



U.S. Chemical Safety and
Hazard Investigation Board

Fatal Hydrogen Sulfide Release at PEMEX Deer Park Refinery

Deer Park, Texas | Incident Date: October 10, 2024 | No. 2024-05-I-TX

Investigation Report

Published: February 2026



SAFETY ISSUES:

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





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The October 10, 2024, fatal hydrogen sulfide release at the
PEMEX Deer Park Refinery fatally injured two people:

Jason Scott

Jose Perez, Jr.

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ABBREVIATIONS

ANSI	American National Standards Institute
ARU	Amine Regeneration Unit
ASME	American Society of Mechanical Engineers
CCPS	Center for Chemical Process Safety
CFR	Code of Federal Regulations
CSB	U.S. Chemical Safety and Hazard Investigation Board
EPA	Environmental Protection Agency
FCC	Federal Communications Commission
IDLH	Immediately Dangerous to Life or Health
ISC	ISC Constructors, LLC
LOTO	Lock-out/Tag-out
OSHA	Occupational Safety and Health Administration
P&ID	Piping and Instrumentation Diagram
PEMEX	Petróleos Mexicanos
PEMEX Deer Park	Deer Park Refining, Limited Partnership
ppm	Parts-per-million
PSM	Process Safety Management
RMP	Risk Management Plan
SIMOPs	Simultaneous Operations

EXECUTIVE SUMMARY

On October 10, 2024, at 4:23 p.m., approximately 27,000 pounds of toxic 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 and injured several others.

The release occurred when contract workers from Repcon, Inc. (Repcon) opened piping containing hydrogen sulfide gas. Instead of opening a pipe flange on empty piping, the workers mistakenly opened an identical piping segment 5 feet away, releasing pressurized hydrogen sulfide gas and fatally injuring one of the Repcon workers. The released hydrogen sulfide traveled downwind to the adjacent unit, where a worker from ISC Constructors, who was unaware of the release, inhaled the toxic hydrogen sulfide and also was fatally injured. The release continued for nearly an hour until PEMEX Deer Park emergency responders reassembled the leaking flange, stopping the release. Thirteen additional contract workers were transported to nearby medical facilities to be evaluated for hydrogen sulfide exposure.

In addition to the fatalities and injuries, shelter-in-place orders were issued by officials in the neighboring cities of Deer Park, Texas, and Pasadena, Texas, that remained in effect for several hours due to the release. While the facility was not physically damaged, PEMEX Deer Park reported property damage of \$12.3 million associated with the incident, resulting from the loss of use in the Amine Unit and downstream processes.

SAFETY ISSUES

The CSB's investigation identified the safety issues below.

- **Positive Equipment Identification.** PEMEX Deer Park did not establish an adequate method to clearly identify the equipment that Repcon workers were to open before the work was authorized to begin. PEMEX Deer Park's procedures required operators to prepare a drawing and a list of piping flanges to open, but the piping flanges could not be identified using these documents alone. To aid the contractors, operators hung identification tags to indicate each flange that Repcon was to open. The tag for the intended flange was placed in a location that the Repcon workers did not see: on a platform railing above the intended flange. Due to the lack of a reliable method to identify the intended equipment, the Repcon workers searched for unlocked flange-locking devices, which they commonly observed elsewhere in the refinery.

Accidental releases resulting from opening of the wrong equipment occur regularly in the chemical processing and refining industries. At the time of this report, there are no industry standards for positive equipment identification that apply to chemical processing or refining. Other industries, including health care 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. ([Section 3.1](#))

- **Work Permitting and Hazard Control.** PEMEX Deer Park's work permitting process was broad and did not control the hazards associated with opening piping in an operational unit. On the day of the incident, PEMEX Deer Park issued Repcon a broad-scope work permit that covered different jobs with different hazards and without clear, unambiguous hold points. As a result, the Repcon workers

overlooked a written instruction in the permit to stop work and have a PEMEX Deer Park operator join them before opening hydrogen sulfide piping. Furthermore, the work permit did not evaluate or control the hazards of pipe opening activities directly upwind of a unit where many other contract workers were performing scheduled maintenance activities. ([Section 3.2](#))

- **Turnaround Contractor Management.** On the day of the incident, Repcon workers were reassigned from working on a shutdown, isolated, and emptied unit undergoing scheduled maintenance (called “turnaround”) to working on 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 not aware that they were working in a different unit or that the unit was operational and contained toxic hydrogen sulfide. Although PEMEX Deer Park had provided onboarding information to the Repcon workers about the precautions for working in the shutdown turnaround unit, PEMEX Deer Park did not inform the Repcon workers about the hazards associated with working in the operational unit before assigning them the flange opening task. As a result, the Repcon workers did not follow the usual precautions associated with working around live equipment. ([Section 3.3](#))
- **Conduct of Operations.** The CSB identified numerous instances where PEMEX Deer Park policies and procedures were not aligned with actual practices. These discrepancies were apparent in PEMEX Deer Park’s standards for operators and management personnel. In many cases, PEMEX Deer Park’s written documentation was consistent with industry guidance and accepted best practices. However, both management and operations personnel often misunderstood or were unaware of these expectations and frequently deviated from required practices. As a result, PEMEX Deer Park deviated from documented work permitting and hazard evaluation requirements, which contributed to the incident. ([Section 3.4](#))

CAUSE

The CSB determined that the cause of the incident was the opening of incorrect equipment, which released pressurized hydrogen sulfide. PEMEX Deer Park did not establish an effective method to clearly identify the correct equipment to open before authorizing opening the equipment. Contributing to the severity of the incident was PEMEX Deer Park’s failure to adequately evaluate the hazard posed by opening equipment within an active unit that was adjacent to a unit undergoing a turnaround where many contractors were exposed to the hydrogen sulfide release. Additionally, PEMEX Deer Park deviated from several of their own policies and procedures that could have prevented the incident.

RECOMMENDATIONS

To PEMEX Deer Park^a

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 instructions that define the hazards, safeguards, and requirements of the unit associated with the work. The procedures should require each craftworker to receive clear communication on the identified hazards, control measures, and all other requirements 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's *Conduct of Operations and Operational Discipline*. The system should include:

- a) the management commitment to process safety,
- b) employee input on policies and procedures,
- c) methods to ensure that policies and procedures can be effectively followed, to include, at a minimum:
 - 1) permitting,
 - 2) equipment marking, and
 - 3) energy isolation procedures, and
- d) regular audits to verify adherence to conduct of operations metrics, to include, at a minimum:
 - 1) performance expectations,
 - 2) training,
 - 3) management visibility,
 - 4) leadership by example, and

^a As discussed in Section 3.1.3.1 below, herein, because PEMEX Deer Park made improvements after the incident to ensure that equipment is accurately identified when removing blinds, the CSB is not issuing a recommendation to PEMEX Deer Park related to positive equipment identification.

5) worker knowledge and awareness.

To the American Society of Mechanical Engineers (ASME)

2024-05-I-TX-R4

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

1 BACKGROUND

1.1 PEMEX DEER PARK REFINERY

The PEMEX Deer Park Refinery (**Figure 1**) is a petroleum refinery located in Deer Park, Texas [1]. The refinery was constructed by Shell in 1929. In 1993, Shell formed a joint venture with Deer Park Refining, Limited Partnership (“PEMEX Deer Park”) to share ownership of the refinery [2]. PEMEX Deer Park is an indirect subsidiary of Petróleos Mexicanos (“PEMEX”), a petroleum company headquartered in Mexico City, Mexico, that is wholly owned by the federal government of Mexico [3]. In January 2022, PEMEX acquired the entire refinery, which then became known as the PEMEX Deer Park Refinery [2].



Figure 1. PEMEX Deer Park Refinery [4]. (Credit: PEMEX)

PEMEX owns seven refineries, six in Mexico and the PEMEX Deer Park Refinery in the United States [1, 5]. The PEMEX Deer Park Refinery employs approximately 1,000 personnel and 1,200 contract workers during normal operations [1]. The United Steelworkers (USW) union represents PEMEX Deer Park hourly maintenance and operations employees [1]. On the day of the incident, there were 1,729 contractors and personnel from other companies, as well as 252 PEMEX Deer Park employees onsite.

1.2 HYDROGEN SULFIDE

Hydrogen sulfide is generated from sulfur that naturally exists in crude oil during the refining process [6, p. 833]. Hydrogen sulfide is a colorless, highly toxic gas that can cause damage to the eyes and the respiratory system [7, 8]. Exposure to concentrations as low as 100 parts per million (ppm) is considered immediately

dangerous to life or health (IDLH) [7].^a Concentrations over 1,000 ppm can cause nearly instant death [8]. Hydrogen sulfide is heavier than air and tends to travel near the ground during a release [7].^b

1.3 AMINE REGENERATION UNIT AND SULFUR RECOVERY UNIT

The incident occurred in the PEMEX Deer Park Refinery's Amine Regeneration Unit ("Amine Unit"), which separates hydrogen sulfide from aqueous amine. The resulting vapor, known as acid gas, is a mixture comprising approximately 90 percent hydrogen sulfide and 10 percent carbon dioxide. The acid gas is transferred through process piping to downstream units and the Sulfur Recovery Unit ("Sulfur Unit") to convert the hydrogen sulfide into sulfur, as shown in **Figure 2**. Each refinery unit has a defined perimeter (battery limit) with manual isolation valves at the perimeter capable of isolating the unit from the rest of the refinery process (**Figure 2**).

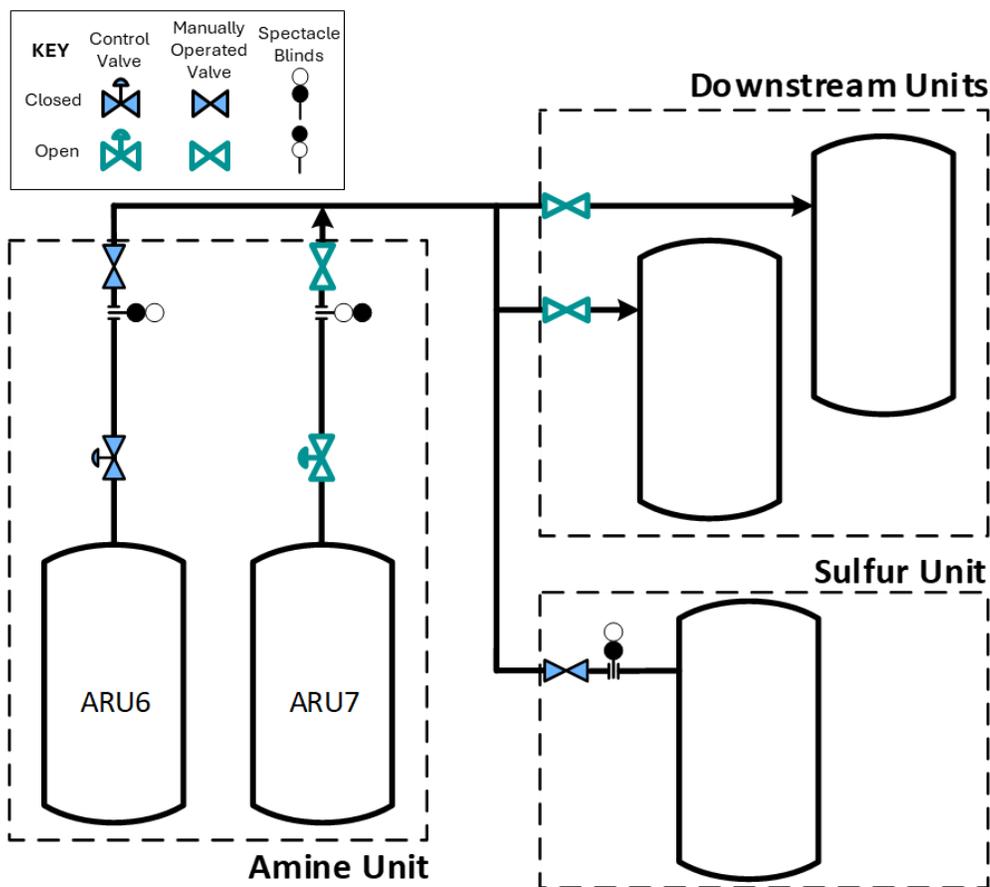


Figure 2. Acid gas process flow from the Amine Unit to the Sulfur Unit and other downstream processes, with valve configuration at the time of the incident. Valves next to the dotted lines represent process battery limits.^c (Credit: CSB)

^a The Occupational Safety and Health Administration defines immediately dangerous to life or health as, "any condition [...] that poses a threat to life or that would cause irreversible adverse health effects [29 CFR 1926.1202 - Definitions]."

^b Hydrogen sulfide with concentrations between 4.3 percent and 45 percent forms a flammable mixture with air [7].

^c Battery limit refers to the perimeter of a specific manufacturing process area [31].

The relative locations of the Amine Unit and the Sulfur Unit at the refinery are shown in **Figure 3**.

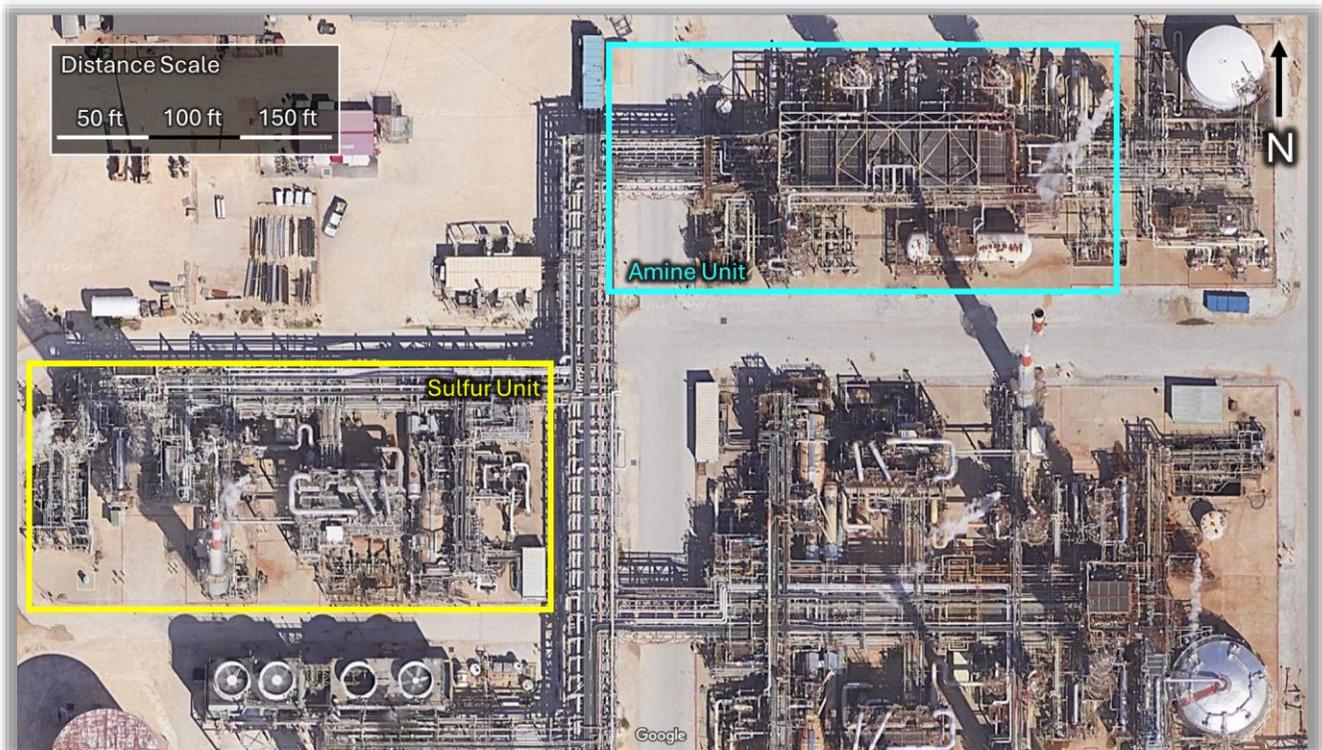


Figure 3. Relative locations of the Amine Unit and Sulfur Unit. (Credit: Google Earth, annotated by CSB)

1.3.1 AMINE UNIT “RUN-AND-MAINTAIN”

The Amine Unit includes two identical and parallel processes, designated as ARU6 and ARU7. The ARU6 and ARU7 equipment and piping are located in the same general area, with piping segments for both units sharing the same platforms to access the equipment. ARU6 was shut down for maintenance activities at the time of the incident, and the process piping had been depressurized, purged, and isolated. ARU7 was operating normally after already having gone through the same maintenance activity the week before the ARU6 work (**Figure 2**). PEMEX Deer Park called this unit status “Run-and-Maintain,” where equipment would be shut down for maintenance while parallel and redundant equipment remained operational. As part of the maintenance activities, contract workers would install and remove piping isolation devices, called blinds (**Figure 4**), from Amine Unit equipment.

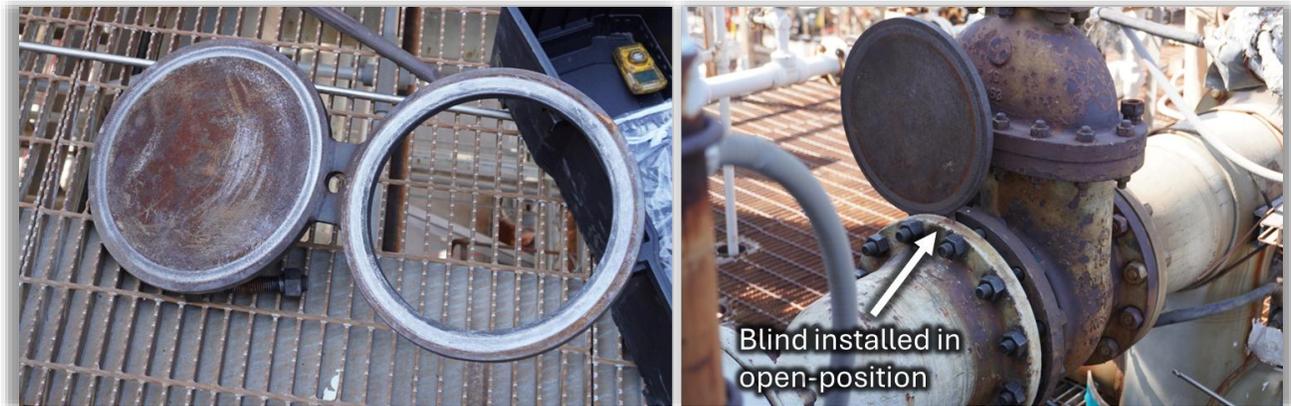


Figure 4. A “figure-eight” or “spectacle” blind used to isolate piping in the Amine Unit.^a (Credit: CSB)

1.3.2 SULFUR UNIT TURNAROUND

On the day of the incident, the nearby Sulfur Unit (**Figure 2**) was in a scheduled unit shutdown, called a turnaround, for planned maintenance activities. Unlike Run-and-Maintain status, the Sulfur Unit was in “Positive Isolation” status, where all equipment within the unit’s boundaries is considered shut down, depressurized, decontaminated, and isolated from outside hazardous process energy. At the time of the incident, contract workers from at least 10 different companies were performing various turnaround maintenance activities in the Sulfur Unit.

The areas containing the Amine Unit and the Sulfur Unit were equipped with permanently mounted hydrogen sulfide gas detectors with alarms. When the gas detector identifies a hydrogen sulfide concentration exceeding 10 ppm, an alternating high/low tone sounds in the unit where it is located, accompanied by a red light signal. The detectors also activate a flashing light and an audible alert on the control room console for the unit. The Sulfur Unit’s permanent gas detectors were not operable on the day of the incident, however, due to planned maintenance related to the Sulfur Unit turnaround. A permanent gas detector inside a structure within the Sulfur Unit was operational, but it was connected to its own audible alarm and red light signal, which were completely separate from the alternating high/low tones produced by the stationary horns within the Sulfur Unit.

1.4 CONTRACTORS

1.4.1 REPCON

Repron, Inc. (Repron) is an industrial services contractor headquartered in Baton Rouge, Louisiana, that provides mechanical, maintenance, and construction services [9]. The PEMEX Deer Park Refinery hired Repron to conduct pre-planned maintenance activities during the Sulfur Unit turnaround. PEMEX Deer Park also tasked Repron with installing and removing blinds from Amine Unit equipment, a task unrelated to the Sulfur Unit

^a “Figure-eight” or “spectacle” blinds (**Figure 4**) can be rotated, or “rolled,” from the isolated (closed) position to an open position, which does not require removal of the blind from the piping. **Figure 4** (right) shows an example of a spectacle blind installed in the open position.

turnaround activities.^a The blinds were removed by craftworkers, called boilermakers, who specialize in fabrication, assembly, installation, and repair of pressure vessels [10].

1.4.2 CODE RED

Code Red Safety (Code Red) is an industrial services contractor headquartered in Chicago, Illinois [11]. PEMEX Deer Park hired Code Red to provide safety-related equipment, such as radios, gas detectors, and respirators, during the Sulfur Unit turnaround. PEMEX Deer Park also tasked Code Red with providing continuous air monitoring using portable hydrogen sulfide gas detectors stationed throughout the Sulfur Unit.^b Code Red also managed the handheld radio system for workers supporting the Sulfur Unit turnaround.

1.4.3 ISC

ISC Constructors, LLC (ISC) is an industrial services company which provides electrical, instrumentation, control system engineering, and construction services [12]. PEMEX Deer Park hired ISC as its electrical and instrumentation contractor for the Sulfur Unit turnaround.

1.5 PERSONAL PROTECTIVE EQUIPMENT

PEMEX Deer Park required personnel to wear personal hydrogen sulfide gas detectors when entering the Amine Unit and Sulfur Unit. The gas detectors were worn on the user's clothing near the breathing zone.^c Upon detecting hydrogen sulfide above 10 ppm, the detector alerts the user with a tone, lighting, and vibration.

Due to the hazardous nature of a portion of the ARU6 blind removal work, Repcon boilermakers used a supplied-air respirator system consisting of a mask, a regulator, and hoses connecting the mask to the supplied air via a quick-disconnect fitting. Each worker also wore a compressed air cylinder^d ("escape bottle"), which connected to the mask via a hose and supplied up to 5 minutes of air (**Figure 5**) in the event they had to escape the area in an emergency. To more effectively use the escape bottle during an emergency release, the user must first open the air supply valve on the air cylinder and then pull on the quick-disconnect fitting to disengage from a supplied air hose. The user can then evacuate the area wearing the mask and using the portable emergency air supply. The PEMEX Deer Park policy did not require personnel to wear personal gas detectors while using supplied-air respirators.

^a PEMEX Deer Park also had tasked Repcon with installing and removing blinds on ARU7 equipment the week prior to the incident.

^b Upon activation, the monitor would emit an alternating high/low tone with accompanying flashing light.

^c The Occupational Safety and Health Administration (OSHA) defines the breathing zone as the "area forward of the shoulders within a 6-to-9 inch radius of a worker's nose and mouth" [35].

^d When full, the pressure in the cylinder measures 2,200 pounds per square inch gauge, allowing for 5 minutes of breathing air.



Figure 5. Supplied air respirator system. The Repcon boilermakers had the escape bottle shown on the left of the figure. (Credit: 3M [13, 14])

1.6 WEATHER

During the incident, the wind blew from the northeast at approximately 2 miles per hour, with gusts up to 8 miles per hour.

1.7 DESCRIPTION OF SURROUNDING AREA

Figure 6 shows the PEMEX Deer Park Refinery and depicts the area within 1, 3, and 5 miles of the facility boundary. Summarized demographic data for the approximate 1-mile vicinity of the PEMEX Deer Park Refinery are shown below in **Table 1**. There are more than 6,400 people residing in more than 2,440 housing units, most of which are single units, within 1 mile of the PEMEX Deer Park Refinery. Detailed demographic data are included in **Appendix B**.

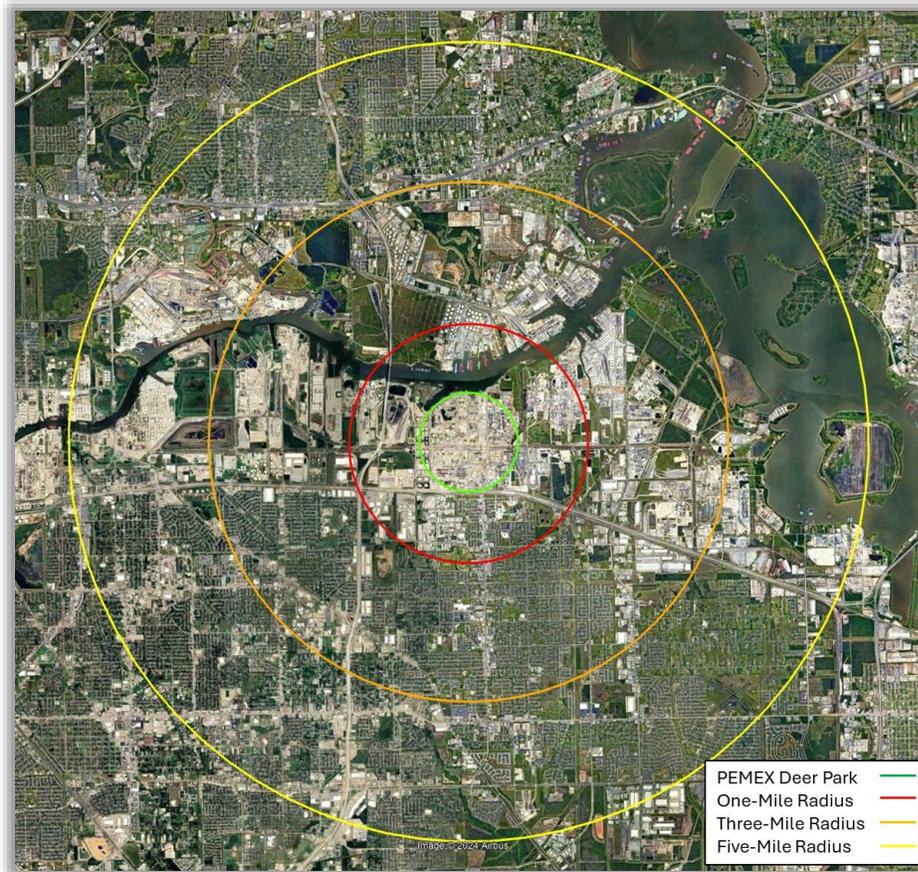


Figure 6. Overhead satellite image of the PEMEX Deer Park Refinery and the surrounding area. (Credit: Google Earth, annotated by CSB)

Table 1. Summarized Demographic Data for Approximately One-Mile Vicinity of the PEMEX Deer Park Refinery. (Credit: CSB using data obtained from Census Reporter)

Population	Race and Ethnicity		Per Capita Income	% Persons Below Poverty Line	Number of Housing Units	Types of Housing Units	
6,453	White	54%	\$ 36,595 ^a	0%	2,448	Single Unit	94%
	Black	1%				Multi-Unit	6%
	Native	1%				Mobile Home	0%
	Asian	1%				Boat, RV, Van, etc.	0%
	Islander	0%				X	
	Other	0%					
	Two+	2%					
	Hispanic	41%					

^a Census Reporter reports that Deer Park, Texas’ per capita income was \$36,595. The Census Bureau reports that the overall per capita income for the United States from 2024 was \$45,256.

2 INCIDENT DESCRIPTION

2.1 SULFUR UNIT TURNAROUND

On October 3, 2024, PEMEX Deer Park shut down the Sulfur Unit and began the scheduled turnaround maintenance tasks. Beginning October 3, Repcon boilermakers installed and removed blinds and performed other pipefitting tasks throughout the Sulfur Unit as directed by PEMEX Deer Park. By October 6, all equipment within the Sulfur Unit had been shut down, depressurized, decontaminated, and isolated from other processes. Between October 6 and 10, Repcon boilermakers continued to perform pipefitting and blinding tasks within the isolated Sulfur Unit. Per PEMEX Deer Park's turnaround procedures, PEMEX Deer Park operators would mark the location of blinds in the Sulfur Unit with a blind tag (**Figure 7**, left). Once the blinds were installed, operators or Repcon boilermakers would place a flange-locking device (**Figure 7**, right) over bolts on either side of the flange. PEMEX Deer Park operators would then lock the flange-locking devices closed.



Figure 7. Blind tag (left) and flange-locking device (right). (Credit: CSB)

2.2 AMINE UNIT BLIND INSTALLATION

On October 8, PEMEX Deer Park operators prepared ARU6 equipment for scheduled maintenance by emptying, depressurizing, and purging piping, closing valves, and completing equipment lock-out/tag-out (LOTO). The ARU6 maintenance activity was not a part of the Sulfur Unit turnaround. That evening, PEMEX Deer Park issued a work permit to Repcon to install 15 blinds in the ARU6 piping. Before the work could begin, PEMEX Deer Park's procedures required the operator to develop a list of the blinds and an associated drawing to identify the blind locations. A PEMEX Deer Park operator developed the list and drawing. Per PEMEX Deer Park operators' typical practice, they hung orange-and-blue blind tags to identify each of the 15 blinds authorized for removal in the permit. For 14 of the blinds, operators hung the blind tags directly on the blind. The last blind, designated as Blind 407, was located on acid gas piping and could not be easily accessed. Instead of hanging the

blind tag directly on the blind, the PEMEX Deer Park operators hung the blind tag on a nearby railing (Figure 8).



Figure 8. ARU6 Blind 407 could not be easily accessed, so operators hung the blind tag on the railing on the platform above the piping. (Credit: CSB)

A PEMEX Deer Park operator and the Repcon night shift foreman then walked through the unit to discuss the work. During the walkthrough, the Repcon night shift foreman confirmed the location of LOTO valves and added his signature to the tags. Afterward, the Repcon night shift foreman gathered three boilermakers, who had been supporting the Sulfur Unit turnaround activities, to perform the ARU6 blinding work. The boilermakers worked through the night and into the morning of October 9 to install blinds in the ARU6 process piping at the specified locations.

After the boilermakers finished installing a blind, they typically placed an unlocked flange-locking device (Figure 7) on each flange, which was the required practice in the Sulfur Unit turnaround, where they had been working in the days prior. The boilermakers consequently placed unlocked flange-locking devices on the ARU6 equipment. PEMEX Deer Park's procedures did not require the use of flange-locking devices for the ARU6 blind installation activities, however. The Repcon night shift foreman stated to the U.S. Chemical Safety and Hazard Investigation Board (CSB) that they did not witness PEMEX Deer Park operators lock the flange-locking devices after they were placed on ARU6 equipment. The PEMEX Deer Park operator also stated to the CSB that he was not aware that the flange-locking devices had been placed on ARU6 equipment because they were not normally used outside of turnaround activities.

The PEMEX Deer Park operator confirmed that all the blinds were properly installed and closed Repcon's work permit on the morning of October 9. PEMEX Deer Park then proceeded with the scheduled maintenance on ARU6 equipment.

2.3 WORK PERMITTING FOR BLIND REMOVAL

On October 10, 2024, around 7:00 a.m., Repcon day shift boilermakers arrived to continue turnaround tasks in the Sulfur Unit. None of the Repcon day shift boilermakers working on October 10 had previously performed work in the Amine Unit. By 7:30 a.m., PEMEX Deer Park had completed scheduled maintenance activities on ARU6 and was ready to remove blinds and start up the equipment. At 8:18 a.m., a PEMEX Deer Park operator issued a work permit to Repcon to remove the 15 ARU6 blinds in the Amine Unit.

The work permit stated that a PEMEX Deer Park operator would be present when opening connected piping segments to the atmosphere—an activity called a “line break.” For the first 13 blinds, the permit required workers to wear air-purifying respirators, leather gloves, and hearing protection during the line breaks.^a For the final two blinds, which were located in acid gas piping, the permit required workers to wear supplied-air respirators during the line breaks due to the risk of acid gas backflow or leak-by from the associated process piping.

The PEMEX Deer Park operator provided the previously developed blind list and drawing to the Repcon day shift foreman. The operator escorted the Repcon day shift foreman and four Repcon day shift boilermakers through the unit to show them the blinds indicated on the drawing. None of the day shift boilermakers had been present previously for the ARU6 blind installation activities. Only the Repcon day shift foreman had previously walked all the blind locations when receiving the job package.

During the walkthrough, the PEMEX Deer Park operator verified that all piping connected to the first 13 blinds had been depressurized by opening drain valves and bleed valves, checking pressure gauges, performing atmospheric testing, and pointing out open-ended piping segments in the presence of the work crew. However, the operator did not verify that the piping at the final two blind locations had been depressurized because he expected to be present later when the work crew was ready to open those flanges. One of the final two blinds, labeled Blind 407 (**Figure 8**), was located on the acid gas piping approximately 25 feet above the ground.

Repcon boilermakers began removing the blinds from the ARU6 piping. The PEMEX Deer Park operator witnessed Repcon complete 12 of the first 13 blinds, but needing to attend to other responsibilities in the unit, the PEMEX Deer Park operator then left the area. The Repcon foreman told the CSB that he believed that he was verbally permitted to continue removing blinds with his crew; so the Repcon boilermakers continued with their work.

2.4 AMINE UNIT BLIND REMOVAL

Over the next several hours, the four Repcon boilermakers worked in two pairs, opening flanges and removing blinds from the ARU6 piping. The boilermakers told the CSB that they looked for either the orange-and-blue blind tags or unlocked red flange-locking devices to locate the 15 blinds (**Figure 7**), rather than referencing the blind list or drawing. As will be described in Section 3.1.1, the blind list and drawing did not clearly indicate where each flange to be opened was located.

^a All workers in the ARU6 were also required to wear fire-resistant clothing, safety shoes, a hard hat, hearing protection, a personal hydrogen sulfide monitor, and safety glasses.

Around 3:00 p.m., the Repcon boilermakers completed the blind removal at the first 13 locations and prepared to remove the final two blinds. Around 3:30 p.m., the PEMEX Deer Park operator, who previously had left the area where the blinds were being removed, completed his shift and briefed the replacement night shift operator on the ongoing ARU work activities. The day shift operator then left the refinery.

Before beginning work to remove the final two blinds, the Repcon boilermakers obtained supplied-air respirators and escape bottles from Code Red (**Figure 5**). Two of the boilermakers went to a blind location elsewhere in the unit. The remaining two boilermakers climbed to a fixed, elevated platform to begin work at the Blind 407 location. The Repcon foreman accompanied the boilermakers to the Blind 407 location to provide instructions. The foreman then left to locate a contractor from another company to serve as the “bottle watch,” the person responsible for monitoring the supplied air tanks connected to the boilermakers’ respirators, among other responsibilities. Once the foreman returned with the bottle watch, the boilermakers connected their respirators to the supplied-air hoses. The boilermakers then removed their personal hydrogen sulfide gas detectors and placed them on the platform nearby because PEMEX Deer Park’s policy did not require personal gas detectors to be worn while using supplied-air respirators. Despite the permit requiring the PEMEX Deer Park operator to be present for the final line breaks, no operator was present for the Repcon removal of Blind 407.

The two Repcon boilermakers at the Blind 407 location encountered two identical piping segments 5 feet apart. The ARU6 piping, which was the intended location of the work, had previously been depressurized, purged, and isolated via closed and locked-out valves. Five feet away, the ARU7 piping segment (**Figure 9**)—which had not been depressurized, purged, and isolated—contained approximately 90 percent hydrogen sulfide gas at a pressure of about 15 pounds per square inch gauge.

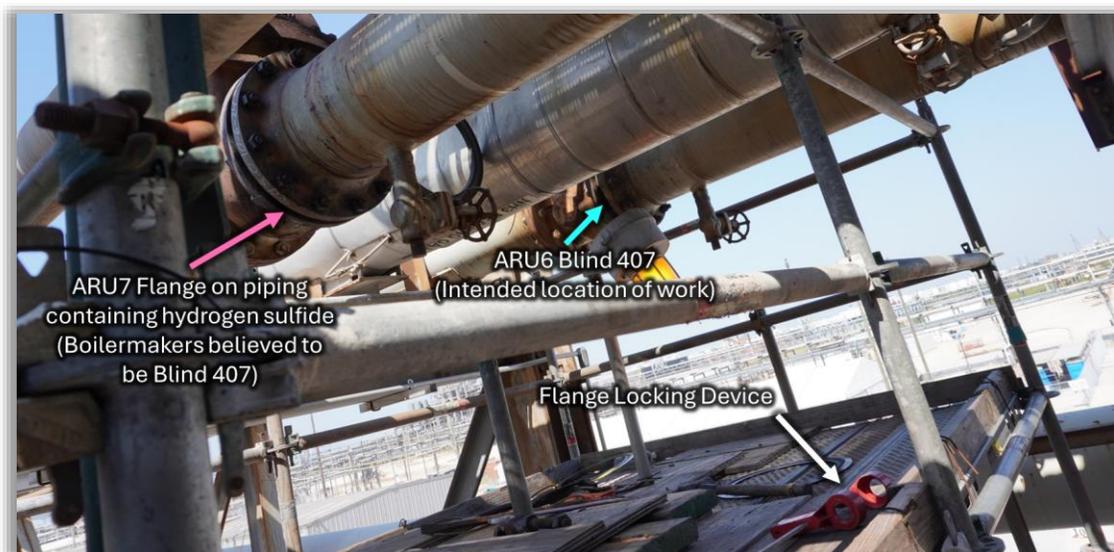


Figure 9. Adjacent ARU6 and ARU7 acid gas piping flanges (taken after the incident, when both blinds had been installed in the closed position). A flange-locking device was found on the work scaffold underneath the ARU7 acid gas piping flange. (Credit: CSB)

The two Repcon boilermakers stated to the CSB that they did not see the orange-and-blue Blind 407 tag that had been fastened to the railing above the blind (**Figure 8**). Instead, the boilermakers observed a flange-locking

device on the ARU7 flange and therefore believed that the ARU7 flange was the intended location of the work, unaware that Blind 407 was located on the piping segment 5 feet away. After the incident, the CSB located a flange-locking device underneath the ARU7 piping (**Figure 9**).

2.5 HYDROGEN SULFIDE RELEASE

Believing that they were working on Blind 407, the Repcon boilermakers began removing bolts from the ARU7 flange, which was not covered by the work permit. Moments later, hydrogen sulfide began leaking from the flange. Because they were wearing supplied-air respirators and did not have personal hydrogen sulfide gas detectors, the two Repcon boilermakers did not detect the hydrogen sulfide leak by either air monitoring or odor detection. As a result, they continued to loosen and remove bolts from the ARU7 flange.

Approximately 100 feet away, at 4:22 p.m., portable gas monitors in the Sulfur Unit detected a hydrogen sulfide concentration above the alarm threshold of 10 ppm and alerted Code Red technicians, who attempted to notify PEMEX Deer Park operators of the release via hand-held radio. However, Code Red technicians told the CSB that they received no response from the operators.

At 4:23 p.m., the ARU7 flange bolts were disassembled enough that the flange burst open, forcefully releasing toxic hydrogen sulfide gas (**Figure 10**). The two boilermakers realized that material was releasing from the piping and disconnected their supplied air connections to flee from the area. One boilermaker opened the valve to engage air flow from his escape bottle, proceeded down a ladder located approximately 30 feet away from the release point, and made his way to the primary assembly point. The other boilermaker was unsuccessful in evacuating using the escape respirator, however. He inhaled the released hydrogen sulfide, collapsed near the top of the ladder 30 feet away, and died from hydrogen sulfide poisoning at the scene.

Emergency responders later found the deceased boilermaker with his respirator mask removed, lying next to him. The emergency escape cylinder was also found lying next to him, with the strap wrapped around one leg, but not clipped or secured to his torso. The regulator on his respirator was found set to continuous flow, and the escape bottle was empty at the conclusion of the incident.

2.6 ALARMS AND NOTIFICATION OF THE RELEASE

Over the next several minutes, PEMEX Deer Park field operators in the Amine Unit, console operators in the control room, and emergency responders received notifications of the emergency.

At 4:24 p.m., the bottle watch worker located at the ground level near the release point used his hand-held radio to alert PEMEX Deer Park emergency responders of the unresponsive Repcon boilermaker, stating, “We need



Figure 10. Hydrogen sulfide release from the ARU7 flange. (Credit: PEMEX Deer Park)

emergency rescue. Man-down. ARU.” He ran to the field operations building to notify the PEMEX Deer Park field operators of the unresponsive worker.

The wind^a carried the released hydrogen sulfide through the nearby Sulfur Unit (**Figure 11**). Less than 1 minute after the flange was opened, at 4:24 p.m., Code Red’s portable gas monitors that were stationed throughout the Sulfur Unit detected the hydrogen sulfide, recording concentrations exceeding 500 ppm and reaching nearly 800 ppm in some areas (**Figure 11**).^b The portable gas monitors began to alarm audibly at the location of each gas detector, and the functioning, permanently mounted alarm at a structure within the Sulfur Unit also started to alarm.

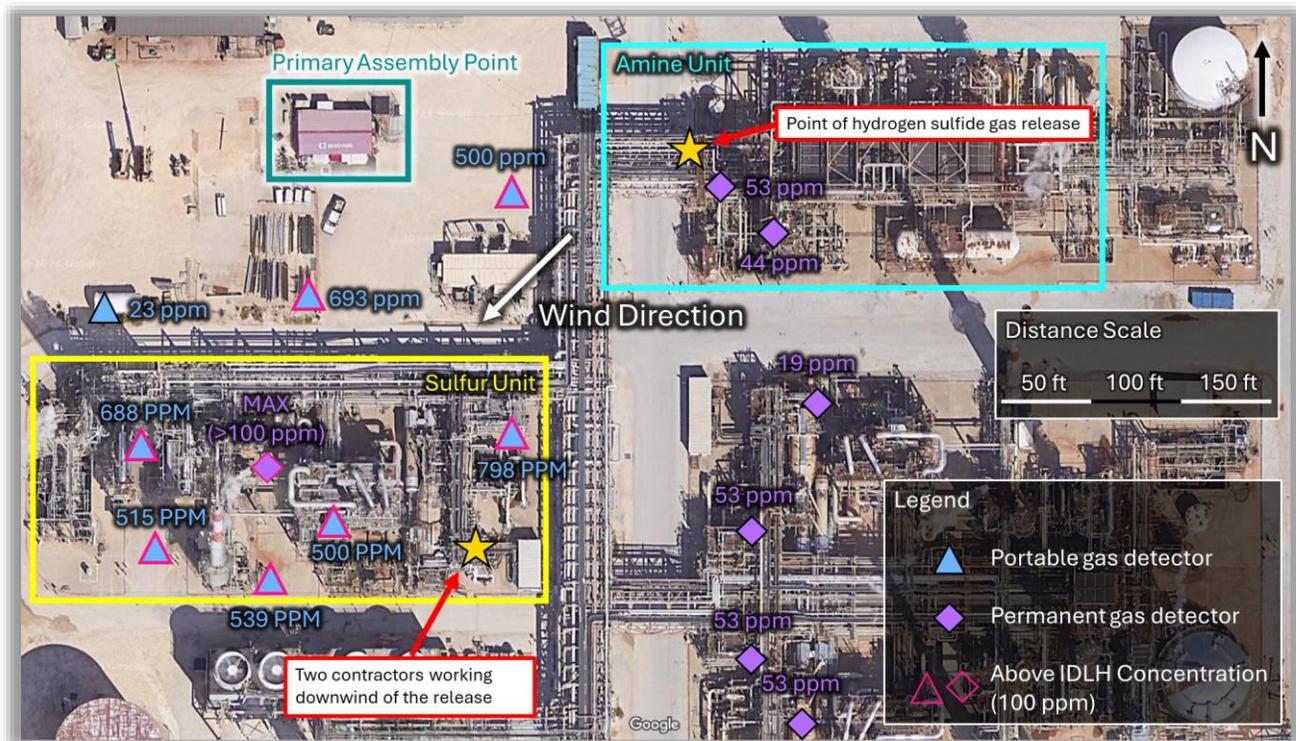


Figure 11. Overhead view of the hydrogen sulfide release location and adjacent units, with gold-colored stars indicating the approximate location of the fatally injured. The numerical values depict the maximum hydrogen sulfide concentration (ppm) at each location over the course of the incident. (Credit: Google Maps, annotated by CSB)

Between 4:24 and 4:27 p.m., console operators in the control room detected a rapid pressure decrease on the acid gas transfer lines, and soon after, a field operator from a downwind unit called to notify the control room of a suspected leak. Over the next several minutes, console operators attempted to determine the source of the leak.

Between 4:27 and 4:28 p.m., at least 4 minutes after the release began, the Amine Unit gas monitors detected hydrogen sulfide concentrations greater than 50 ppm, and alarms started to sound in the Amine Unit.

^a During the release, the wind blew from the northeast at approximately 2 miles per hour, with gusts up to 8 miles per hour.

^b Hydrogen sulfide concentration of 100 ppm is considered IDLH [7]. Concentrations over 1,000 ppm can cause a near-immediate fatality [8].

Between 4:29 and 4:34 p.m., emergency responders arrived at the Sulfur Unit and sounded the site-wide alarm at 4:35 p.m., 12 minutes after the release began.

2.7 DOWNWIND EXPOSURE TO THE RELEASE

Two ISC contract workers (Section 1.4.3) were working on Sulfur Unit equipment about 250 feet away and downwind from the release (**Figure 11**). Because the ISC workers were within a deinventoried turnaround area, PEMEX Deer Park did not require them to wear respiratory protection for their permitted work, and they did not have escape respirators.

At 4:24 p.m., the portable gas monitors in the unit indicated dangerously high hydrogen sulfide concentration in their area, between 500 and 800 ppm. Between 4:24 and 4:27 p.m., the ISC workers smelled hydrogen sulfide and heard nearby alarms. Moments later, their personal hydrogen sulfide gas detectors alarmed, indicating that the hydrogen sulfide concentration in their breathing zone was at least 10 ppm. While attempting to evacuate, one of the workers lost consciousness and fell while descending a caged ladder. He was found on the ground on the east side of the Sulfur Unit, fatally injured from hydrogen sulfide poisoning. The other worker stated to the CSB that he lost and regained consciousness and was able to escape the area.

Over the next several minutes, other contractors working in the Sulfur Unit became aware of the release either by smelling hydrogen sulfide, hearing the portable gas detector alarms, or hearing the alarms of their personal hydrogen sulfide gas detectors. The contractors began evacuating to the primary assembly point, which was located upwind toward the direction of the release, as shown in **Figure 11**. Once evacuated, 47 contractor workers from 10 companies were evaluated for hydrogen sulfide exposure. Many of their personal hydrogen sulfide gas detectors had exceeded the maximum reading of 100 ppm. An additional 13 contractors were taken to nearby medical facilities, evaluated for hydrogen sulfide exposure, and released.

2.8 STOPPING THE RELEASE

PEMEX Deer Park operators donned self-contained breathing apparatuses and attempted to locate and stop the release. After locating the leaking flange on ARU7, a PEMEX Deer Park operator attempted to close manual valves upstream and downstream of the release. However, the operator could not fully close the manual valves necessary to isolate the leak before his contained breathing air supply became low, and he evacuated the area.

At 4:49 p.m., 26 minutes after the release began, a console operator closed a remotely operated control valve upstream of the release and redirected upstream acid gas flow to the emergency flare system. However, pressurized acid gas flowed back from the downstream processes through open manual valves (**Figure 12**), and the release continued.

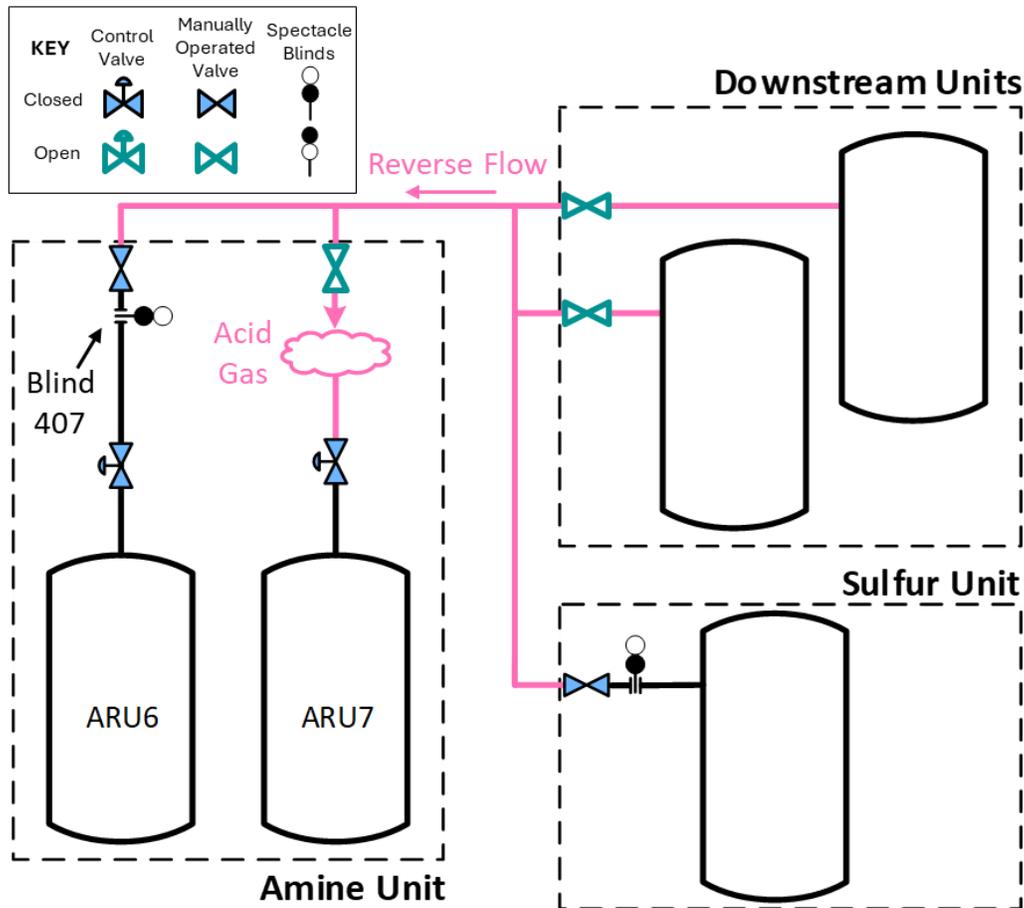


Figure 12. Reverse flow of acid gas during the release. (Credit: CSB)

Around 5:22 p.m., nearly an hour after the release began, emergency responders reassembled the leaking flange, stopping the release.

2.9 CONSEQUENCES OF THE INCIDENT

The incident at the PEMEX Deer Park Refinery resulted in two fatalities and the release of more than 27,000 pounds of hydrogen sulfide into the atmosphere. Thirteen contractor workers were taken to nearby medical facilities to be evaluated for hydrogen sulfide exposure. The neighboring cities of Deer Park and Pasadena issued shelter-in-place orders that lasted several hours. Although there was no physical damage to equipment, PEMEX Deer Park reported property damage of \$12.3 million, associated with the incident, resulting from the loss of use of the Amine Unit and downstream processes.^a

^a The Occupational Safety and Health Administration (OSHA) inspected PEMEX Deer Park and issued three citations associated with the incident and a proposed penalty of \$49,650.

3 SAFETY ISSUES

The PEMEX Deer Park Refinery incident involved opening hazardous process piping to remove isolation blinds. This common refinery maintenance activity can be performed safely with more effective equipment identification and administrative procedures. Deficiencies in the way that PEMEX Deer Park physically marked equipment for opening, permitted contractor work activities, and managed contractors working in turnaround and other units ultimately contributed to the inadvertent opening of piping containing toxic hydrogen sulfide and subsequent worker fatalities.

The following sections discuss each of these practices as safety issues contributing to the incident:

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

Appendix A contains the accident map (AcciMap), which provides a graphical analysis of this incident.

3.1 POSITIVE EQUIPMENT IDENTIFICATION

PEMEX Deer Park did not have an effective standardized identification system for equipment openings. PEMEX Deer Park planned for Repcon to use the provided written blind list, drawing, and a unit walkthrough to identify the location of blinds for the Amine Unit maintenance task (Section 2.3). This method, as defined in PEMEX Deer Park's Run-and-Maintain isolation procedure, did not include any requirement to place physical markings, flange-locking devices, or blind installation tags to identify the location of equipment openings. In the absence of a clearly defined system for identifying the specific equipment to be opened, the Repcon boilermakers relied on these other equipment identifiers to determine the location of blinds. As will be explained in this section, absent, misplaced, and inconsistently used equipment identifiers led the boilermakers to the wrong equipment, resulting in the hydrogen sulfide release.

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 [32, p. 811].

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

3.1.1 INTENDED EQUIPMENT IDENTIFICATION METHODS

PEMEX Deer Park used written job aids and a jobsite inspection as the primary methods for craftworkers^a to identify the locations of blinds. In addition to the operators pointing out the work location during the inspection, PEMEX Deer Park's permitting procedures required operators to develop a list of blinds and a drawing to identify blind locations, which the permit authorizer provided to the Repcon foreman. However, on the day of the incident, these job aids proved ineffective in helping the boilermakers identify the correct location of the intended work.

The PEMEX Deer Park work permitting procedure required operators to develop a drawing indicating the location of blinds, stating, "This drawing may be computer generated or hand drawn" and "...may be [...] sketched." Consistent with PEMEX Deer Park's procedures, the operator provided Repcon with a written list of blinds in the Amine unit and a computer sketch of the process, rather than a detailed technical drawing.^b PEMEX Deer Park procedures did not require operators to include a clear technical drawing to aid in locating the blinds. An excerpt of relevant portions of the drawing is shown in **Figure 13**.

As highlighted in yellow in **Figure 13**, the location of Blind 407 is shown to be on piping not connected to any other portion of the process, rendering it ineffective for identification. Further, the sketch inaccurately depicts Blind 407 as adjacent to Blind 408. This arrangement implies that these two blinds could be spatially adjacent, similar to the parallel and adjacent ARU6 and ARU7 piping segments (**Figure 9**). However, Blind 408 was actually located several yards away on a different piping segment, accessed by a different platform.

KEY LESSON

Job aids for equipment opening activities should clearly and positively identify which equipment is associated with the authorized work.

Physically marking piping after positively identifying the location and using detailed drawings are proven methods to minimize the likelihood of error.

^a As used in this report, the term "craftworkers" refers to a range of workers on the site, including the boilermakers involved in the incident.

^b The drawing that the PEMEX Deer Park operator provided to Repcon was a copy of a drawing that appears in the Amine Unit maintenance activity operator procedure. Although the operating procedure drawing specifies the location of blinds necessary to complete the maintenance activity, it does not provide instructions for installing or removing the blinds.

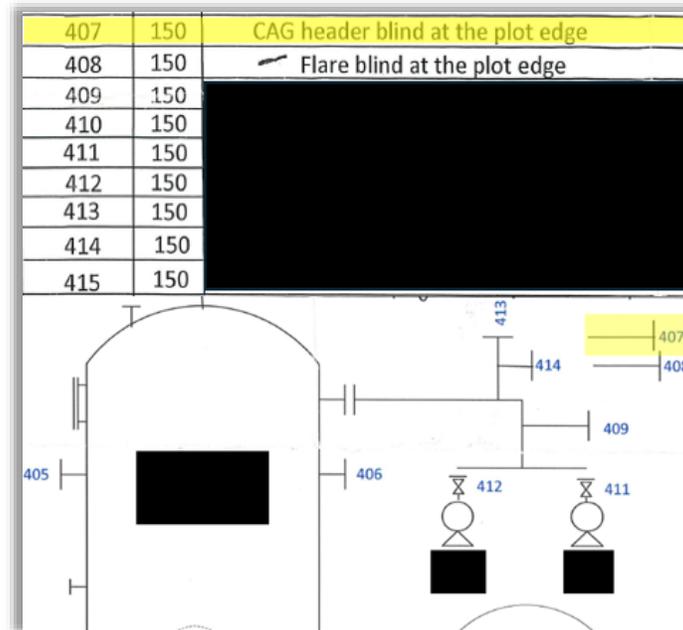


Figure 13. ARU6 blind list and drawing with Blind 407 highlighted. (Credit: PEMEX Deer Park, modified by CSB)

After the incident, the Repcon foreman told the CSB that the written job aids that PEMEX Deer Park provided differed from the type of job packet Repcon expected:

They gave me what looked like a package, but it wasn't like a regular package. It only had like the equipment numbers and some flanges where they were to perform the blinds. [...] There [were] no pictures. There was a tower and some flanges where we're going to blind. And on the side, a couple of tag numbers that we're going to work on. [...] Well, complete package, like the ones I was working on...on turnaround, [...] you have pictures of the valve on different angles. You'll have step-by-step on everybody involved, [operations], [...] us performing the work. [...] And also probably like a small map of the area where you're going to be working at, as like in blueprints of the lines, everything.

Without useful written job aids, the boilermakers needed to locate blinds by other means, such as equipment identifiers that were poorly located (Section 3.1.2).

The CSB concludes that PEMEX Deer Park's job aids—a written list and a process sketch—were insufficient in directing the Repcon workers to the intended pipe opening location. If PEMEX Deer Park's permitting and isolation procedures had required that a comprehensive job package be provided that included clear, detailed drawings, the Repcon boilermakers may have more clearly understood the intended location of the work.

3.1.2 UNINTENDED EQUIPMENT IDENTIFIERS

In the absence of a standardized and clearly communicated equipment marking system, the Repcon boilermakers resorted to using other equipment markers and visual cues to locate flanges to open. As discussed

below, due to the inconsistent and uncontrolled use of these markers, the boilermakers selected the wrong equipment, believing it was the intended location of the work.

Equipment Identifier #1 – Flange-locking Devices

Flange-locking devices (**Figure 14**) were commonly placed on flanges during the Sulfur Unit turnaround to secure a blind installation. PEMEX Deer Park did not instruct Repcon to install these flange-locking devices for the Amine Unit maintenance task, however. Nevertheless, the surviving Repcon boilermakers told the CSB they located the isolation blinds in the Amine Unit primarily by looking for unlocked flange-locking devices because the flange-locking devices were used in the Sulfur Unit. As the Repcon boilermakers removed the blinds, they collected the flange-locking devices, as shown in **Figure 15**. As detailed in Section 2.2, when the boilermakers attempted to locate Blind 407, they found an unlocked flange-locking device on the ARU7 piping, which informed their decision to open the piping, believing it was the location of Blind 407. After the incident, the CSB found the flange-locking device under the ARU7 piping, as shown in **Figure 16**.



Figure 14. Blind tag (left) and flange-locking device (right).^a (Credit: CSB)

^a The photo of the red flange-locking device was taken in another part of the facility and is displayed here as an example of an installed lock.

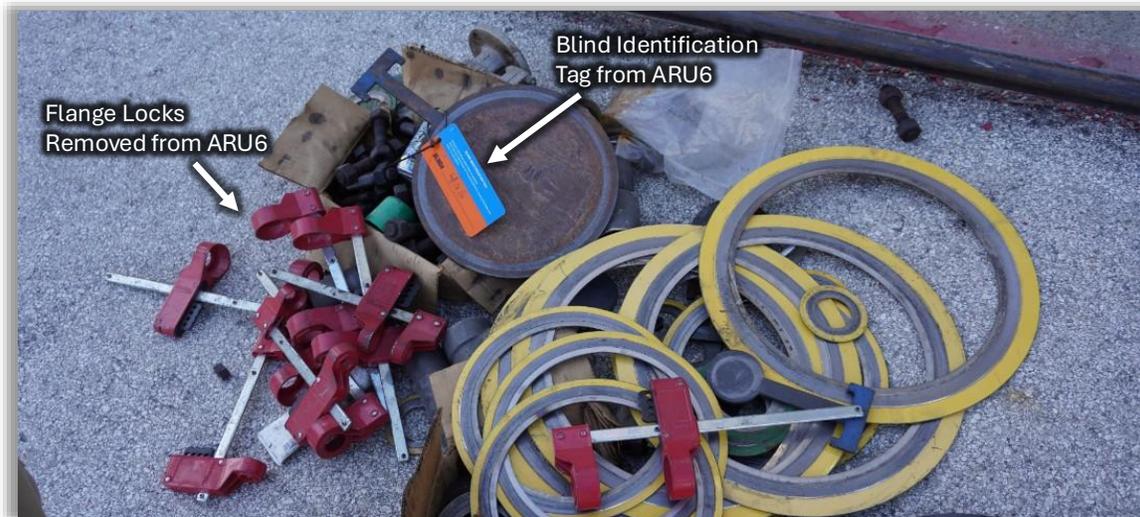


Figure 15. Flange-locking devices and blind tag from the ARU6 maintenance activity. (Credit CSB)

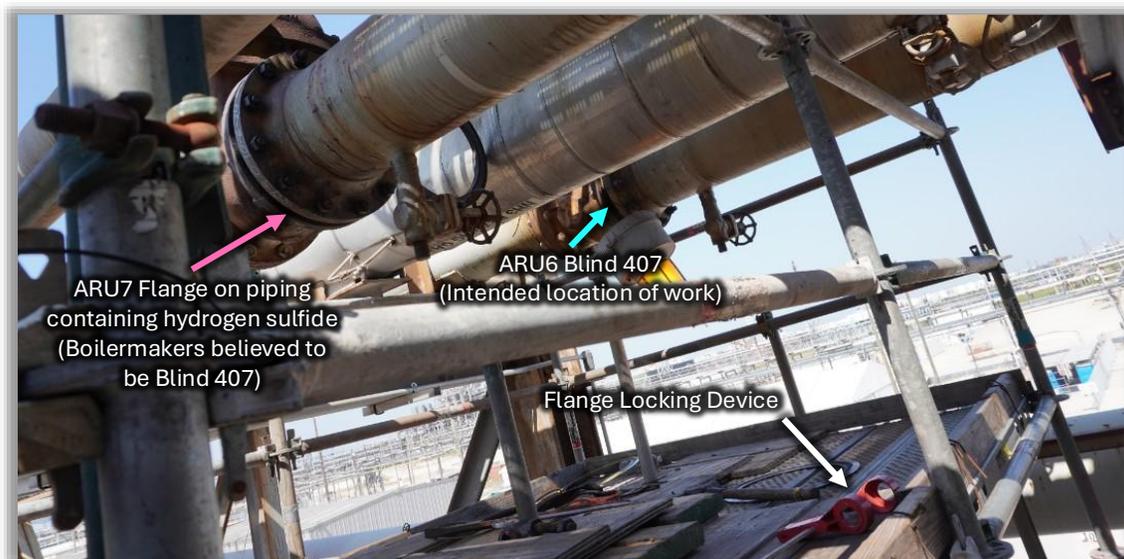


Figure 16. Adjacent ARU6 and ARU7 acid gas piping flanges (taken after the incident, when both blinds had been rolled to the closed position). A flange-locking device was found on the work scaffold underneath the ARU7 acid gas piping flange. (Credit: CSB)

Based on PEMEX Deer Park’s procedures and the CSB’s interviews with operators, PEMEX Deer Park never intended that the flange-locking devices be used to identify equipment for opening. The flange-locking devices were intended to secure an installed blind in place during a turnaround. Because the Repcon boilermakers were familiar with the flange-locking devices, however, they depended on them as equipment identifiers in the absence of a more effective equipment marking system.

The CSB concludes that PEMEX Deer Park did not have a clearly defined system to identify equipment for opening during Run-and-Maintain operations. In the absence of a clearly defined equipment marking system, the Repcon boilermakers chose flanges to open where they saw flange-locking devices. An unlocked flange-locking

device on ARU7 piping led the Repcon boilermakers to mistakenly choose an active line to open, believing it to be the Blind 407 location.

Equipment Identifier #2 – Blind tags

PEMEX Deer Park's turnaround policy required an operator to hang a numbered tag on each isolation blind after its installation. Once the maintenance crew removed the isolation blind, the associated tag would be returned to PEMEX Deer Park operators. Although this procedure was specific to turnarounds, PEMEX Deer Park operators placed blind installation tags in the Amine Unit before the work began to help Repcon contract workers identify the location of blind installations. Because this was not a documented procedure for Run-and-Maintain, there was no requirement to place it directly on the flange or check its placement, however.

As discussed in Section 2.2 and shown in **Figure 8**, the identification tag for Blind 407 was not placed directly on the ARU6 flange. With the boilermakers primarily looking for the flange-locking devices, they did not search for the misplaced tag for Blind 407, which was out of sight from the work location. After the incident, two of the three boilermakers told the CSB that they were aware of the tags, but they focused on the flange-locking devices to identify which equipment to open.

The CSB concludes that PEMEX Deer Park's inconsistent and uncontrolled blind tag identification system during the Amine Unit's maintenance did not give a clear indication of what equipment was to be opened. As a result, the Repcon boilermakers relied on the flange-locking devices they had previously used during the Sulfur Unit turnaround to identify which blinds to remove for the ARU6 maintenance task. The Repcon boilermakers identified the work location by spotting a misplaced flange-locking device on the ARU7 acid gas flange, as the Blind 407 identification tag was out of sight.

Equipment Identifier #3 – Circle-X Marking

PEMEX Deer Park instructed turnaround contract workers to use a marking system for identifying the location of equipment openings. PEMEX Deer Park educated contract workers about the marking method during the onboarding briefing for the Sulfur Unit turnaround, but the system was not included in any written procedures or materials provided to the contract workers. As a result, contractors and PEMEX Deer Park operators inconsistently used the marking system.

The marking practice for identifying the location of equipment openings consisted of three distinct marks made by three separate parties, resulting in a Circle-X, as shown in **Figure 17**. PEMEX Deer Park operations would make the first identifying slash; then a designated maintenance worker would make the second slash; and finally, the maintenance worker performing the equipment opening would circle both slashes. After the markings were made, there was no requirement to erase them.

KEY LESSON

Improvised equipment identifiers can add unnecessary confusion, resulting in errors when selecting equipment to open. Standardized markings with verification requirements ensure that all parties understand which equipment should be opened before the work begins.

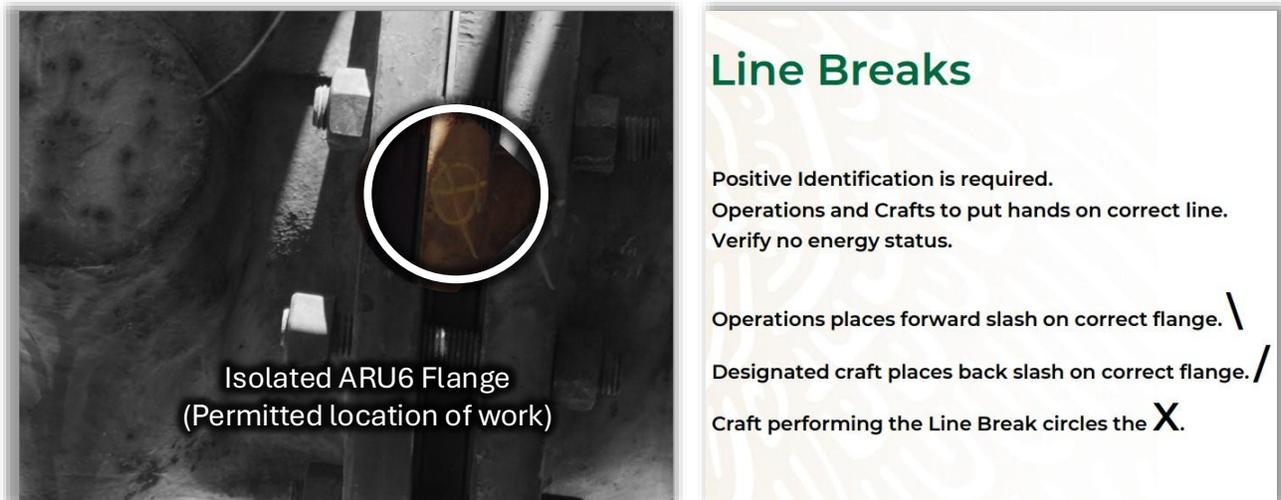


Figure 17. ARU6 Blind 407 piping flange with markings circled in white (left). (Credit: CSB) Onboarding training slide describing the marking practice for the identification of equipment openings during a turnaround (right). (Credit: PEMEX Deer Park)

At the time of the incident, the ARU6 flange was marked with a complete Circle-X marking, indicating that the flange had been visited by the three parties, as shown in **Figure 17**. The different night shift Repcon worker crew used this Circle-X practice to mark the location of the equipment openings when installing the ARU6 blinds. After the installation of the blinds, the Circle-X marking remained on the ARU6 flange.

In an interview with the CSB, a PEMEX Deer Park operator voiced his concern with the marking system:

Why are we putting these Xs and Os on there when all the flanges already have Xs and Os? **How do you determine which one's which?**" (emphasis added)

With no requirement to erase the Circle-X, workers would not know when the marking was placed unless they were part of the team that marked the equipment.

The CSB concludes that PEMEX Deer Park's use of the Circle-X marking system added unnecessary confusion due to the inability to determine whether the marks were placed from a previous equipment opening. PEMEX Deer Park should have a clear equipment identification process used across turnarounds and normal operations.

Equipment Identifier #4 – Orientation and Labeling of Identical Piping Systems

From the boilermakers' perspective at the location of Blind 407, the upstream locked-out valve on ARU6 appeared to align with the downstream ARU7 acid gas piping (**Figure 18**). As shown in **Figure 18**, the Amine Unit's pipe bends are not immediately noticeable and would require tracing out the piping segment from the upper deck to differentiate the two piping systems.

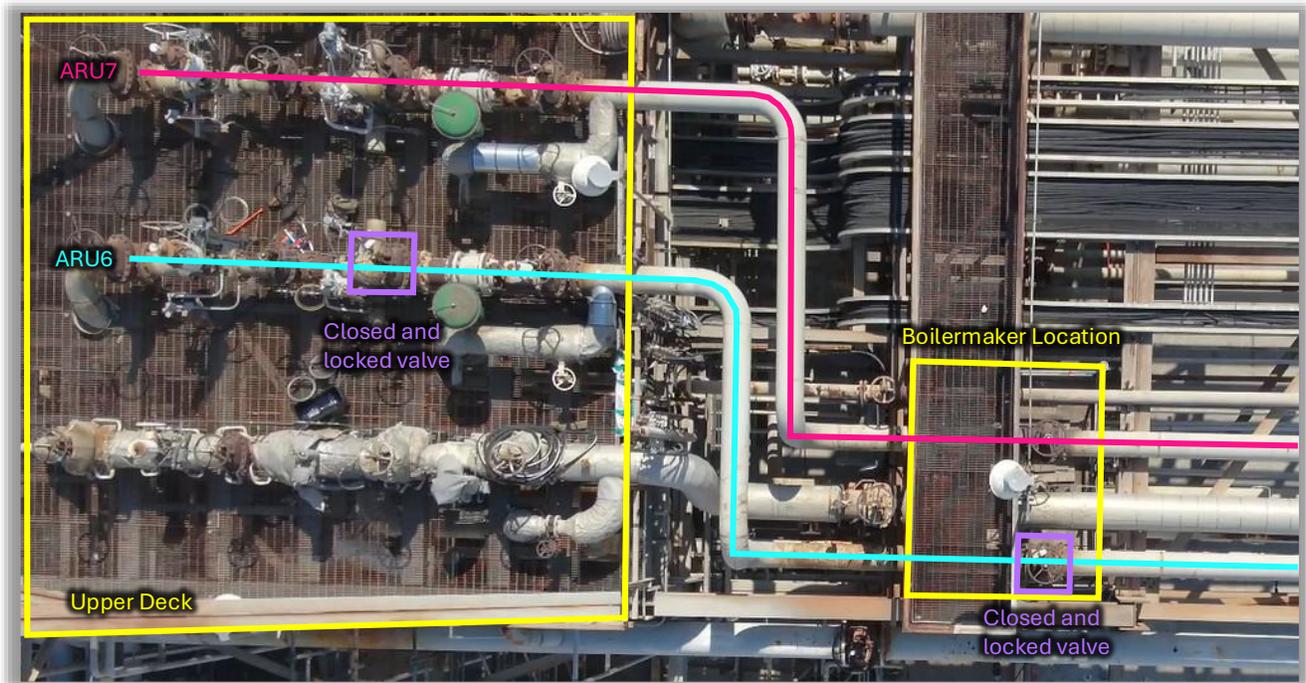


Figure 18. Overview of the Amine Unit piping configuration near the location of the boilermakers. (Credit: CSB)

At the time of the incident, neither of the two identical acid gas piping systems in the Amine Unit were labeled, despite being separated by only 5 feet at the boilermaker location in **Figure 18**. Without permanent labels, unless the workers traced the piping system themselves, they could differentiate the two piping systems only by using the equipment identifiers #1, #2, and #3 described above. Equipment identifiers #1 and #2 were only applicable to turnaround operations (which this work was not), and equipment identifier #3 was not established in procedure and was therefore inaccurate and confusing.

PEMEX Deer Park’s equipment labeling policy states that it adheres to the American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME) A13.1 *Scheme for the Identification of Piping Systems* standard.^a The standard, which describes requirements for the identification of aboveground piping, and recommends installing and maintaining labels/legends on process piping “close to valves or flanges; adjacent to changes in direction, branches, and where pipes pass through walls or floors; and at intervals on straight pipe runs sufficient for identification” [15].

Before PEMEX became the sole owner and operator of the refinery (Section 1.1), Shell’s *Human Factors Engineering* document specified the labeling of equipment and piping:

[A] pipe label or marker visible from the valve shall be place[d] before every block valve used to isolate piping systems or major equipment at a manifold or **battery limit**. [...] For pipe racks, **pipe labels or markers** on two or more pipes

^a OSHA requires adherence to this standard in [29 CFR 1910.119\(d\)\(3\)\(iii\)](#).

in a group of pipes located side-by-side (e.g., in a pipe rack) **shall be installed side-by-side** so they can be easily read together. (emphasis added)

PEMEX Deer Park referenced this Shell document in its equipment labeling policy but did not continue the practice for the acid gas piping within the Amine Unit. Consequently, there were no labels on the ARU6 or ARU7 acid gas piping to differentiate the two systems.

The CSB concludes that the Amine Unit's two different but visually identical piping systems were not distinctly labeled, and the boilermakers could not distinguish between the two different systems. Pipe labeling could have provided an additional visual aid to confirm the location of the ARU6 piping system. With no labeling on the ARU6 or ARU7 piping systems and an unclear piping orientation, the Repcon boilermakers relied on other, inappropriate equipment identifiers. This led them to mistakenly open the acid gas piping section of ARU7.

The CSB recommends that PEMEX Deer Park label all piping in ARU6 and ARU7 in accordance with ANSI/ASME A13.1 *Scheme for the Identification of Piping Systems*.

Missed Equipment Identifiers – LOTO Valve and Blind Orientation

At the time of the incident, there were additional visual cues that could have been used to determine the status of the Amine Unit's piping systems. PEMEX Deer Park expected that the boilermakers would visit the locked-out downstream ARU6 block valve or have the Repcon foreman communicate this isolation point to them. Additionally, the orientation of the spectacle blinds for both ARU6 and ARU7 could have indicated the status of the two piping systems. As shown in **Figure 4** and **Figure 19**, the ARU7 blind was in the "open" position during the incident and could have been an indication that the ARU7 acid gas piping was operational. However, the boilermakers did not consider the locked-out block valve or the ARU7 spectacle blind position because they were not looking for them.

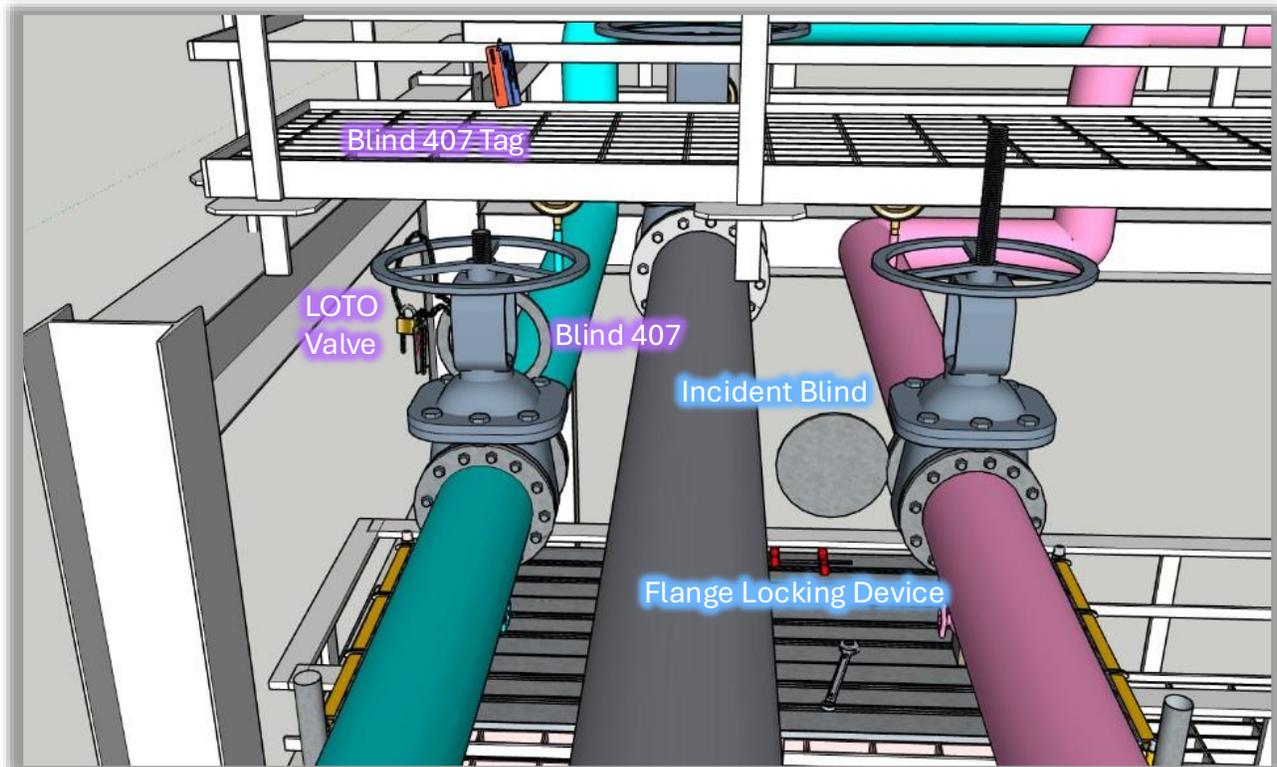


Figure 19. Overhead perspective of the Amine Unit's acid gas piping showing the equipment identifiers for ARU7 (highlighted blue) and the equipment identifiers for ARU6 (highlighted purple). (Credit: CSB)

As described in Section 3.3 below, the boilermakers mistakenly believed that the Amine Unit was part of the turnaround, where units were under turnaround status, negating the need to check for a locked-out valve and spectacle blind position. The CSB interviewed the surviving Repron boilermaker tasked with removing Blind 407, and he accurately identified the position of spectacle blinds in several photos. Regardless, the boilermaker told the CSB that they were not looking for whether the spectacle blinds were open or closed because they were looking for flange-locking devices.

A 2021 Center for Chemical Process Safety (CCPS) conference paper discusses how visual details are sometimes overlooked:

The human visual system sees with its brain, not with its eyes. The human vision system is wired in a way that misses details that are critical for safety. Think about why so many motorcycles are involved in highway crashes. People do not see them because they are looking for larger vehicles [16].

The boilermakers were focused on identifying flange-locking devices to locate the ARU6 blinds. Even though the locked-out valve and blind orientation were important visual cues for determining the equipment's status, the boilermakers thought the equipment had been drained, depressurized, and vented. As a result, they did not perceive the need to verify the status of the system.

Figure 20 shows the incident location from the boilermaker’s perspective by highlighting the equipment identifiers in place—the flange-locking device and the Circle-X marking. Because the boilermakers were not looking for locked-out valves or spectacle blind positions, the flange-locking device directed them to work on the ARU7 piping.

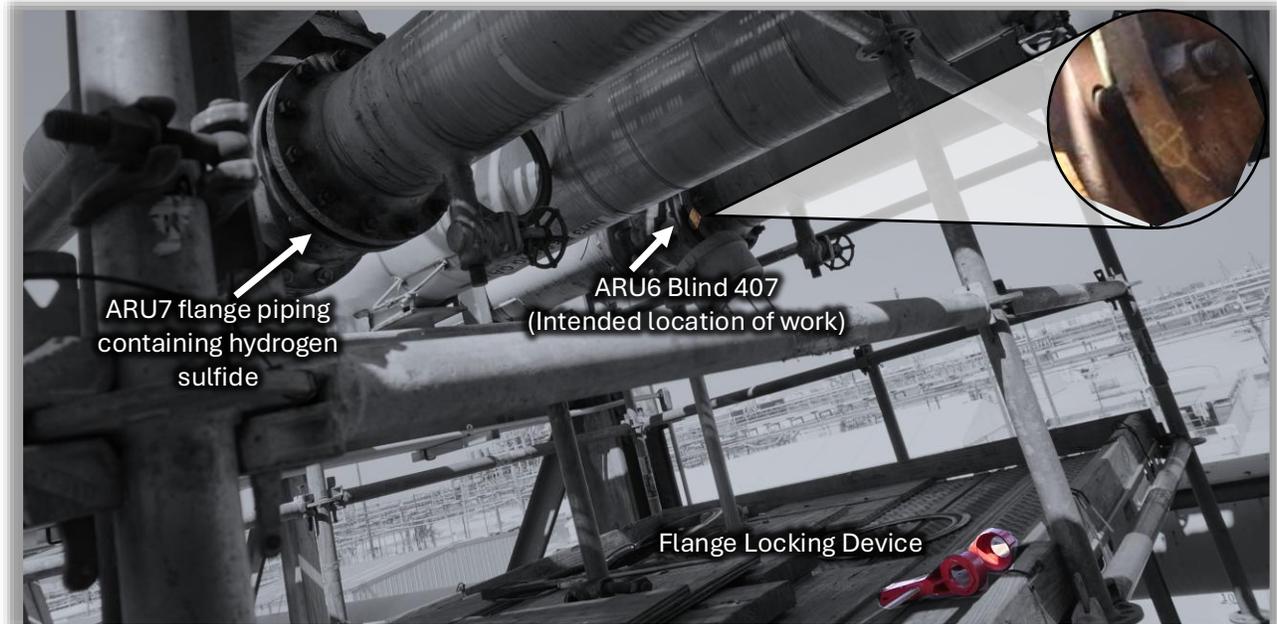


Figure 20. ARU6 and ARU7 acid gas piping segments as found after the incident. (Credit: CSB)

The CSB concludes that the Repcon boilermakers did not look for the ARU6 LOTO valve as an isolation point, as they were unaware that the unit was partially operational. The orientation of the blinds indicated the status of both of the acid gas piping systems. However, the boilermakers believed that they were in a shutdown turnaround unit, where all the equipment is depressurized and isolated from outside hazardous process energy. As a result, they relied on the flange-locking devices and blind tags that were required during turnarounds.

3.1.3 STANDARDIZED EQUIPMENT IDENTIFICATION SYSTEM FOR LINE OPENING ACTIVITIES

As discussed above, PEMEX Deer Park used an inadequate written system to direct contract workers to the location of blinds as part of the permitted work. The written blind list and drawing, along with the inconsistent use of physical equipment identifiers, however, was ineffective in directing the Repcon boilermakers to the correct location of Blind 407. A standardized equipment identification system that uses clear equipment markings could have ensured that the boilermakers positively identified Blind 407 and prevented the incident.

3.1.3.1 Industry Guidance and Existing Practices

The CCPS’s *Safe Work Practice: Line Opening* provides guidelines for identifying the location of equipment for opening. CCPS states that the following should be completed to manage and mitigate line opening hazards:

1. Identify the location of each line opening by marking locations on the pipe.
2. Positively identify location of each line opening at the time of on-site inspection.
3. During on-site inspection, verify the person performing the work or accepting the permit knows the location of the line opening.
4. Use the P&ID^a to determine all isolation/blinding or block/bleed valve locations. Develop an isolation/blinding/block/bleed list for the job [17, p. 6].

As discussed above, PEMEX Deer Park's adherence to the CCPS guidelines were either ineffective or nonexistent for the permitted ARU6 blind removal task. Each of these failed safeguards contributed to the misidentification of the Blind 407 location, ultimately leading to the incident. Regardless, PEMEX Deer Park had an established procedure for positively identifying and marking piping for opening, but it only applied to cutting and drilling activities, not flange opening activities. As described below, PEMEX Deer Park's line cutting procedure followed the CCPS line opening guidance and could have prevented the incident if it had been applied to flange opening activities.

Methods to Positively Identify Equipment for Opening

PEMEX Deer Park's line-cutting procedure required two pieces of orange tape that point to exactly where the cut is required (**Figure 21**). According to the procedure, a PEMEX Deer Park operator and a separate line opening coordinator would inform the line opening crew of the location of the openings. The persons performing the line opening would then apply the orange tape where they understand the equipment should be opened. The line-cutting procedure then required both operations and the line-cutting craftworkers to sign and date the orange tape during the joint jobsite inspection (**Figure 21**).

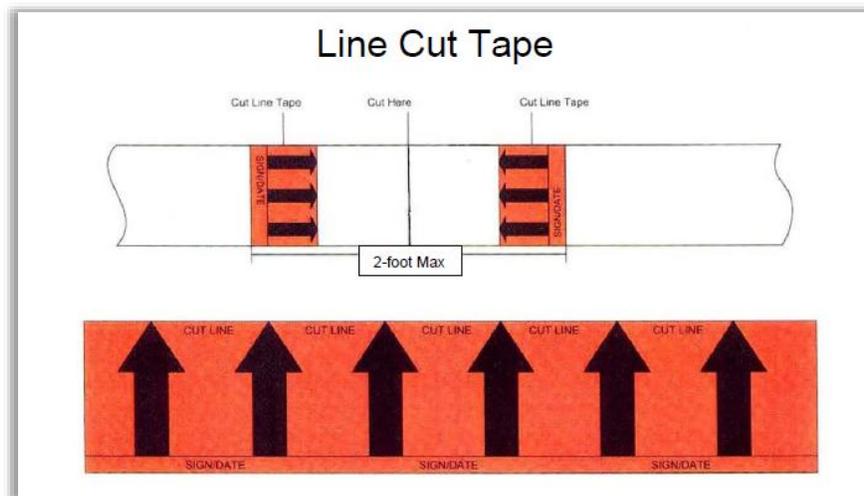


Figure 21. Control tape to identify piping for line cutting. (Credit: PEMEX Deer Park)

^a A piping and instrumentation diagram (P&ID) is a schematic drawing that shows the details of piping, vessels, and instrumentation, and their interactions [18]. The symbols and identifying features of P&IDs are prescribed by American and international standards, so that a P&ID can be easily interpreted from one facility to another [19].

The line-cutting procedure further required completion of a safety checklist for each line opening, as shown in **Figure 22**. The procedure required both a PEMEX Deer Park operator and a separate line opening coordinator to sign the safety checklist after confirming all items had been completed. The work permit was then issued only after the physical markings were placed on the pipe, both operations and the work crew had positively identified the location by placing their signatures, and the joint jobsite inspection had been completed to authorize the line opening activities.

Process Unit Name: _____		
<u>Equipment / Line to Be Cut:</u> _____		
What <u>process material</u> or utility stream was last contained in this equipment? _____		
Is an SDS on the job site? _____		
<u>Person performing cut:</u> _____		
Number of cuts to be made: _____		
Has line cut location(s) been agreed to by line cut crew and operations representative?	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Has the line and / or equipment been rendered safe to perform an intrusive line opening through the proper isolation, draining and venting of the system by following an equipment specific procedure, and by following the _____ Safety Order to ensure isolation is adequately performed?	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Operations Representative/Permit Writer and the Line Cut Crew have <u>walked the job</u> and have verified the isolation, draining, and venting of the process line and or equipment to be cut.	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Are there any naturally forming seal legs, line pockets, or unopened valves on the equipment or line to be cut?	Yes <input type="checkbox"/>	No <input type="checkbox"/>
<i>If answering, "Yes" to above question, what method has been performed to ensure that all process or flush material has been drained prior to continuing with an intrusive opening?</i>		
Has a JSA/TSA been written for the line cutting task to be performed?	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Are there any special considerations for this specific task (<u>stored energy</u> , trapped liquids in low points/ etc.)?	Yes <input type="checkbox"/>	No <input type="checkbox"/>
If yes, please explain what mitigations have been made.		
Has the <u>line cut tape</u> been installed and have both the <u>permit writer and line cut crew signed</u> and dated during the joint job site inspection?	Yes <input type="checkbox"/>	No <input type="checkbox"/>

Figure 22. PEMEX Deer Park line cutting safety checklist. (Credit: PEMEX Deer Park, annotations by CSB)

During the CSB's investigation, a PEMEX Deer Park operator indicated familiarity with this method and suggested how it could be applied to all line opening activities, including flange opening and blind removal:

[M]aybe if there was some kind of flange tape that, [workers] get trained on saying, "[W]ith this flange tape [...] on here, if the operator's signature [is] not on

the flange tape, you don't open it." It can be blue. You know, like our cold cut's tape's orange. Maybe we need to have some blue tape saying, "[Don't] open this flange unless the operator's signature [is] on it and your foreman's signature [is] on it."

The CSB concludes that PEMEX Deer Park had written procedures that standardize pipe marking for pipe cutting but did not have a standardized process for flange opening and blind removal activities. Had PEMEX Deer Park required clear standardized markings for all line opening activities, this incident may have been prevented.

Post-Incident Improvements

Following the incident, PEMEX Deer Park enacted a procedure to ensure that blind locations are positively identified by both PEMEX Deer Park operators and the craftworker opening equipment. When installing a blind, the procedure requires the equipment owner and the specific craftworker installing the blind to sign a yellow blind location tag before the work is permitted (**Figure 23**). Likewise, the procedure requires the equipment owner and the specific craftworker removing the blind to sign a orange-and-blue blind identification tag before permitting a task to open equipment to remove blinds (**Figure 23**). The procedure requires the equipment owner to hang tags directly on the blind. Additionally, the specific craftworker installing or removing the blind must sign the blind tag, and if the signing craftworker must be replaced, the new craftworker must sign the tag before the equipment is opened.

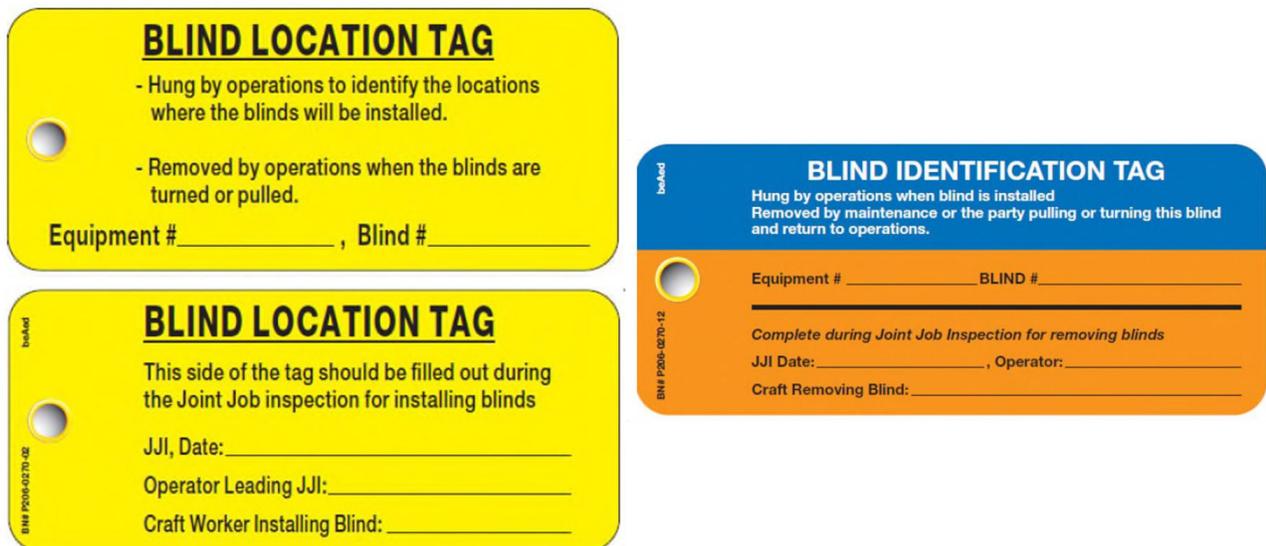


Figure 23. Blind location tag used to positively identify equipment when installing blinds (left). Blind identification tag used to positively identify equipment when removing blinds (right). (Credit: PEMEX Deer Park)

Because of the improvements to ensure that equipment is accurately identified when removing blinds, the CSB is not issuing a recommendation to PEMEX Deer Park related to positive equipment identification.

3.1.3.2 A Recurring Hazard – Similar Recent Incidents

Working on the wrong equipment is a common occurrence that continues to happen in the chemical industry. In 2025 alone, two similar incidents reported to the CSB involved workers opening the wrong piece of equipment.

PBF Energy, Martinez, California^a

On February 1, 2025, contractors installing blinds disassembled an incorrect flange, resulting in a fire and a release of more than 50,000 gallons of hydrocarbon material. PBF Energy tasked contract workers with installing an isolation blind at Flange A (**Figure 24**) to prepare a unit for turnaround maintenance. PBF Energy operations placed a yellow tag between Valve 2 and Valve 3 to indicate the location of the blind installation. However, the contract workers had not received training on the refinery's equipment opening policies and procedures and were unfamiliar with PBF Energy's tagging practices. After completing a field walkthrough to verify that the piping segment between Valve 1 and Valve 2 was empty, an operator issued a permit to the contractor work crew supervisor at 11:30 a.m. on February 1.

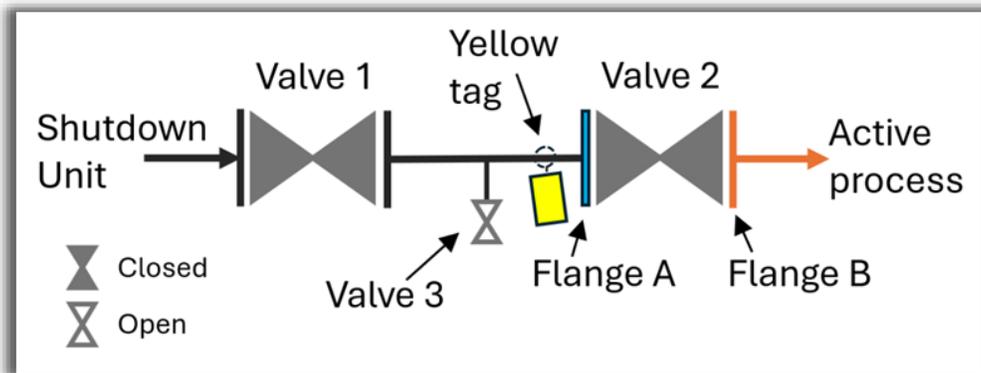


Figure 24. Existing isolation before blind installation. (Credit: CSB)

At approximately 1:25 p.m., two contract workers began unbolting Flange B, which was not isolated from the active process, believing it was the intended location to install the blind. At this time, neither the workers' supervisor nor the operator who issued the permit were present. Minutes later, flammable material escaped from the opened Flange B. A standby worker activated an air horn to stop the work, and the two contract workers safely evacuated from the area.

At about 1:30 p.m., the flammable material ignited and exploded with flames erupting in the area. Hot hydrocarbon material (exceeding 600 degrees Fahrenheit) continued releasing from Flange B, fueling the fire. The fire escalated over three days and involved other equipment until emergency responders finally extinguished it on February 4, 2025.

The full description of the PBF Energy incident can be found in the CSB's [Incident Reports, Volume 4](#).

^a See PBF Energy, February 01, 2025, in [Incident Reports, Volume 4](#)

Olin, Freeport, Texas^a

On May 20, 2025, around 8:15 a.m., approximately 8,000 pounds of toxic chlorine gas were released at the Olin Corporation facility in Freeport, Texas. The release seriously injured one employee and resulted in approximately \$23 million in property damage. On the day of the incident, an Olin operator issued a work permit to two contract maintenance workers to replace rupture disc RD-217N (Figure 25). Prior to the incident, Olin's operations team mistakenly tagged a different rupture disc (identified as RD-217S) (Figure 25) for replacement after isolating and emptying the surrounding piping. The permitted rupture disc, RD-217N, was located on active piping containing liquid chlorine. The unit operator and the maintenance workers did not perform a field walkthrough of the job to confirm the location of the work, nor did the contract workers review or sign the equipment isolation plan or the tag that identified the rupture disc holder to be opened.

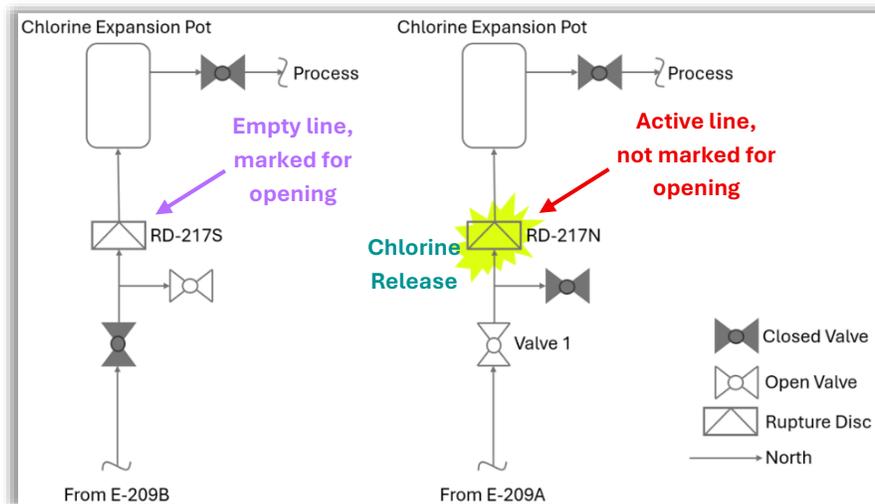


Figure 25. Simplified equipment drawing showing the relevant equipment and valve positions before the rupture disc replacement work began. (Credit: CSB)

At approximately 8:10 a.m., one of the maintenance workers began disassembling the RD-217N rupture disc holder. At 8:15 a.m., liquid chlorine at a pressure of 100 pounds per square inch began releasing from the partially disassembled rupture disc holder. The maintenance workers evacuated from the area. Alarm horns in the unit were activated after chlorine gas detectors identified the release. Local officials issued a shelter-in-place order for the cities of Clute and Lake Jackson. At 9:03 a.m., emergency responders closed an upstream valve to stop the release.

The full description of the Olin incident can be found in the CSB's [Incident Reports, Volume 4](#).

Similarities

The incidents at PEMEX Deer Park, PBF Energy, and Olin all involved contract workers who opened active equipment because the intended work location was not positively identified by all parties.

^a See *Olin, May 20, 2025*, in [Incident Reports, Volume 4](#).

- At PEMEX Deer Park, a blind tag was placed apart from the equipment, and the company expected contract workers to use a written list and drawing to identify the location of the equipment. In the absence of clear equipment markers, contract workers used flange-locking devices to choose equipment to open, which were not intended to identify equipment (Section 3.1.2).
- At PBF Energy, a tag was hung next to the intended location of the opening, but contract workers were unfamiliar with the tagging practice. As a result, the tagging system was not used by contract workers to positively verify the intended equipment opening location.
- At Olin, the planned work documents correctly showed that a piece of equipment required replacement, but Olin’s operations team had mistakenly isolated, cleared, and tagged a different but identical piping system. Consequently, the contract workers used the provided paperwork to identify the work location and open active equipment without clear indication of the isolated piping.

Each of these incidents highlights the need for a standardized method to mark equipment for opening that includes positive verification by both the equipment owner and the workers opening the equipment.

The CSB concludes that incidents occur when the wrong equipment is opened because of ineffective equipment identification methods that do not require positive identification by both the equipment owner and the persons performing the work.

3.1.3.3 Marking Methods in Other Industries

Several industries have developed methods to positively identify important areas or specific locations for work. For example, the medical field uses a robust marking method to identify the location of a surgical procedure. A different example is the national phone number 8-1-1, which is a service that connects homeowners with professionals who mark utility lines to prevent unintended damage before undergoing excavation projects [18]. The chemical industry can benefit from enacting a standardized method of identifying equipment that requires opening for maintenance.

The Medical Field’s “Wrong Site Surgery” Prevention Practices

In 2014, the Joint Commission^a and Health Research & Educational Trust published a study detailing the causes of wrong-site surgery incidents and proposed recommendations to prevent them:

There were 463 incidents of wrong-patient, wrong-site, wrong-side and wrong-procedure surgeries voluntarily reported to the Joint Commission[...] from January 1, 2010, through December 31, 2013. The national incidence rate—not only in operating rooms but in many other settings in hospitals and ambulatory surgery centers ... —is estimated to be much higher, perhaps as often as 50 incidents per week in the United States. [...] These organizations identified 29

^a The Joint Commission was founded in 1951 and is an independent, nonprofit organization that provides accreditation to healthcare organizations and programs across the United States [34]. The Joint Commission evaluates whether a healthcare organization meets established standards for patient care and safety. The accreditation also qualifies organizations to participate in federally funded healthcare programs [33].

main causes of wrong-site surgeries, ranging from scheduling processes to operating-room procedures to organizational culture [19, p. 4].

Some of the causes of wrong-site surgeries are very similar to the causes of the wrong flange being opened. Those causes and the proposed solutions are in **Table 2** below.

Table 2. Comparison of “Wrong Site Surgery” Solutions and the Wrong Equipment Opening Incident at PEMEX Deer Park [19].

Cause	Joint Commission’s Solution	Similarity to PEMEX Deer Park Incident
Inconsistent use of site-marking. Examples include someone other than surgeon marks site, site mark is made with unapproved surgical-site marker, stickers are used instead of marking the skin, and inconsistent site marks are used by surgeons.	Create new protocol requiring surgeons to use a single-use surgical-site marker with a consistent mark type (e.g., surgeon’s initials) placed as close as anatomically possible to the incision site.	Equipment identifiers, including flange-locking devices, blind tags, and Circle-X markings were used in the Amine Unit. (Section 3.1.1)
Hand-off communication or briefing process is ineffective.	Perform a pre-operative briefing upon arrival in the operating room with patient involvement, if possible, to verify patient identity, procedure, site, and side, along with any other critical information.	PEMEX Deer Park had no method to verify that craftworkers understood and positively identified the equipment for opening. (Sections 2.2 and 3.1)

The Joint Commission reported that organizations that participated in its study and had adopted its process improvement tools reduced the number of surgical cases with identifiable risks for wrong-site surgery by 46 percent in the scheduling area, 63 percent in the pre-op/holding area, and 51 percent in the operating room [19].

811 Call-Before-You-Dig

In 2005, the Federal Communications Commission (FCC) designated 8-1-1 as the nationwide three-digit number for contractors and the public to connect with underground utility operators and local governments before conducting excavation projects [20]. The 8-1-1 call-before-you-dig initiative came from the consolidation of all one-call communication centers’ phone numbers into a single nationwide number to help prevent widespread digging accidents. These centers function as local communication hubs for two or more utility companies, government agencies, or other operators of underground facilities to coordinate notifications about excavation activities [21, pp. 6-8].

After a caller dials 8-1-1, the one-call center contacts the local utility companies to have them mark any buried utility lines with paint, flags, or both (**Figure 26**) before any excavation activities commence. The marking practice maps out the underground facilities to help excavators avoid digging near any pipes, conduits, or cables, which can lead to an accident if struck and damaged. As shown in **Figure 26**, each color represents a specific utility and is standardized in accordance with the American Public Works Association color code, which is based on the ANSI Z535.1 *Safety Color Code* standard [22].



Figure 26. Utility color code and marked site depicting underground facilities. (Credit: Missouri 811)

The 8-1-1 call-before-you-dig program has helped excavators collaborate with underground facility operators to promote public safety. According to the U.S. Department of Transportation, excavators who call 8-1-1 before they dig have a 99 percent chance of avoiding an incident, injury, environmental harm, and even death [23].

The CSB concludes that positive identification marking standards in the medical and utility industries have reduced the instances of misidentification incidents. Similar standards in the chemical and refining process industries could reduce the likelihood of accidental release events due to equipment misidentification.

3.1.3.4 Need for an Industry Standard

There is limited guidance on marking standards for positive identification of equipment openings. At the time of this report's publication, the CSB was unable to locate an industry standard requirement for equipment markings to ensure that the wrong equipment is not mistakenly opened, other than LOTO requirements.^a As discussed below, a standardized, consistently used method to mark the location of equipment openings by all parties could have prevented this incident and other similar recent incidents.

The CSB concludes that incidents involving the opening of the wrong equipment continue to occur because there is insufficient industry guidance to standardize equipment opening markings. As the CSB recommends below, steps can be taken to prevent future incidents.

ASME is a not-for profit membership organization that enables collaboration, knowledge-sharing, and skills development across all engineering disciplines. Since 1928, ASME has published the standard ASME A13.1 *Scheme for the Identification of Piping Systems* [15]. This standard recognizes that mistakes made in disconnecting pipes at the wrong place have resulted in numerous injuries to personnel and damage to property and prescribes requirements and recommendations to promote greater safety through a uniform system for identifying piping contents. The standard also recognizes the potential for confusion among craft workers who change employment from one plant to another, such as Repcon's employees [15, p. vii]. The standard does not,

^a Although LOTO methods are critically important to control hazardous energy, the methods prescribed in ANSI Z244.1 *The Control of Hazardous Energy Lockout, Tagout and Alternative Methods* and other similar publications do not include requirements to physically mark the areas that will be opened.

however, prescribe requirements or give recommendations for uniform labeling to facilitate equipment opening and/or line break activities.

The CSB recommends that the American Society of Mechanical Engineers (ASME) develop written guidelines for marking equipment for opening. The guidelines should define a standard practice for equipment marking that includes clear identifiers of the area to be opened and means to remove the markings at the conclusion of the work.

3.2 WORK PERMITTING AND HAZARD CONTROL

Robust permitting systems are a generally accepted means to mitigate hazards, control work, and ensure that the intended equipment is worked on. The work permit process can be effective in controlling hazards by ensuring that work permits are unambiguous, specific to the job, and consider risk to other processes.

The CCPS provides guidance on developing a permit-to-work system, which includes strategies to ensure that equipment is correctly identified. Specifically, the CCPS recommends that permit authorizers inspect the jobsite together with the workers; ensure that the correct type of permit for the class of work is issued; and ensure that the permit describes the exact location, hazards, and persons authorized to do the work. [24, pp. 3, 8]. Further, the CCPS recommends that work permits define unambiguous hold or stop points when critical steps must be verified before execution [25, pp. 7, 10].

As described below, PEMEX Deer Park's permit-to-work system did not effectively control the hazards of opening piping within the active Amine Unit that was upwind of the Sulfur Unit in turnaround, where dozens of other contractors were working.

3.2.1 SPECIFIC PERMITS TO CONTROL SPECIFIC HAZARDS

PEMEX Deer Park issued Repcon a broad permit to remove all 15 blinds from ARU6, even though the acid gas blinds presented unique hazards and required a PEMEX Deer Park operator to be present. As a result, the Repcon boilermakers believed that they were authorized for all blind removal work and mistakenly chose the ARU7 flange, assuming it to be the location of Blind 407. If PEMEX Deer Park had issued a separate work permit for the acid gas blind removal, the operator likely would have been present for the acid gas flange opening and correctly identified the location of Blind 407.

PEMEX Deer Park's permitting procedure allows multiple jobs to be included on the same permit, as long as the work is performed by the same contract worker using the same piece of equipment and the hazards and safeguards associated with the work are the same. The procedure states:

Written work permits are typically issued for each task; however, multiple jobs by the same craftworker, **on the same piece of equipment**, may be covered on

KEY LESSON

The scope of a work permit must be the right size for the job. A permit that is too broad may fail to control all the hazards a worker could encounter. Each permit should control the specific hazards for the work being authorized.

one permit provided that the isolation, **hazards, and safeguards are the same**. Each job must be **listed individually** on the permit for each work area **after it has been checked** for proper isolation, decontamination and assessment for potential hazards. (emphasis added)

The permit issued to Repron authorized the boilermakers to remove all 15 blinds associated with the ARU6 maintenance, even though the permitted work involved removing blinds on different equipment with differing hazards and differing safeguards. As depicted by the purple annotations in **Figure 27**, the task of removing the first 13 blinds did not pose a potential acid gas exposure hazard, and the permit required boilermakers to wear only half-face respirators. The removal of the acid gas blinds, including Blind 407, involved potential exposure to acid gas and required the boilermakers to use supplied air, as shown by the red annotations in **Figure 27**. The permit recognized the differing hazards posed by the two tasks, as demonstrated by the requirement for more stringent respiratory protection for Blind 407. The acid gas blind removal task posed a greater risk than the removal of the first 13 blinds. The permit also specified “Ops present for each break,” which indicated that operators were supposed to be present when the connected piping for the 13 blinds was first opened to the atmosphere and again when the acid gas piping, which posed a greater risk, was opened to the atmosphere.

PERMIT TO WORK

Permit type: A or B (circle one) Unit/Area: ARU6 / Sulphur Equipment #: [redacted]
 Company/Craft: Repron Filters Issue Date: 10/10/24 Expires Date: 10/16/24
 Job Description: Remove 15 blinds on ARU6 Piping Column
Blind #407, Blind #408, CAG+Flare will be done with supplied air

ENTRY PERMIT # _____ PRODUCT Lean Dec SDS/Product Code #(s) _____

Emergency Response Information "For Fires, Gas Releases, Rescues, or Medical Emergencies" Call 6-4444
 Grid Map Location _____ Cross Streets _____
 Primary Assembly Area _____ Secondary Assembly Area _____

Atmospheric Testing Required Yes No
 % Oxygen _____ Atmospheric Gas Tester: _____
 % LEL _____ Was GC used to analyze Sample? Yes No
 If yes, GC results must be attached to permit
 PPM - List Components tested and results for each
MS Sp. Co. Pm

Automotive Entry Yes No
 Continuous Atmospheric Monitoring required _____
 Shut down engines to refuel _____
 Do not leave motors running unattended _____
 Stop work/Shut down motors if leak occurs _____
 List Equipment: _____

Electrical Safety Req Yes No
 Ohms Test Results \leq 1 _____
 Tools/Equipment grounded _____
 GFCI in place _____
 Non-rated equipment is attended _____
 Other: Testing drill

Process LOTO Required? Yes No
 Direct Isolation _____ Group Isolation _____
 Chained & Locked _____ Isolation List in EIF _____
 Tagged _____ Isolation Drawing in EIF _____
 Blinded _____ Lock Box# _____
 Air Gapped _____ Lock Seal# _____
 Exclusive Control _____

Electrical LOTO Required? Yes No
 Circuit breaker open _____ Disconnected & tagged _____
 Operations Lock & Tag(s) _____ Energized Job prep checklist completed _____
 Maintenance Lock & Tag(s) _____ Opns & Maint. Tags hung for troubleshooting _____
 Start / Stop station tagged _____ Safety Ground installed and tested _____
 Circuit breaker closed _____ Standby to guard Disconnect Device _____
 Disconnect Device within sight & <15' from work _____

Equipment Condition _____ Full _____ Empty _____ N/A If empty, indicate how it was decontaminated.
 Drained/Pumped Out _____ Steam Purged _____ Depressurized _____ Other: _____
 Water Washed _____ Nitrogen Purged _____ Vented _____
 Chemically Cleaned _____ Bleeders Open _____

PPE & Other Safety Requirements
 Goggles/Faceshield (Circle one) _____
 Gloves (Leather/Chemical/Electrical) _____
 Type _____
 Hood (Chemical/Thermal/Welding/Blasting) _____
 Suit (Chemical/Thermal/FR Tyvek/Tyvek) _____
 Boots (Chemical/Rubber/Thermal) _____
 Safety Harness (Lanyard/SRL) _____
 Hearing Protection _____
 Single _____ Double _____

Air Purifying Respirator _____
 Type: Half face
 Fresh Air Job _____
 Supplied Air Respirator - SAR _____
 IDLH Job _____
 Airline resp. with egress _____
 Standby with S.C.B.A. _____
 Bottle Watch required _____
 & instructions issued _____

Regulated area (i.e. benzene, asbestos) established _____
 Barricade Area _____
 Safety shower/eyewash located _____
 Heat Stress Work/Rest required _____
 Continuous Monitoring _____
 Passive (4 Gas) _____ Active _____
 Conflicting Work Mitigated _____
 Other _____

Additional Precautions:
First Air on CAG+Flare B/Fed.
Ops present for each break

Figure 27. Work permit issued to Repron to remove ARU6 blinds. Purple text corresponds with work on the first 13 blinds, where the acid gas hazard is not present. Red text corresponds with work where an acid gas exposure hazard exists. (Credit: PEMEX Deer Park; edits by CSB)

The removal of the blinds on the acid gas piping (including Blind 407) posed different hazards from the other 13 blinds. As such, the work should have been authorized as part of a separate permit, issued just before the work was to be completed. If a separate permit had been issued for Blind 407 and the other acid gas blind, the operator likely would have been present at the commencement of the acid gas flange opening, ensuring that Blind 407 was correctly identified.

The CSB concludes that PEMEX Deer Park issued a work permit to Repcon that covered removing blinds with different hazards, even though its procedures prohibited the practice. Had the task to remove blinds on acid gas piping, to include Blind 407, been issued on a separate permit, it would have prompted a separate joint jobsite inspection and made it likely that a PEMEX Deer Park operator would have been present to positively identify Blind 407 on the ARU6 piping, preventing the incident.

Post-Incident Improvements

Following the incident, PEMEX Deer Park updated the work permit procedure to require both the foreman and craftworker performing the permitted work to be present for the pre-job walkthrough for permits involving energy isolation.

3.2.2 HOLD OR STOP POINTS

The CCPS recommends the use of hold points or stop points within a permit-to-work system when critical steps must be followed, such as when equipment openings must pause until an operator is present [25]. Specifically, the CCPS states that job aids and work packages should be unambiguous and succinct and clearly define who is responsible for critical actions and stop or hold points [25, pp. 7, 10].

The work permit issued to Repcon stated “Ops present for each break” (**Figure 27**), and the PEMEX Deer Park operator stated that he verbally told the Repcon foreman to alert an operator before opening the acid gas piping. The Repcon foreman told the CSB that he believed the requirement for operator presence was only for the first break that morning and that the operators had given him verbal permission to proceed with the acid gas pipe opening. The Repcon boilermakers also told the CSB that they believed they were authorized to complete all 15 blind removals after they were given the work permit.

Although the work permit (shown in **Figure 27**) includes a requirement for operator presence, the recollections by the permit issuer, permit receiver, and boilermakers show that the written statement on the permit was ineffective as an stop or hold point.^a The CSB concludes that because PEMEX Deer Park’s work permit lacked a defined hold or stop point, the operators, the foreman, and the boilermakers all understood the requirements

KEY LESSON

Hold points within a permit-to-work system help ensure that critical actions are not missed or skipped. To be effective, permit hold points must be unambiguous and clearly define responsibilities before the work can continue.

^a The use of two distinct work permits, as described in Section 3.2.1, would have functioned similarly to an unambiguous hold point.

differently. As a result, the boilermakers mistakenly chose an active hydrogen sulfide line to open without the operator present to prevent their error.

3.2.3 CONTROLLING HAZARDS TO SURROUNDING PROCESSES

An effective permit-to-work process evaluates not only the hazards to those performing the work but also the hazards that the work presents for people involved in surrounding processes. PEMEX Deer Park's permitting process did not effectively identify the risk of performing intrusive line break work near the Sulfur Unit, where dozens of other contractors were working.

The CCPS's guidance on permit-to-work systems expects organizations to evaluate and control hazards to surrounding process units before issuing work permits [24]. Specifically, the CCPS states that the permit-to-work system should identify and control hazards by:

- Communicating the job to all relevant stakeholders, including the area workforce and **neighboring units** [24, p. 7].
- Coordinating work activities with other supervisors and managers when the work affects **two units simultaneously** [24, p. 12].
- **Limiting personnel** and vehicle traffic in the area [24, p. 7].

PEMEX Deer Park was aware that the Amine Unit maintenance activity presented a hazard to surrounding units. The Amine Unit maintenance procedure, which is specifically used when one ARU is operating and the other is shut down, stated that “a significant leak will result in [hydrogen sulfide] drifting downwind and possibly affecting neighboring units.”

PEMEX Deer Park intended to control line break hazards through its standardized procedure for generating work permits, which stated:

Permitting Work that involves breaking containment of process lines that could potentially release harmful vapors or have the potential to expose others in adjacent or downwind areas, requires prioritization of all work activities in the area.

PEMEX Deer Park's procedure for generating work permits also stated that hazards to surrounding units should be evaluated. The procedure required that several individuals have responsibility to identify and manage risks to other processes associated with the permitted activity, including the equipment owner, permit issuer, permit cosigner, and permit receiver. The procedure stated that the hazards should be documented on a Simultaneous Operations (SIMOPs) form (**Figure 28**). However, the form provided no guidance on how to perform a SIMOPs evaluation or mitigate the associated hazards.

Projects SIMOPS Cosigner Sheet		
Unit/Area:		Date:
Task Description	Project Equipment Owner/Permit Writer	Unit Operator

Figure 28. The SIMOPs form required by the standardized procedure. (Credit: PEMEX Deer Park)

The work permit issued to Repcon to remove the ARU6 blinds (shown in Figure 29) indicated that the conflicting work was reviewed and managed. However, none of the PEMEX Deer Park process owners, permit issuers, or reviewers completed a SIMOPs form (Figure 28).

PPE & Other Safety Requirements

- Goggles/Faceshield (Circle one)
- Gloves (Leather/Chemical/Electrical)
 - Type _____
- Hood (Chemical/Thermal/Welding/Blasting)
- Suit (Chemical/Thermal/FR Tyvek/Tyvek)
- Boots (Chemical/Rubber/Thermal)
- Safety Harness (Lanyard/SRL)
 - Single _____ Double _____
- Hearing Protection
- Air Purifying Respirator
 - Type 1/2 Face
 - Fresh Air Job
 - Supplied Air Respirator - SAR
 - IDLH Job
 - Airline resp. with egress
 - Standby with S.C.B.A.
 - Bottle Watch required & instructions issued
- Regulated area (i.e. benzene, asbestos) established
- Barricade Area
- Safety shower/eyewash located
- Heat Stress Work/Rest required
- Continuous Monitoring
- Passive (↑ Gas) _____ Active _____
- Conflicting Work Mitigated
- Other _____

Figure 29. A section of the permit issued to the Repcon boilermakers who were performing the ARU maintenance. The red circle shows where the permit indicated the SIMOPs hazards were evaluated. (Credit: PEMEX Deer Park, modified by CSB)

The CSB found that the PEMEX Deer Park operators generally viewed SIMOPs and conflicting work considerations as simply a checkbox to complete when issuing a permit. As one PEMEX Deer Park operator described:

I don't really know much about SIMOPs either. It's more like part of the permit, one of the boxes that you check... That box probably gets checked a lot without people even thinking about it, you know?

Additionally, a PEMEX Deer Park safety specialist told the CSB:

[SIMOPs is] basically just a checkmark to say that SIMOPs has been considered and been looked at by operations. [...] I think it is up to their discretion.

Moreover, even though the work permit form required conflicting work to be reviewed and managed, PEMEX Deer Park's procedures did not provide any guidance to the operators about how to perform a SIMOPs evaluation.

The CCPS defines SIMOPs as “two or more different activities that are close enough to interfere with each other and transfer risk or performance implications” [26, p. xxii]. Failure to address the hazards associated with SIMOPs can result in impacts to the environment and surrounding community, property damage, and personnel injury [27, pp. 5-6]. The CCPS recommends that companies determine what potential interactions exist between jobs, identify the most hazardous consequence from each scenario, and develop safeguards to mitigate the risk [27, pp. 12-15].

By opening piping that contained hydrogen sulfide in the Amine Unit while turnaround work was being performed in the adjacent Sulfur Unit, PEMEX Deer Park created a SIMOPs hazard. Performing a SIMOPs review or similar hazard analysis could have identified the potential for the Sulfur Unit workers to be exposed to hydrogen sulfide if it were released. Additionally, as part of the SIMOPs review, PEMEX Deer Park could have developed mitigative actions, such as delaying the Amine Unit maintenance until after turnaround or doing it when fewer Sulfur Unit workers were onsite.

The CSB concludes that PEMEX Deer Park did not evaluate the hazards of opening piping in the Amine Unit directly upwind of the Sulfur Unit, where many contractors were working on turnaround activities. PEMEX Deer Park's permit-to-work system did not prepare its employees to evaluate and control the hazards to other process units, such as by delaying the Amine Unit pipe opening activities until conclusion of the turnaround. As a result, dozens of contractors were working in the path of the hydrogen sulfide release, with one of the turnaround worker fatally injured and 13 others injured.

3.3 TURNAROUND CONTRACTOR MANAGEMENT

Because contract workers generally are hired to perform specific, specialized tasks, such as during maintenance turnarounds, they are often unfamiliar with all facility hazards and operations [28, p. 366]. Companies must ensure that contract workers accurately understand the hazards associated with their work area. PEMEX Deer Park had turnaround contract workers perform work in a live operating unit without first ensuring that they were aware of the hazards and controls in the new work area.

Industry and Regulatory Guidance

The CCPS guidelines highlight the importance of ensuring that contract workers are aware of the hazards in their work area:

The company must supply appropriate information to the contractor to ensure that the contractor can safely provide the

contracted services. As a minimum, the **facility's safety policies, procedures to control work, and general work rules should all be provided to the contractor with sufficient lead time** so that the contractor can train their personnel. [...] Such information could include an **overview of the process and its hazards** [...]. Depending on the tasks that the contractor will perform, additional technical information (e.g., P&IDs) may have to be supplied [28, pp. 374-375]. (emphasis added)

Further, OSHA's Process Safety Management (PSM) standard and the Environmental Protection Agency's (EPA's) Risk Management Plan (RMP) rule require both companies and contractors to communicate the hazards associated with a contract worker's task and the associated process.

The [employer/owner or operator] shall inform contract employers of the known potential fire, explosion, or toxic release hazards related to the contractor's work **and the process.**^a

The contract [employer/owner or operator] shall assure that each contract employee is instructed in the known potential fire, explosion, or toxic release hazards related to his/her job **and the process** [...].^b (emphasis added)

Managing Contractors Between Different Units

On October 10, 2024, four Repcon boilermakers were reassigned from the shutdown, de-inventoried, and isolated Sulfur Unit to the partially operating Amine Unit. Up to this point, PEMEX Deer Park had briefed the Repcon boilermakers only on the Sulfur Unit turnaround. As a result, the boilermakers viewed all of their assigned work as part of the turnaround, even after the sudden reassignment to the Amine Unit. Because they were unaware that the Amine Unit was active, the Repcon boilermakers expected all the equipment in the Amine Unit to be empty. By relying on the red flange-locking devices and blind installation tags specific to turnarounds to identify which equipment to open, the Repcon boilermakers inadvertently disassembled a flange on the operating ARU7 process.

PEMEX Deer Park utilized two distinct systems with different rules and requirements for maintenance tasks in different process units, known as "Run-and-Maintain" and "Positive Isolation." Run-and-Maintain activities (discussed in Section 1.3.1) occur when units are operational or partially operational, and more stringent requirements exist. Positive Isolation (discussed in Section 1.3.2) is used during outages and turnarounds, under which everything within the boundaries of the unit is considered shut down, depressurized, decontaminated, and

^a [29 CFR 1910.119\(h\)\(2\)\(ii\)](#) and [40 CFR 68.87\(b\)\(2\)](#)

^b [29 CFR 1910.119\(h\)\(3\)\(ii\)](#) and [40 CFR 68.87\(c\)\(2\)](#)

isolated from outside hazardous process energy. As shown in **Figure 30**, on the day of the incident, the Amine Unit was operating in Run-and-Maintain, while the Sulfur Unit was in Positive Isolation

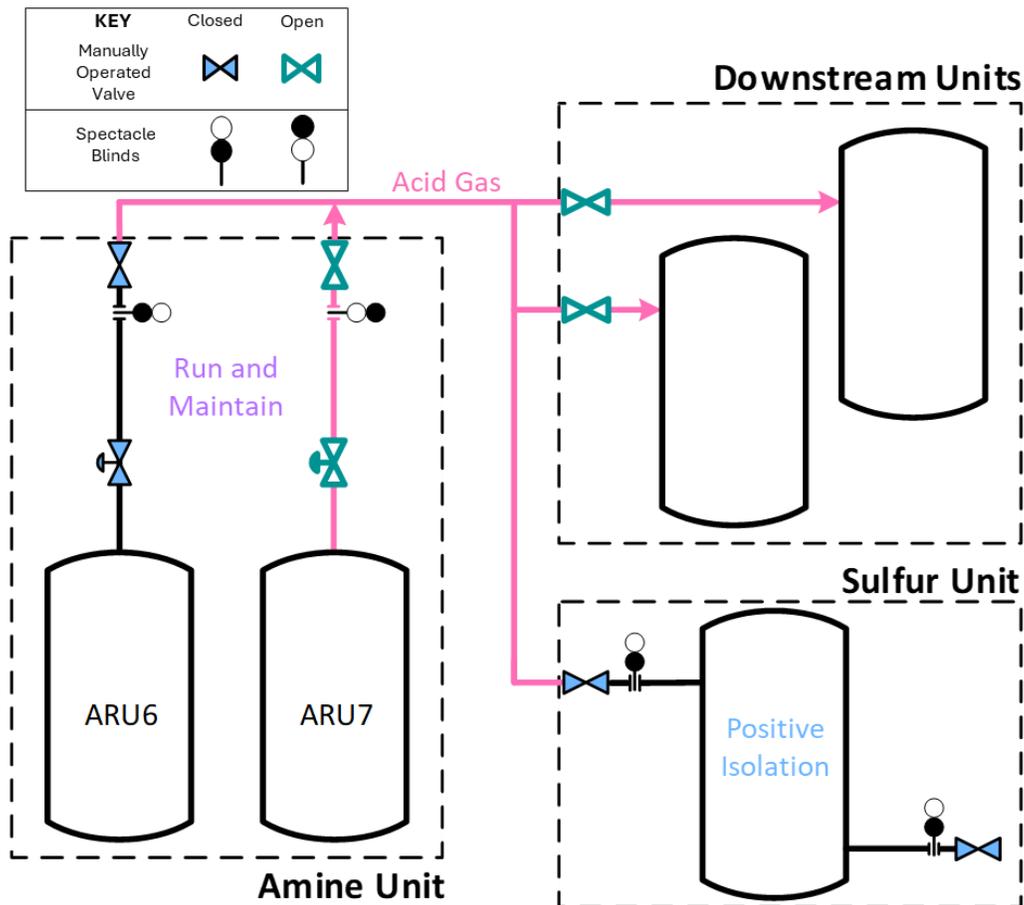


Figure 30. Amine Unit under Run-and-Maintain and the turnaround Sulfur Unit under Positive Isolation with adjacent operating units.^a (Credit: CSB)

PEMEX Deer Park's procedures had defined, more stringent requirements for Run-and-Maintain operations to control the hazards of working around live equipment. In contrast, the Positive Isolation rules during turnaround were less stringent because workers were assumed to be working around depressurized and empty equipment. The difference between the Run-and-Maintain and Positive Isolation requirements left the Repcon boilermakers with a misperception of the hazards in their work area, as illustrated in **Figure 31**.

^a The Sulfur Unit under turnaround had a total of 50 isolation blinds installed to achieve Positive Isolation Status.

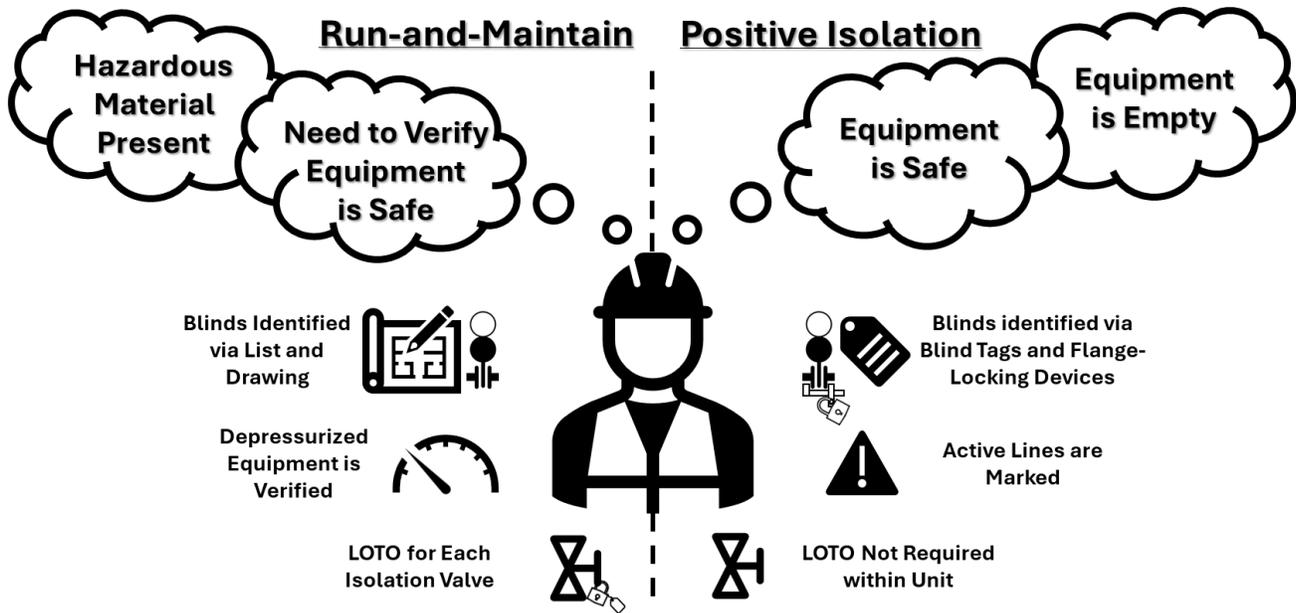


Figure 31. The applicable requirements within Run-and-Maintain (left) and Positive Isolation (right). (Credit: CSB)

Boilermakers Believed They Were Working Within a Turnaround

At the start of the turnaround, PEMEX Deer Park provided an onboarding briefing to the Repcon boilermakers with information specific to the Sulfur Unit turnaround. The turnaround onboarding did not include information on the Amine Unit or a description of Run-and-Maintain operations. The Repcon boilermakers who were tasked with removing Blind 407 had been working on the turnaround for at least 10 consecutive days before the incident. Four days before the incident, when the Sulfur Unit achieved Positive Isolation, the Repcon boilermakers started working in a shutdown, depressurized, deinventoried, and isolated unit (right side of **Figure 31**).

On October 10, PEMEX Deer Park reassigned the boilermakers from the Sulfur Unit in Positive Isolation to the Amine Unit in Run-and-Maintain. The reassigned boilermakers had not been involved in the Amine Unit blind installation and had not previously worked outside the Sulfur Unit turnaround in the days prior to the incident. Further, PEMEX Deer Park did not brief the boilermakers on Run-and-Maintain expectations (left side of **Figure 31**) comparable to the turnaround onboarding for the Sulfur Unit. Although the boilermakers had been trained in and previously worked in Run-and-Maintain operations, they were not aware that their reassignment to the Amine Unit was outside the turnaround. As a result, the boilermakers were unaware of the hazards involved in removing the Amine Unit blinds near active equipment, which required Run-and-Maintain procedures for mitigation, as depicted in **Figure 31**.

In an interview with the CSB, the Repcon foreman acknowledged that PEMEX Deer Park had communicated the status of the Amine Unit to him. However, even though this information was clearly communicated to the foreman, the boilermakers did not receive it. PEMEX Deer Park had not directly informed the Repcon boilermakers about the Amine Unit's status or the hazards associated with the maintenance task. Instead, under PEMEX Deer Park's policy, the foreman, acting as the dedicated craftsperson, was expected to relay all this information to his crew.

PEMEX Deer Park expected the Repcon day shift foreman to communicate all the permit and job requirements to the boilermakers, as the Repcon foreman had the most familiarity with the Amine Unit maintenance tasks. After the incident, PEMEX Deer Park established a policy to ensure direct communication between a PEMEX Deer Park operator and the workers performing the job.

The CSB concludes that PEMEX Deer Park and Repcon did not sufficiently communicate to the boilermakers that they were being relocated from a shutdown turnaround unit to an active unit, and did not instruct the Repcon boilermakers on the requirements and precautions for working in a Run-and-Maintain unit. As a result, the Repcon boilermakers were unaware of the hazards in the Amine Unit while removing blinds from the equipment.

The Repcon boilermakers stated to the CSB that they believed the Amine Unit was a part of their turnaround activities:

Repcon Boilermaker #1: Yeah, well, I mean, we were doing the turnaround there, so yeah. Usually, in a turnaround, the unit's shut down.

CSB Investigator: So you...thought that the [Amine] Unit was in turnaround as well?

Repcon Boilermaker #1: Yes. [...] Like I said, [...] the PEMEX operator never told us otherwise. Like it was...we were at the turnaround.

CSB Investigator: Okay. So you thought all the work you were doing was turnaround work?

Repcon Boilermaker #1: Yes.

Additionally:

CSB Investigator: What did you know about that [Amine] Unit? What was different between that and the job you were doing on the turnaround?

Repcon Boilermaker #2: Different? I mean, I don't know. [...] The only thing I remember is that PEMEX had mentioned that we needed to pull out blinds for that unit.

CSB Investigator: Did you know the operational status of the unit? What was running, what was not running?

Repcon Boilermaker #2: No. I mean, they would just tell us, "Okay, these are the blinds that we're going to work on." And that's it. They wouldn't point out, hey, this is running, this is not running.

KEY LESSON

It is important to establish direct communication between company personnel and the workers performing a job to ensure that the handoff of information is as accurate as possible.

CSB Investigator: Did you know what materials or chemicals were in the unit, in the pipes, in the vessels?

Repcon Boilermaker #2: No.

The CSB concludes that the Repcon boilermakers believed they were working in a shutdown unit with pre-determined safeguards, which led to them being unaware of the hydrogen sulfide hazard within the partially operating Amine Unit. The boilermakers did not perceive the change in their work environment that constituted the necessary risk awareness and procedures to perform equipment openings around operating units.

Hazard Awareness and Overlooked Safeguards

Because the boilermakers believed that they were working under the established safeguards of the turnaround environment (**Figure 31**), they had a misperception of the unit hazards and overlooked practices and safeguards necessary to ensure the equipment was safe. The boilermakers perceived that verifying the equipment status was inconsequential, as they expected the Amine Unit also to be shut down, depressurized, decontaminated, and isolated, like the rest of the turnaround equipment.

Because the boilermakers had been working in the Sulfur Unit under Positive Isolation, they overlooked established administrative safeguards, as depicted in to ensure the equipment was safe to work on during Run-and-Maintain operations:

- **Blind Tags and Flange-Locking Devices** – As was discussed in Section 2.1, blind tags and flange-locking devices were used on blinds within the Sulfur Unit undergoing a turnaround. The boilermakers defaulted to these equipment identifiers to locate blinds due to their familiarity with them from the Sulfur Unit turnaround.
- **Active Lines Marked** – In Positive Isolation, PEMEX Deer Park required any equipment containing hazardous materials to be marked with “Active Line” tags. Because the boilermakers believed that they were working under the turnaround environment, they assumed that any piping without an “Active Line” tag was empty.
- **Lock-out-Tag-out** – Under Positive Isolation, PEMEX Deer Park did not require LOTO for intrusive work within the unit. Unaware that they were working outside of Positive Isolation, the boilermakers did not check all LOTO valves in their area before starting their work and assumed that all nearby equipment was empty.

Concerns About Whether Workers Could Adapt to a Changing Work Environment

Several PEMEX Deer Park operators were aware and concerned that switching contract workers between units with differing rules could introduce human error. PEMEX Deer Park operators described to the CSB their concerns:

PEMEX Deer Park Operator #1:

They’re peeling these guys off that are working [positive isolation]. **The rules are completely different.** They’re pulling them off to work a Run-and-Maintain

unit. They're used to breaking [into equipment]. By this time in the turnaround, they were used to breaking [equipment] open that didn't have nothing in it because we got the unit completely blinded. **So for them to see a valve open and to break a flange right next to it, it's not a big deal to them.** They just have a [permit] saying they can do it because I go out there and check it, **"Yep, you can do it. We're in [positive isolation]."**(emphasis added)

PEMEX Deer Park Operator #2:

I think that they should have a dedicated crew and don't pull people from turnaround on[to] a live running unit because they think... We also think that they thought it was running out of the turnaround. It was still turnaround. You know, **turnaround you feel safe** because everything's blinded. Every line in the turnaround...the bleeder is blinded. So they must've thought they were in a safe zone. (emphasis added)

PEMEX Deer Park Operator #3:

I'm not a fan of... You know, in this particular case, they were borrowing maintenance from the turnaround people to come over and do maintenance on running units. I think that's a terrible idea. I think **we have different rules for maintenance during turnaround than we do on units that are live.** And borrowing those people who are used to working on a turnaround, to come over and do maintenance on live units is a bad idea. (emphasis added)

PEMEX Deer Park Operator #4:

When we have a turnaround, [...] **we cannot bring other [contract workers]** into the turnaround, **besides the [worker] that's doing the turnaround.** Like, they cannot bring the PEMEX instrumentation, the PEMEX fitters in there. So then **why would you take the turnaround [workers]** and put them **on a job that's not turnaround?** (emphasis added)

The CSB concludes that the Repcon boilermakers were not prepared to perform work on a Run-and-Maintain unit after performing work under the safeguards of the adjacent Sulfur Unit undergoing a turnaround. The Repcon boilermakers were unaware of the different rules and requirements for conducting maintenance tasks within the partially operating Amine Unit. They relied on the rules of Positive Isolation, where all equipment is de-inventoried, decontaminated, depressurized, and isolated, and the blind locations are identified with tags and secured with flange-locking devices. Because the boilermakers believed that they were working within Positive Isolation, they overlooked several administrative safeguards and ultimately opened an active acid gas line, believing it was empty.

The CSB recommends that PEMEX Deer Park develop procedures to ensure that any craftworkers introduced to or removed from a unit in Positive Isolation Status receive instructions that define the hazards, safeguards, and requirements of the unit associated with the work. The procedures should require each craftworker to receive

clear communication on the identified hazards, control measures, and all other requirements before commencing work in a new area.

Post-Incident Improvements

Following the incident, PEMEX Deer Park added requirements to the turnaround procedure for operators to display signs to distinguish Run-and-Maintain operations from areas under Positive Isolation Status (**Figure 32**). Additionally, during a joint jobsite inspection, a feather flag will be placed at the jobsite. The signage and flag will serve to alert craftworkers about the transition between a turnaround area and a live unit.



Figure 32. Signage displayed to distinguish Run-and-Maintain areas from Positive Isolation areas. (Credit: PEMEX Deer Park)

3.4 CONDUCT OF OPERATIONS

Conduct of operations, also called operational discipline, is a CCPS pillar of *Risk Based Process Safety*. Conduct of operations is the practice of executing operational and management tasks in a deliberate and structured manner to minimize variations in performance [28, p. 470]. Conduct of operations ensures reliable performance by establishing standards of behavior at every level of an organization, from workers to senior leadership [28, p. 471]. In his book *An Engineer's View of Human Error*, renowned process safety expert Trevor Kletz commented about the importance of error prevention at all levels of an organization:

Every accident is due to human error: someone, usually a manager, has to decide what to do; someone, usually a designer, has to decide how to do it; someone, usually an operator, has to do it. All of them can make errors but the operator is at the end of the chain and often gets all the blame. We should consider the people who have opportunities to prevent accidents by changing

objectives and methods as well as those who actually carry out operations [29, p. 2].

The CSB has identified ways in which PEMEX Deer Park policies and procedures (the standards of behavior) misaligned with actual practices (organizational performance). These discrepancies were apparent in PEMEX Deer Park standards applying both to operators and management personnel. **Table 3** lists the incongruities discussed earlier in this report to highlight the pervasiveness of PEMEX Deer Park's conduct of operations issues.

Table 3. Conduct of Operations discrepancies contributing to the October 10, 2024, incident.

Standard of Behavior	Organizational Performance	Report Reference
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.	Section 3.1.1
Procedures state that piping must be distinctly labeled per ANSI/ASME A13.1 <i>Scheme for the Identification of Piping Systems</i> .	PEMEX Deer Park did not label identical Amine Unit piping segments located 5 feet apart.	Section 3.1.1
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.	Section 3.2.1
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.	Section 3.2.2
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.	Section 3.2.3
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.	Section 3.3

The CSB concludes that PEMEX Deer Park did not have a robust conduct of operations practice, as shown by the frequent discrepancies between established procedures and the actions by engineering and operations personnel that contributed to the incident.

In the book *Conduct of Operations and Operational Discipline*, the CCPS provides guidance for implementing systems that support robust conduct of operations [30]. The excerpts below provide examples of practices that could improve PEMEX Deer Park’s conduct of operations.

[Conduct of operations] applies to all departments and all levels of the organization: management, operations, technical support, administrative support, and hourly personnel. Inherently, the phrase conduct of *operations* implies that the operations department will be heavily involved. But the same principles can be applied by other work groups to attain the goals of the organization [30, p. 200].

Mutual trust between managers and front-line workers is essential for the success of any improvement initiative. The only way that trust can be established and maintained is for all parties to clearly understand the standards to which they will be held accountable [30, p. 170].

Management Commitment to Performance

A functional conduct of operations system starts with management and supervision. Conduct of operations methods and metrics are established by management and implemented by supervisors. An organization’s conduct of operations principles start with the leadership. The CCPS states:

As management’s first-line representative in an organization, the supervisor has specific responsibilities for the development, implementation, communication, and maintenance of [conduct of operations] performance standards. In preparing for the development effort, the supervisor should first determine that the appropriate methods of operation (standard operating procedures) are being followed by the worker [30, p. 174].

Specifically, the CCPS recommends that management and supervisors ensure that operations staff effectively follow standards and procedures via the following methods:

- “Confirm that the workplace is logically arranged and conducive to the required tasks.” [30, p. 174].
- “Verify that the equipment is set up properly and is operating within the appropriate specifications, tolerances, and safety parameters. A thorough check should be made to ensure that the proper inspection

and safety equipment (e.g., H₂S [hydrogen sulfide] detectors [...]) is in place and that the employee is familiar with its use.” [30, p. 175].

- “Ask the employee to describe the safest and most appropriate way of using equipment and performing both normal and emergency job functions (e.g., [...], breaking flanges, taking samples, [...], evacuating).” [30, p. 175].

Audits

Systematic and independent audits verify conformance with policies and procedures and can identify a breakdown in operational discipline. Accordingly, audits are an important tool to be used during the development and implementation of a conduct of operations system. For instance, audits reveal out-of-date or inaccurate procedures, out-of-date or flawed drawings, and incomplete work permits. PEMEX Deer Park established a permit auditing system due to discrepancies found between completed permits and the procedures. However, PEMEX Deer Park did not adhere to the auditing system, and operators were allowed to continue issuing permits without input from their supervisors. To be effective, audits must specifically evaluate conduct of operations issues, including performance expectations, training, management visibility, leadership by example, and worker knowledge and awareness [30, p. 187].

The CSB recommends that PEMEX Deer Park establish a conduct of operations system that establishes and enforces behavioral and performance metrics in accordance with CCPS’s *Conduct of Operations and Operational Discipline*. The system should include the management commitment to process safety; employee input on policies and procedures; methods to ensure that policies and procedures can be effectively followed, to include, at a minimum, permitting, equipment marking, and energy isolation procedures; and regular audits to verify adherence to conduct of operations metrics, to include performance expectations, training, management visibility, leadership by example, and worker knowledge and awareness.

KEY LESSON

Even the best written programs are ineffective if they do not represent the actual practices of the people within the organization. A successful conduct of operations program ensures consistency in process safety, safe work practices, and how things are done at every level of the company.

4 CONCLUSIONS

4.1 FINDINGS

Positive Equipment Identification

1. PEMEX Deer Park's job aids—a written list and a process sketch—were insufficient in directing the Repcon workers to the intended pipe opening location. If PEMEX Deer Park's permitting and isolation procedures had required that a comprehensive job package be provided that included clear, detailed drawings, the Repcon boilermakers may have more clearly understood the intended location of the work.
2. PEMEX Deer Park did not have a clearly defined system to identify equipment for opening during Run-and-Maintain operations. In the absence of a clearly defined equipment marking system, the Repcon boilermakers chose flanges to open where they saw flange-locking devices. An unlocked flange-locking device on ARU7 piping led the Repcon boilermakers to mistakenly choose an active line to open, believing it to be the Blind 407 location.
3. PEMEX Deer Park's inconsistent and uncontrolled blind tag identification system during the Amine Unit's maintenance did not give a clear indication of what equipment was to be opened. As a result, the Repcon boilermakers relied on the flange-locking devices they had previously used during the Sulfur Unit turnaround to identify which blinds to remove for the ARU6 maintenance task. The Repcon boilermakers identified the work location by spotting a misplaced flange-locking device on the ARU7 acid gas flange, as the Blind 407 identification tag was out of sight.
4. PEMEX Deer Park's use of the Circle-X marking system added unnecessary confusion due to the inability to determine whether the marks were placed from a previous equipment opening. PEMEX Deer Park should have a clear equipment identification process used across turnarounds and normal operations.
5. The Amine Unit's two different but visually identical piping systems were not distinctly labeled, and the boilermakers could not distinguish between the two different systems. Pipe labeling could have provided an additional visual aid to confirm the location of the ARU6 piping system. With no labeling on the ARU6 or ARU7 piping systems and an unclear piping orientation, the Repcon boilermakers relied on other, inappropriate equipment identifiers. This led them to mistakenly open the acid gas piping section of ARU7.
6. The Repcon boilermakers did not look for the ARU6 LOTO valve as an isolation point, as they were unaware that the unit was partially operational. The orientation of the blinds indicated the status of both of the acid gas piping systems. However, the boilermakers believed that they were in a shutdown turnaround unit, where all the equipment is depressurized and isolated from outside hazardous process energy. As a result, they relied on the flange-locking devices and blind tags that were required during turnarounds.
7. PEMEX Deer Park had written procedures that standardize pipe marking for pipe cutting but did not have a standardized process for flange opening and blind removal activities. Had PEMEX Deer Park

required clear standardized markings for all line opening activities, this incident may have been prevented.

8. Incidents occur when the wrong equipment is opened because of ineffective equipment identification methods that do not require positive identification by both the equipment owner and the persons performing the work.
9. Positive identification marking standards in the medical and utility industries have reduced the instances of misidentification incidents. Similar standards in the chemical and refining process industries could reduce the likelihood of accidental release events due to equipment misidentification.
10. Incidents involving the opening of wrong equipment continue to occur because there is insufficient industry guidance to standardize equipment opening markings.

Work Permitting and Hazard Control

11. PEMEX Deer Park issued a work permit to Repcon that covered removing blinds with different hazards, even though its procedures prohibited the practice. Had the task to remove blinds on acid gas piping, to include Blind 407, been issued on a separate permit, it would have prompted a separate joint jobsite inspection and made it likely that a PEMEX Deer Park operator would have been present to positively identify Blind 407 on the ARU6 piping, preventing the incident.
12. Because PEMEX Deer Park's work permit lacked a defined hold or stop point, the operators, the foreman, and the boilermakers all understood the requirements differently. As a result, the boilermakers mistakenly chose an active hydrogen sulfide line to open without the operator present to prevent their error.
13. PEMEX Deer Park did not evaluate the hazards of opening piping in the Amine Unit directly upwind of the Sulfur Unit, where many contractors were working on turnaround activities. PEMEX Deer Park's permit-to-work system did not prepare its employees to evaluate and control the hazards to other process units, such as by delaying the Amine Unit pipe opening activities until conclusion of the turnaround. As a result, dozens of contractors were working in the path of the hydrogen sulfide release, with one of the turnaround worker fatally injured and 13 others injured.

Turnaround Contractor Management

14. PEMEX Deer Park and Repcon did not sufficiently communicate to the boilermakers that they were being relocated from a shutdown turnaround unit to an active unit, and did not instruct the Repcon boilermakers on the requirements and precautions for working in a Run-and-Maintain unit. As a result, the Repcon boilermakers were unaware of the hazards in the Amine Unit while removing blinds from the equipment.
15. The Repcon boilermakers believed they were working in a shutdown unit with pre-determined safeguards, which led to them being unaware of the hydrogen sulfide hazard within the partially operating Amine Unit. The boilermakers did not perceive the change in their work environment that constituted the necessary risk awareness and procedures to perform equipment openings around operating units.

16. The Repcon boilermakers were not prepared to perform work on a Run-and-Maintain unit after performing work under the safeguards of the adjacent Sulfur Unit undergoing a turnaround. The Repcon boilermakers were unaware of the different rules and requirements for conducting maintenance tasks within the partially operating Amine Unit. They relied on the rules of Positive Isolation, where all equipment is de-inventoried, decontaminated, depressurized, and isolated, and the blind locations are identified with tags and secured with flange-locking devices. Because the boilermakers believed that they were working within Positive Isolation, they overlooked several administrative safeguards and ultimately opened an active acid gas line believing it was empty.

Conduct of Operations

17. PEMEX Deer Park did not have a robust conduct of operations practice, as shown by the frequent discrepancies between established procedures and the actions by engineering and operations personnel that contributed to the incident.

4.2 CAUSE

The CSB determined that the cause of the incident was the opening of incorrect equipment, which released pressurized hydrogen sulfide. PEMEX Deer Park did not establish an effective method to clearly identify the correct equipment to open before authorizing opening the equipment. Contributing to the severity of the incident was PEMEX Deer Park's failure to adequately evaluate the hazard posed by opening equipment within an active unit that was adjacent to a unit undergoing a turnaround where many contractors were exposed to the hydrogen sulfide release. Additionally, PEMEX Deer Park deviated from several of their own policies and procedures that could have prevented the incident.

5 RECOMMENDATIONS

To prevent future chemical incidents, and in the interest of driving chemical safety excellence to protect communities, workers, and the environment, the CSB makes the following safety recommendations:

5.1 PEMEX DEER PARK

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 instructions that define the hazards, safeguards, and requirements of the unit associated with the work. The procedures should require each craftworker to receive clear communication on the identified hazards, control measures, and all other requirements 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's *Conduct of Operations and Operational Discipline*. The system should include:

- a) the management commitment to process safety,
- b) employee input on policies and procedures,
- c) methods to ensure that policies and procedures can be effectively followed, to include, at a minimum:
 - 1) permitting,
 - 2) equipment marking, and
 - 3) energy isolation procedures, and
- d) regular audits to verify adherence to conduct of operations metrics, to include, at a minimum:
 - 1) performance expectations,
 - 2) training,
 - 3) management visibility,
 - 4) leadership by example, and

5) worker knowledge and awareness.

5.2 AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

2024-05-I-TX-R4

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

6 KEY LESSONS FOR THE INDUSTRY

To prevent future chemical incidents, and in the interest of driving chemical safety excellence to protect communities, workers, and the environment, the CSB urges companies to review these key lessons:

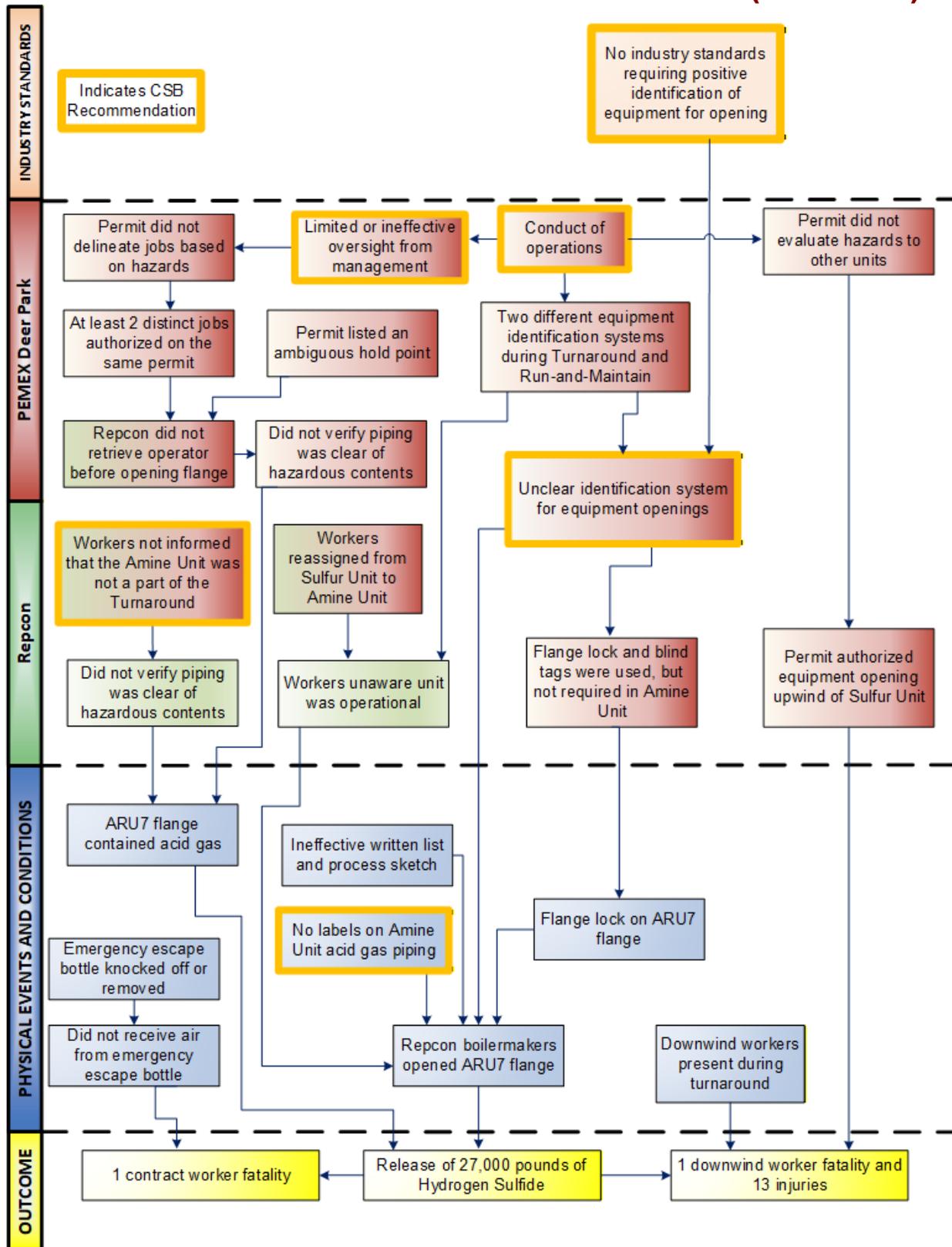
1. Job aids for equipment opening activities should clearly and positively identify which equipment is associated with the authorized work. Physically marking piping after positively identifying the location and using detailed drawings are proven methods to minimize the likelihood of error.
2. Improvised equipment identifiers can add unnecessary confusion, resulting in errors when selecting equipment to open. Standardized markings with verification requirements ensure that all parties understand which equipment should be opened before the work begins.
3. The scope of a work permit must be the right size for the job. A permit that is too broad may fail to control all the hazards a worker could encounter. Each permit should control the specific hazards for the work being authorized.
4. Hold points within a permit-to-work system help ensure that critical actions are not missed or skipped. To be effective, permit hold points must be unambiguous and clearly define responsibilities before the work can continue.
5. It is important to establish direct communication between company personnel and the workers performing a job to ensure that the handoff of information is as accurate as possible.
6. Even the best written programs are ineffective if they do not represent the actual practices of the people within the organization. A successful conduct of operations program ensures consistency in process safety, safe work practices, and how things are done at every level of the company.

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APPENDIX A—SIMPLIFIED CAUSAL ANALYSIS (ACCIMAP)



APPENDIX B—DESCRIPTION OF SURROUNDING AREA

Figure B-1 shows the five populated census blocks within approximately 1 mile of the PEMEX Deer Park Refinery.

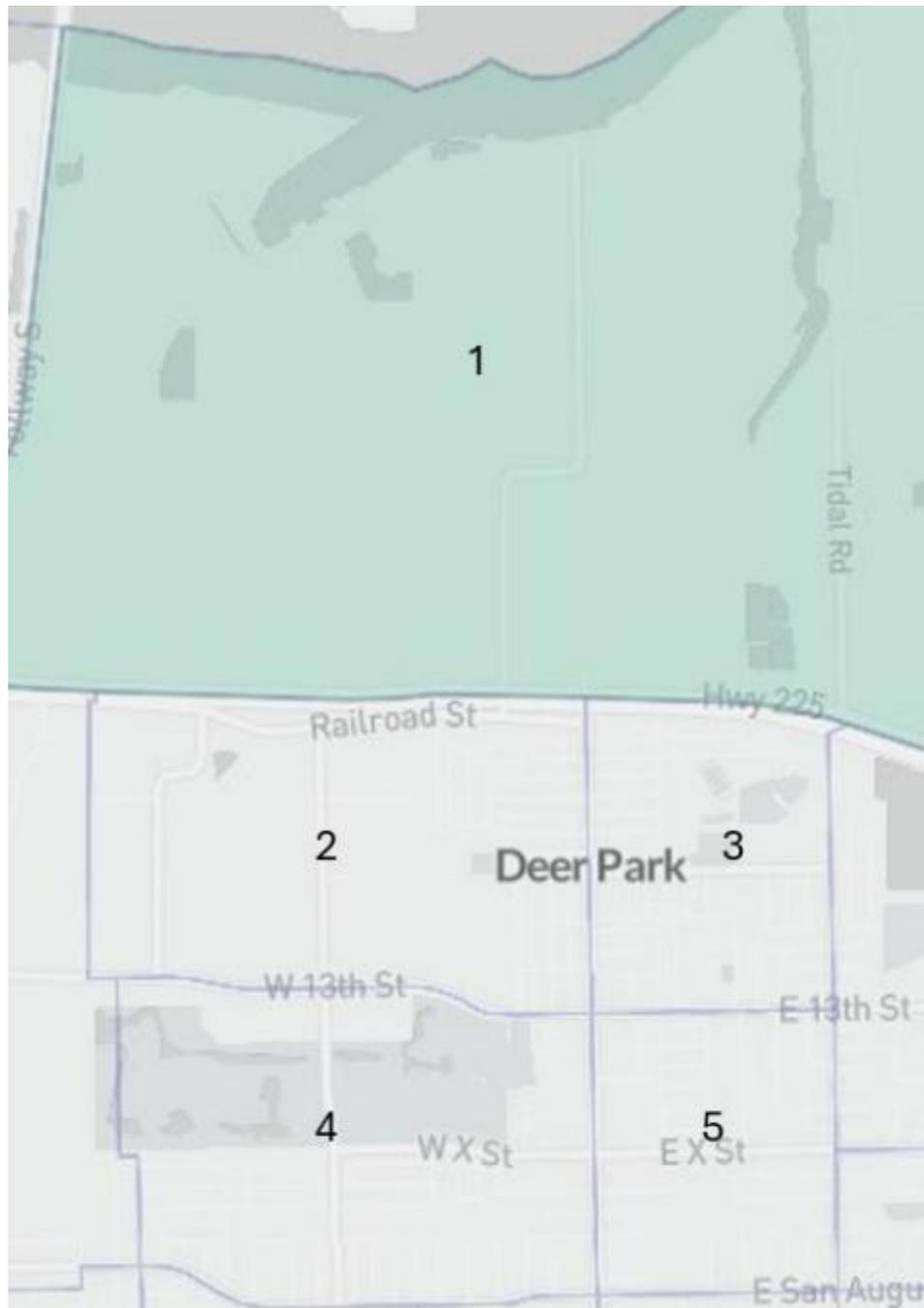


Figure B-1. Census blocks near the PEMEX Deer Park Refinery. (Credit: Census Reporter with annotations by CSB)

Table B-1 contains demographic data for these census blocks.

Table B-1. Tabulation of demographic data.

Tract Number	Population	Median Age	Race and Ethnicity (%)		Per Capita Income	% Persons Below Poverty Line	Number of Housing Units	Types of Structures (%)	
1	1	35	100.0%	White	\$ 150,000	0.0%	1	100%	Single Unit
2	1,296	42	55.0%	White	\$ 41,542	0.0%	590	100%	Single Unit
			0.0%	Black				0%	Multi-Unit
			0.0%	Native				0%	Mobile Home
			0.0%	Asian				0%	Boat, RV, van, etc.
			0.0%	Islander				X	
			0.0%	Other					
			7.0%	Two+					
			37.0%	Hispanic					
3	1,406	33	41%	White	\$ 19,920	0.0%	487	99%	Single Unit
			0%	Black				0%	Multi-Unit
			1%	Native				1%	Mobile Home
			0%	Asian				0%	Boat, RV, van, etc.
			0%	Islander				X	
			0%	Other					
			0%	Two+					
			58%	Hispanic					
4	1,606	46	61%	White	\$ 48,124	0.0%	550	100%	Single Unit
			0%	Black				0%	Multi-Unit
			0%	Native				0%	Mobile Home
			0%	Asian				0%	Boat, RV, van, etc.
			0%	Islander				X	
			0%	Other					
			0%	Two+					
			39%	Hispanic					
5	2,144	37	58%	White	\$ 35,851	0.0%	820	83%	Single Unit
			4%	Black				17%	Multi-Unit
			2%	Native				0%	Mobile Home
			3%	Asian				0%	Boat, RV, van, etc.
			0%	Islander				X	
			0%	Other					
			2%	Two+					
			33%	Hispanic					



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