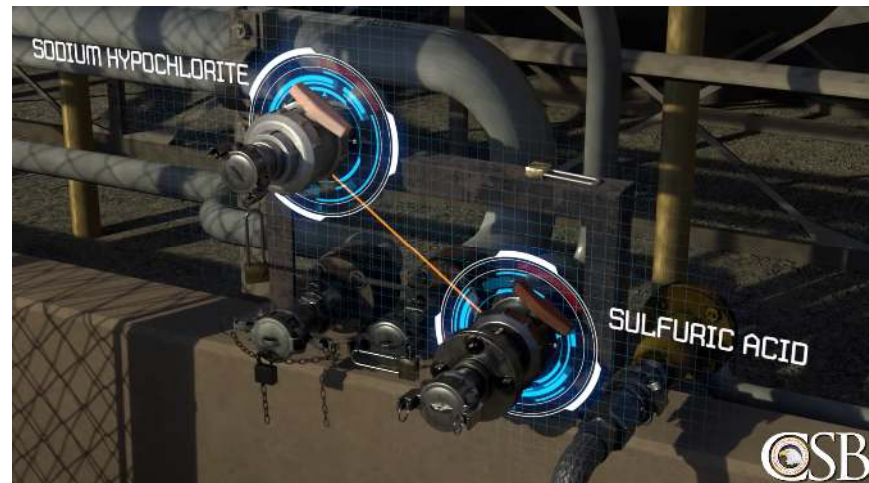
Quantity handled

Raw material handling/control

Location: chemicals stored or handled in the same area

Connected to the same vessel

Firefighting (water or other)



Equipment Considerations

- Warehouse storage (segregation for incompatible materials)
- Tank farm manifolds with common hose fittings, poor labeling
- Batch operations with multiple materials used in process vessels



Process Hazard Analysis

Tank farms

Loading/unloading activities

Large quantities of reactive hazard substances or potential mixtures



Process Hazard Analysis: Evaluate the Risk

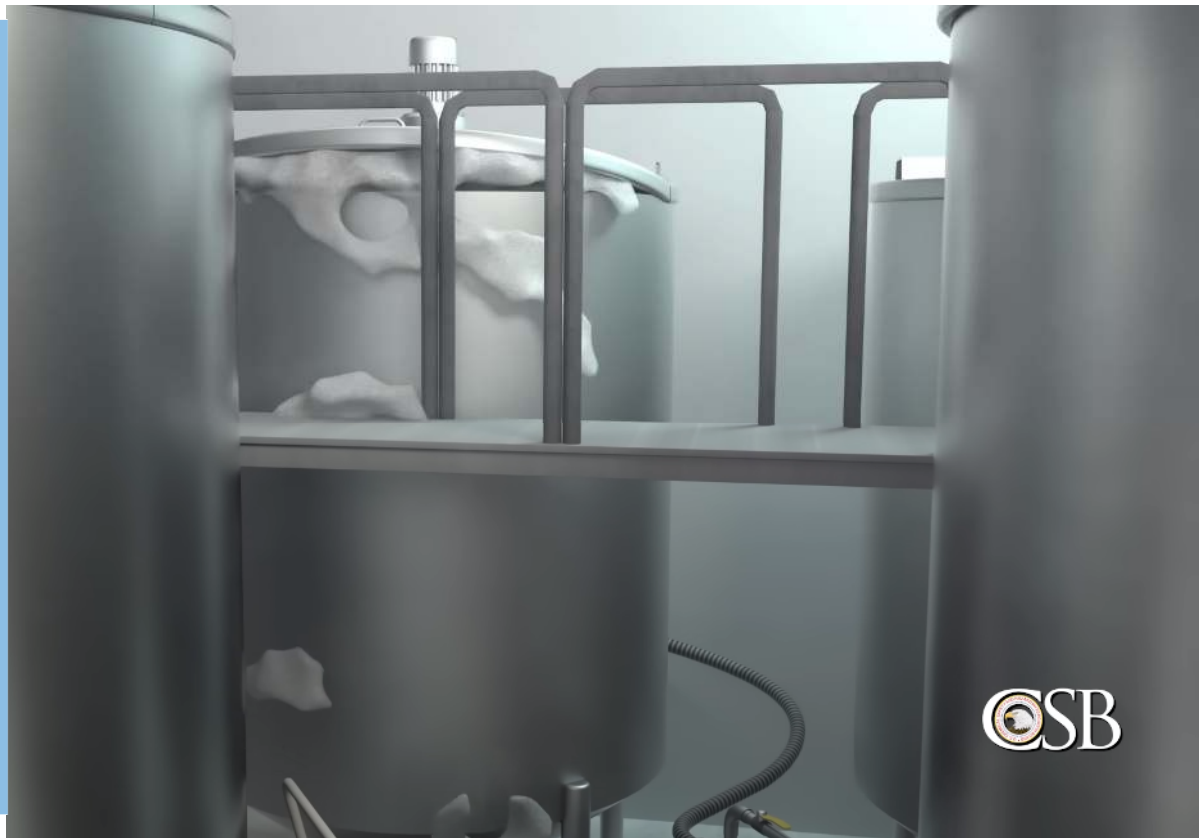
- Upset scenario: cause-consequence pair
- Likelihood: how often is the operation performed
- Severity: how much material can react
- Safeguards: identify current preventive or mitigative measures

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



Safeguard Design

- Interlocks
- Gas detection/alarm
- Relief system design
- Building design considerations (ventilation)



Reactivity Hazard Management Summary

- Process safety information
- Identify hazards
- Evaluate consequences
- Determine safeguards
- Manage change





Thank you!

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