March Public Meeting

U.S. Chemical Safety and Hazard Investigation Board

Woodland Pulp Mill

Public Business Meeting

March 19, 2026

U.S. Chemical Safety and Hazard Investigation Board

Incident Overview

Credit: Google Earth

Summary

- The Woodland Pulp Mill, located in Baileyville, Maine, has been in operation since the early 1900s and manufactures wood pulp for use in paper products.
- On January 27, 2026, in the early afternoon, sulfuric acid mixed in an enclosed sewer pipe with other sulfurous compounds, resulting in the generation and release of hydrogen sulfide.
- Hydrogen sulfide is a highly toxic gas, which is considered immediately dangerous to life and health at 100 ppm, and at low concentrations smells like rotten eggs. Continued exposure or high concentrations may limit the ability to detect the odor.

Consequences

- Numerous workers at Woodland Pulp Mill were exposed to toxic hydrogen sulfide.
- Two workers later died from the hydrogen sulfide exposure, including a co-op from the University of Maine and a process engineer.
- There were no known off-site damages or injuries

Background

Response

- Baileyville Fire Department and Downeast EMS responded
- The CSB deployed four investigators on February 9, 2026, to interview personnel, gather evidence, and collect documentation.

Ongoing Investigation

- Continue interviews with Woodland Pulp Mill employees
- Additional site documentation
- Potential cause identification
- Assessment of causal factors

Credit: Woodland Pulp Mill

U.S. Steel Clairton Fatal Explosion

Interim Recommendations

CSB Public Business Meeting

March 19, 2026

Investigator Drew Sahli

U.S. Chemical Safety and Hazard Investigation Board

U.S. Chemical Safety and Hazard Investigation Board

U.S. Steel Clairton Coke Oven Gas Explosion

CSB Interim Recommendations

Facility Siting

- Two fatalities
- Five serious injuries
- Significant property damage and loss of production

Coke Battery

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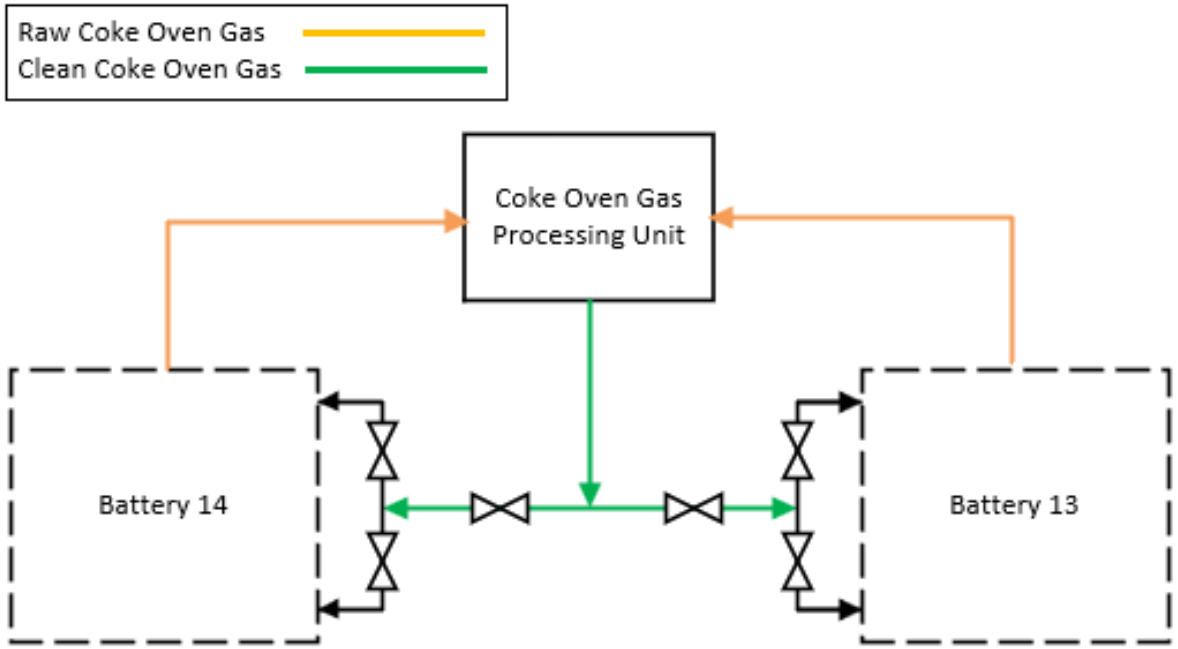
- Coal ⟶ Coke
- Coke battery – series of coke ovens
- Heating process generates coke oven gas
- Processed coke oven gas used to heat coke ovens
- Coke oven gas:
  - Hydrogen, 40-60%
  - Methane, 20-30%
  - Nitrogen, 3-15%
  - Carbon monoxide, 3-6%



Facility Siting

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- Facility siting concerns the design, construction, and location of occupied buildings
- Analyzes the location of buildings in relation to toxic, flammable, explosive processes
- Very broadly, facility siting hazards are usually addressed by:
  - Analyzing the process for fire, explosion, and toxic release hazards
  - Often involve quantitative release and blast modeling
  - Determining specific areas vulnerable to those hazards
  - Locating personnel and buildings away from those hazards
  - Designing and constructing buildings to be resistant to those hazards
- Facility siting evaluation is required for processes covered by OSHA PSM and EPA RMP, as part of PHA
- Industry guidance has existed since the mid-1990s
  - API
  - CCPS

Battery 13/14 Transfer Area

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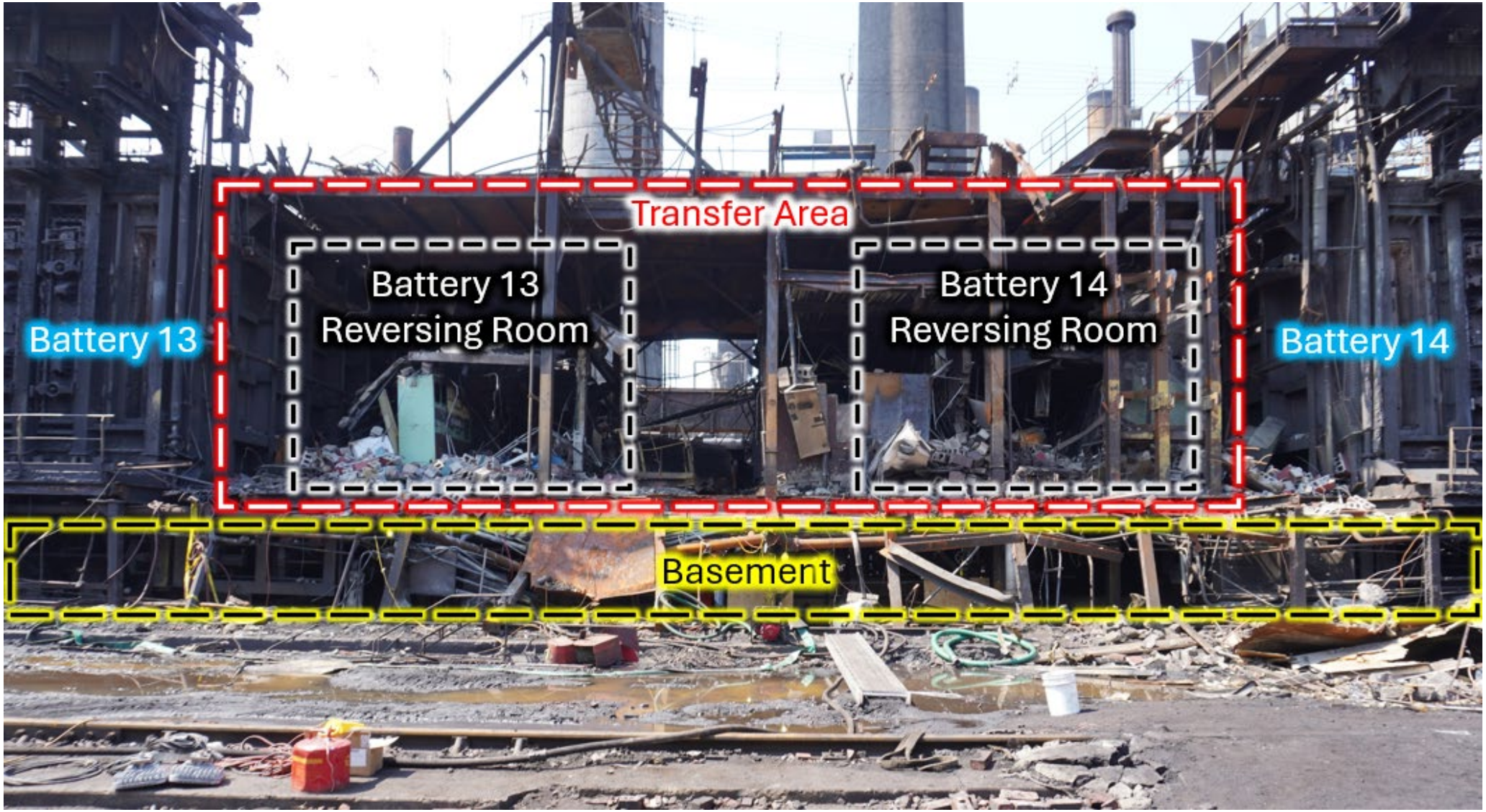

Facility Siting at US Steel

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- Prior to the incident, US Steel had not conducted a facility siting evaluation for Batteries 13 and 14
- US Steel conducted PHAs for its coke oven gas processes in 1998, 2003, 2008, 2013, and 2018.
- US Steel consistently chose not to evaluate facility siting
  - PHA documentation from 1998, 2003, and 2008 all clearly state that the PHA team did not consider facility siting
  - The 2018 PHA team claims to have considered facility siting, but the topic is not mentioned anywhere in the PHA documentation
- US Steel management rejected a recommendation from the 2003 PHA team to conduct a facility siting evaluation
- US Steel management believed that the OSHA PSM standard did not apply to the coke oven gas processes

Basis for Recommendations

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- US Steel's decision not to address facility siting in its coke batteries increased the severity of this incident.
- After the incident, US Steel decided to relocate the workers stationed in the reversing rooms from the 13/14 transfer area to a different building
- US Steel has not conducted a facility siting evaluation to inform that decision
- US Steel has 6 coke batteries; all of them have routinely occupied buildings, that are not blast resistant, and which are located nearby coke oven gas piping and other potential hazard sources
- US Steel can reduce the severity of potential future incidents by evaluating and appropriately mitigating facility siting hazards at the Clairton facility

Recommendations

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- CSB issued two interim recommendations:

- Conduct a facility siting evaluation for all occupied buildings at the Clairton facility in accordance with prevailing industry good practice guidance
- Appropriately address facility siting hazards according to the methods discussed in those industry guidance documents

Investigation Path Forward

U.S. Chemical Safety and Hazard Investigation Board

- The US Steel Investigation is ongoing
- The investigation team is conducting on-site evidence testing
- The CSB is investigating:
  - US Steel's use of cast iron equipment in explosive service
  - US Steel's and its contractors' policies and operating procedures
  - US Steel's process safety management systems
- Additional recommendation, if appropriate, will be in final report

Accurate Energetic Systems

March 19, 2026

U.S. Chemical Safety and Hazard Investigation Board

Incident Overview

Summary

- On October 10, 2025, at 7:47 a.m., approximately 23,000 pounds of explosives were involved in multiple detonations in Building 602 at the Accurate Energetics Systems (AES) facility in McEwen, Tennessee.

Consequences

- The explosion fatally injured 16 AES employees
  - 11 Building 602 workers
  - 5 transient personnel
- 7 non-fatal injuries
  - 1 serious injury (hospitalization)
- Complete destruction of Building 602
- Damage to 9 surrounding buildings
- Estimated $4.3MM property damages
- No off-site consequences known at this time

Accurate Energetic Systems

Accurate Energetic Systems

- Located in McEwen, Tennessee
- Manufactures explosives for military, aerospace, mining, avalanche control, and commercial demolition
- Employs about 140 people and operates 3 shifts 6 days per week

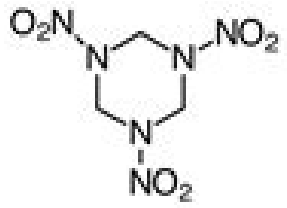
Melt-Pour and Cast Boosters

- “Melt-pour” process in Building 602 involved melting explosives in kettles and pouring into cardboard or plastic tubes to form “cast boosters”

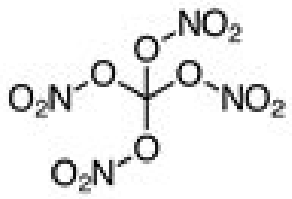
High Explosives and Secondary Explosives

- “High explosives” designed to detonate
- “Secondary explosives” designed to use a detonator to explode
- Secondary explosives can be accidentally ignited from heat, friction, impact, or electric spark

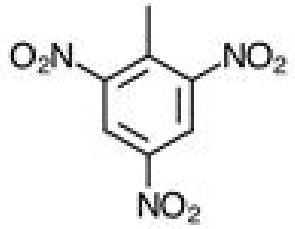
Explosive Materials



RDX



PETN



TNT

TNT (Trinitrotoluene)

- Common military and commercial explosive
- High explosive (detonation potential)

RDX (Cyclotrimethylene Trinitramine)

- Powdered or crystallized nitroamine high explosive

PETN (Pentaerythritol Tetranitrate)

- Powdered or pressed nitrate ester high explosive
- Pelletized PETN used in cast boosters

Comp B (RDX Composition B)

- 60% RDX, 40% TNT melt/pour mixture

Tritonal

- 80% TNT, 20% aluminum melt/pour mixture

Pentolite

- 50% PETN, 50% TNT melt/pour mixture

Explosive Initiation and Sensitivity

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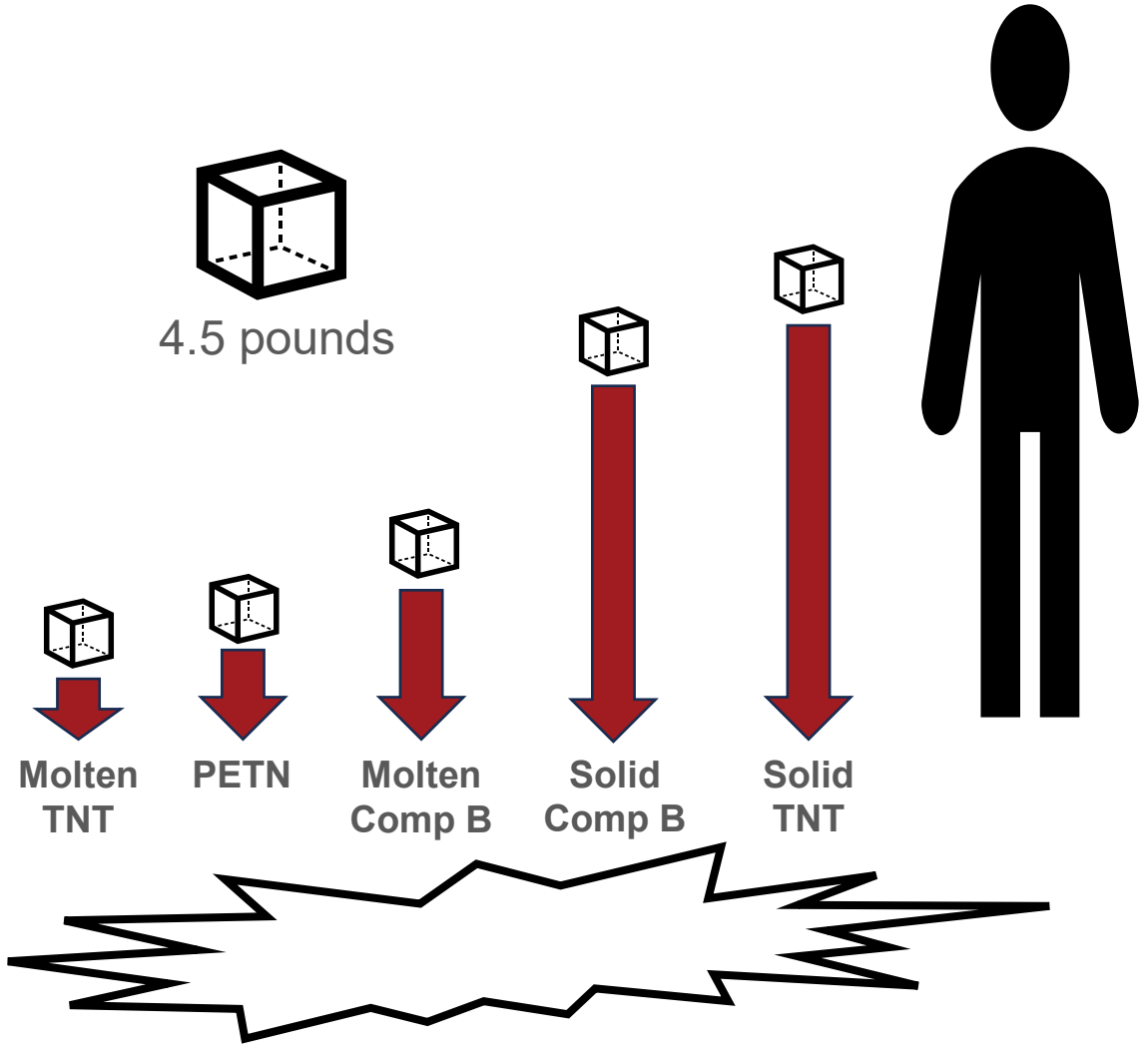
	Impact Drop Height with 50% Chance of Initiation
TNT (Solid)	3 feet
TNT (Molten)	3 inches
Comp B (Solid)	2 feet 6 inches
Comp B (Molten)	1 foot
Tritonal (Solid)	2 feet 9 inches
Pentolite (Solid)	1 foot
PETN (Solid)	7 inches

- As an illustration of sensitivity, a molten TNT detonation can be initiated from impact energy that is comparable to the energy of a cell phone striking the ground from a 2.5-foot drop height. Similarly, a solid TNT detonation can be initiated from impact energy that is comparable to the energy of a 4-pound textbook being dropped from an approximate height of 3.5 feet.



Background

Building 602

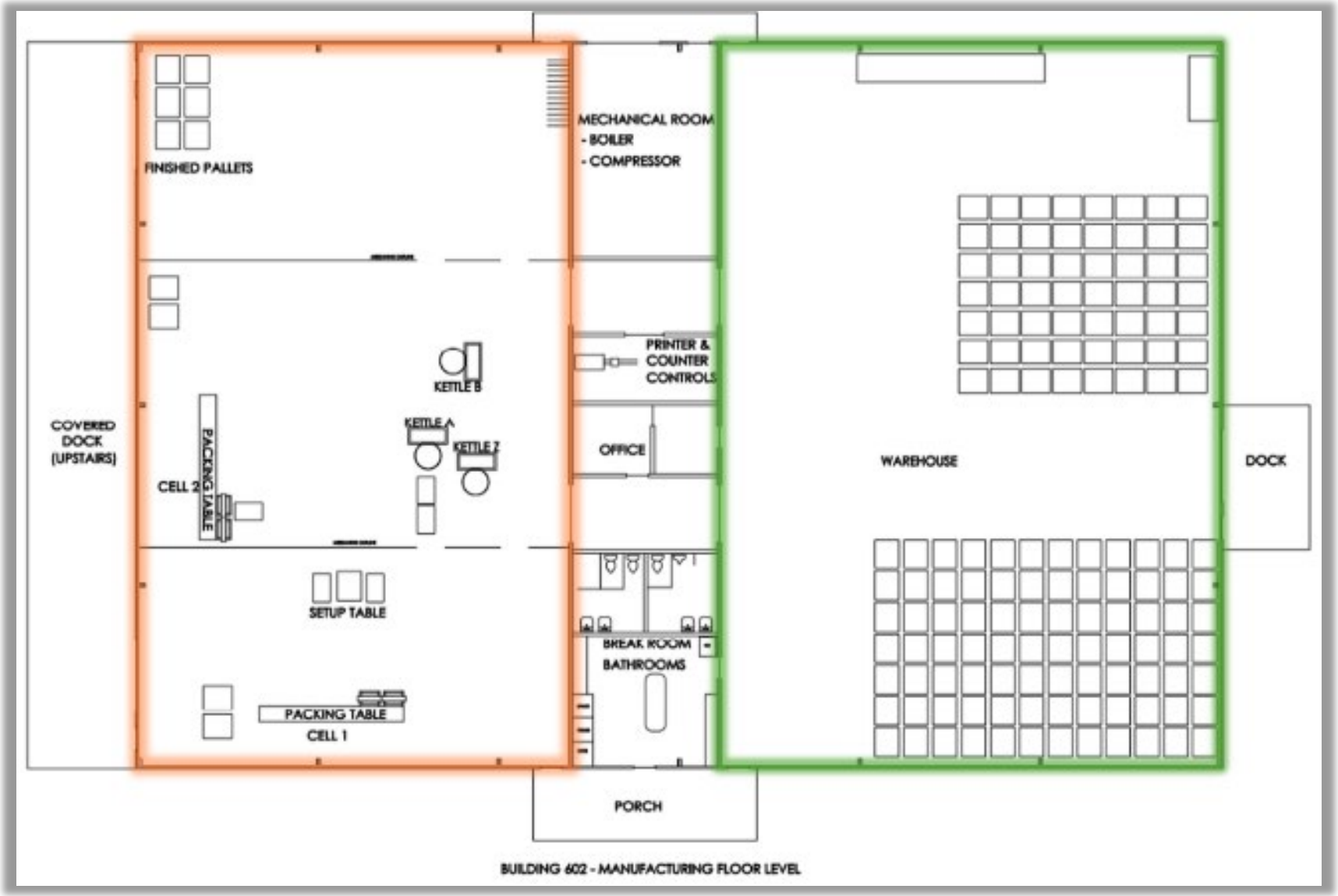
- Building 602 housed the Melt/Pour operations, where TNT-based explosives were melted in kettles and manually poured into cast booster charges

- Building was constructed in 2012 to increase production capacities

- Building 602 did not have a fire suppression system
  - Alternate system using early detection fire cameras was approved by the Tennessee Fire Marshal's office in 2016

- AES established limits for the building:
  - 30,000 pounds of explosives
  - 40 AES melt/pour employees
  - 10 transients while the building was in operation

Building 602 Layout



Melt/Pour Process Description

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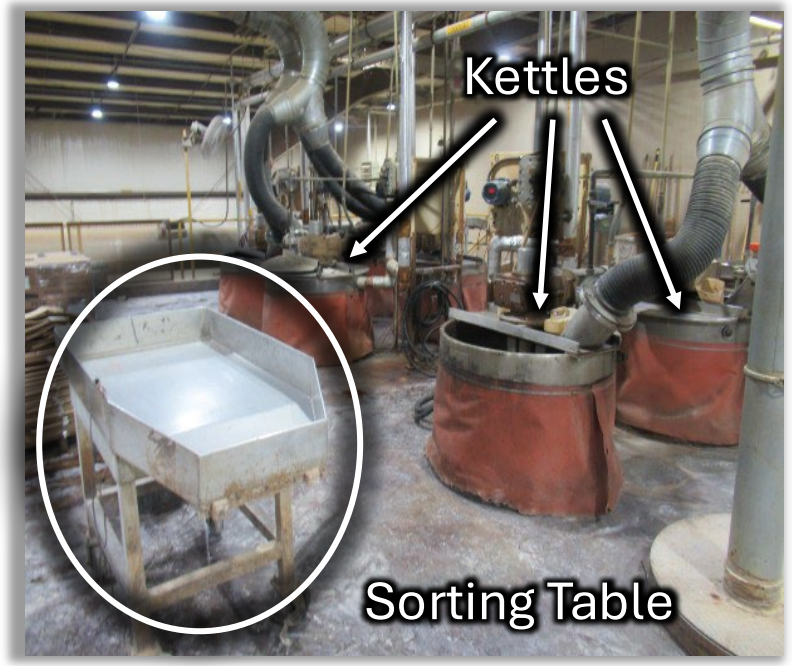
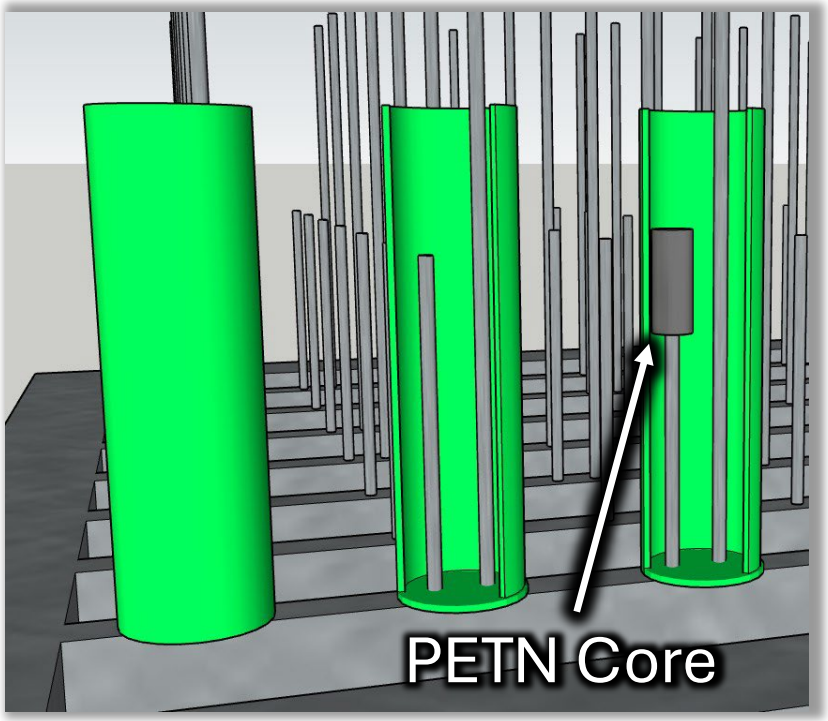
Initial Receipt and Melting Operations

- Explosives were delivered to the upper floor of the building in boxes
- The explosives were spread over a metal sorting table to inspect for foreign materials before being placed into the kettle.
- The materials in the kettles are melted by steam that flows through the jacket of the kettle. Once melted, the operator transferred the molten mixture to the first floor.



Melt/Pour Process Description



Cast Booster Preparation

- Also on the ground floor, operators prepared the booster tubes to receive the molten explosives. Wheeled carts were staged, and metal fixtures, called “pin bars,” were inserted into the carts’ frames. Operators would put the empty tubes onto the pin bars and place a PETN core on one of the pins inside each tube.

Melt/Pour Process Description

Pouring Operations

- Once molten explosives were transferred to the downstairs kettles, operators dipped plastic pitchers into the molten mixture and poured the mixture into the prepared tubes

Packaging Operations

- Once cooled and solidified, the operators used a pneumatic press to remove the cast boosters from the fixtures and cleaned off any excess explosives with a brush. The operators packaged the finished cast boosters into cardboard boxes, which were prepared for shipment to customers.

Incident Description

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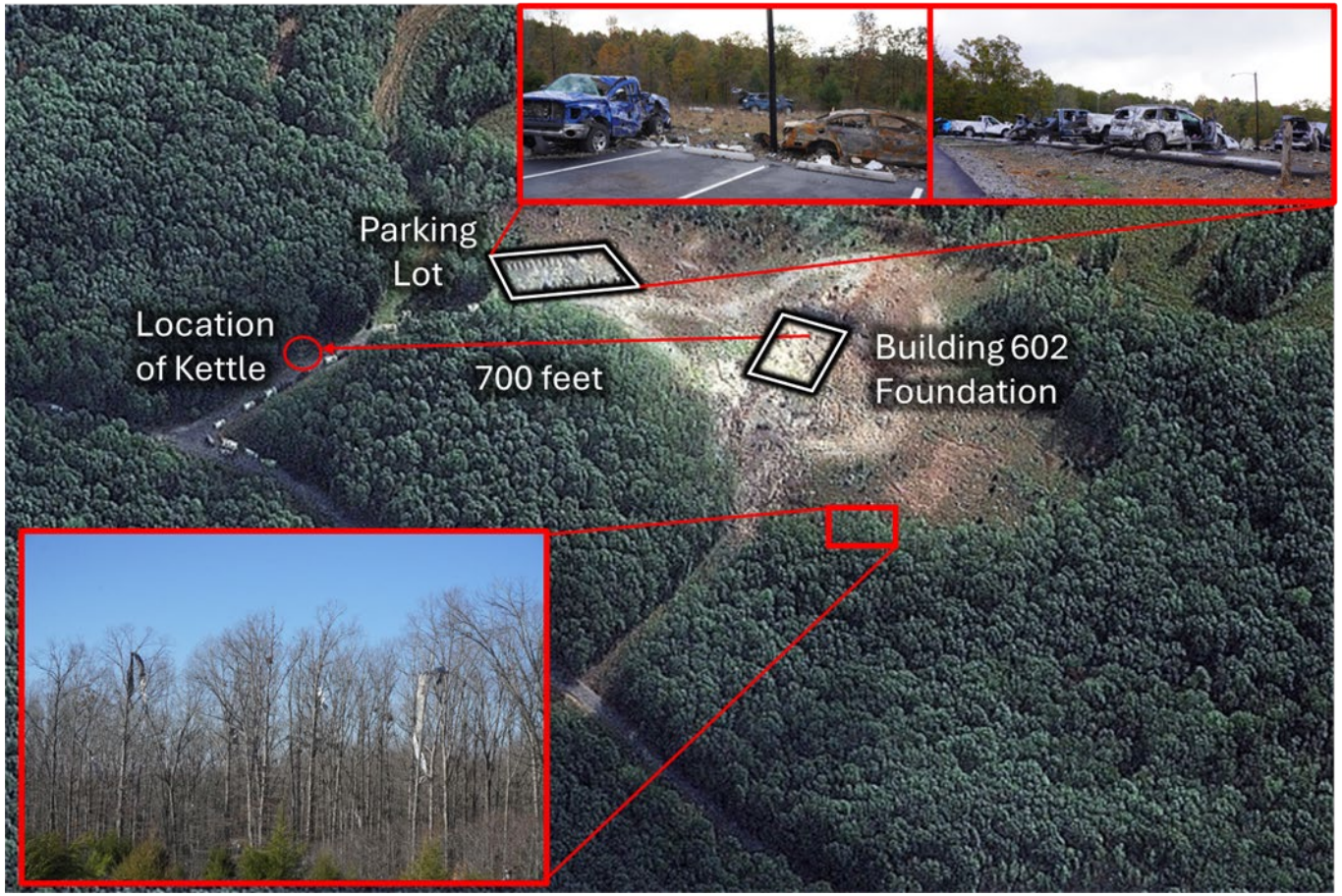
Building 602 Activities

- On October 10, at 7:00 a.m., first shift began their shift.
- At the time of the incident, 16 AES employees were in the building performing various tasks.
- At least 8 other AES employees were in the building within an hour of the explosion.
- At approximately 7:47 a.m., the incident occurred.

Impacts

- All sixteen employees in the building were fatally injured
- One employee was hospitalized
- Six other employees reported injuries
- Nine additional buildings were damaged

Incident Description



- Debris was launched from the building. Following the incident, one kettle was found approximately 700 feet away from the building. The explosion destroyed vehicles in the employee parking lot approximately 350 feet away.

Incident Description

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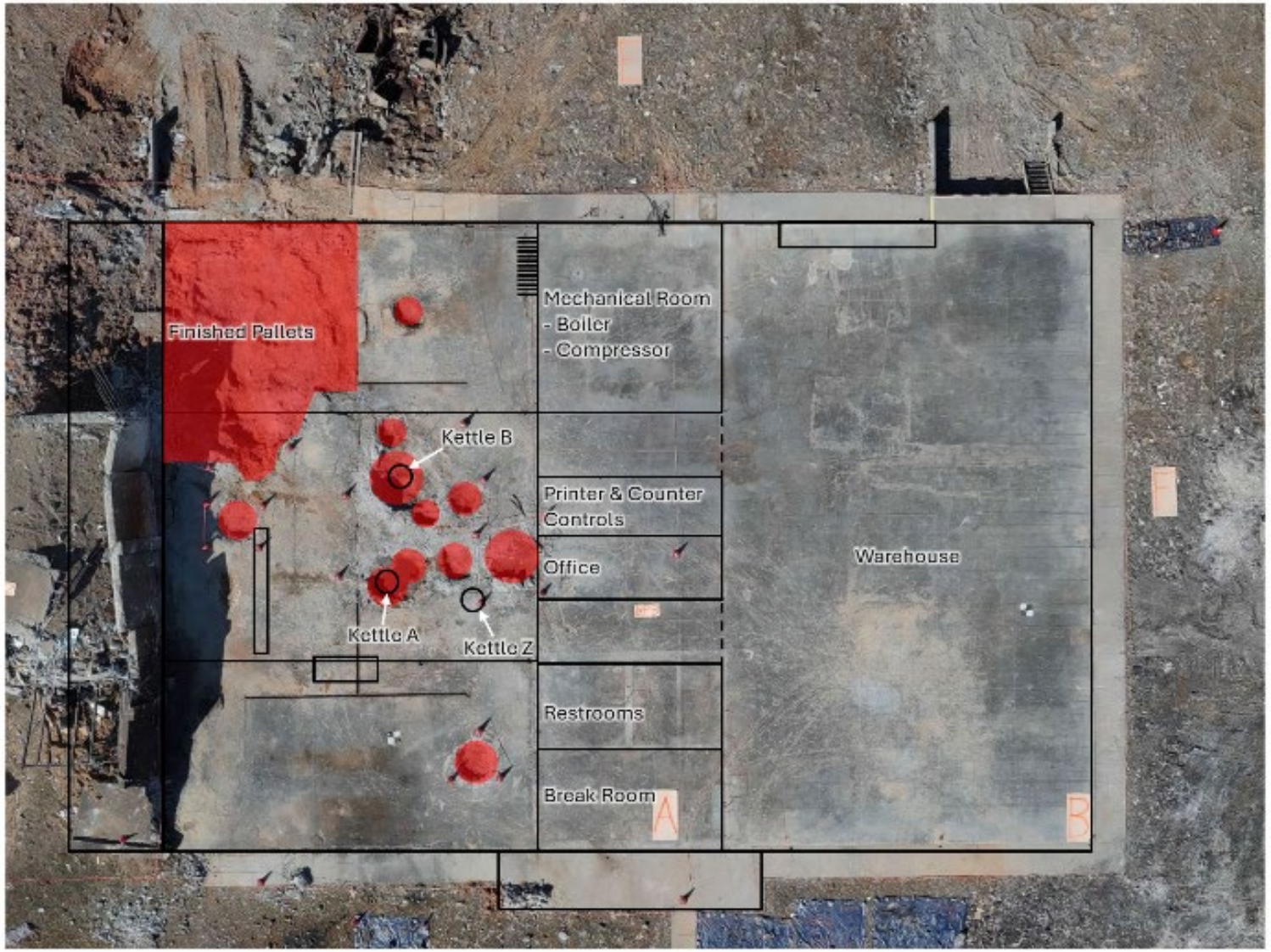
Crater Analysis

- At the time of the incident, 24,600 pounds of explosives were in Building 602.
- The first explosion likely occurred on the ground floor.
- Multiple explosions occurred following this initial explosion.
- The CSB has been able to identify the equipment and materials at each of these locations to aid in further analysis.



Path Forward

Ongoing Investigation Research

- The investigation is ongoing. The CSB is continuing to gather facts and analyze several areas, including:
  - Cause or probable cause of the potential initiating event;
  - AES's explosive safety and process safety management programs;
  - Equipment design of the kettles used at the AES facility;
  - Sensitivities of in-process explosive materials; and
  - Industry guidance for commercial facilities that manufacture explosives.

- Complete findings, analyses, and recommendations, if appropriate, will be detailed in the CSB's final investigation report.

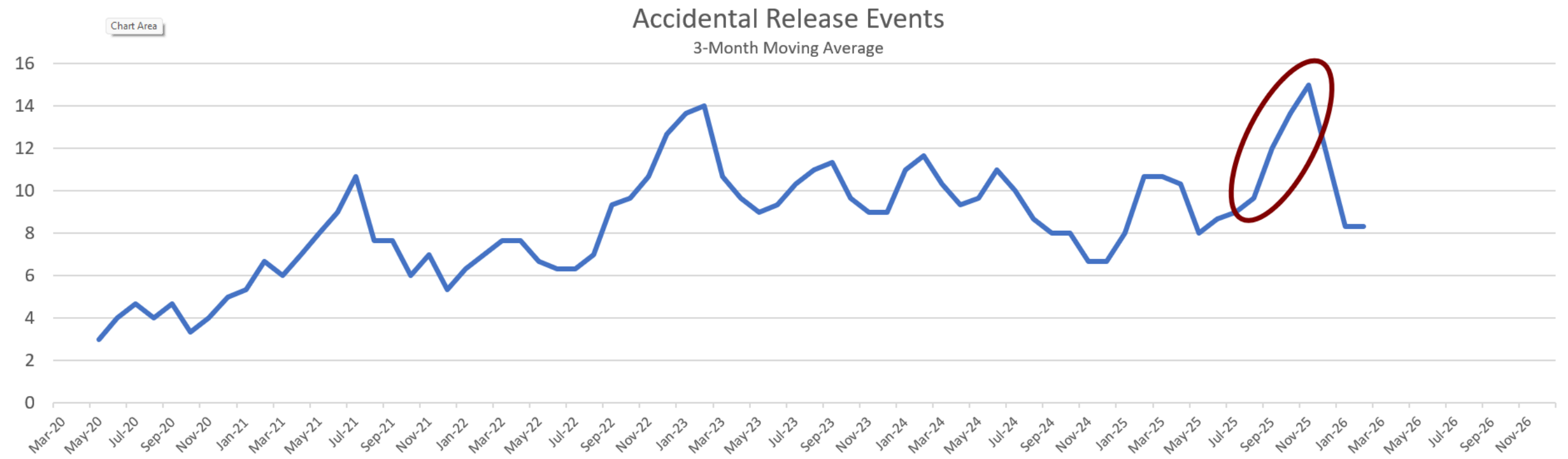
Accidental Release Team

Eduardo Alvarez

U.S. Chemical Safety and Hazard Investigation Board

Accidental Release Reporting

- 609 reportable events (through February 2026)
- 92 with fatalities, 334 with serious injuries, and 292 with substantial property damage
- Event reporting returned to a more typical level after the all-time high of 45 events reported from September through November



CSB Incident Reports

U.S. Chemical Safety and Hazard Investigation Board

Incident Reports – Volume Four

- Thirteen accidental release events in seven states
- Two fatalities, 10 serious injuries, and $1 billion in property damage

Volume Four – Highlighted Events

- Two 2025 events where the wrong equipment was disassembled, resulting in an accidental release with high consequences
- Combined, these two events resulted in one serious injury and $947 million in property damage
- These events were prioritized because they are similar to the October 10, 2024, incident at the PEMEX refinery in Deer Park, Texas, where a release of toxic hydrogen sulfide gas resulted in two fatalities and 13 injuries
- Concerning trend of chemical industry accidents linked to ineffective safety management systems governing the opening of equipment

PBF Energy
February 1, 2025 | Martinez, California

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Incident Summary (Volume 4 – Event #12)

- An explosion and fire caused $924 million in property damage
- Contract workers inadvertently opened a pipe flange on an active system during turnaround maintenance preparation, releasing and igniting flammable hydrocarbons
- The workers had not been trained on the refinery's tagging system used to identify which flange should be opened
- Neither the workers' supervisor nor a unit operator was present when the flange was disassembled

Probable Cause

- Opening a flange connected to an active process containing pressurized flammable liquid
- Refinery's tagging system should make it obvious which equipment workers should disassemble
- Having a knowledgeable person present could have prevented the incident by ensuring that workers unfamiliar with the equipment disassembled the correct flange.

Olin
May 20, 2025 | Freeport, Texas

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Incident Summary (Volume 4 – Event #13)

- Chlorine release seriously injured one worker, triggered a shelter-in-place for the community, and caused $23 million in property damage
- A maintenance worker disassembled a rupture disc holder in an active chlorine system, releasing approximately 8,000 pounds of toxic chlorine gas
- Olin's operations team had mistakenly isolated, cleared, and tagged a different but nearly identical piping system and did not isolate, clear, or tag the piping associated with the rupture disc that the maintenance worker disassembled

Probable Cause

- Mistaken disassembly of a rupture disc holder in an operating chlorine system.
- Breakdown in equipment opening and control of work programs contributed to the incident

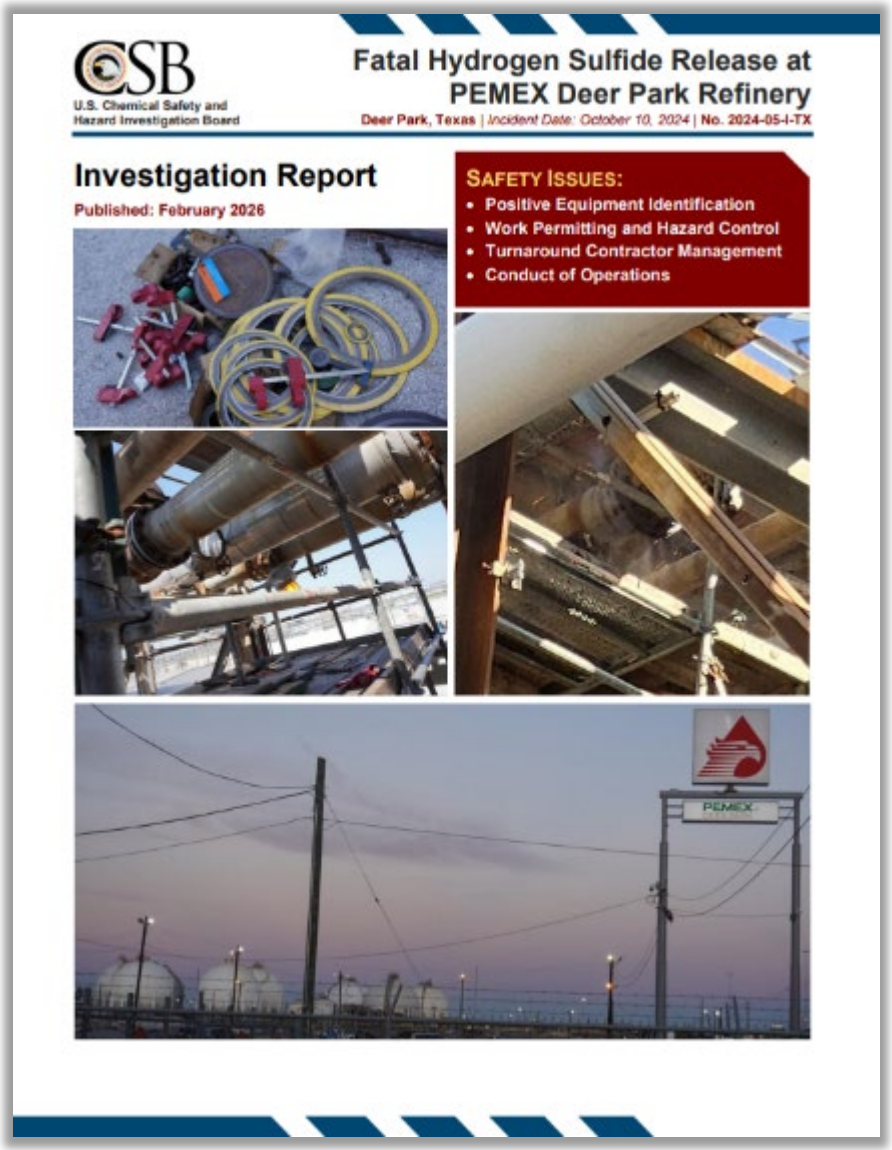
Fatal Hydrogen Sulfide Release at PEMEX Deer Park

Public Meeting Q2FY2026

March 19, 2026

U.S. Chemical Safety and Hazard Investigation Board

PEMEX Deer Park



- On October 10, 2024, at 4:23 p.m., approximately 27,000 pounds of hydrogen sulfide gas were released during a maintenance activity at the PEMEX Deer Park Refinery in Deer Park, Texas.

- The release fatally injured two contract workers. Officials in the neighboring cities of Deer Park and Pasadena issued shelter-in-place orders that lasted several hours.

- The CSB determined that the cause of the incident was the opening of incorrect equipment, which released pressurized hydrogen sulfide.
  - PEMEX did not establish an effective method to clearly identify the correct equipment to open.
  - PEMEX did not adequately evaluate the hazard posed by opening equipment within an active unit that was adjacent to a unit undergoing a turnaround.
  - PEMEX deviated from several of their own policies and procedures that could have prevented the incident.

- The CSB published the final investigation report in February 2026.

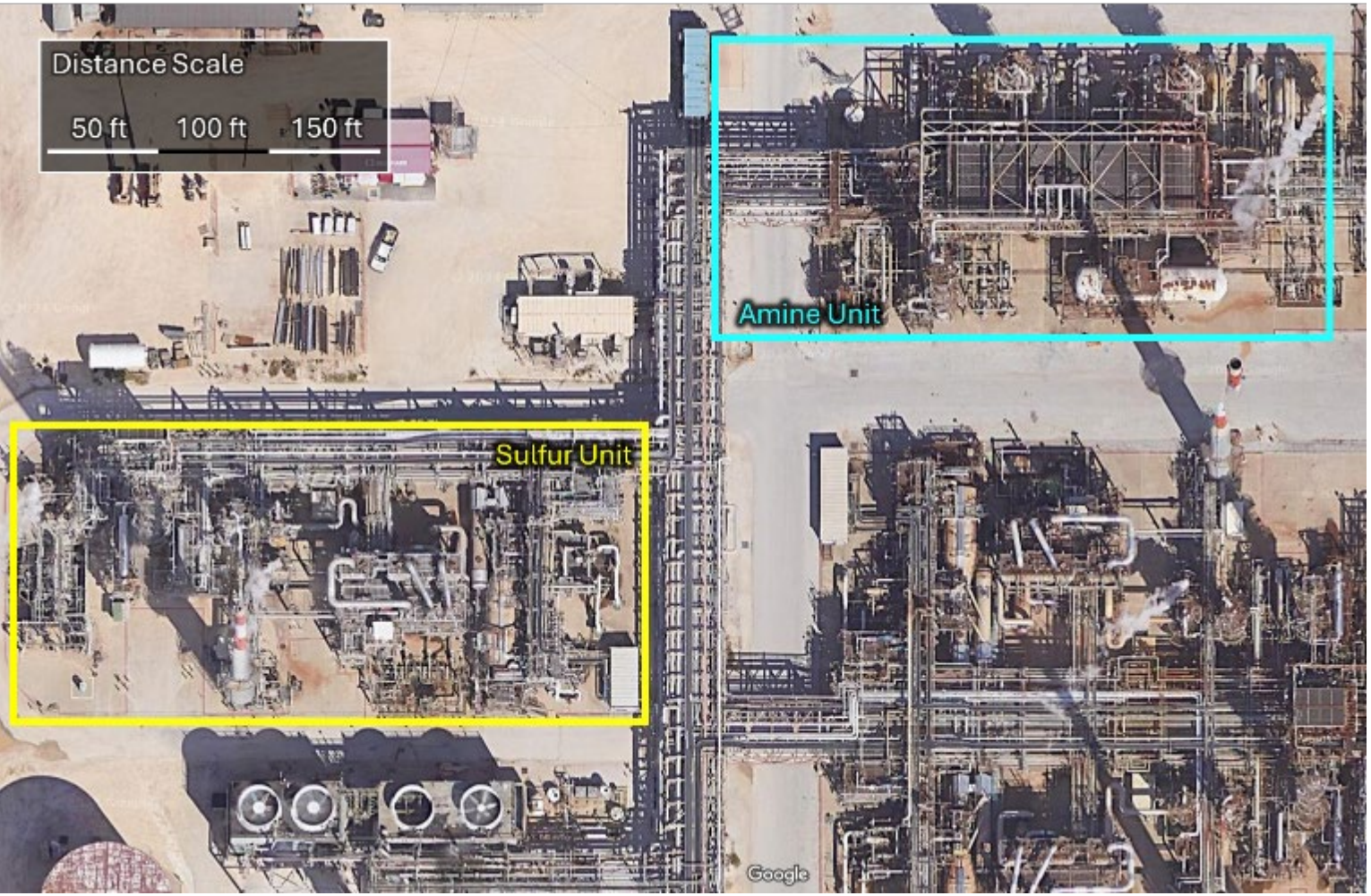
For more information, visit www.csb.gov

Incident Summary

Sulfur Unit Turnaround

- Prior to the incident, PEMEX Deer Park tasked Repcon with supporting a turnaround in the Sulfur Unit. PEMEX Deer Park shut down the unit on October 3rd, 2024.
- By October 6th, all equipment in the Sulfur Unit was shut down, empty, and isolated. From October 6-10, Repcon workers isolating piping hung blind tags on flanges and secured piping with flange locking devices.

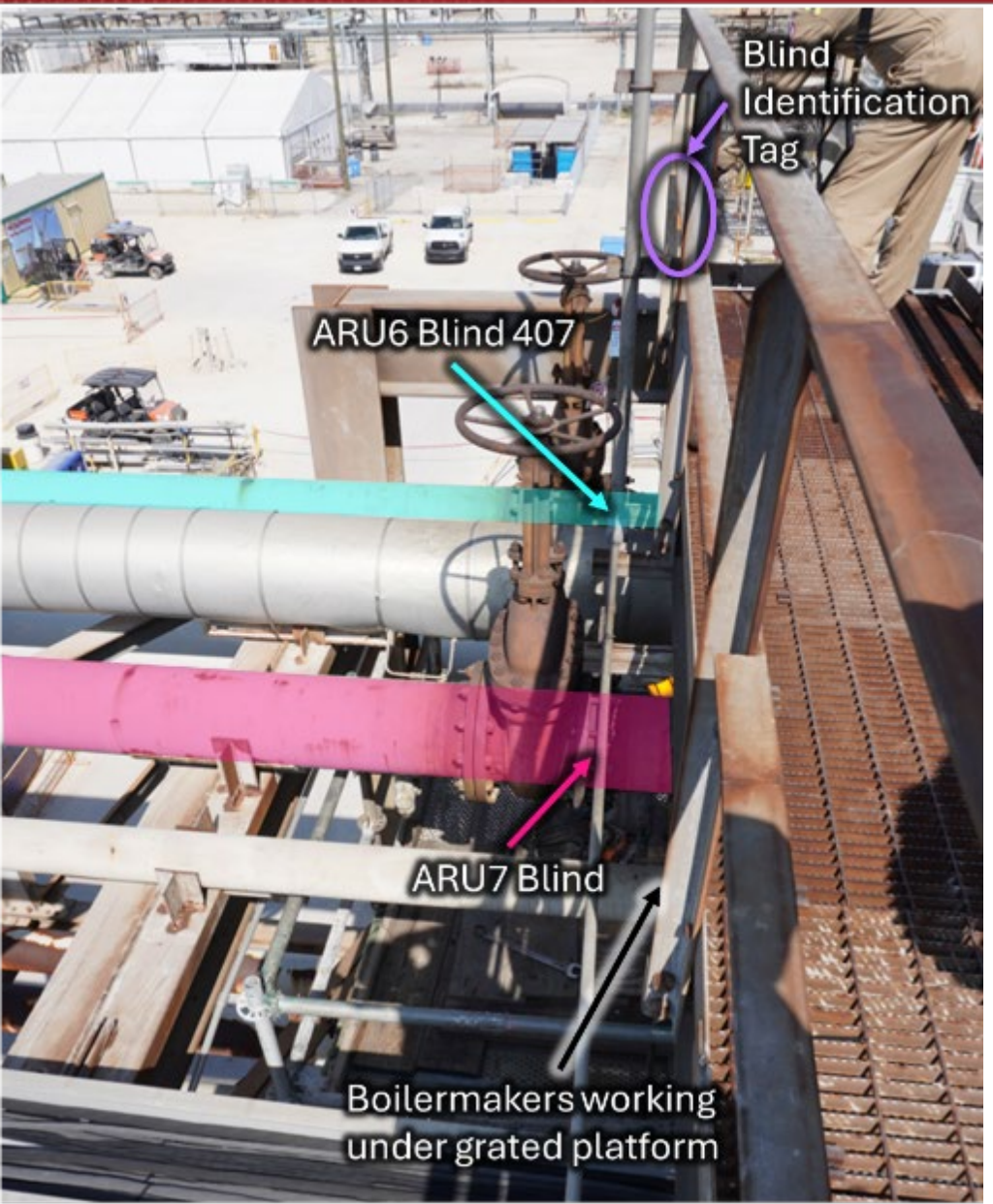
Incident Summary



Amine Unit Maintenance

- On October 8th, PEMEX Deer Park prepared the Amine Unit for maintenance.
- Unlike the Sulfur Unit, the Amine Unit was partially operational.
- To prepare for maintenance, PEMEX Deer Park operators hung blind tags on piping like they would do in the Sulfur Unit.
- On Blind 407, the operator hung the tag on the platform railing above the piping.
- That night, Repcon workers installed 15 blinds in the Amine Unit piping and placed flange-locking devices on each flange.
- PEMEX Deer Park did not require flange-locking devices for the Amine Unit task and the PEMEX Deer Park operator was unaware the workers placed the devices.
- On October 9th, Amine Unit maintenance was complete.

Incident Summary



Amine Unit Blind Removal

- On October 10th, PEMEX Deer Park issued a work permit to Repcon to remove the 15 blinds in the Amine Unit. Two of the blinds were located on piping containing acid gas.
- The operator gave the Repcon foreman a drawing and a list of the 15 blinds and completed a process walkthrough. They did not visit the last two blind locations on the acid gas lines.
- The Repcon foreman gathered four boilermakers, who had all been working in the shutdown and empty Sulfur Unit for the previous 10 days.
- The boilermakers split into pairs and removed the first 13 blinds from the Amine Unit. They determined blind locations by looking for blind tags or flange-locking devices since they were used to seeing them in the Sulfur Unit.

Incident Summary

Acid Gas Blind Removal

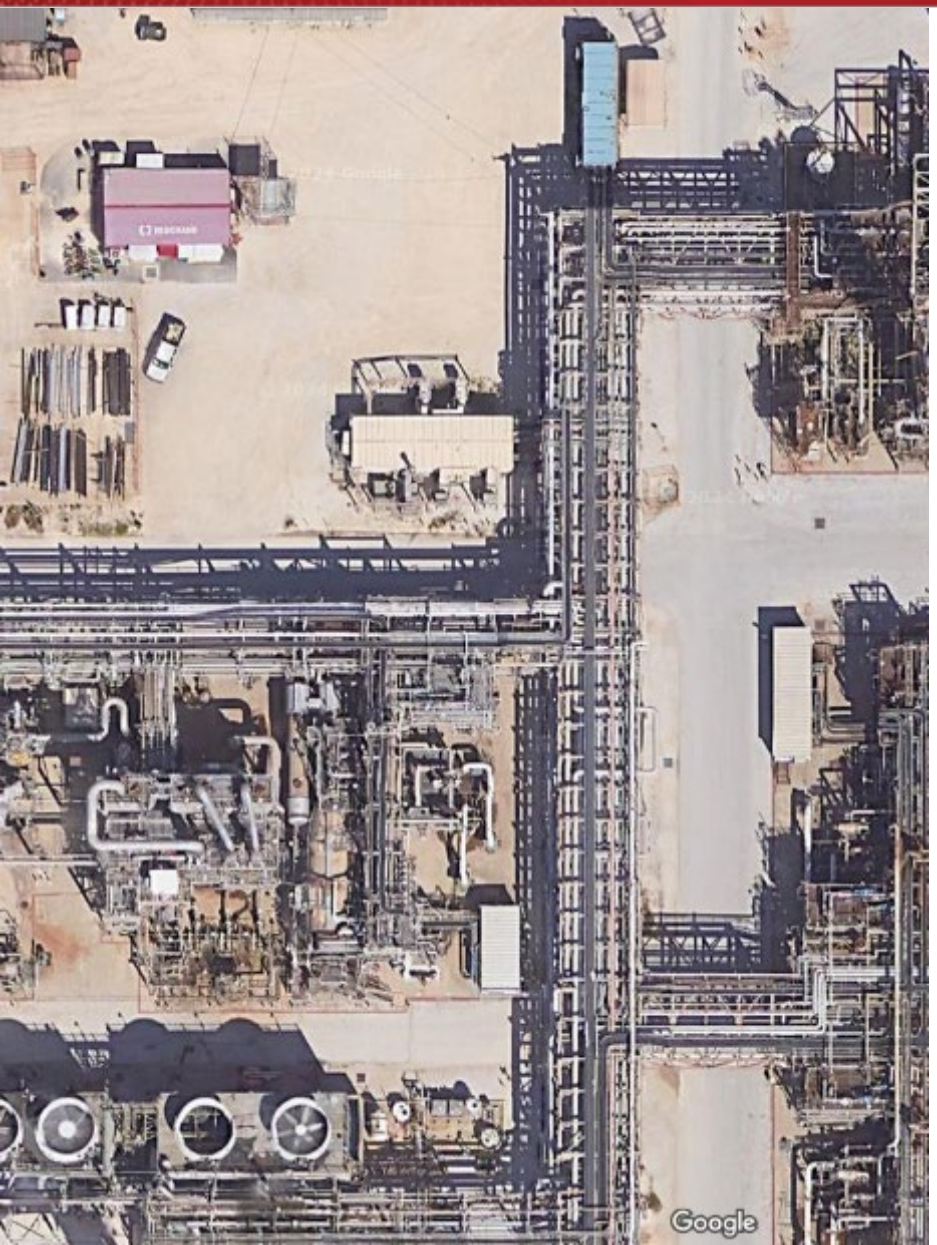
- Boilermakers put on supplied air respirators with escape bottles and climbed to the platform to work on Blind 407.
- Boilermakers saw two identical piping segments located 5 feet apart—one contained acid gas on ARU7
- They did not see a blind tag, but did see a flange-locking device on ARU7, so they falsely believed it was the location of Blind 407.
- The Blind 407 tag was on the railing above the platform, and they did not see it

Incident Summary

Hydrogen Sulfide Release and First Fatality

- Believing that they were working on Blind 407, the boilermakers removed bolts from the ARU7 flange.
- At 4:23 p.m., the flange opened and released toxic hydrogen sulfide.
- One boilermaker disconnected his air hose, but inhaled hydrogen sulfide and collapsed several feet away. Emergency responders later found him fatally injured from hydrogen sulfide poisoning.
- The fatally injured boilermaker was found with this respirator mask removed, lying next to him. The escape bottle was found with the strap wrapped around one leg, but not secured to his torso.
- The respirator regulator was found set to continuous flow.
- The escape bottle was empty at the conclusion of the incident.
- The other boilermaker safely escaped the release.

Incident Summary



Downwind Impact and Second Fatality

- The wind carried the hydrogen sulfide into the nearby Sulfur Recovery Unit, where portable alarms activated. The Amine Unit alarms activated 4 minutes after the release began.
- Two contract workers 250 feet downwind were in the path of the hydrogen sulfide release. One worker was fatally injured from the release, and the other was able to evacuate to the primary assembly point.
- Other contractors heard alarms and evacuated to the primary assembly point, which was located upwind towards the direction of the release.
- 47 contractors from 10 companies were evaluated for hydrogen sulfide poising. An additional 13 contract workers were taken to medical facilities.
- The sitewide alarm sounded 12 minutes after the release began.
- An hour after the release began, emergency responders bolted the flange, stopping the leak.

Safety Issues

- Positive Equipment Identification
- Work Permitting and Hazard Control
- Turnaround Contractor Management
- Conduct of Operations

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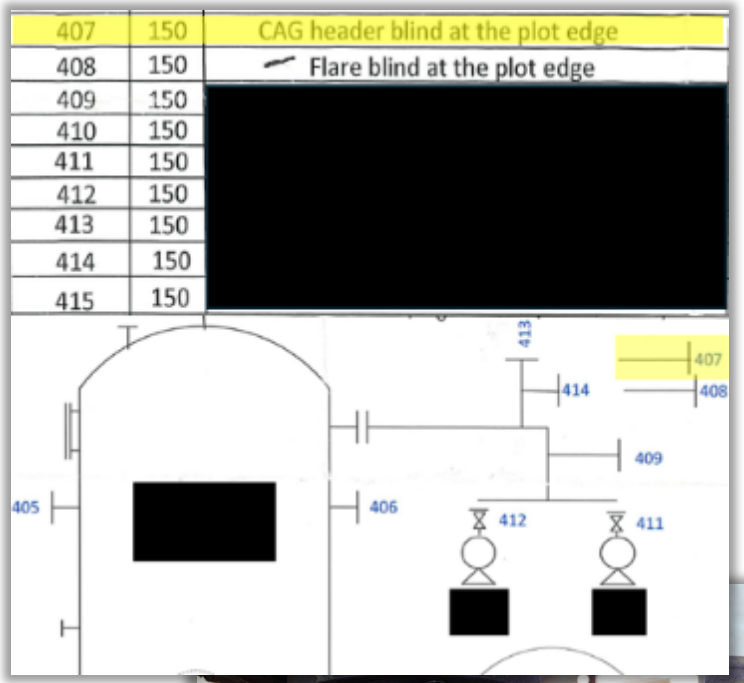
Safety Issues

Positive Equipment Identification

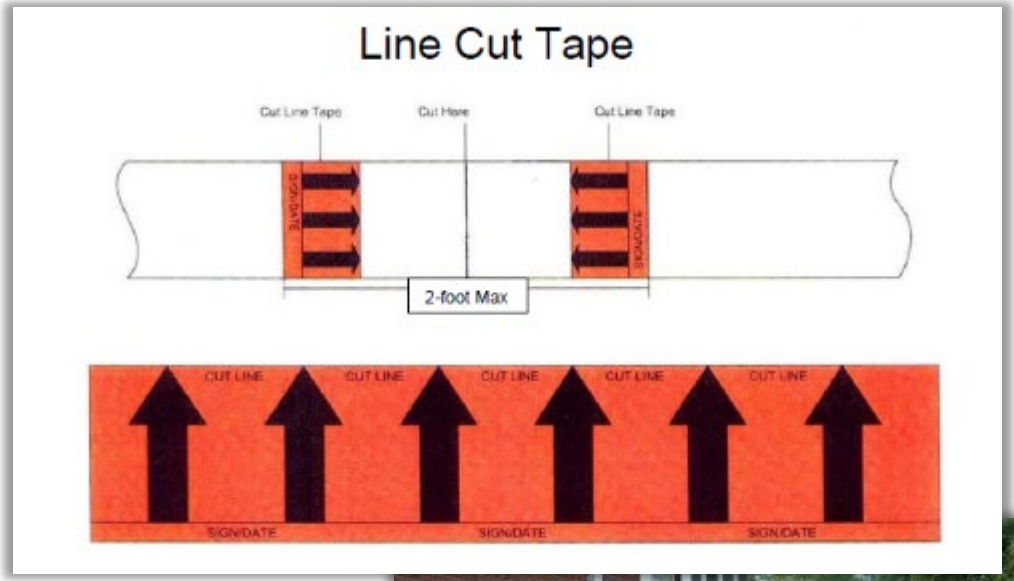
- PEMEX Deer Park did not establish an adequate method to clearly identify equipment to be opened
- PEMEX Deer Park did not require physical markings on equipment
- To aid the contractors, operators hung identification tags on flanges
- The tag for the intended flange was placed out of sight
- Because the Repcon workers did not have a reliable way to identify the intended equipment, they instead looked for unlocked flange-locking devices
- After the incident, PEMEX Deer Park now requires the use of tags with two signatures that are agreed upon by all parties before opening



Safety Issues

Positive Equipment Identification

- Accidental releases resulting from the opening of the wrong equipment are common. The CSB's report evaluates the PEMEX Deer Park incident along with two other similar incidents:
  - PBF Energy, Martinez, California (Feb 2025)
  - Olin, Freeport, Texas (May 2025)
- There are no industry standards for positive equipment identification that apply specifically to chemical processing or refining.
- Other industries, including healthcare and utilities, have established standards and best practices for marking, which have been shown to reduce the number of incidents.
- An industry standard applying to chemical processing and refining could reduce future incidents resulting from opening the wrong equipment.



Safety Issues

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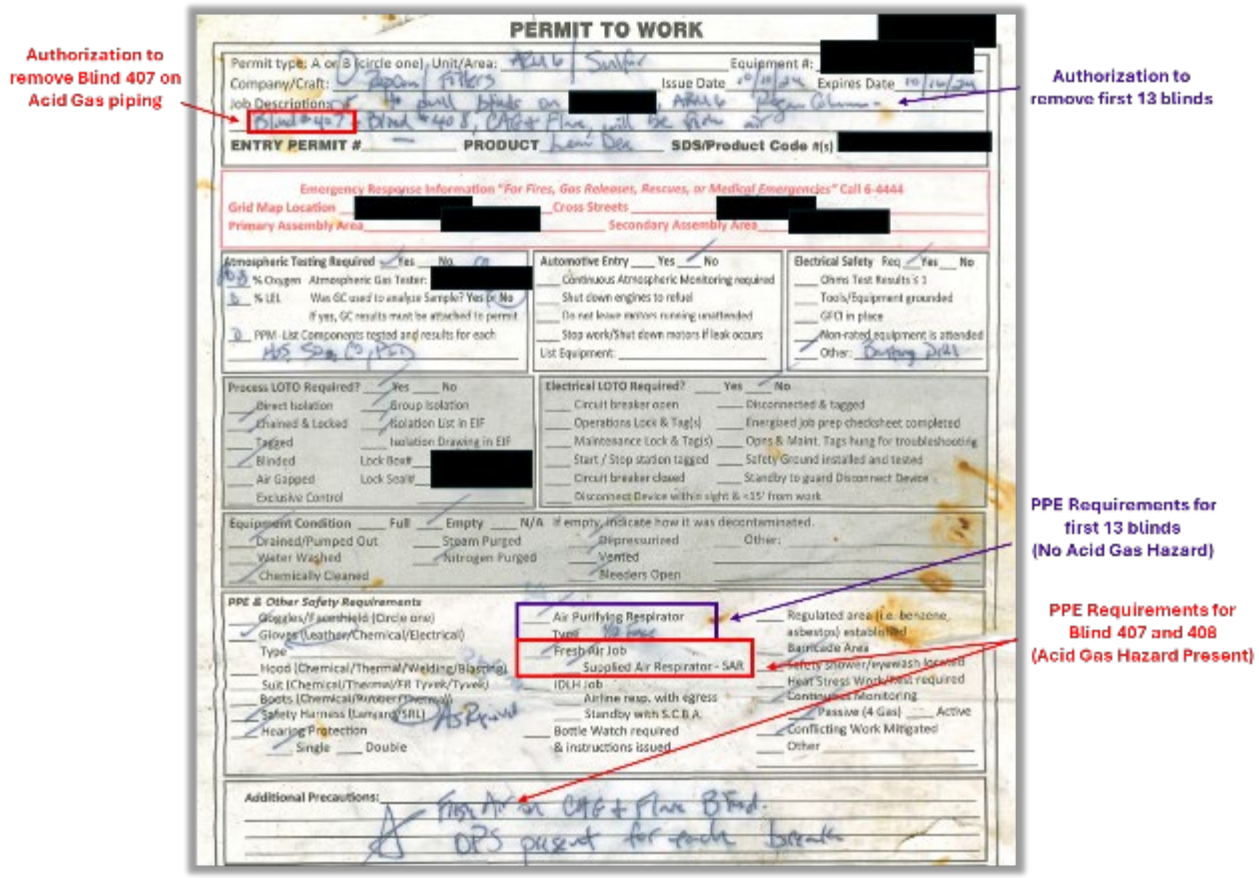
Work Permitting and Hazard Control

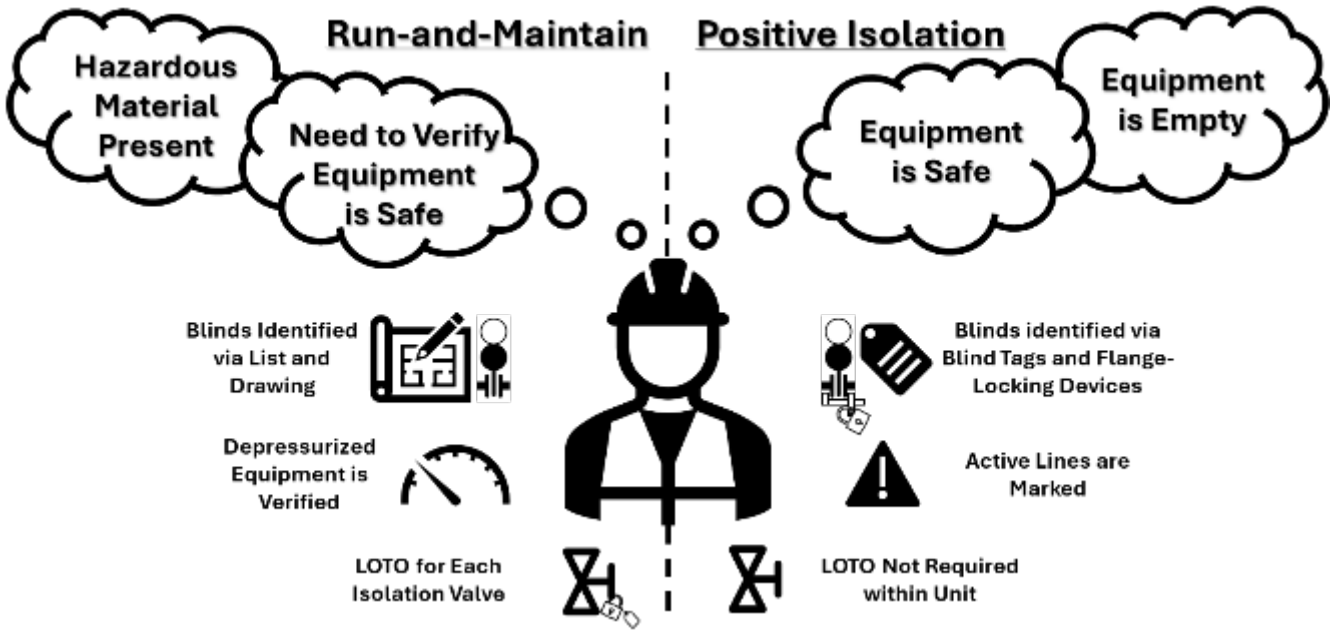
- PEMEX Deer Park issued Repcon a broad-scope work permit that covered different jobs and unclear hold points.
- Repcon workers overlooked written instructions, believing that they were authorized to remove all the blinds in the unit.
- The work permit process did not evaluate or control hazards of pipe opening activities directly upwind of the turnaround workers.



Safety Issues

Turnaround Contractor Management

- Repcon workers were reassigned from a shutdown, isolated, and emptied unit undergoing turnaround to the partially operational unit where the incident occurred.
- Due to the abrupt shift in the work environment and the proximity of the two units, the workers were neither aware that they were working in a different unit nor that the unit was operational and contained hazardous hydrogen sulfide
- PEMEX Deer Park had trained the Repcon workers on the precautions for working in the shutdown turnaround unit but neither PEMEX Deer Park nor Rpecon informed them of the hazards associated with working in the operational unit before assigning them the flange opening task. As a result, the Repcon workers overlooked the usual precautions associated with working around live equipment.



Safety Issues

U.S. Chemical Safety and Hazard Investigation Board

Conduct of Operations

- Numerous instances where PEMEX Deer Park policies and procedures were not aligned with actual practices.
- Written documentation was consistent with industry guidance and accepted best practices; however, both management and operations personnel often misunderstood or were unaware of the expectations and frequently deviated from required practices.
- PEMEX Deer Park deviated from documented work permitting requirements, emergency procedures, hazard evaluation, and management of change processes, which all contributed to the incident.

Standard of Behavior	Organizational Performance
Procedures specified that a drawing and a written blind list were to be used to locate blinds during Run-and-Maintain, and blind tags and a Circle-X marking are used for identification during turnaround.	A sketch, a blind list, blind tags, and Circle-X markings were all present but inconsistently used in the Amine Unit.
Procedures state that piping must be distinctly labeled per ANSI/ASME A13.1 *Scheme for the Identification of Piping Systems*.	PEMEX Deer Park did not label identical Amine Unit piping segments located 5 feet apart.
Permitting procedures require separate work permits for jobs with different hazards.	All ARU6 blinds were included on a single permit, even though the acid gas blinds posed a higher risk.
The work permit included notes to hold the job until an operator could be present.	Noted permit hold points were ambiguous, and the permit receiver and craftworkers misinterpreted the requirement.
Permitting procedures require permit authorizers to evaluate and control hazards to neighboring units.	Impacts to surrounding processes were not controlled as part of the permitting process, and permit issuers were unaware of how to conduct a review of conflicting processes.
PEMEX Deer Park operators will communicate with a contractor representative, who will then communicate all requirements directly with craftworkers.	Boilermakers were unaware that their work in the Amine Unit was not a part of the Sulfur Unit turnaround and were unaware of the differing hazards and requirements.

Recommendations

- PEMEX Deer Park
- American Society of Mechanical Engineers (ASME)

U.S. Chemical Safety and Hazard Investigation Board

Recommendations – PEMEX Deer Park

U.S. Chemical Safety and Hazard Investigation Board

2024-05-I-TX-R1

Label all piping in ARU6 and ARU7 in accordance with ANSI/ASME A13.1 *Scheme for the Identification of Piping Systems*.

2024-05-I-TX-R2

Develop procedures to ensure that any craftworkers introduced to or removed from a unit in Positive Isolation Status receive training that clearly defines the hazards, safeguards, and requirements of the unit associated with the work. The procedures should require each craftworker to receive and understand the training before commencing work in a new area.

2024-05-I-TX-R3

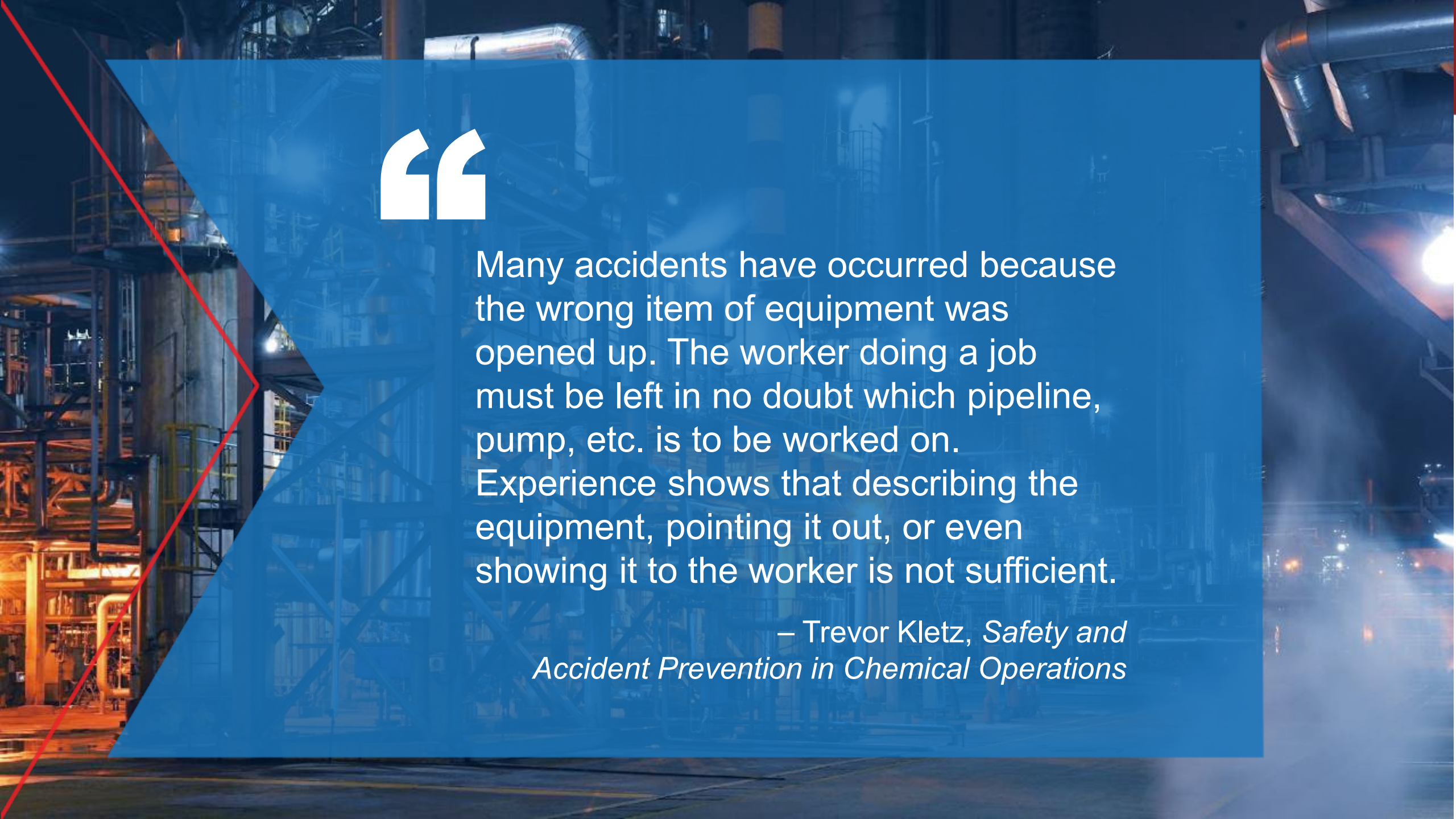
Establish a conduct of operations system that establishes and enforces behavioral and performance metrics in accordance with CCPS *Conduct of Operations and Operational Discipline.*

Recommendations – ASME

U.S. Chemical Safety and Hazard Investigation Board

2024-05-I-TX-R4

Develop written guidelines for marking equipment for opening. The guidelines should define a standard practice for equipment marking which includes clear identifiers of the area to be opened and means to remove the markings at the conclusion of the work.



Many accidents have occurred because the wrong item of equipment was opened up. The worker doing a job must be left in no doubt which pipeline, pump, etc. is to be worked on. Experience shows that describing the equipment, pointing it out, or even showing it to the worker is not sufficient.

– Trevor Kletz, *Safety and Accident Prevention in Chemical Operations*

Explosions and Fires at Dow Louisiana Operations

Public Meeting Q2FY2026

March 19, 2026

U.S. Chemical Safety and Hazard Investigation Board

Dow Plaquemine

- On July 14, 2023, at approximately 9:15 p.m., a series of explosions and fires occurred at Dow's Louisiana Operations' Glycol II plant in Plaquemine, Louisiana.
- The explosions and fires caused significant damage to nearby process equipment in the Glycol II plant and resulted in the release of over 31,000 pounds of toxic ethylene oxide. Local authorities also issued a shelter-in-place order, affecting hundreds of nearby residents.
- The CSB published the final investigation report in February 2026.

For more information, visit www.csb.gov

Dow Plaquemine

- The CSB determined that the cause of the incident was the puncture of a rupture disc by metal debris that allowed the introduction of ethylene oxide into piping that contained air. The ethylene oxide ignited, and the ethylene oxide and combustion products propagated through pressure relief piping to a reflux drum that was filled with ethylene oxide. The ethylene oxide in the vapor space of the reflux drum heated and decomposed, causing the reflux drum to fail catastrophically due to increased pressure from the decomposition reaction.

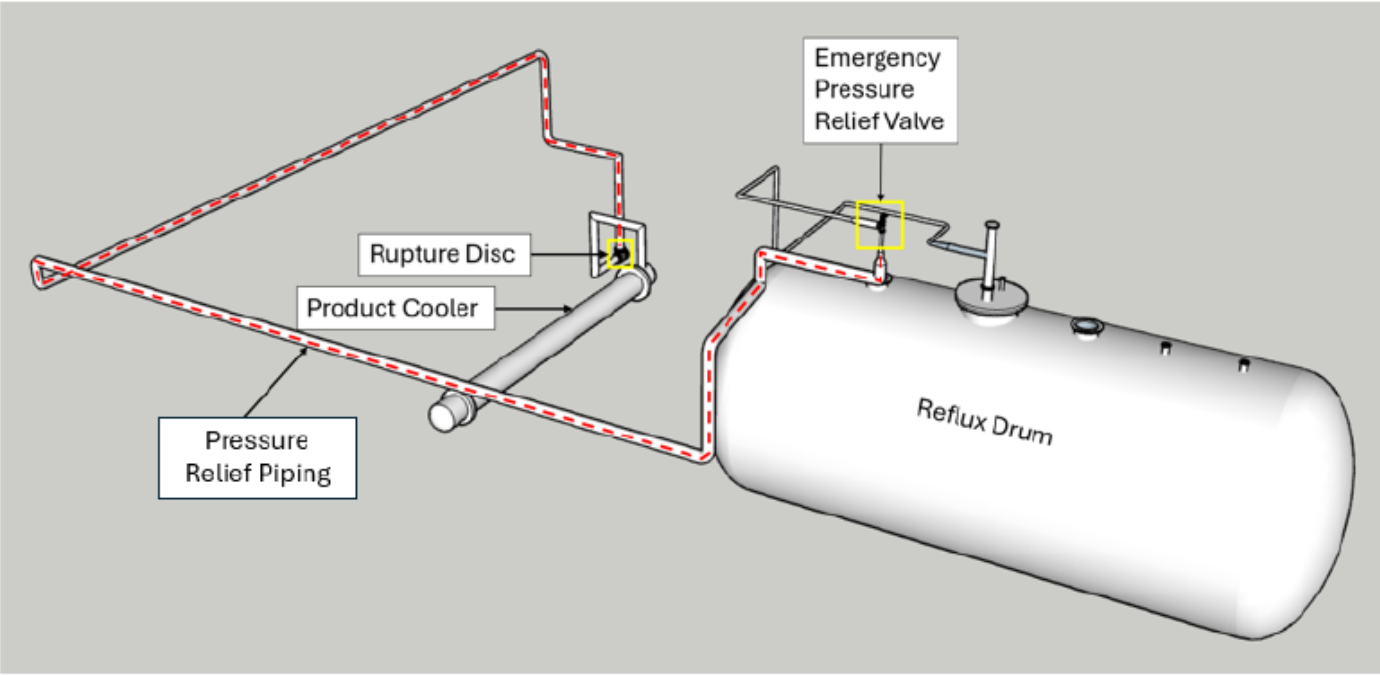
- Contributing to the incident was Dow's inadequate vessel closure procedures and practices, which allowed the vessel to be restarted without ensuring that it was adequately cleaned.

- Also contributing to the incident was Dow's failure to maintain an inert atmosphere in the pressure relief piping

- Contributing to the severity of the incident was the design of Dow's product cooler's emergency pressure-relief system, which discharged its pressure-relief effluent back into the reflux drum. .

For more information, visit www.csb.gov

Incident Summary



November 2020 Maintenance Activities

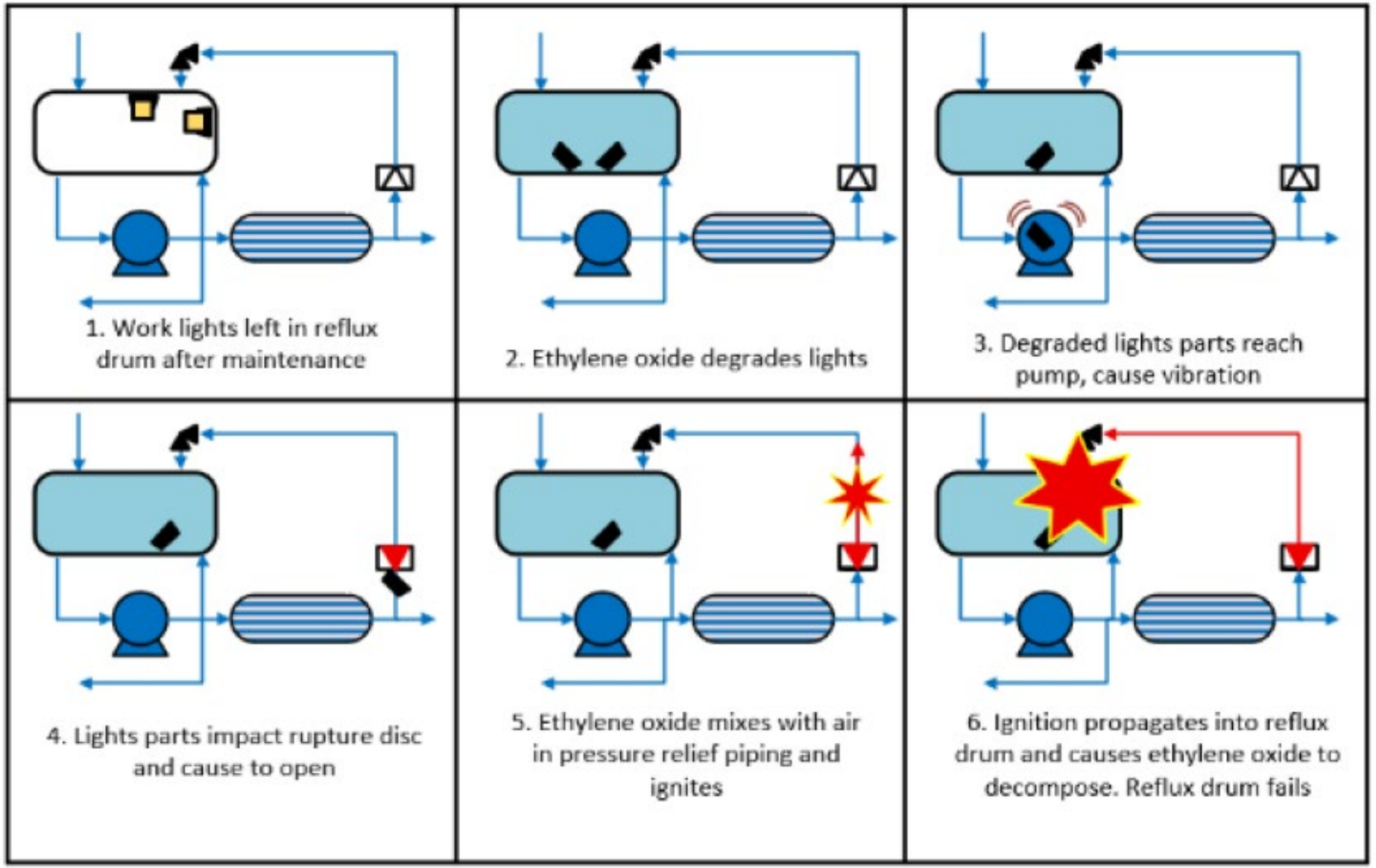
- On November 20, 2020, the rupture disc protecting the product cooler was replaced as part of regular maintenance and inspection activities. Upon completing the installation of the rupture disc, Dow workers pressurized the pressure relief piping between the rupture disc and PRV with nitrogen, which was used as an inerting gas in the Glycol II unit to prevent ethylene oxide decomposition and reaction.
- Over the next two months, the nitrogen pressure in the rupture disc discharge piping gradually decreased and the piping filled with air. No additional nitrogen was added to the pressure relief piping between the November 2020 maintenance activities and the incident.

Incident Summary

2023 Turnaround Activities

- In May 2023, the Glycol II unit underwent a turnaround. One of the turnaround activities included cleaning out and performing an internal inspection of the reflux drum.
- The work order for this activity included tasks to “install low voltage lights” prior to the work beginning and “remove internal low voltage lights” after the work was completed inside of the reflux drum.
- After the work was completed, the reflux drum was closed for restart.
- Unbeknownst to the workers, some of the portable work lights from the turnaround work were left behind in the reflux drum.
- After the turnaround work was complete, the ethylene oxide unit was started up and began operating without issues. During this time, the reflux drum filled with ethylene oxide, and the reactive chemical began to degrade the work lights.

Incident Summary



Incident Summary

Consequences

- Dow reported that approximately 31,525 pounds of ethylene oxide were released during the incident, which included the ethylene oxide de-inventorying from process equipment that followed the fire.
- Dow also reported that its property damages were estimated to be $43 million. No injuries were reported as a result of the incident.
- After the explosion, the Iberville Parish Council Office of Emergency Preparedness issued a shelter-in-place order for residents living within a half-mile of the Dow site. The shelter-in-place order was lifted at approximately 3:40 a.m. the following day.

Safety Issues

- Vessel Closures Practices
- Inerting System Control
- Pressure Relief System Design

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Safety Issues

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Vessel Closure Practices

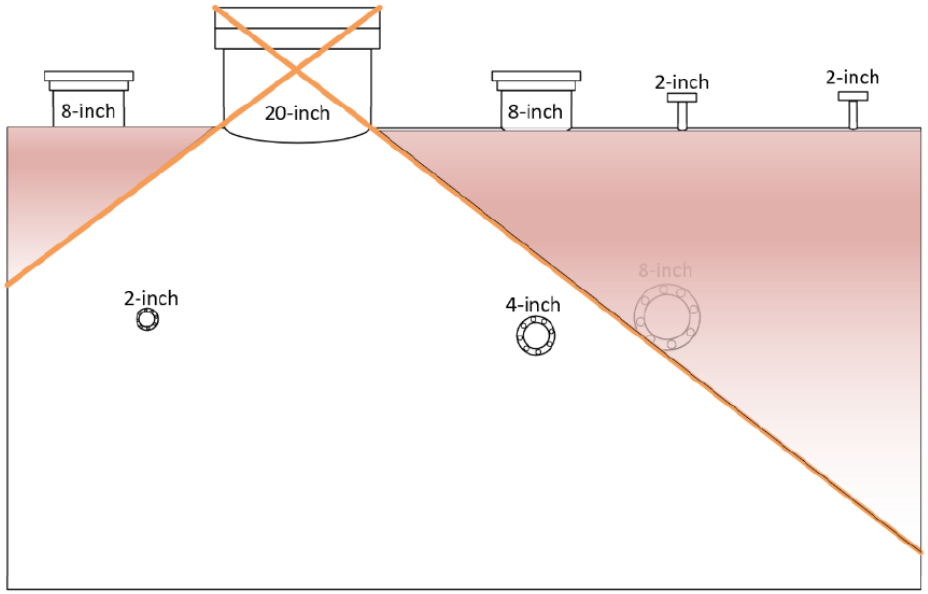
- Portable work lights were left in the reflux drum after the May 2023 turnaround work in the drum had concluded. Debris consistent with the work lights was found in the reflux drum, the downstream pumps, the product cooler, and the rupture disc after the incident.
- At the time of the incident, Dow's vessel closure process had no official procedure in place related to tracking equipment placed inside a vessel during maintenance and inspection activities requiring confined space entries.
- Dow's vessel closure process and practices did not adequately identify whether the reflux drum was clean and empty after maintenance was completed.

Safety Issues

Vessel Closure Practices

- Dow's vessel closure procedure did not give adequate guidance related to ensuring the cleanliness of the equipment. For example, the document did not tell the operator what steps to follow or what it means for a vessel to be "clean" after maintenance.

- As part of the vessel closure process, the permit writer would be "looking for anything visible to the eye that could be in the drum." The permit writer would use a flashlight to inspect the inside of the vessel without actually entering the vessel. If the permit writer did not see anything in the vessel, the permit writer would order the vessel to be bolted and closed. However, not only did the operators not actually enter the vessel, they also did not use inspection mirrors or other means, such as a boroscope, to check the inside of the vessel.



Safety Issues

Vessel Closure Practices

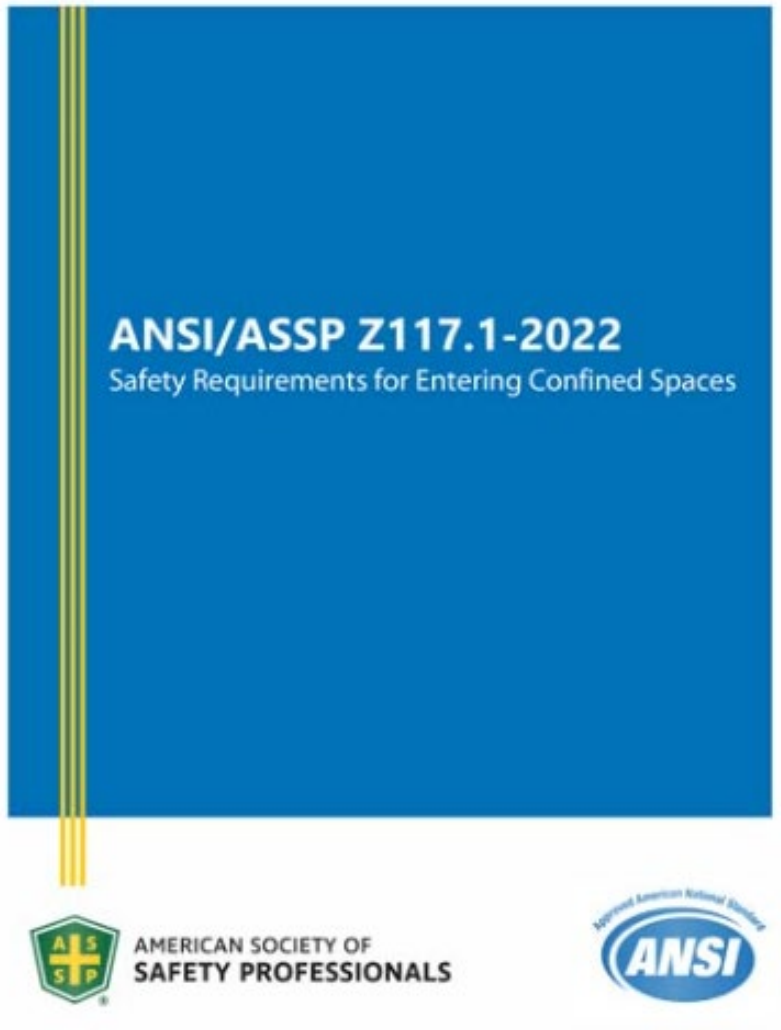
- The NFPA has two documents which discuss safety considerations for confined space work. NFPA 326 and NFPA 350 provide guidance for conducting confined space entry and work, specifically on how to identify, evaluate, assess, and mitigate hazards present during confined space work.

- NFPA 326 and 350 have extensive guidance on evaluating confined spaces prior to entry and during work, they provide no guidance on ensuring that a confined space has been cleaned appropriately after work has been completed.

Safety Issues

Vessel Closure Practices

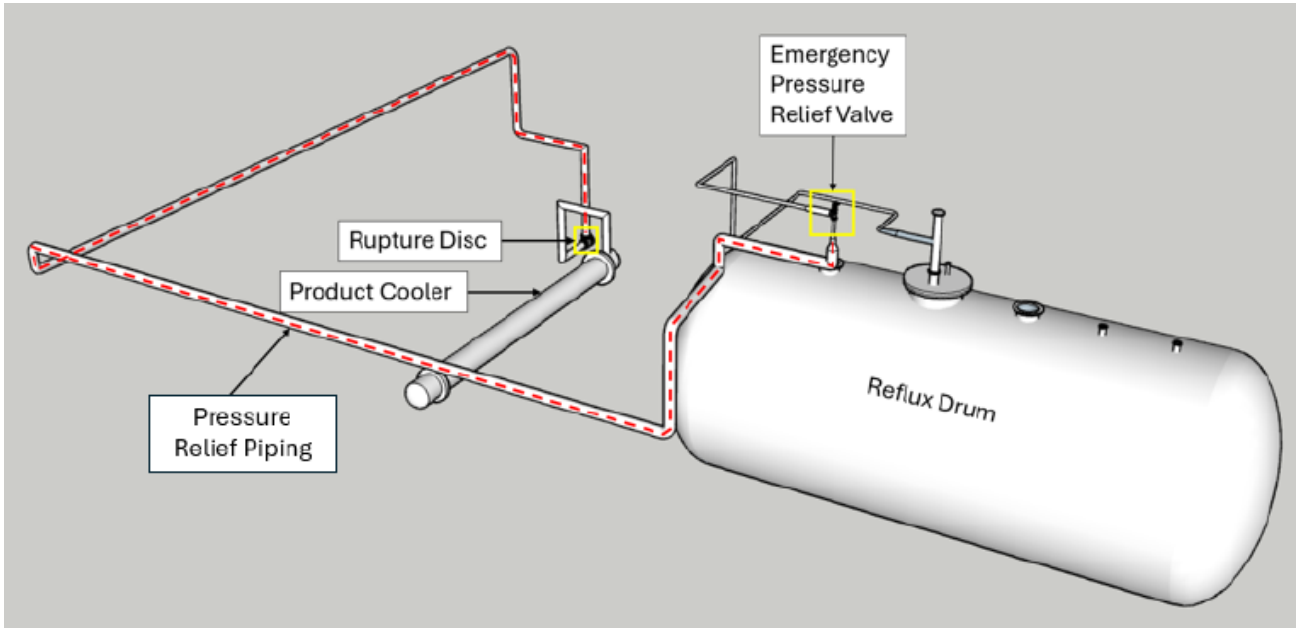
- The American Society of Safety Professionals (ASSP) and the Approved American National Standard (ANSI) organization also have guidance for working in confined spaces titled ANSI/ASSP Z117.1 Safety Requirements for Entering Confined Spaces. This document is intended to provide “minimum safety requirements to be followed while entering, exiting, and working in confined spaces”.
- ANSI/ASSP Z117.1 has similar requirements to NFPA 350 and provides guidance on multiple aspects of confined space work. Like NFPA 350, however, the standard provides no guidance on how to ensure that a confined space is clean after work has been completed.



Safety Issues

Inerting System Control

- Ethylene oxide liquid discharged into the vapor space of properly inerted equipment or piping will not carry sufficient energy to ignite the vapor in the absence of oxygen.
- At Dow's facility, nitrogen is one of the primary safeguards to ensure ethylene oxide equipment that contained a vapor phase would not react or combust in the vapor space.
- Prior to the incident, nitrogen would be manually charged into the pressure relief piping whenever the system was opened for maintenance or inspection, and no procedure required regular charging of nitrogen.
- There is no evidence that an operator or management official checked the pressure in the system in the two-plus years between rupture disc work in 2020 and the incident in 2023, or that any management system prompted them to do so.



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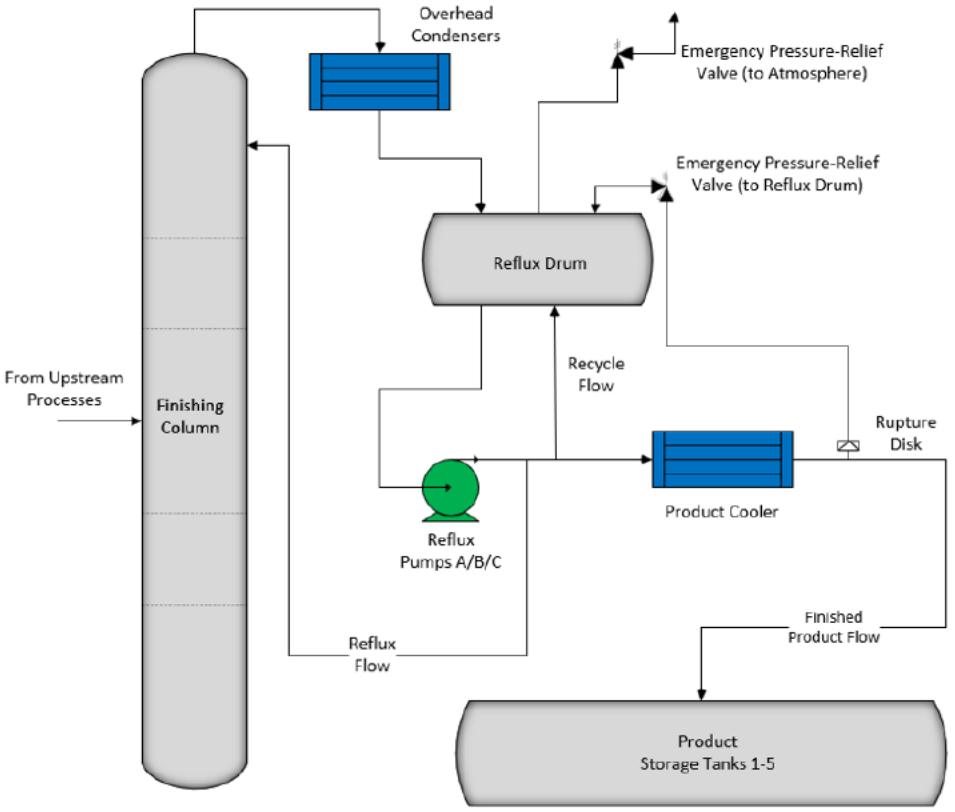
Pressure Relief System Design

- After the ethylene oxide ignited within the pressure relief piping, the flame front built pressure as it propagated toward the PRV and the reflux drum.
- When this flame front reached the reflux drum, it heated and ignited the large quantity of ethylene oxide present in the drum, which decomposed and significantly increased the severity of the incident when the reflux drum exploded.
- The product cooler was replaced in 2011. The pressure relief system between the product cooler and the reflux drum was put in place when the new product cooler system was installed. The new system changed the product cooler to eliminate certain overpressure scenarios but did not eliminate the need for the pressure relief piping completely.
- After the incident, the pressure relief piping from the product cooler into the reflux drum was eliminated completely



Recommendations

- The Dow Chemical Company
- National Fire Protection Agency (NFPA)
- American Society of Safety Professionals (ASSP)

U.S. Chemical Safety and Hazard Investigation Board

Recommendations – The Dow Chemical Company

U.S. Chemical Safety and Hazard Investigation Board

2023-03-I-LA-R1

At all Dow ethylene oxide facilities, identify all process lines in ethylene oxide service that should be or are inerted and currently are not continuously monitored during normal operation. For all lines identified, determine whether the line can be eliminated, and if not, establish proper controls such as inerting and monitoring to ensure the process line is adequately inerted.

Recommendations – National Fire Protection Agency

U.S. Chemical Safety and Hazard Investigation Board

2023-03-I-LA-R2

Update NFPA 350 Guide for Safe Confined Space Entry and Work to provide guidance on how to ensure that vessels that have undergone confined space entry are left clean and ready for startup after the entries are completed.

2023-03-I-LA-R3

Update NFPA 326 Standard for the Safeguarding of Tanks and Containers for Entry, Cleaning, or Repair to provide requirements for to ensure that vessels that have undergone confined space entry are left clean and ready for startup after the entries are completed.

Recommendations – American Society of Safety Professionals

U.S. Chemical Safety and Hazard Investigation Board

2023-03-I-LA-R4

Update ANSI/ASSP Z117.1 Safety Requirements for Entering Confined Spaces to provide guidance on how to ensure that vessels that have undergone confined space entry are left clean and ready for startup after the entries are completed.

Office of Recommendations

Charles B. Barbee, Director of Recommendations

Amanda Johnson, Recommendations Specialist

Adam Henson, Recommendations Specialist

U.S. Chemical Safety and Hazard Investigation Board

Office of Recommendations

U.S. Chemical Safety and Hazard Investigation Board

- Highlighted Recommendations
- Safety Spotlight

Highlighted Recommendations

U.S. Chemical Safety and Hazard Investigation Board

Loy Lange Box Company Pressure Vessel Explosion

- April 3, 2017
- Steam Explosion
- 3 Members of the Public Fatally Injured
- 1 Worker Fatally Injured
- Extensive Property Damage

CSB Recommendation R4 to City of St. Louis Board of Aldermen:

Require inspections of boilers and pressure vessels in accordance with good practice.

CSB Recommendation R5 to City of St. Louis Board of Aldermen:

Require inspections of pressure vessels be conducted by commissioned inspectors.

Highlighted Recommendations

U.S. Chemical Safety and Hazard Investigation Board

Loy Lange Box Company Pressure Vessel Explosion

STL BOA Implementation of R4 & R5:

- Preliminary Meetings
- Board Bill Number 69
- Ordinance 72037

Closed – Acceptable Action

Highlighted Recommendations

U.S. Chemical Safety and Hazard Investigation Board

- Valero McKee R4
  - Closed - Acceptable Action
- LyondellBasell R5
  - Closed – Acceptable Alternative Action
- Chevron R29
  - Closed – Acceptable Alternative Action
- Husky R14
  - Open – Acceptable Response or Alternate Response
- Remote Isolation R1
  - Open – Acceptable Response or Alternate Response

Safety Spotlight

U.S. Chemical Safety and Hazard Investigation Board

American Fuel and Petrochemical Manufacturers

CSB Safety Spotlight:
AN ILLUSTRATION OF CHEMICAL SAFETY EXCELLENCE — American Fuel and Petrochemical Manufacturers Voluntarily Implements a Safety Recommendation Not Issued to Them

U.S. Chemical Safety and Hazard Investigation Board

The U.S. Chemical Safety and Hazard Investigation Board (CSB) is spotlighting the positive actions of entities that have implemented a CSB safety recommendation issued to a different recommendation recipient. The primary focus of this Safety Spotlight is on the American Fuel and Petrochemical Manufacturers (AFPM) for the organization's action in response to a recommendation addressing fluid catalytic cracking (FCC) units made by the CSB to a different party as a result of the agency's investigation of the explosion and fire at the Husky Energy refinery in 2018.

View of the Husky Energy Superior refinery following the April 26, 2018 explosions and fire.

Husky Energy Superior Refinery Explosion and Fire (2018)[1]

CONSEQUENCES: 36 workers injured, facility destroyed, $550 million onsite damage, $110,000 offsite property damage, and evacuation and shelter-in-place orders for nearby communities.

On April 26, 2018, an explosion and fire occurred at the Husky Energy refinery in Superior, Wisconsin (Husky Superior). This incident occurred during a unit shut down in preparation for maintenance. While the FCC Unit was being shut down, a flammable mixture of oxygen and hydrocarbon formed inside the primary and sponge absorber, resulting in the explosion. The CSB investigated this incident and concluded, among other things, that Husky Superior relied upon unverifiable and degraded safeguards to prevent the mixture of air and hydrocarbons within their FCC unit's process equipment. The investigation resulted in 16 recommendations intended to prevent a similar incident.

The recommendation pertinent to this Safety Spotlight is CSB Recommendation No. 2018-02-I-WI-R13, which was issued to the American Petroleum Institute (API) but was voluntarily implemented by AFPM on its own initiative. The text of the recommendation is below:

Using API's processes to determine the appropriate safety product, develop a publicly available technical publication for the safe operation of fluid catalytic cracking (FCC) units. The document should be applicable to both new and existing units. Include the following topics at a minimum:

a) Description of typical FCC unit hazards, including air leaks into hydrocarbon systems or hydrocarbon leaks into air systems that could form a flammable mixture during transient operation (startup, shutdown, stand-by, and the actions required to transition between these modes). If needed, include differences between possible reactor/regenerator configurations;

b) Recommended practices for safeguards to control FCC unit hazards;

1 https://www.csb.gov/husky-energy-superior-refinery-explosion-and-fire

Page 1

FCC Process Safety Regional Workshops:

- 18 Workshops
- Over 700 Attendees
- 76 of 93 Refineries in the U.S. and Canada with FCC Units Represented

- **www.afpm.org/issues/safety-health/fcc-process-safety**

Video

Didion Mining

U.S. Chemical Safety and Hazard Investigation Board

Public Comments

Steve Hamrick & Hillary Cohen
Moderating

Public@csb.gov

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Thank you for attending

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