GO Kettleman Compressor Station Ignition RCE Evaluation Report

SIF Classification: HSIF - High Energy SIF-A **Cause Evaluation Report Type:** RCE

This report has been hereby reviewed and approved by the following:			
Role	**Name, LAN ID**	**Title**	**Signature**
Sponsor	[redacted]	Gas Transmission & Distribution / Director	[redacted]
Team Lead		Gas Clearance Operations / Sr Manager	
Cause Evaluator		Gas CAP / Quality Operations Specialist	

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Report Rev: 01b 9/12/2024

Report Type: Full Report with Executive Summary and Appendices

Report Stage: Post CARB Changes

PG&E Cause Evaluation Report

EXECUTIVE SUMMARY

CAP Title: Gas Operations Kettleman Compressor Station Ignition RCE	CAP # 129207510

Description of Event

A cross-functional team of PG&E Gas and contract coworkers (CWs) was supporting valve replacement work at Kettleman Compressor Station ([redacted] Plymouth Ave., Avenal, CA 93204) under Project S-1391 and work clearance document (WCD) #80252165. The clearance included blowing down and purging gas from the system (establishing clearance), to allow the contract team to perform construction work, then purging air from and reintroducing gas back into the system (removing clearance to restore the system). Gas Operations conducts clearance and purging work per TD-4441S Gas Clearances and A-38 Purging Gas Facilities respectively.

On the morning of July 9, 2024, while purging out-of-service (clearing the system) in preparation for construction, crew members, concerned about reaching acceptable gas-in-air levels, deviated from the clearance document steps. During troubleshooting, a blind flange, downstream of Valve 78 (V-78), was removed to provide an additional fresh air source for the air movers. This blind flange was ultimately not reinstalled. The flange removal was neither a step in the existing clearance, nor was it added using the red line clearance revision process detailed in TD-4441P-10 "System New Clearances for Gas Transmission Facilities" Section 3.8 for Revising an Active Clearance.

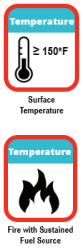
On July 10, 2024, following completion of construction, clearance activities to re-introduce gas and purge air from the system were initiated:

- The approved clearance required V-56 to be "checked open" for purging, however, it had been closed for stem seal replacement work on July 8, 2024 and only partially opened prior to the purge – operations that had not been documented nor approved as part of the sequence of operations in the clearance.
- Gas was re-introduced to the system from a 34-inch control valve (V-90), a clearance point with 618psig differential (per trending data gathered via Cimplicity)
- There are two ways to operate V-90, manual hydraulic and manual pneumatic.
- When attempting to manually operate V-90 hydraulically, oil unexpectedly discharged from the actuator's manual hydraulic override system relief valve and the valve failed to operate.
- V-90 was then partially opened using the manual pneumatic controls. This method is not effective for fine throttling as required for purging in Design Standard A-38.

Gas from V-90 began to displace air at multiple vent locations per the established clearance plan. It is suspected that because of the partial open position of V-56, a greater amount of gas flow was directed toward V-78. Instead of gas exiting the half-inch diameter vertical vent valve downstream of V-78 as approved in the clearance, gas exited the full 6-inch pipe opening horizontally where the blind flange had been removed on July 9. Gas flowed directly into an opposing blind flange 18-inches away at V-79. This resulted in deflection in all directions, including into the excavation below. Within minutes, a hazardous air-gas plume0F[1] developed. At approximately 1842, the air-gas plume ignited, resulting in serious burns to one coworker and minor injuries to others nearby.

Other CWs in the area immediately responded, attending to the seriously injured CW, and extinguishing various spot fires using pre-staged fire extinguishers. A CW at V-90 closed the valve to shut in the gas shortly before ignition, allowing the flame to extinguish within about one minute. The seriously injured CW received 2nd and 3rd degree burns and was airlifted to a specialized burn unit. The CW has since been released and remains off work.

[1] Hazardous conditions exist when an air-gas mixture is between an LEL of 5% and UEL of 15%

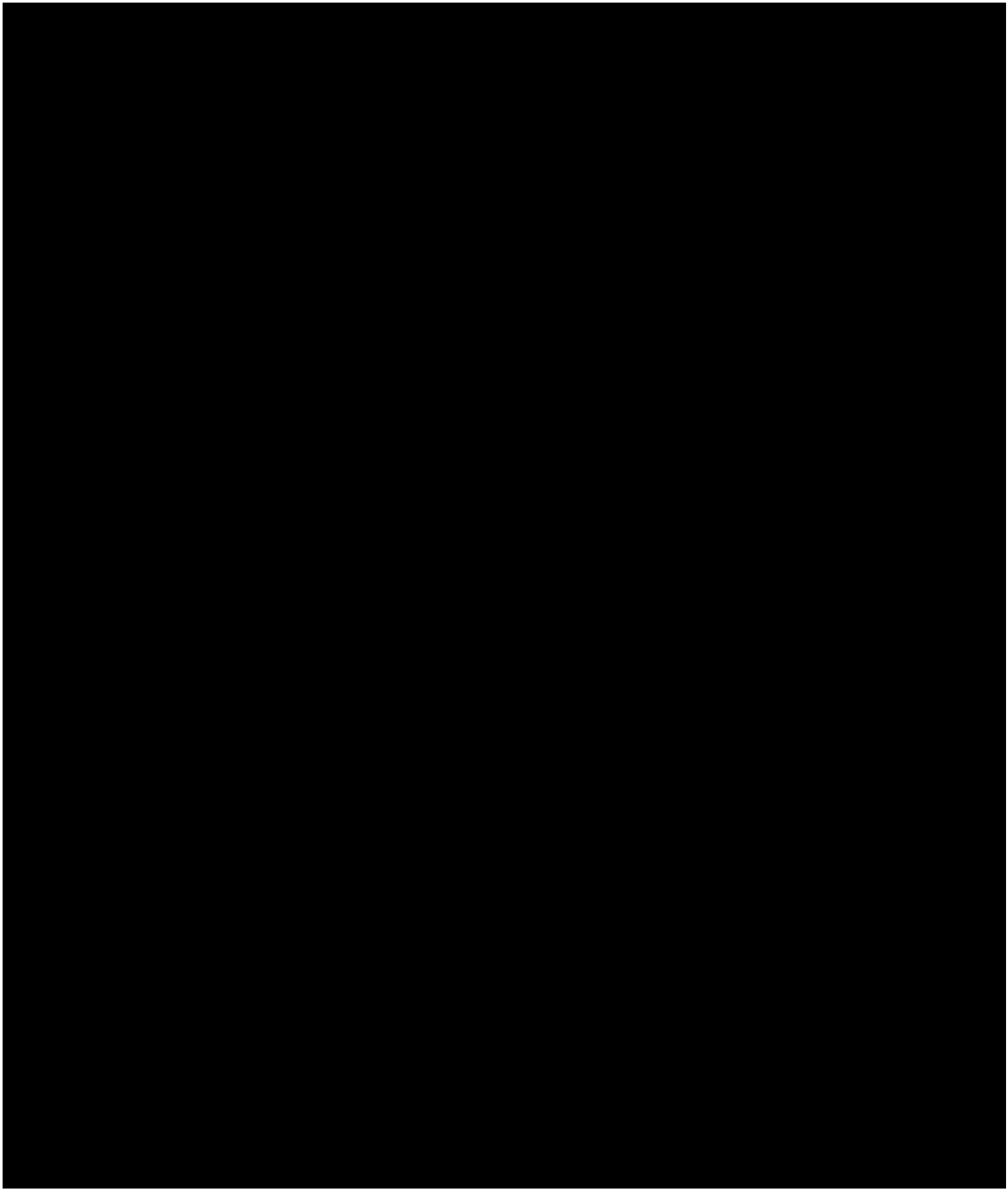
Why SIFs Occur / Essential Controls	**Essential controls** at the worksite targets the stuff that can kill or seriously injure you (STKY), and when installed, verified, and used properly, are not vulnerable to human error. *(Used for initial SIF determination, per SAFE-1100S)*		
	Present	N/A	
	Missing	N/A	
	Disabled	The clearance boundary for WCD #80252165 was compromised at the half-inch downstream vent valve for V-78 (V-78 D/S VENT). Specifically, the six-inch bolted blind flange where V-78 D/S VENT was mounted, had been unbolted and removed with no plan to reinstall prior to purging activities. This six-inch open flange connection was the vent location where the hazardous air/gas mixture was purged from and began accumulating. The step to remove the flange and its half-inch vent was made in the field without stopping to contact Gas Control and redlining the clearance. The process for modifying and redlining clearances is described in TD-4441P-10 “System New Clearances for Gas Transmission Facilities” Section 3.8 for Revising an Active Clearance.	
	 SIF Prevention	**High Energy SIF Determination Justification per SAFE-1100S: Temperature** • Temperature of ignited gas with temperature above 150 degrees for two or more seconds, and a fire with a sustained fuel source meet SAFE-1100S high energy criteria. • High energy was released via ignited gas and came in direct contact with the worker. Per SAFE-1100S, contact is defined as an instance when high energy is transmitted to the human body.	

Problem Statement	**Standard**	Gas Design Standard Purging Gas Facilities (GDS A-38) Safety: 1. Vented natural gas and air/gas mixtures must be diffused into the air without hazard to company personnel, the public, or property.
	Deviation / Defect	Gas was purged in a configuration that allowed the gas to accumulate and create a hazardous air/gas mixture. This does not meet the expectation of “diffused into the air without hazard.”
	Consequence	The air/gas mixture ignited, and coworker was injured with second- and third-degree burns. Two additional coworkers received minor injuries related to the incident.
	Significance	Unacceptable purging configurations can result in conditions that lead to gas ignition. Ignited gas may result in serious injuries or fatalities, damage to facilities, and regulatory impacts.

Cause Analysis Conclusion	**Root Cause**	Failure to achieve effective change in safe behaviors and the implementation of essential controls to mitigate high-energy hazards.
	CAPRs	CAPR1: Develop Safety and Culture Achievement Plan CAPR2: Establish Exclusion Zones CAPR3: Install and Stage Vent Stacks CAPR4: Implement Risk Identification and Readiness Reviews
	Contributing Cause 1	Configuration control is not rigorously applied when executing clearance work.
	CAs	CC1 CA1: Develop Configuration Control Devices CC1 CA2: Evaluate Clearance Supervisor Roles and Responsibilities CC1 CA3: Implement Clearance and Tagging Event Monitoring Process
	Contributing Cause 2	Gas coworker fundamental knowledge and proficiency challenges.
	CAs	CC2 CA1: Implement Training for Clearance Operations CC2 CA2: Develop A-38 Job Aid and Purging Training

	Contributing Cause 3	Failure to recognize risk and address causes of repeating events.
	CAs	CC3 CA1: Implement Trending and Performance Monitoring CC3 CA2: Establish Quality Improvement for High-Risk Programs

Extent of Condition	**Object**	Worker performing Gas non-vertical purging that enables the creation of a hazardous air/gas mixture with potential for ignition.
	Defect	Ignition of a hazardous air/gas mixture while purging or venting at a Gas Transmission Location.
	Similar Object	Worker performing any Gas venting or purging that enables the creation of a hazardous air/gas mixture with potential for ignition.
	Similar Defect	Ignition of a hazardous air/gas mixture while purging or venting at any Gas Transmission or Distribution Location.
	EOC Actions	1. Stand Down on horizontal Purging and venting activities unless authorized per Engineering and O&M Director approval. 2. Publish interim field guide and training on A-38 (Blowdown and Purging). 3. Eliminate horizonal purging and venting. 4. Approve pre-engineered vent stack use for depressurizing blowdown. 5. Eliminate pneumatic operated valves during manual purging (non-automatic).
	Results	CAPs initiated Electric Operations and Power Generation to evaluate similar conditions and risks.



END of Executive Summary

1 Scope of Investigation

The root cause evaluation will cover the following areas: event description, project planning, selection of equipment and work execution. Information that will not be provided includes the actual source of ignition and facts related to the event from the injured coworker's perspective.

Review of the incident revealed the combination of purge drive valve selection, a hazardous purge vent orientation, and proximity of personnel to the purge vent location created the hazardous air /gas environment for an ignition and subsequent injuries to coworkers.

2 Event Description

2.1 Event Description - Site Operational History

The Kettleman Compressor Station (KCS) is located at [redacted] Plymouth Ave., Avenal, in Kings County, at approximate mile point (MP) 354 along the Line 300A (L-300A) and Line 300B (L-300B) Backbone System known as the “Baja Path”. This station boosts the pressure of gas in Lines 300A and 300B up to a maximum station discharge pressure of 840psig and provides feeds to both L-306 (to Morro Bay) and L-190 (to Coalinga Nose).

KCS has three gas turbine driven centrifugal compressors, K-1, K-2, and K-3, rated at 7,170 horsepower each. When station compression is offline and flow is reversed, bypass valves control pressure and monitor valves V-354.01B and V-353.85A provide over pressure protection (OPP). Maximum throughput of KCS is 975 MMSCF. The station is designed for unattended operation but can be operated in local or remote modes.

2.2 Event Description - Project S-1391 Overview

Leaks were identified on ten valve actuators throughout KCS. A full replacement of both the actuator and valve was recommended for three of the ten locations – Valves V-48, V-52, V-54. Station Project S-1391 was designed to replace the three valves in two phases. The 300A phase included the replacement of V-54 while the 300B phase included the replacement of V-48 and V-52. Additional scope was added to the 300A phase to replace the gland plate and stem seals on valve V-56 as a preventative maintenance measure. It was made aware to the RCE team that many phases of this Project had occurred include some schedule and execution plan changes. Additionally, there were other Projects impacting the Clearance Work boundary for S-1391, making selection of an inlet control valve for “fine throttling” per A-38 challenging. The following report covers events that took place as part of the 300A phase of S-1391.

2.3 Event Description - Clearance Work Execution

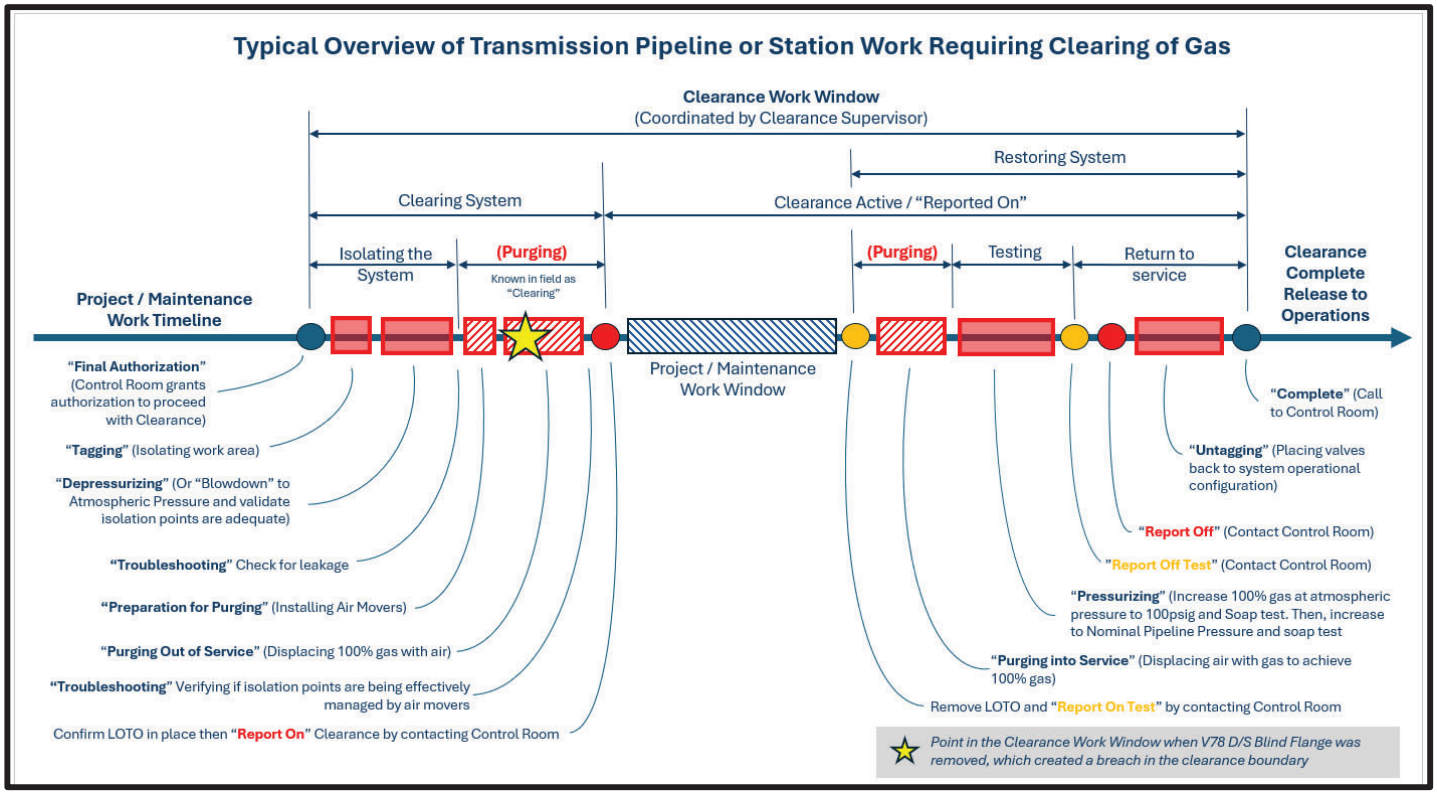


Figure 1. The sequence of steps in the clearances include isolate, vent, purge out of service, perform valve replacement and repair, and purge into service to restore to normal operation

When a complex Project Clearance need is identified, the Gas Clearance Writing team is notified, and a Writer assigned per TD-4441S “Gas Clearances” rev.4a (05/28/2024). The Clearances Writers for Gas Operations are a mix of PG&E and Contracted coworkers that enter relevant data for the execution of the clearance into the work clearance document (WCD). Gas Clearance Writers hold a role in SAP to initiate, design, and print Gas Clearances (same as Gas Clearance Supervisors). Once drafted and ready for review, a handoff is made to Gas Clearance Endorsers who review, provide feedback on, support, and concur with (or reject) the proposed work clearance before the approver consents (or rejects). The Approver (Gas Clearance Coordinator) is a single accountable PG&E coworker who consents to (or rejects) the proposed clearance work.

When the time comes to execute a complex Project Clearance, a Clearance Supervisor is expected to have been selected early on and be preparing to field work by conducting walkdowns and gathering appropriate resources to support air movers, gas monitoring with gas ranger devices, and positioning components. Clearance Supervisors can be either from within GPOM or TPCO per IBEW Letters of Agreements 14-40-PGE and R1-13-47-PGE.

A Gas Operations Clearance Supervisor the PG&E employee who is responsible for and manages the clearance. Per TD-4441S “Gas Clearances” rev.4a (05/28/2024):

- Clearance supervisor is responsible for all aspects of completing the clearance, most importantly clearing the line and safe isolation of hazardous energy. Specific responsibilities include, but are not limited to, the following:
    - Fully understanding the intended work and the scope and details of the clearance, including communication steps and operational activities.
    - Ensuring all required notifications (internal and external) are made.

- Acting as sole point of communication between the clearance and gas control, using three-way communication as described in the Safety and Performance Fundamentals Handbook. The clearance supervisor is responsible for adding the preliminary date and time to the GCD for place keeping.
- Conducting tailboards before beginning clearance work (and at other times during the clearance as deemed necessary by the clearance supervisor).
- Managing and being responsible for all aspects of the clearance work.
- Approving all work performed during the clearance, per the GCD (refer to the utility procedures governed by this standard [see 1.2] for specific instructions).
- Identifying authorized personnel, ensures that they understand the work being performed and associated energy hazards, and ensures that they follow hazardous energy control procedures. Authorized personnel are qualified personnel who execute gas system new clearances (i.e., personnel isolating energy by operating valves, or squeezers) or who sign on with the clearance supervisor in order to perform work on the cleared equipment.
- Being accountable for the acquisition, completion, and placement of all tags and locking devices, even if the tasks are delegated to other individuals.
- Any device locks, corresponding keys, and the main lockbox (if applicable).
- Understanding the contingency plan for any unexpected problems with the planned work.
- Complying with recordkeeping steps described in the utility procedures governed by this standard.

Event Description - July 8, 2024 (Clearance Phase 1: System Depressurization)

At 0605, final authorization was obtained from the Gas Control Center (GCC) for Work Clearance Document (WCD) # 80252165. At 0640, clearance operations began, and valves were positioned to isolate piping for project work. At 0925, V-94 was slowly opened to blowdown the isolated piping to atmospheric pressure. The initial pressure of the isolated piping was 634 psig and was confirmed flat (0 psig) at 1222.

The approved clearance required V-56 to be “checked open” for purging, however, it had been closed for stem seal replacement work on July 8, 2024, and only partially opened prior to the purge – operations that had not been documented nor approved as part of the sequence of operations in the clearance

At 0842 V-56 was checked open as required by the clearance however, at 1225, it was closed in preparation for the gland and stem seal replacement work. Closure of V-56 was not documented in the clearance nor was it identified as a required step during clearance planning.

Event Description - July 9, 2024 (Clearance Phase 2: Purging out of Service / System Cleared)

At 0416 clearance operations resumed and steps taken to purge the isolated piping out of service in preparation for construction by the contractor. Air movers were installed at various locations to displace the gas with air to achieve an acceptable Lower Explosive Limit (LEL) reading at monitored locations. At 0545, after initial efforts failed to achieve an acceptable LEL, a blind flange, downstream of V-78, was removed for additional fresh air.

The blind flange that was removed had an installed, half-inch diameter, **vertical** hand valve assembly intended for blowdown and purging. This hand valve had been included as a technical object in the clearance, defined as “VENT D/S V-78,” and incorporated into the system configuration for clearance operations. The removal of this blind flange ultimately resulted in an un-intended system configuration of a 6-inch **horizontal** opening pointing directly into an opposing 6-inch blind flange 18 inches away (Figure 2).

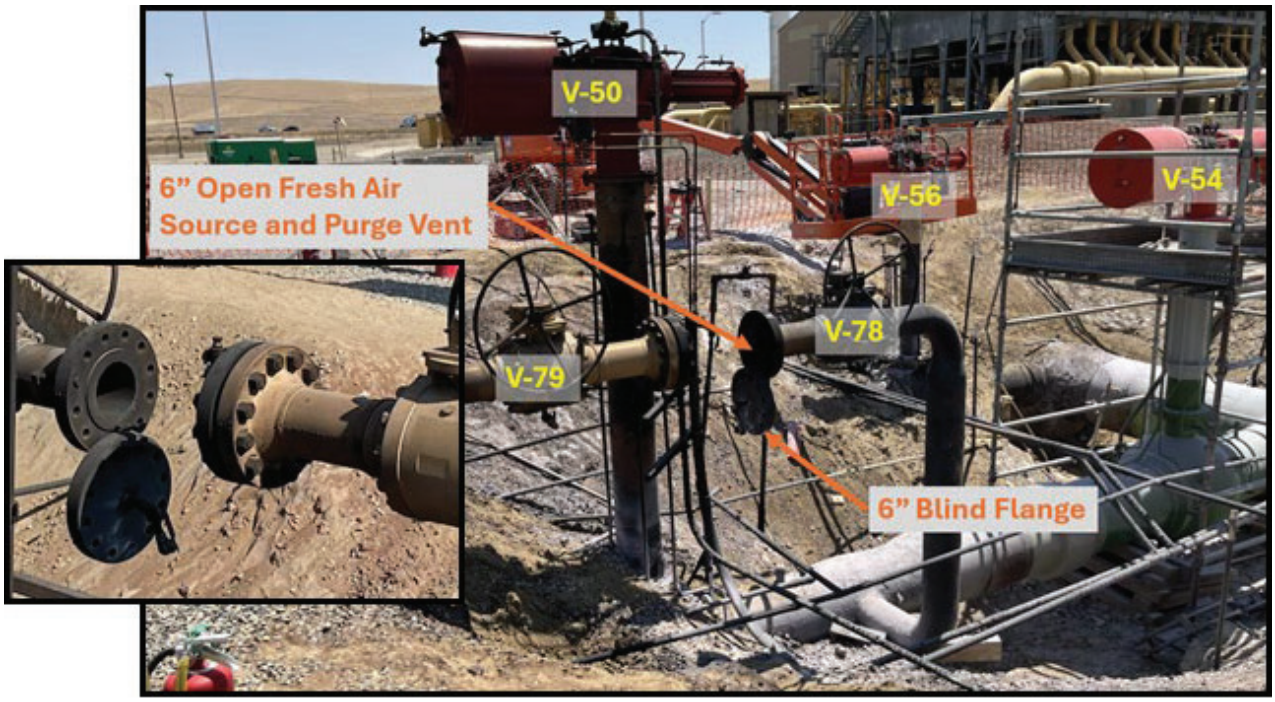


Figure 2: V-78 Blind Flange Removed (shown hanging)

After LEL readings were achieved, the clearance was "reported on" to the GCC. At 0708, gas was detected at monitoring locations and additional troubleshooting was performed to identify and mitigate the source of the gas. At 0822, the isolated piping was confirmed clear, once more, and the system was released to the contractor for construction.

At 0923, the Contractor began cut out and removal of the existing 24-inch valve V-54 and 34-inch by 24-inch tee assembly. At 1209 the Contractor began installing the new 34-inch by 24-inch tee.

By 1422, installation of the tee was completed, however the installation of the final tie-in piece, including V-54, was left for the following day. As a result of the 24-inch end of the tee being open to atmosphere, air moving operations continued overnight to maintain acceptable air-gas levels.

Gland and stem seal replacement work on V-56 continued through the end of shift.

Event Description - July 10, 2024 – (Purging into Service & Ignition)

At 0631, an acceptable LEL was confirmed at sampling locations and Contractor resumed construction work. At 1141, new V-54 was installed and ready for non-destructive examination (NDE). At 1324, NDE was confirmed acceptable, and construction was considered complete.

At 1705, stem seal repair work on V-56 was completed. V-56 was then partially opened prior to the beginning of the purge back into service. As the clearance had previously called for checking V-56 fully open, the closure, and subsequent partial opening of V-56, was not in alignment with the clearance instructions nor Gas Design Standard (GDS) A-38, "Purging Gas Facilities," which states: *"All open valves must be fully open except isolation valves and the throttled driver valve, if used."* (Figure 3)

At 1707, the clearance was reported “on test” to GCC in preparation for purging the isolated piping back into service and coworkers were positioned at specific locations to monitor for 100% gas. At 1808, direction was provided to coworker to operate V-90 for the reintroduction of gas. (Figure 4)

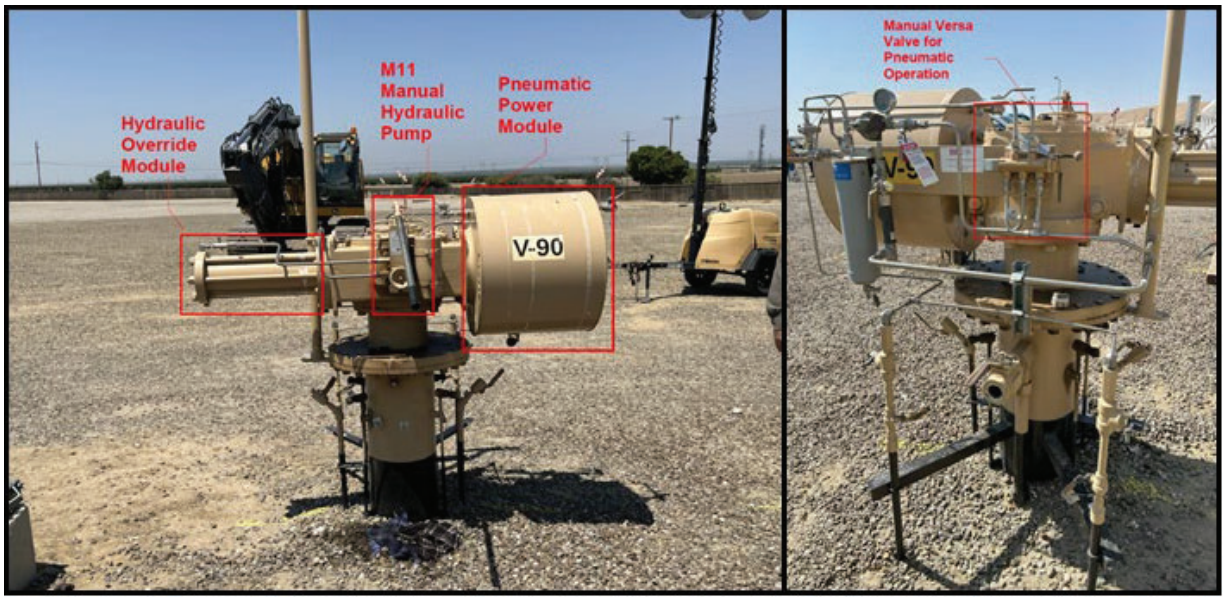


Figure 4: V-90 Detail View (Purge Drive Valve for Purge into Service Sequence and Ignition)

V-90 is a 34-inch buried full port ball valve with a high-head extension. It is equipped with a pneumatic Bettis G5024 double acting actuator with a M11 hydraulic backup override. The intent was to slowly open the valve with the M11 hydraulic override system. At this time, the differential across V-90 was approximately 618psid. Upon attempting to open the valve with the hydraulic override system, oil was discharged from the relief port and the valve failed to turn. A decision was then made to utilize the actuator's pneumatic system to open the valve. The exact failure mechanism of the hydraulic override system is unknown at the time of this writing. However, after consulting with the manufacturer and review of the vendor manual it is presumed the hydraulic fluid relieved due to incorrect position switch configuration leading to operating the valve into the "closed"

At 1825, V-90 was opened and gas was re-introduced into the system. A coworker, TPCO Lead Gas Control Technician 1 (TLT-1) positioned at the monitoring location near V-20, provided direction, by text message, to the coworker operating V-90 GPOM Gas Control Tech 2 (GCT-2). An increase in gas flow was made three times. At 1843, it had been indicated that too much gas had been sent. V-90 was immediately closed when excess flow was recognized through audible and haptic indication.

During this purging operation, gas exited the 6-inch diameter opening downstream of V-78 directly into an opposing blind flange 18-inches away. Gas was deflected in all directions, including into the excavation below, creating a large dust and debris cloud. Ignition occurred shortly after the formation of this cloud and lasted for approximately 1 minute, self-extinguishing as gas flow was shut off at V-90 prior to ignition.

Figure 6 shows the location of coworker positions at the time of ignition. At the start of the purge, GPOM Operator Mechanic 1 (GOM-1) had been standing approximately 10-feet away from the 6-inch horizontal opening at V-78. They began to vacate the area when they noticed the rapidly growing debris cloud. As they were running away from their initial location, the cloud ignited, injuring GOM-1 and causing 1st, 2nd, and 3rd, degree burns to their arms, hands, back and neck. Coworkers nearby immediately responded and tended to the injured coworker. Two additional coworkers experienced minor first-aid injuries. Emergency services were called, and notifications were made to Leadership and Safety. Kettleman Compressor Station was secured and made safe until further direction could be obtained.

Equipment involved

The equipment items involved in this incident investigation are:

- V-90, 34-inch Cameron T-32 isolation valve with double acting Bettis actuator w/hydraulic override
- V-56, 24-inch Grove B5 control valve with double acting Bettis actuator w/hydraulic override
- V-78, 6-inch Grove B5 isolation valve with blind flange on downstream side and half-inch vent with hand ball valve attached to the drilled/tapped hole on the blind
- Various Mueller Save-a-Valves (1-inch and 2-inch nominal diameter) placed on the isolated piping to provide fresh air sources for air mover operation during the purge out-of-service operation.

3 Problem Statement

Problem Statement	**Task**	Gas Purging
	Object	Utility Worker
	Standard	**Gas Design Standard Purging Gas Facilities (GDS A-38)** Safety Section: *1. Vented natural gas and air/gas mixtures must be diffused into the air without hazard to company personnel, the public, or property.*
	Deviation / Defect	Gas was purged in a configuration that allowed the gas to accumulate and create a hazardous air/gas mixture. This does not meet the expectation of "diffused into the air without hazard."
	Consequences	The air/gas mixture ignited, and coworker was injured with second- and third-degree burns. Two additional coworkers received minor injuries related to the incident.
	Significance	Unacceptable purging configurations can result in conditions that lead to gas ignition. Ignited gas may result in serious injuries or fatalities, damage to facilities, and regulatory impacts.

4 Containment and Interim Actions

	Containment Actions	Complete	Due
1	Establish Air Mover Plan (including staffing plan) to place station in safe temporary configuration under current clearance.	[redacted]	Complete
2	Suspend purging operations at incident site (Safety Stand Down – GSOM, Completed Friday, July 12, 2024, 7:00 AM-7:30 AM via Teams Meeting).		Complete
3	Develop and host GSOM Purging Operations Stand Down.		Complete

	Interim Actions	Complete	Due
1	Determine process and steps necessary to develop a return to service plan.	[redacted]	Complete
2	Perform engineering evaluation to determine extent of damage and integrity of local equipment involved in the event, including test plan.		Complete
3	Explore whether grounding was needed.		Complete

5 Operating Experience

An analysis of both the internal and external past incidents was conducted using key word searches same/similar for this event. The following is a summary of findings and recommendations so that ineffective corrective actions from past incidents can be analyzed for ways to improve their effectiveness and prevent recurrences.

The review of internal operating experience concluded that working in the presence of a gaseous atmosphere is a highly hazardous activity, but that the risks associated with venting gas horizontally and/or near coworkers were not fully understood and controlled. Additionally, crews performing purging and clearance activities while not using or unaware of associated procedural guidance is common. (See Appendix B)

6 Extent of Condition

An Extent of Condition (EOC) analysis was performed to determine if the company is at risk for the same or similar event occurring. The exposure to similar conditions exists throughout the system wherever gas is being vented in an environment with the potential for ignition. (See Appendix C)

7 Extent of Cause

The primary focus of the Extent of Cause review are the root causes. This review focuses on the actual root causes of the condition and on the degree that these root causes have resulted in additional weaknesses. It involves putting a reasonable boundary around the population of other processes, equipment, or human performance jobs with the potential to be impacted by the same underlying reasons or drivers of this event. A summary of the extent of cause is provided below, for additional details see Appendix D.

Root Cause – 1 Failure to achieve effective change in safe behaviors and the implementation of essential controls to mitigate high-energy hazards.

Extent of Root Cause – 1: The RCE Team determined that similar weaknesses exist throughout the system, despite company-wide efforts to prioritize high energy controls and the capacity to fail safely. (See Appendix D).

8 Event Technical Details

8.1 Ignition Analysis & Modeling

Immediately following the event, an engineering investigation was initiated by the RCE team to gain insight into the nature and scale of the hazardous plume and potential ignition sources at the V-78 vent location. The RCE team collaborated with PG&E's Applied Technology Services (ATS) and Exponent to perform the incident investigation through performing site visits, 3D scanning, modeling and a review of technical references in the subject area.

The technical investigation would require that the flowrate and velocity of the gas leaving V-78 be determined to better understand the conditions at the location of ignition. To accomplish this, Exponent performed modeling of the gas flow in the simulated piping network using Aspen HYSYS modeling software. ATS would then take Exponent's results and apply a different modeling software, ANSYS, that would produce 3D simulations of the plume of gas leaving V-78. The RCE team provided construction drawings to ATS and Exponent, along with purge vent valving configurations, a range of inlet purge drive valve (V-90) and V-56 positions to serve as inputs to the model development and engineering investigation.

The preliminary results of the simulations indicate that the gas flow rate at the V-78 vent outlet ranged widely depending on how much the inlet purge valve V-90 was open and whether V-56 was open but were significant even when V-90 was barely open with V-56 open as well. Based on preliminary results, even with V-90 7.5° open, which is 2.5° after flow would have been initiated which occurs at 5°, the velocity of gas leaving at V-78 vent location would have been over 100 feet per second (ft/sec).

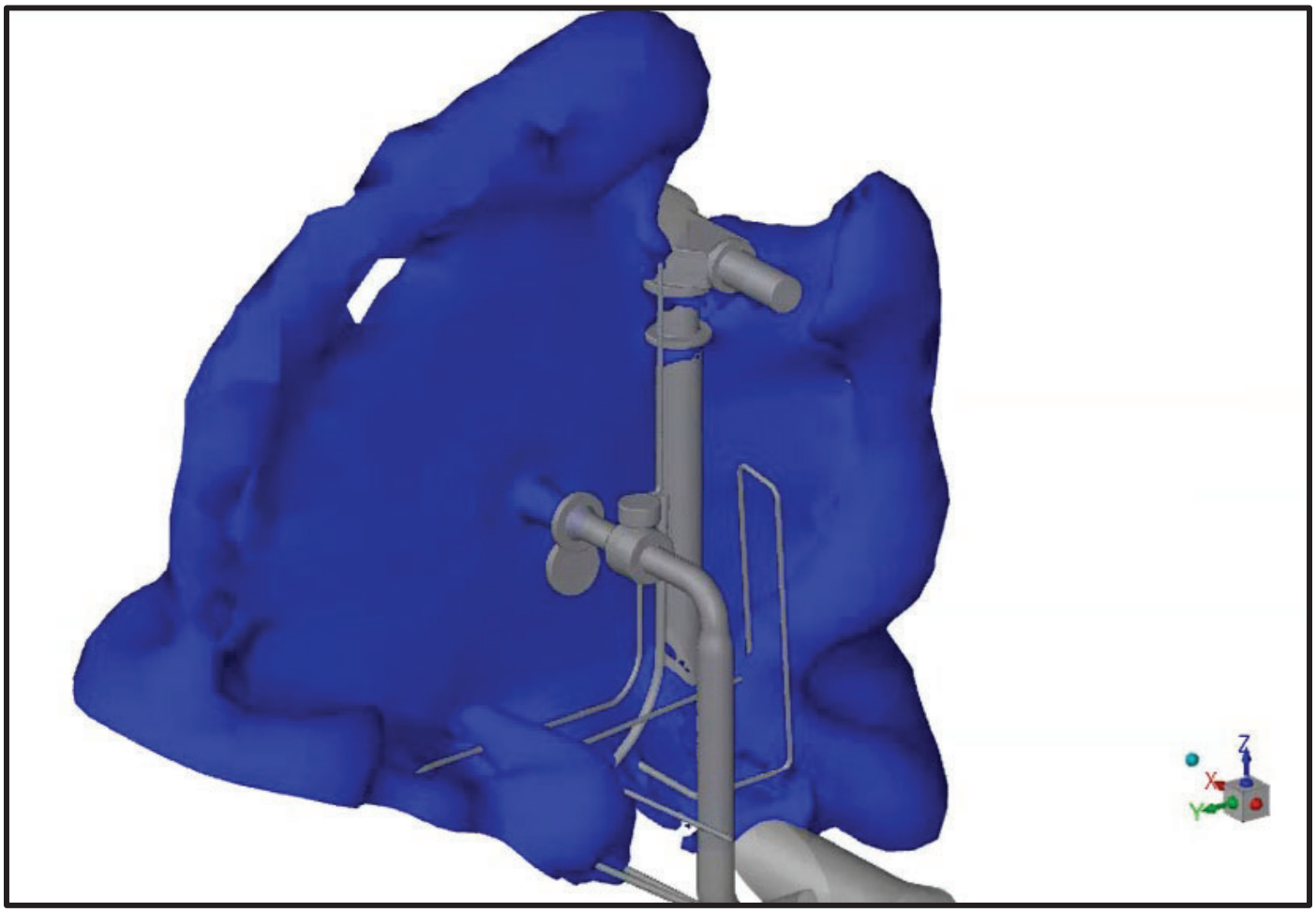


Figure 7: ATS ANSYS model of gas plume (blue) at V-78 vent location

8.2 HYSYS Model Setup and Assumptions

Exponent performed computer modeling of the gas flows in the piping section being purged into service using Aspen HYSYS software. The piping network included in the purging operation was recreated in HYSYS with the objective of calculating the pressure, density, velocity, and mass flow rate at the purge vent outlet downstream of V-78. A list of assumptions used in the modelling effort are included below.

- V-56, installed in the pipeline leading towards V-J and B7948, was partially open while the piping was being purged into service. Simulations were performed separately with this valve open and closed since there was no confirmation of the actual position.
- The actual position of V-90 at the time of incident is unknown, thus the model is run under three scenarios of 7.5°, 10° and 15° open. The dimensions of V-90 opening area were calculated by PG&E using input from Cameron. Exponent used this information to calculate flow through V-90. Note that the flow will be initiated through the valve at 5° per the valve manufacturer.
- Flow is choked at V-90 (purge inlet)
- Only three large bore valves are open for purge (V-94, V-78 and V-J). There were other small diameter vents open but were omitted in the model as they were deemed not to be relevant to the model.
- Dead legs are ignored
- Pipeline is assumed to be made of mild steel (for calculating friction factor)
- Gas is 100% methane
- Peng-Robinson Equation of State is Valid
- Gas is considered compressible.

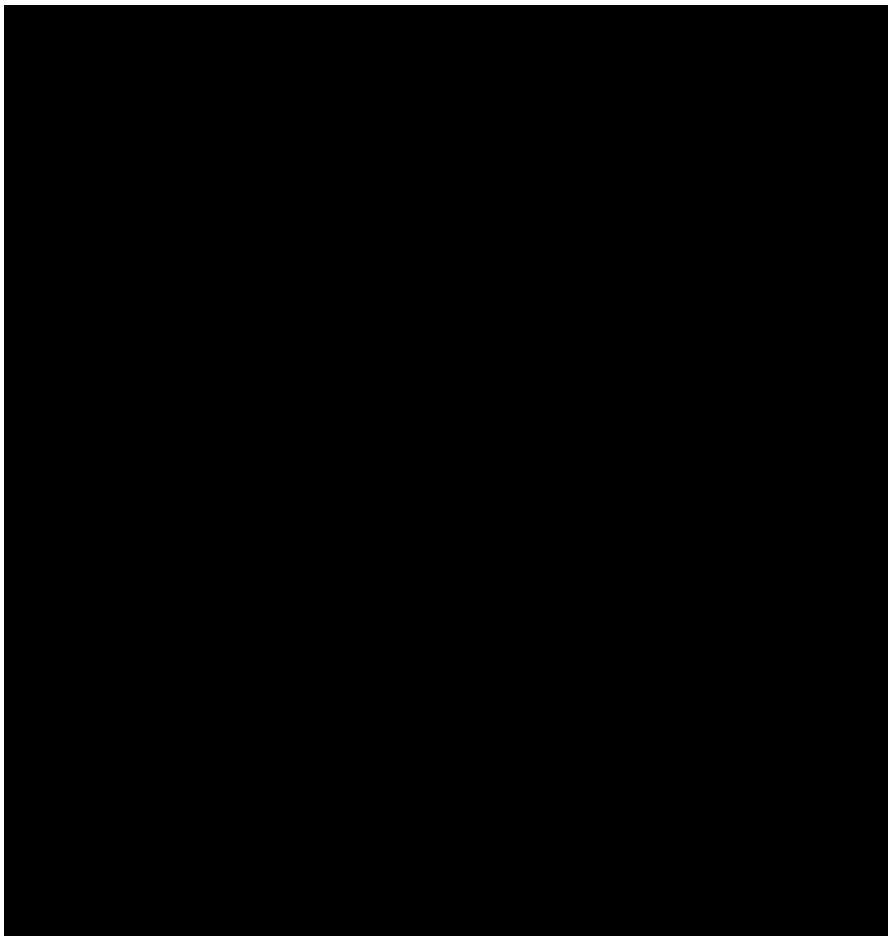


Figure 8: HYSYS Model Piping Schematic

8.3 HYSYS Model Results and Excessive Purge Velocities

HYSYS model results show the flow velocity leaving V-78 to be excessive under all modeled conditions. GRI recommends that for large bore pipe we do not drop below 7.3 ft/sec purge velocity (Figure:9) while the modeled conditions may indicate the velocity was as high as almost 1,500 ft/sec (sonic velocity), at V-78. (Figure 9)

V-90 Deg Open (^{0})	V-56 Position	V-78 Flow Rate (MMSCFH)	V-78 Flow Velocity (ft/s)*
15	Open	10.7	1,465
10	Open	3.76	1,465
7.5	Open	1.33	1,465
15	Closed	13.7	1,465
10	Closed	5.66	1,465
7.5	Closed	1.91	1,465

Figure 9: HYSYS Model preliminary results - V-78 leaving gas flow rate at various purge inlet valve

*Due to high released pressure from V-90 at various opening degrees, the gas remains at choked-flow state (sonic velocity) at V-78. However, the flow rate varies with changes in V-90 position. Under choked-flow conditions, the mass flow of gas will increase at V-78 but the velocity will stay constant.

Based on research by the Gas Research Institute (GRI) that developed a method of calculating the minimum purge velocity needed to minimize mixing, a 440 feet per minute (ft/min) (7.3 feet per second [ft/sec] or 5 miles per hour [mph]) velocity is recommended for large-bore pipe and a 1000 ft/min (16.7 ft/sec or 11.4 mph) velocity for small-bore pipe. Figure 1 illustrates how the recommended purge velocities compare and exceed the minimum GRI-calculated velocities.

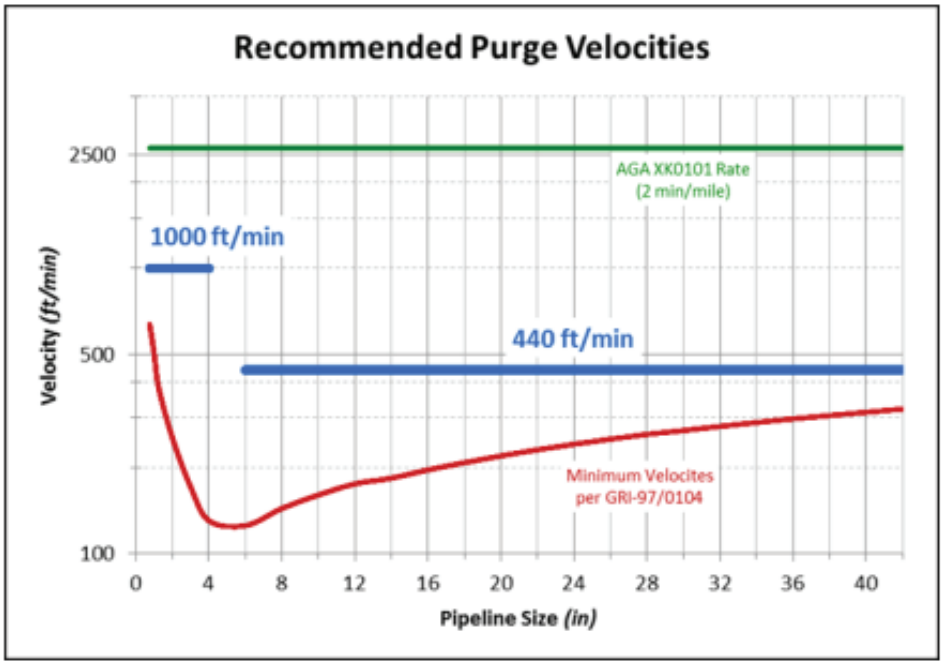


Figure 1. Recommended Purge Velocities

Figure 10: GDS A-38 Recommended Purge Velocities

8.4 ANSYS Model Results and Plume Shape

ATS modeling software produced 3D simulations of the plume of gas leaving V-78 (figures 10, 11). To accomplish this, the ATS team recorded the incident location using 3D laser scanning technology to create an immersive virtual environment for further investigations. The 3D captures were then imported into ANSYS, which is a computational tool to simulate the fluid dynamics of the plume emerging from V-78. Results of the HYSYS model developed by Exponent were applied to the ATS ANSYS model. ATS performed the simulation on the in-house workstation spending approximately 3600 CPU-hour of computation to resolve 4 seconds of the purging process.

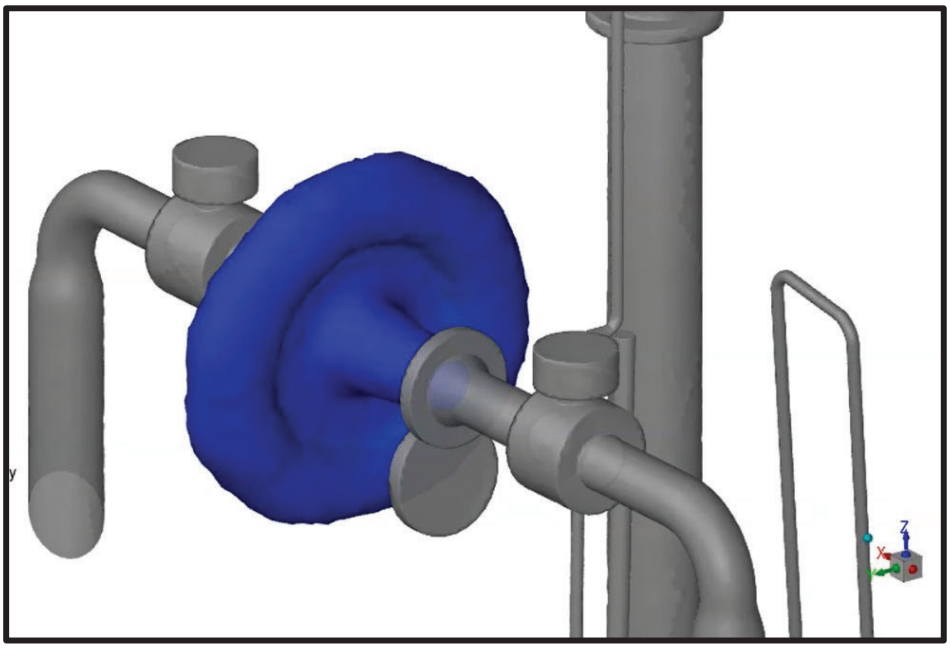


Figure 11: ATS ANSYS simulation using 3D scanned V-78 vent location (Dark Blue surface indicates LEL)

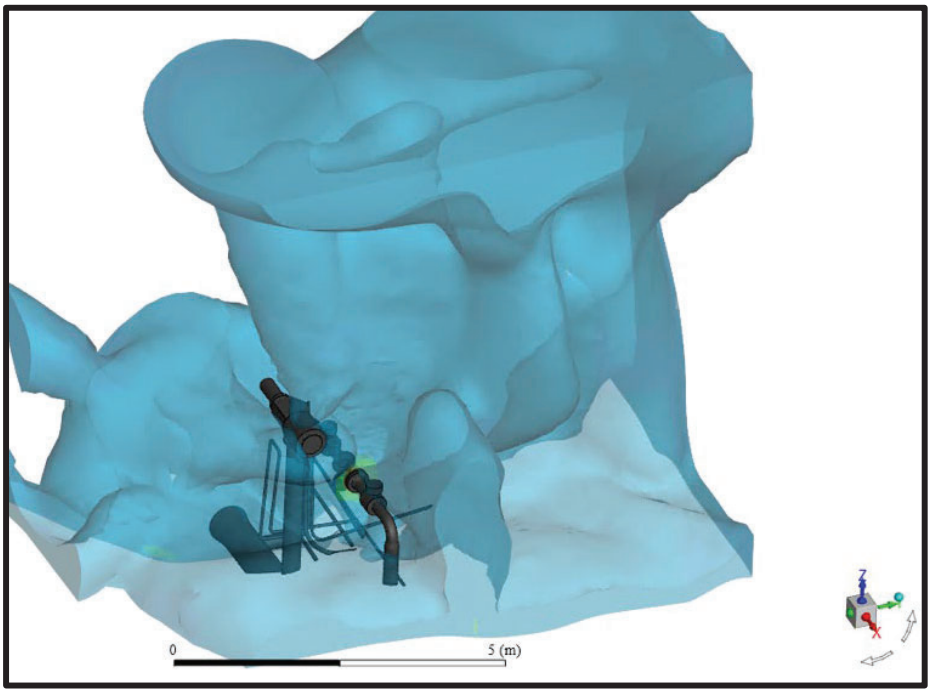


Figure 12: ATS ANSYS Results Purging into Obstruction at V-78

8.5 **Ignition** Analysis Summary of Insights

The precise ignition source and location could not be determined to a certainty; however, several potential ignition sources were also assessed:

- An electrostatic discharge from the generated dust cloud cannot be ruled out as the ignition source and is more likely than other ignition sources considered.
- An electrostatic discharge from either the pipeline itself (due to charging from the venting gas) or an electrostatic discharge from an employee in the vicinity of the venting gas (due to electrostatic accumulation on their person) cannot be ruled out as potential ignition sources.
- A mechanical spark from debris exiting the pipeline at high velocity or kicked up by the venting gas cannot be ruled out but is considered low likelihood.
- Electrical equipment near the venting gas was locked out, tagged out, and ruled out as a potential ignition source.

8.6 **Purging into an Obstruction**

Electrostatic discharge from the generated dust cloud cannot be ruled out as the ignition source and is more likely than other ignition sources considered in the purge ignition assessment. The act of purging horizontally, directly into an obstruction, redirected the flow of gas from horizontal to all directions away from the opposing flange from V-78. This redirection of flow, some toward the ground, generated a dust cloud potentially containing electrostatic discharge that created conditions that could lead to ignition. Vertical purging without an obstruction would have generated a plume shape that is more uniform, likely mitigating conditions that develop electrostatic discharge and a source for ignition. The images in the figure below demonstrate that the LEL boundary reached the soil where electrostatic discharge could have ignited the mixture. The blind flange opposing V-78 was removed and retained for evaluation at ATS.

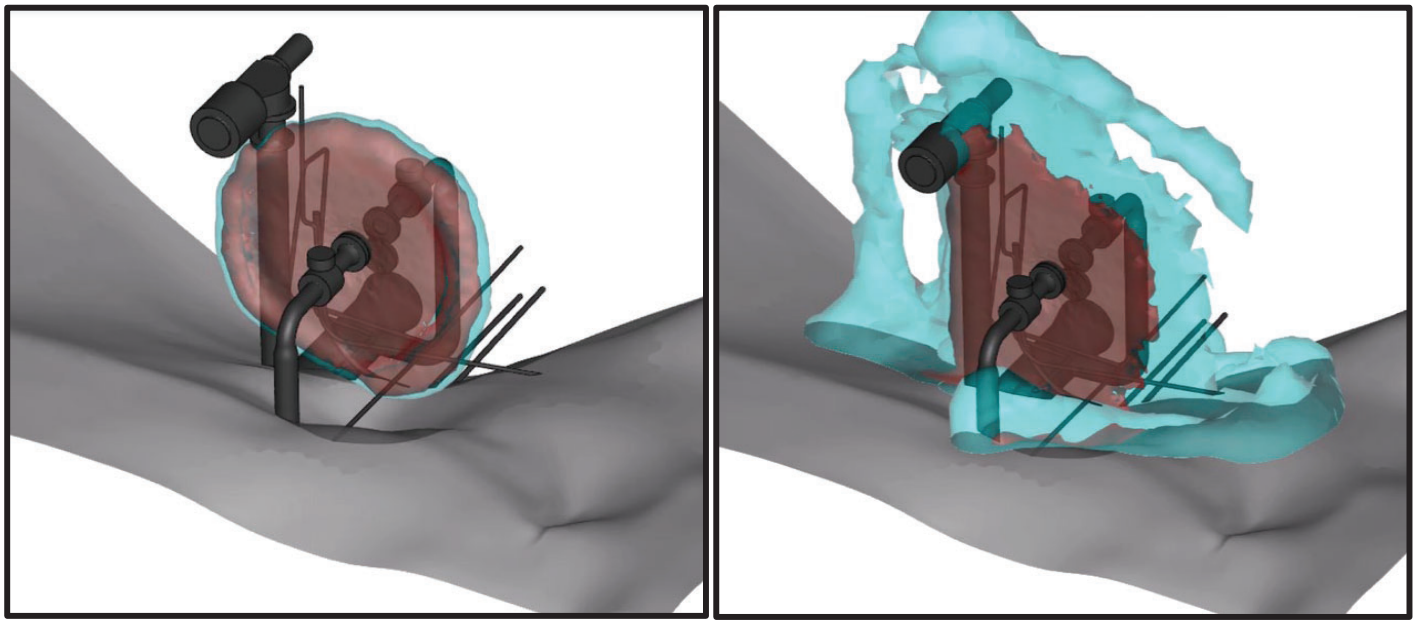


Figure 13: ANSYS Results Purging into Obstruction at V-78. LEL boundary in blue and UEL boundary in red.

8.7 Multiple Projects

The RCE team learned that both projects (S-1391 and S1369) shared a common isolation point. A common isolation point is not an issue if the projects were set to occur on different days. A review of WCD# 80252165 revealed that both projects occurring on the same day was a less than desirable condition and led to the selection of V-90 as a control inlet point that would require fine throttling for purging back into service.

At the time of the event, multiple projects were under construction:

- **Project S-1369**
  Opportunistic effort to replace valves near the L-306 intertie with SoCal Gas while they were conducting a pipeline outage to install an insulating joint. This work was in a separate part of the KCS yard. This project was required to complete the agreement between PG&E and SoCal Gas for the sale of L-306.

- **Project S-1326**
  Turbine exchange for the K-3 unit. This work was necessitated by the unit reaching the end of its manufacturer recommended fired hour lifespan and the requirement to maintain reliable operation of the unit. The Clearance Boundaries shared an isolation point at V-353-85A. This was a clearance writing error that would not have happened if the projects were spaced out to occur on separate days. The projects S-1391 & S-1369 occurring on the same day led to planning the WCD# 80252165 document in a less than desirable manner.

- **Project S-1315**
  Phase 2 of Project S-1315 was scoped to address 15 valves with Ledeen (brand name) Actuators. These had developed gas leaks and required repair to meet California Air Resources Board (CARB) compliance. To prevent future leaks, all valves identified as requiring actuator replacement were also scoped for gland and stem seal replacement. While finalizing scope for Project S-1315, it was identified that the maximum allowable stem torque (MAST) for three valves, V-48, V-52, and V-54 could not be determined. This required replacement of the valves, in addition to the actuators, because new actuators could not be appropriately sized for the existing valves. S-1315 performed a portion of the initial scope.

- **Project S-1391**
  Due to material unavailability of Project S-1315 Phase 2, S-1391 was created to replace the three valves and the balance of actuators and stem seals (for existing valves) not addressed during S-1315 execution.

8.8 Valve V-90 (Clearance Purge Drive / Inlet Control Valve Location)

Selection of V-90 as a 34” purge driver for reintroducing gas back into the system was not ideal for the close-proximity work at Kettleman Station. Due to valve type, size, operating specifications, and configuration within the system, V-90 was not capable of the fine throttling required of a purge drive valve to safely bring the cleared piping back to acceptable gas levels prior to re-pressurization. This valve was a less than adequate choice for the reasons outlined below.

- **Operational Data**

  V-90 is a Cameron T32 ANSI 600 weld end full port ball valve, installed in 2012 as part of an In Line Inspection (ILI) upgrade project to facilitate ILI operations on L-300A. It is equipped with a Bettis G5024 double acting actuator to allow Operations to locally open and close the valve with a manually operated Versa pneumatic shuttle valve that ports gas to the open and close side of the cylinder. The shuttle valve vents the cylinder when in the neutral position and the valve will remain in its current position until

further action is taken. It is also equipped with a Bettis M-11 hydraulic operator, typically used as an emergency backup if the pneumatic controls are out of service or failed. There is no feedback or control from this valve to the station control system.

V-90 serves as a Mainline valve on L-300A and, when closed, will isolate flow on the line with all other station valves in their normal positions. For WCD # 80252165 V-90 was used as an isolation point to minimize system impact and limit the volume of piping that needed to be depressurized.

- **Valve Maintenance History**

  V-90 is maintained semi-annually per TD-4521S. The Bettis actuator is maintained annually per TD-4545P-09. Due to system constraints during maintenance activities, the valve is only partially operated to ensure adequate flow on L-300A. The valve is partially operated with the pneumatic and hydraulic controls during actuator maintenance. This is a normally open valve, so maintenance activities occur with up and downstream pressure equalized. The last maintenance of the valve was performed in May of 2024 and no deficiencies were identified.

- **Valve Operation for WCD # 80252165**

  V-90 was selected as the purge driver during the clearance development process. At the time of the purge, the differential pressure (psid) across the valve was 618 psid. As differential increases, additional torque is needed to operate the valve. The torque required to operate the valve at 0 differential is 77,500 in-lbs vs. 185,650 in-lbs at a pressure of 618 psid. (see figure 13) The initial plan was to use the M-11 hydraulic operator to provide fine control of the valve opening.

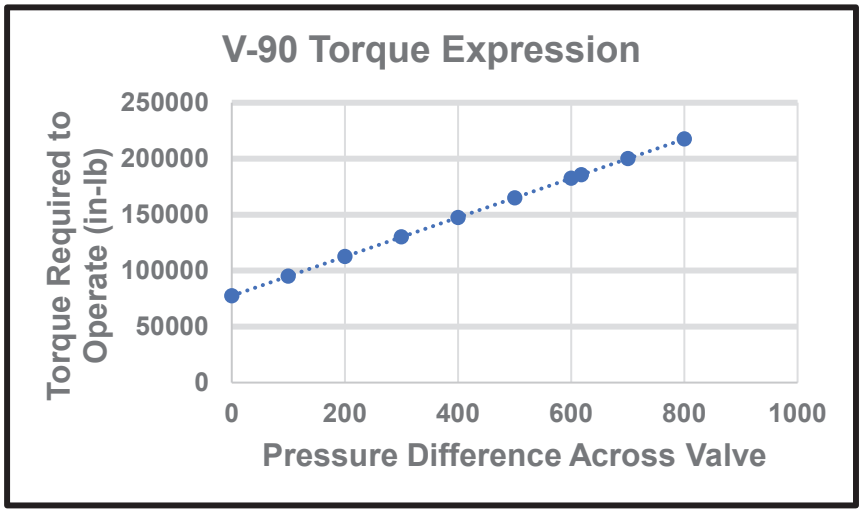


Figure 14. Torque Required v. Pressure Differential across valve

When this strategy was implemented, the hydraulic operator failed to move the valve off the closed stops and relieved oil out of the relief valve that serves to limit the amount of torque the operator can apply to the valve stem. While the hydraulic pump is rated to produce enough torque with this amount of differential, it is never tested under these conditions. Additionally, it was noted during a site visit that the reservoir on the hydraulic operator had a plug installed where a breather should exist. Per the manufacturer this can cause damage to shaft seal due to pressure build up in the reservoir while operating the valve but is not likely to prevent movement. At this time we cannot confirm if the plug was installed during the event or if this was a contributing cause.

After the hydraulic operator failed to operate the valve, the decision was made to utilize the pneumatic controls to position it. Achieving fine control of this valve, as is required for purging operations, with pneumatic controls is exceedingly difficult, if not impossible due to the operational characteristics of the shuttle valve. To achieve initial movement of the valve, the open side of the cylinder must be

pressurized sufficiently to overcome the torque requirements. The only indication of valve position is a small indicator on the top of the actuator that rotates commensurate with the stem of the valve that and is not intended to provide precision indication of valve position. Per the valve manufacturer, flow across the valve seats will not be established until approximately 5° of rotation. During this event, the valve was positioned further open on three occasions once flow was established. Once excessive flow was recognized the operator immediately moved the shuttle valve to position the valve closed. To complete this operation all the pressure on the open side of the cylinder would need to vent and then sufficient pressure would need to be applied to the close side of the cylinder to overcome the valves torque requirements and rotate the valve ball to stop flow.

- **Valve Flow Characteristics**

  Due to the geometry of full port ball valves, the flow rate through the valve is not linear with position. As the valve begins to open, flow increases rapidly with relatively small increases in position. This is shown in the documentation provided by Cameron below in figure 15 that correlates the valve position to the flow coefficient of the valve.

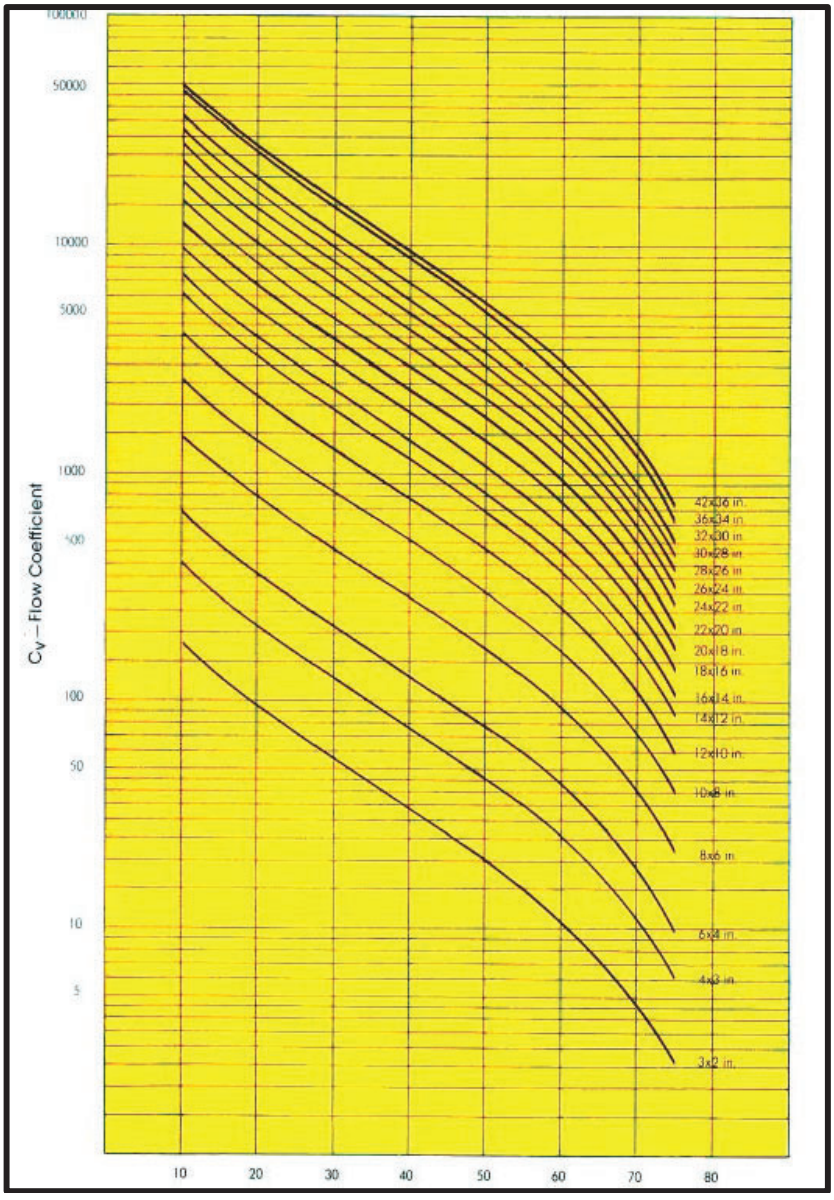


Figure 15: Flow Coefficient Cv vs Closure Angle for reduced opening Cameron ball valves

This rapid increase in flow is due to the increase in cross sectional area of the flow path as the valve travels open as illustrated below (figures 16,17).

Note: Per HYSYS model results, the flow velocity leaving V-78 based on all modeled scenarios for V-90 degree of opening, were found to be excessive under all modeled conditions.

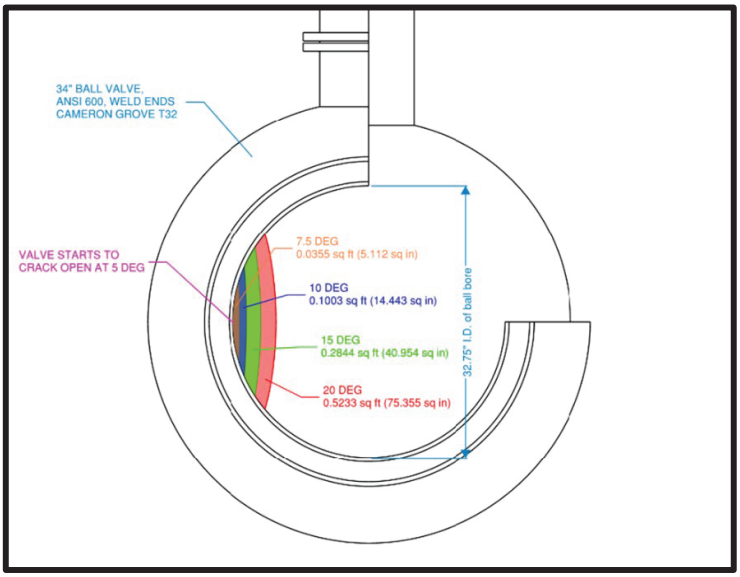


Figure 16: Cut away of V-90 showing opening by degrees

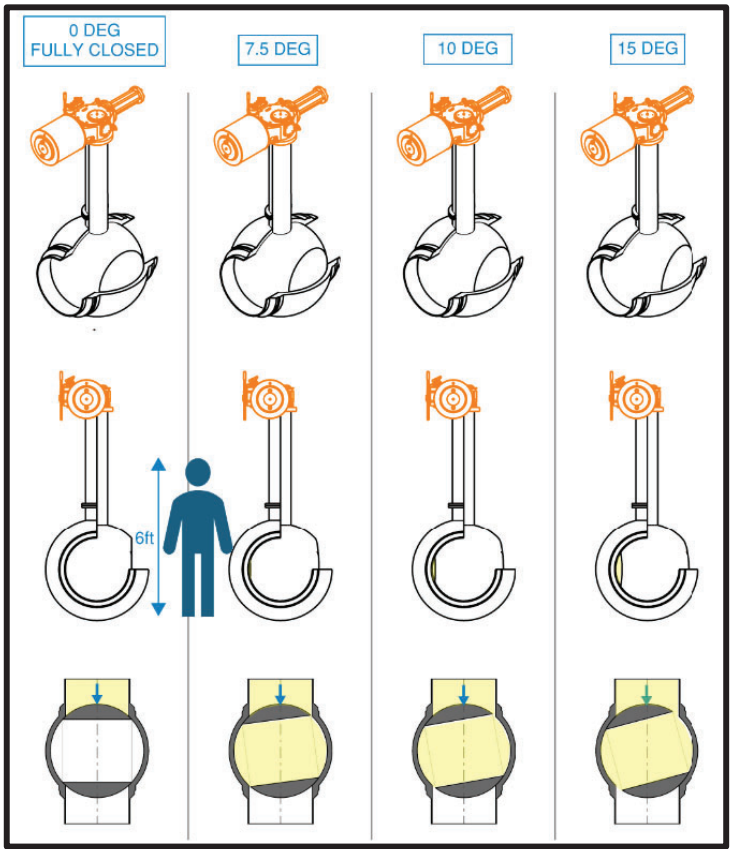
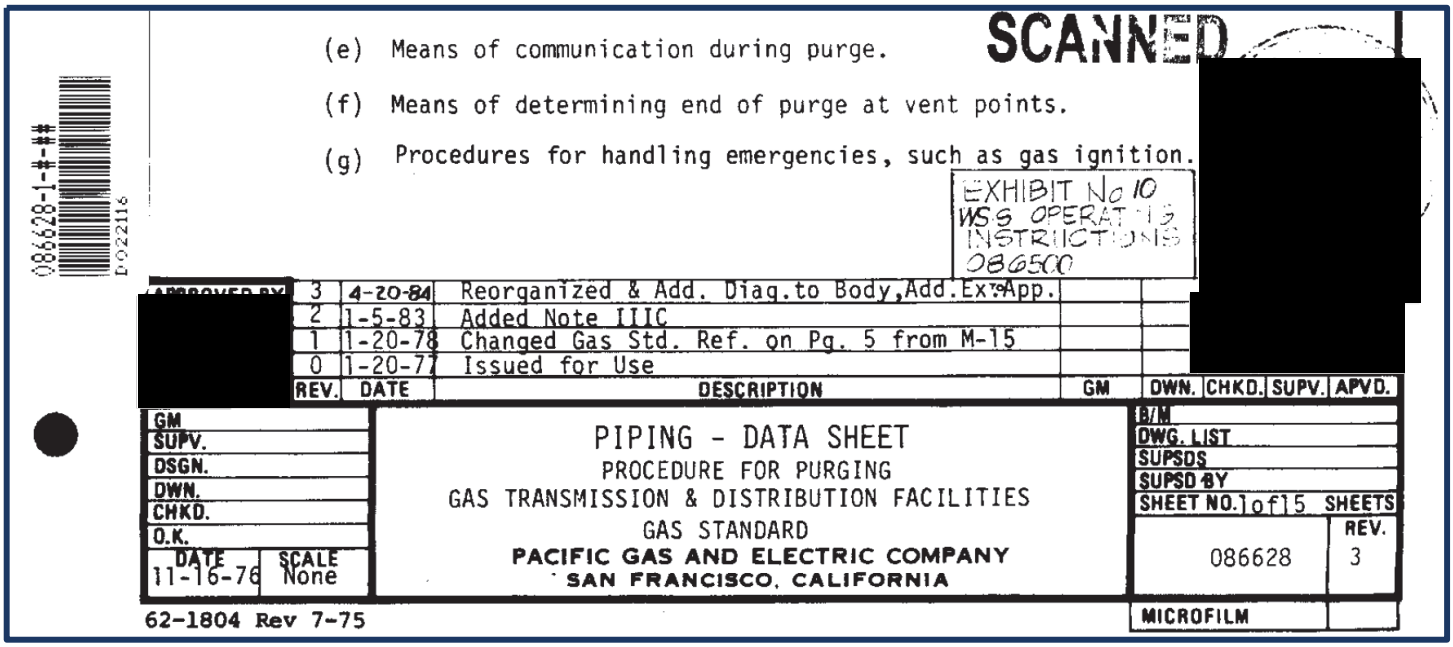


Figure 17: V-90 Open Area at Various Valve Positions

Per the manufacturer the valve will not begin to flow until 4°-5° of rotation. Flow data for valve positions lower than 10% open is not available from the manufacturer due to the high velocities in this range resulting in potential damage to the valve seats. To help visualize this relationship, at 2.5° beyond the cracking point the opening is larger than a 2-inch pipe and at 10° beyond cracking the opening is larger than a six-inch pipe. This non-linear relationship to position and cross-sectional area combined with the large size of the valve further complicates achieving fine control for purging operations, especially with a relatively small volume of piping to be purged.

8.9 PG&E Purging Guidance Documents

A historical review of PG&E's natural gas purging practices was performed to determine evolution over time. The original Gas Standard A-38 (Drawing Number 086628), "Piping – Data Sheet: Procedure for Purging Gas Transmission & Distribution Facilities," was published in January of 1977 and aligns with a well-known industry publication from the American Gas Association (AGA) titled "Operating Section Report: Purging Principles and Practices Catalog No. XK0775" (1975) (figure 18).


(e) Means of communication during purge.

(f) Means of determining end of purge at vent points.

(g) Procedures for handling emergencies, such as gas ignition.

SCANNED

EXHIBIT No 10
WSS OPERATING
INSTRUCTIONS
086500

REV.	DATE	DESCRIPTION	GM	DWN.	CHKD.	SUPV.	APVD.
3	4-20-84	Reorganized & Add. Diag.to Body,Add.Ex.App.					
2	1-5-83	Added Note IIIC					
1	1-20-78	Changed Gas Std. Ref. on Pg. 5 from M-15					
0	1-20-77	Issued for Use					

GM
SUPV.
DSGN.
DWN.
CHKD.
O.K.
DATE 11-16-76
SCALE None

PIPING - DATA SHEET
PROCEDURE FOR PURGING
GAS TRANSMISSION & DISTRIBUTION FACILITIES
GAS STANDARD
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

B/M
DWG. LIST
SUPSDS
SUPSD BY
SHEET NO. 1 of 15 SHEETS
086628
REV. 3
MICROFILM

62-1804 Rev 7-75

Figure 18: Original Gas Standard A-38 circa 1977

The technical guidance in the AGA operating section report is widely accepted as the standard "Purging Manual" for natural gas pipeline operators. As such, PG&Es Gas standards mirror much of the guidance in AGAs 1975 report, including example purge procedures, diagrams, safety information, sequence of operations, and data on purge inlet control pressures for various purge mediums. This AGA "Purging Manual" is now in its 4th Edition (2018) which contains the following pertinent statement:

> *"An essential requirement for developing a successful and safe purging procedure is knowledge of fluid dynamics associated with pipe flow. These requirements include an understanding of pressure drop and flow through pipelines, flow velocity, fluid stratification and gas dispersion processes. Additional requirements include an understanding of basic gas chemistry characteristics including flammable limits of gas mixtures and ignition characteristics. A thorough understanding of the application of these principles for each site-specific situation is required in addition to a well-prepared procedure and hazard assessment detailing the sequence of events, a predetermined rate of introduction of a purge medium and verification of endpoints at properly vented locations. Finally, the steps of the procedure must be followed and carried out by properly trained and qualified individuals."*

The above is embodied in PG&Es current purging guidance which is divided among the Gas Design Standards (GDS) and Code of Safe Practices (CSP) sections below:

- GDS A-38, “Purging Gas Facilities,” Current revision 1h dated July 2023,
- GDS A-38.1, “Installation and Operation of Air Movers,” Current revision 02 dated December 2003,
- GDS A-38.3, “Temporary Vent Stacks,” Current revision 0a dated March 2021
- Code of Safe Practices (CSP), Section 1304, “Vent Stacks” and 1305, “Sources of Ignition or Fire Near Escaping Gas”

GDS A-38, which contains most of the guidance on purging gas pipelines and facilities, has evolved over time as shown in the timeline below:

Publication Date	Revision Level
January 1977	New publication
January 1978	Editorial
January 1983	Minor
April 1984	Minor
October 1992	Editorial
April 2003	Minor
June 2016	Bulletin
March 2017	Bulletin*
February 2019	Major*
March 2019	Minor
June 2019	Minor
July 2019	Minor
March 2021	Minor
August 2021	Minor
August 2022	Minor
October 2022	Minor
April 2023	Minor*

Figure 19: Gas Standard A-38 Revision History
*Associated with SIF incidents

As shown in the history above, GDS A-38 has been updated more frequently in recent years. Several of the updates between June 2016 and the date of this report were initiated by PG&E safety incidents (SIF-A/SIF-P) related to purging and blowdown operations. Blowdown operations are not directly covered in GDS A-38 or any other PG&E guidance document and is recommended for inclusion in future updates.

GDS A-38.1, “Installation and Operation of Air Movers” covers additional purge out-of-service information when air movers are used, including installation and operation of the air movers, details on changes to air mover operation during final tie-ins, troubleshooting, air mover specifications and performance data, and example procedures. GDS A-38.1 has not been revised since 2003, approximately 21 years. Over that time, PG&E gas has moved away from performing “hot work,” particularly “hot cut” methods, that create a window or access coupon in the pipeline which provides adequate fresh air for efficient air mover operation prior to purging out of service (pipeline contains 100% gas during hot cut). To ensure coworkers have the details needed to safely execute purge out-of-service operations using air movers and fresh air sources, it is recommended to update GDS A-38.1 as part of the associated corrective actions.

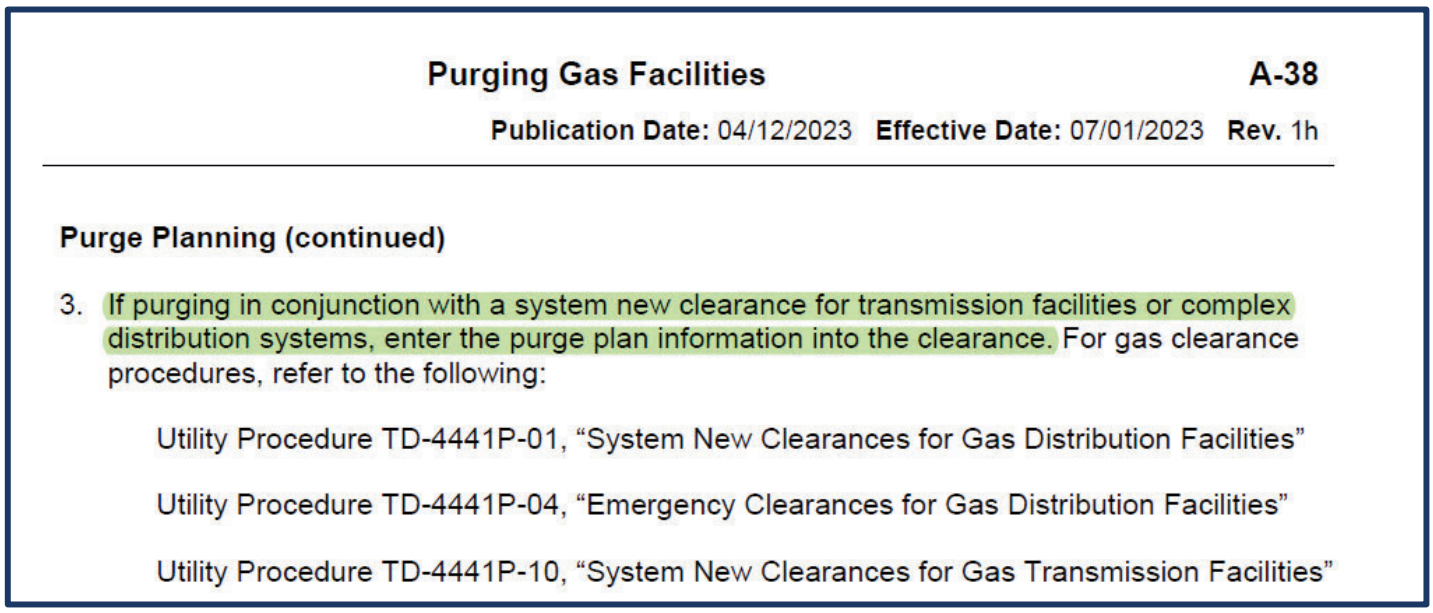
Lastly, GDS A-38.3, “Temporary Vent Stacks” and the Code of Safe Practices (CSP) Section 1304, “Vent Stacks” and 1305, “Sources of Ignition or Fire Near Escaping Gas” are referenced in GDS A-38 and cover the installation of vent extensions to allow gas and air/gas mixtures to escape to atmosphere without hazard during

purging and blowdown operations. Temporary vent extensions are a key safety control to protect coworkers and the public in the vicinity of the escaping gas or air/gas mixture from the associated noise, dust/debris, and odor as well as allowing the operation to “fail safely” if an unintended ignition should occur.

8.10 S-1391 Purge Plan

The total chamber volume of the purge associated with this event was 3,519 cubic feet. The direct-displacement purge operation used pressurized natural gas from an adjacent portion of the Line 300A piping north of the isolated section to replace the air without an intermediate inert gas purge medium (such as a nitrogen slug). This type of purge is commonly used and is described in detail in Section 5.3, “Typical Purging Procedures by Direct Displacement of Flammable Gas or Air” of the American Gas Association (AGA) “Purge Manual” 4th Edition. This section will compare the purge plan being used on July 10th with the governing standards and procedures, highlighting any identified gaps.

For the S-1391 project, purge plan information was intended to be entered into the Work Clearance Document (WCD) #80252165, “KT: S-1391 KCS CARB LEAKS L-300A WORK,” in accordance with GDS A-38 “Purge Planning” Item #3 as shown in figure below:



Purging Gas Facilities **A-38**

Publication Date: 04/12/2023 **Effective Date:** 07/01/2023 **Rev.** 1h

Purge Planning (continued)

3. If purging in conjunction with a system new clearance for transmission facilities or complex distribution systems, enter the purge plan information into the clearance. For gas clearance procedures, refer to the following:

   Utility Procedure TD-4441P-01, “System New Clearances for Gas Distribution Facilities”

   Utility Procedure TD-4441P-04, “Emergency Clearances for Gas Distribution Facilities”

   Utility Procedure TD-4441P-10, “System New Clearances for Gas Transmission Facilities”

Figure 20: Gas Design Standard A-38, "Purge Planning" Item #3 (Page 5)

Upon review of the WCD #80252165 clearance document, key pieces of information required to be included in the purge plan were omitted. As shown in GDS A-38, “Purge Planning” Item #1, the following items must be addressed in the purge plan (only items relevant to the Kettleman purge plan on July 10th are included, **bold** items were omitted):

1. A drawing, map, or sketch of the facility to be purged that shows the routes of the purge flow, all points of isolation, points of segmentation, location of the drivers, location of the source inlets, locations of vents, and monitoring points. Use clearance drawing if applicable.
2. **The required purge drive pressure.**
3. The sequence of purge operations, including all changes in purge-driving pressures, isolation points, venting locations, and monitoring points.
4. **The required capacities of the equipment to be used to drive the purge (e.g., the connected gas system, air compressors, air movers, and CNG equipment).**
5. **The expected duration of the overall purging operation.**

6. The estimated amount of natural gas that will be vented into the atmosphere.
7. **A listing of hazards, risks, and mitigations for venting natural gas, debris, liquids, black powder, sulfur, potential ignition sources, and any asphyxiation hazards.**

Note the omission of the required purge drive pressure and expected purge duration. This information is critical to ensure an adequate purge velocity and flowrate. The minimum purge velocity must be met to avoid stratification and excessive mixing that occur when velocity is too low and other hazards (projectiles, increased range of flammability, etc.) when velocity is too high. The expected purge duration is critical as well, as it allows for the identification of potential abnormal operating conditions (AOCs) when purge end points do not meet the expectation. Without the ability to monitor purge drive pressure and expected duration, the clearance team was severely limited in their capacity to identify hazards, apply essential controls, and fail safely.

In addition to the above, GDS A-38.3 and the Code of Safe Practices (CSP) Section 1304, “Vent Stacks” and 1305, “Sources of Ignition or Fire Near Escaping Gas” have requirements for purge vent stacks and orientation. GDS A-38.3 and CSP 1304 require vent stacks of sufficient size and height to minimize the hazard of releasing gas during purge or blowdown operations. CSP Section 1305 prohibits gas from being blown against the side of an excavation, it must be vented upward. The purge vent location at V-78 during the purge into service, where the 6-inch blind flange was removed and not reinstalled, did not meet the requirements of GDS A-38.3, CSP Section 1304, or Section 1305.

As an administrative control, WCD #80252165 is required to be endorsed by relevant stakeholders in accordance with Utility Procedure TD-4441P-10, “System New Clearances for Gas Transmission Facilities.” For this clearance, the endorsers (shown in the “Approver” column) are shown in the excerpt below:

Approver	Name/Lan Id	Response	Action Date	Action Time
Gas Transmission Control Center (GT)	[redacted]	Approved	07/05/2024	08:31:48
Clearance Supervisor (GT)	[redacted]	Endorsed	07/01/2024	08:02:19
Secondary Local Approver (GT)	[redacted]	Endorsed	07/02/2024	09:06:08
Gas Transmission Supervisor (GT)	[redacted]	Endorsed	07/01/2024	12:10:52
Station Engineer (GT)	[redacted]	Endorsed	07/03/2024	06:50:42
Transmission Planning Engineer (GT)	[redacted]	Endorsed	07/02/2024	22:16:38

Figure 21: WCD #80252165 Endorsement Table

The list of endorsers on WCD #80252165 (Figure 20) was not complete as the requirements in Table 1 of TD-4441P-10 state that the Gas Project Engineering and Design Project Engineer be added as an endorser. The Station Services Station Engineer (also known as Facility Engineer) was added as an endorser as shown above, however, the Project Engineer was not included. TD-4441P-10 also includes a note in Table 2 (figure 21) to “include the pipeline engineer as needed” for station clearances, as they can assist with purge procedure reviews, but the pipeline engineer was not included on this clearance.

Endorser	Responsible for Reviewing	Sections Required to Review
Gas Project Engineering and Design (station clearance, include pipeline engineer as needed)	Whenever endorser is not the station services asset owner, consult with the asset owner when reviewing the following: • Current maximum allowable operating pressure (MAOP) inside station • Safe and proper functionality of station equipment • Safe and proper isolation of station equipment • Contingency plans that include operating station equipment • Proper purge and pack procedure as defined in sequence of operations • Maximum welding pressures • Maximum tapping pressures • Impacts to power gas or sense lines	Header Section, Reference Drawings, Special Instructions, and sequence of operations
Station Services		
Electrical Engineering	• Safe and proper operation of electrical equipment • Safe and proper isolation of electrical equipment • Contingency plans that include operating electrical equipment • Contingency plans that include operating temporary power	
Controls Engineer	• Safe and proper operation of automated equipment • Safe and proper isolation of automated equipment • Contingency plans that include operating automated equipment	
Local First-Line Supervisor, Secondary Local Endorser, Clearance Supervisor	• Safe operation and isolation of clearance • Logistics • Clearance completeness • Feasibility • Hazardous energy control (lockout / tagout [LOTO]) • Impacts to power gas or sense lines • Overpressure risks	Entire WCD

Figure 22: Table 2 of TD-4441P-10

8.11 Configuration Control

When a Gas Clearance is established, the concept of configuration control is paramount. Configuration control can be defined as the ability to take a component, portions of a system, or an entire system out of service in a way that maintains precise control of energy and design thresholds throughout the evolution. Configuration control is maintained through a system of tagging (e.g. Man-on-Line MOL, Caution, and a series of locks that must be removed to operate the equipment also known as Lock out Tag out or LOTO). During the Clearance Work Window (from receiving Gas Control Center Authorization to proceed, through contacting Gas Control Center to report off), Configuration Control must be maintained for worker and system safety and reliability.

Sequence of a typical Transmission Gas Clearance being executed in the field, represented as phases:

- Clearance Execution Phase 1 **"Depressurization"**
  Consult Gas Control Center to gain authorization to proceed with Clearance Work. Begin closing upstream valves and other system components to restrict the flow of gas in the piping, to isolate the portion of the Gas system that needs to be worked on from the rest of normal operating equipment. Hang appropriate tags (e.g., Caution, Danger, etc.) on valves and equipment to confirm position (e.g., open, closed) and warn of hazards. Then, blow down gas within the system from normal operating pressure (can range from 50psig to 600+psig) to atmospheric pressure (0psig).

  Event Note: Currently, during the depressurization or "blowdown" phase of clearance work in Gas, Clearance Supervisors have the task of troubleshooting leak-by at clearance isolation point locations as

they are hanging tags and configuring the system in preparation for purging out of service. There is currently no guidance for how the clearance supervisors are to troubleshoot in this phase and what expectations there are for managing leak-by or other system configuration challenges arise. There are also no steps provided in the clearance work documents denoting how to handle this phase of work from a sequence of steps or Placekeeping standpoint. The transition from depressurization to purging out of service is understood by the RCE team to be a seamless transition with no controls in place to queue the Clearance Supervisor that Placekeeping and following a strict sequence of steps is now required. Through this investigation the organizational factors involved in the HU error of removing the blond flange was caused by a combination of issues. Caution Tags note not to modify configuration without contacting Clearance Supervisors and lack of controls to indicate transitioning from troubleshooting to performing steps in sequence. Clearance Supervisors are given opportunity to operate equipment outside of clearance guidance although TD-4441S guidance says to contact Gas Control for redlining.

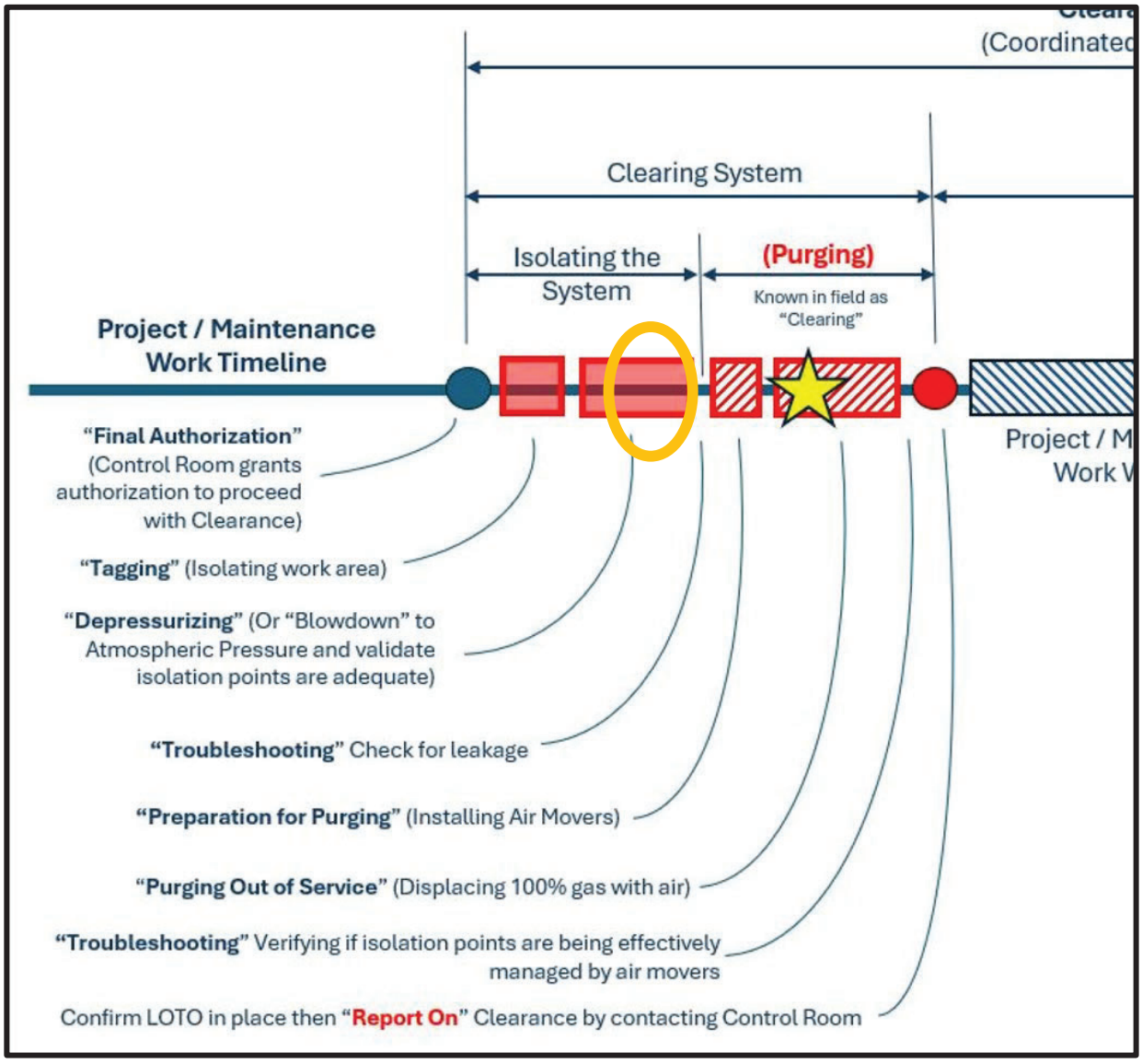


Figure 23: No HU controls when transitioning between Depressurization & Purging out of Service

- Clearance Execution Phase 2 **“Purging out of Service”**
  Once at atmospheric pressure in the system, establish purging and fresh air points within the isolated portion of the system to ensure the contents within of the isolated piping remain at or below Lower Explosive Limit (LEL). This is to ensure gas does not seep into the isolated sections of piping and mix with air to create a potentially explosive condition. Air is then pushed through the isolated portion of the system to displace and purge the gas content out of the system, which is known as “purging out of service”. Once the system is purged out of service the clearance can be “Reported On” to Gas Control which places the system under an active and documented system clearance so maintenance or construction work may proceed, safely.

  Event Note: It was during the establishment of air movers and fresh air sources, at the beginning stage of purging out of service, that V-78s downstream 6-inch flange (and the Caution-tagged-open 0.5-inch vent valve mounted to the face of it) was intentionally removed to aid in establishing fresh air. It was determined at that time that the flanged would remain off until purging into service was complete. This created a breach in the Clearance boundary therefore disabling an essential control (Clearance and Tagging). This established the condition for unsafe purging that followed.

- Clearance Execution Phase 3 **“Purging into Service”**
  Once maintenance and/or construction work are complete, the isolated portion of the system can begin its initial steps to return to service. Any maintenance or construction worker lock devices are removed, and air is then displaced and purged out of the system by the reintroduction of gas. Gas is introduced into the system from one of the upstream main isolation points and is called the “Inlet Control” point.

  Event Note: V-90 was used, in the Kettleman Station S-1391 Project Clearance, as the purge into service inlet control point. The valve was likely operated incorrectly at first, leading to a change in operation from manual hydraulic mode to manual pneumatic mode, a much less controlled way to operate the valve. Once V-90 was opened, a higher-than-expected gas flow was introduced and purged through the 6-inch opening where the flange used to be near V-78. Gas purging from the flange opening was blowing directly into an opposite facing blind flange (obstruction) at a velocity and pressure that created a hazardous air / gas explosive mixture. It is not determined at this time the source of ignition, but that the hazardous plume accumulated near several Gas workers and ultimately ignited leading to injuries. Currently, there is no training for Gas coworkers on how to lead or execute Clearances for complex projects or purge work.

- Clearance Execution Phase 4 **“Pressurizing / Return to Service”**
  Once purging gas back into the system with 0psig is complete, the next step is to begin repressurizing the system. The gas system is pressurized from 1-5psig, to 100psig. Then, soap testing is done to verify no external leak-by is experienced at clearance boundary isolation points. Once soap testing is satisfactorily completed, the gas system is then pressurized to Normal Operating Pressures (NOP). If no leaks are detected, the Clearance work window can be completed by notifying Gas Control Center to restore the system back to Gas Control Operations.

8.12 **Clearance Tagging**

PG&E Gas guidance on Lock Out / Tag Out is provided within TD-4441P-20 “Hazardous Energy Control (Lockout/Tagout) for Gas Clearances” Revision 0a (03/01/2016), as well as SAFE-1009S “Hazardous Energy Control” Revision 2 (06/10/2022). Gas LOTO guidance states that equipment under a Clearance which need to be positioned must be authorized by a Clearance Supervisor. However, the Clearance process standard TD-4441S states Gas Control as the authorizing entity for any configuration changes or deviations from the WCD.

In this incident, a clearance boundary was breached by a Clearance Supervisor coworker without prior authorization from Gas Control. The RCE team identified the guidance on responsibilities for who authorizes configuration changes during Clearance Work to be conflicting and confusing. For instance, a Tag is used to configure/position equipment that if mispositioned, might jeopardize the system or system configuration. In this incident, the Caution Tag hanging on V-78 vent valve was to note the vent was Open per the WCD. Removal of the blind flange to create a fresh air source (FAS) during depressurization resulted in a removal of the V-78 vent valve and its Caution Tag. This act of configuration change was contrary to clearance program guidance, yet permitted under current Tagging guidance.

C. **DO NOT** remove tags or operate tagged equipment except in accordance with the following:

1) For MOL tags, follow the processes described in Section C and Section D for removing locks.

2) For Caution tags, obtain authorization from the clearance supervisor before operating tagged equipment.

- In an emergency situation, if the clearance supervisor is not available to authorize operating equipment tagged with a Caution tag, obtain authorization from the responsible superintendent or Gas Control.

Figure 24: TD-4441P-20 "Hazardous Energy Control (Lockout/Tagout) for Gas Clearances" guidance on when a Caution-Tagged component can be manipulated

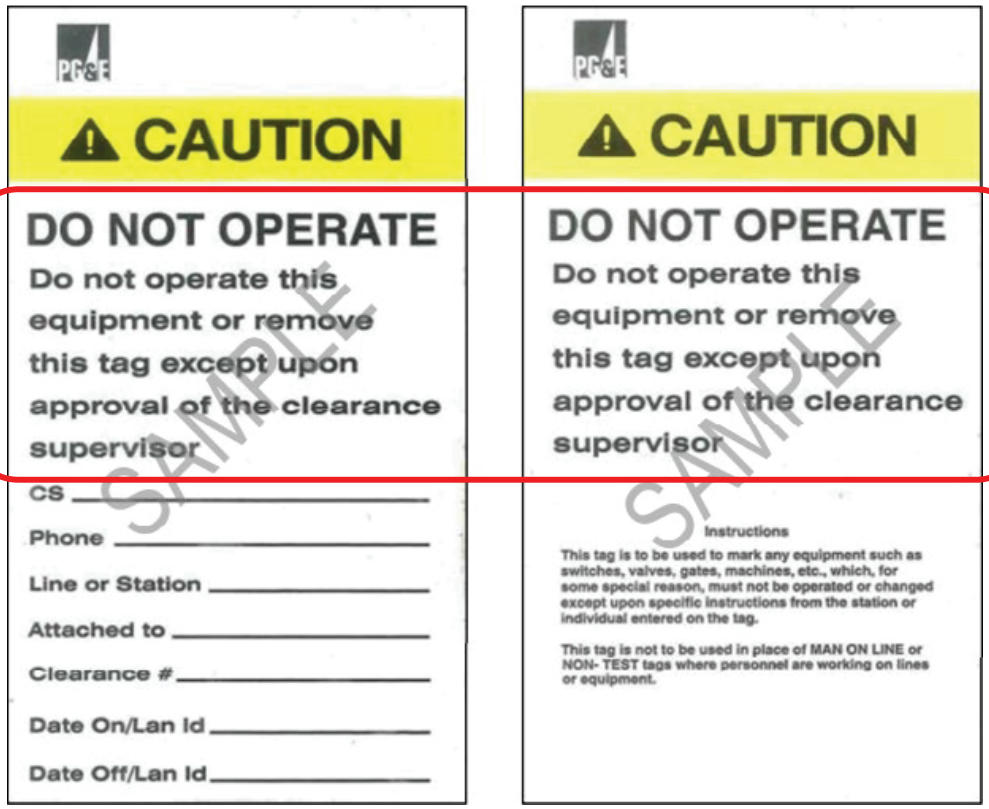
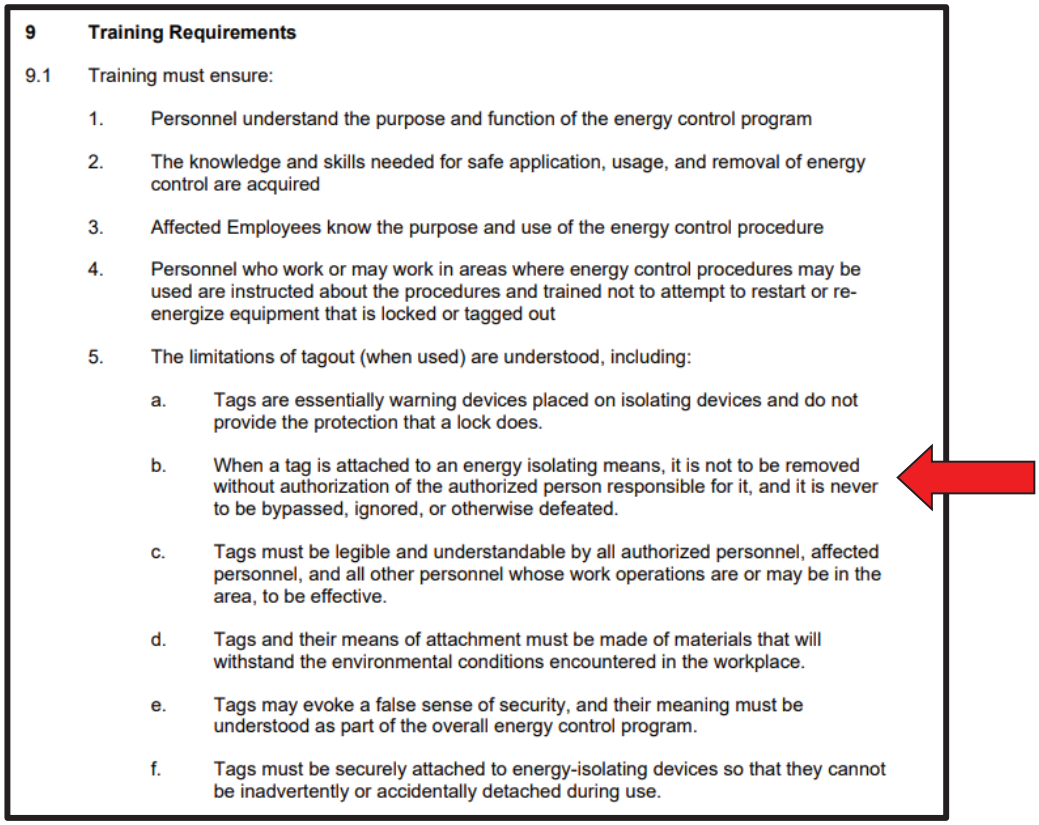


Figure 23: Caution Tag per TD-4441P-20



9 Training Requirements

9.1 Training must ensure:

1. Personnel understand the purpose and function of the energy control program
2. The knowledge and skills needed for safe application, usage, and removal of energy control are acquired
3. Affected Employees know the purpose and use of the energy control procedure
4. Personnel who work or may work in areas where energy control procedures may be used are instructed about the procedures and trained not to attempt to restart or re-energize equipment that is locked or tagged out
5. The limitations of tagout (when used) are understood, including:
   a. Tags are essentially warning devices placed on isolating devices and do not provide the protection that a lock does.
   b. When a tag is attached to an energy isolating means, it is not to be removed without authorization of the authorized person responsible for it, and it is never to be bypassed, ignored, or otherwise defeated.
   c. Tags must be legible and understandable by all authorized personnel, affected personnel, and all other personnel whose work operations are or may be in the area, to be effective.
   d. Tags and their means of attachment must be made of materials that will withstand the environmental conditions encountered in the workplace.
   e. Tags may evoke a false sense of security, and their meaning must be understood as part of the overall energy control program.
   f. Tags must be securely attached to energy-isolating devices so that they cannot be inadvertently or accidentally detached during use.

Figure 25: SAFE-1009S “High Energy Isolation” Standard, Training Requirements for Clearance and LOTO

8.13 S-1391 Project Clearance Overview

On 7/8/24 the clearance crew at Kettleman Compressor Station working on project S-1391 initiated the first steps in the Work Clearance Document (WCD) to isolate the affected section of the piping where a new valve (V54) was to be installed and another valve (V-56) was to have a new stem seam installed as part of a corrective maintenance operation. The RCE team, in partnership with SMEs, reviewed S-1391 WCD and configuration of the system before and at the time of the event.

The following are the insights learned related to configuration control and human performance:

- Critical steps were not included in the WCD that could have aided in the awareness and understanding of system configuration control, such as the positioning of V353.90A, V52, and V-56 for maintenance, Fresh-Air-Sources (F.A.S) were not included in the WCD or design drawings to ensure adequate exchange of gasses (air or natural gas), and required purge drive pressures missing from the WCD.

- After the piping was installed and inspections complete, the desire was to bring the system back to 100% gas, but 0psig in preparation for the next clearance to install another set of valves. Some members of the clearance crew who knew V-56 was closed for the stem seal repair, partially opened the valve for the “purge into service” sequence of operations. PG&E Gas Design Standard A-38 requires the use of a drive pressure gauge, so the crew understands how much gas is being introduced into the system while “purging into service”. There was not a gauge installed, so the only indicator of the amount of gas being introduced would be through sound or feel at a purge point. With V-56 being partially open this could give a false sense of the amount of gas being introduced during the Purge into Service phase. This likely led to the reason several requests were made to open V-90 further to allow more gas into the system during the Purge into Service sequence which allowed an excess amount of

gas to exit the 6-inch valve numbered V-78 and to impinge on the opposing valve V79 which led to a circular large diameter plume of natural gas that resulted in an ignitable atmosphere.

- There was a 2-inch Mueller Save-A-Valve located approximately 20-feet away from V52 which did not allow for that section of pipe to be cleared of gas all the way back to the valve.

- Steps in the Clearance were not adhered to that should have been followed to maintain worker safety and system configuration control such as removing the V-78 downstream flange that also removed a Caution Tag Clearance point (VENT D/S of V-78) as it was mounted to the face of the blind flange, not fully opening V-56 per the WCD after maintenance was performed, and not fine throttling V-90 or monitoring purge drive pressure. The blind flange was dropped at the direction of a supporting Clearance Supervisor, was not redlined per TD-4441S, and was not reinstalled prior to Purging into Service.

The following are the insights learned related to air movement during Clearance Work:

- An air compressor at V353.90A was used to inject air into the 34-inch piping to push the gas towards the air mover at V94. The air injection at this site holds many unknowns such as the size of the hole in the 34-inch pipe at the Mueller Valve Tee to which the gauge tap is attached and extended above ground, and how much air was allowed to be injected in relation to the volume of natural gas to be pushed to the air mover and be expelled from the system. The clearance team also tried to use a small air mover to withdraw gas at V353.90A, however this also has the same unknowns as mentioned in blowing air with an air compressor.

- To introduce air in purge gas procedures, or as safety check for monitoring gas, the RCE team learned that a Save-A-Valve is typically preferred (or recommended) to provide an additional level of safety in case the valve leaked by, or gas remained in the system at the conclusion of Purging out of Service.

- Mueller Save-A-Valves for sampling points commonly referred to as “sniff holes” were so close to the welding operations that they provided no safety check for the welding team installing the new piping.

- It is believed through an analysis of PG&E Gas Design Standards A-38 and A-38.1 that the inadequate fresh air sources led to difficulty and confusion in obtaining gas levels below LEL (Lower Explosive Limit which is 5% for natural gas. Upper Explosive Limit UEL is 15% for natural gas) throughout the system, which led to the decision to remove the 6-inch blind flange attached to V-78 to provide more fresh air into the system. This step was not included in the WCD, nor was Gas Control contacted to redline a change to the WCD. Thus, there was no written reminder to reinstall the blind flange prior to Purge into Service.

8.14 **Operator Qualifications and Clearance Supervisor Training**

The RCE team reviewed the training requirements and Operator Qualifications (OQs) for the work being performed during the execution of WCD #80252165 and identified that it did not provide an adequate level of detail or require significant On the Job Training (OJT) necessary to ensure knowledge, skills, and proficiency to ensure safe execution of the tasks. Below is a summary of the training and OQ requirements relevant to the event.

- **Operator Qualifications**
  To perform Clearance Work, coworkers must hold the required OQ’s. For WCD #80252165 the relevant OQ’s are listed below: (See Appendix A)
    - 04-03 Leak Test at Pressure

- 07-01 Purging with Gas and/ or Air
- 07-04 Air Movers
- 17-01 Valve Operations and Maintenance
- 14-01 Control Valve Systems (Actuated Valves)
- 22-17 Steel pipe joining: Flanged Joints
- 22-18 Steel Pipe Joining: Threaded Joints

The intent of an OQ is to maintain coworker and customer's safety. The narrative below describes the process for attaining two of the pertinent OQs and highlight what the RCE team believes to be gaps in process.

- **07-01 Purging with Gas and/or Air** requires a score of 80% or higher on an open book, written test, administered on a computer. You have full access to all relevant documents (A-38 (Rev 1g), A-38.3 (Rev 0a), TD4150P-01 (rev 1b), TD-4170P01 (rev 0)) that the questions on the test were built from along with a "key word" search function. Most written tests are followed by a performance evaluation that you must pass to become qualified. 07-01 has no performance evaluation. 07-01 also has no formal training program. Purging and venting is briefly discussed during Clearance Class (Gas-9658) but there is not a dedicated training for purging and venting. As illustrated by this and other identified ignition events purging and venting is high-risk and performed frequently.

- **17-01 Valve Operations and Maintenance** requires a score of 80% or higher on an open book, written test, administered on a computer. You have full access to all relevant documents that the questions on the test were built from along with a "key word" search function. You must also pass a performance evaluation. The performance being evaluated is the closing and opening of a pin off tee. Once completed this qualifies you to maintain and operate every type of non-actuated valve PG&E has in its system. There is no dedicated training on Valve operations and Maintenance however it is covered in several training courses offered in the Gas Control Tech. Apprenticeship (GPOM-2000, GPOM-3000 and GPOM-4000).

- **14-01 Control Valve Systems (Actuated Valves)** requires a score of 80% or higher on an open book, written test, administered on a computer. You have full access to all relevant documents that the questions on the test were built from along with a "key word" search function. You must also pass a performance evaluation. The performance evaluation has you demonstrate you can bump test a Becker control valve with one specific type of controller. There is a wide variety of power Actuated Valves in the PG&E system with many different operator and controller configurations. Lack of understanding of the functionality of the pneumatic and hydraulic operation of V-90 in an abnormal operating configuration were contributors to this ignition event. Below is a picture of the V-90 actuator illustrating the pneumatic and hydraulic portions of this equipment along with a depiction of the M-11 selector switch. Lack of specific training for this equipment combined with inadequate experience could have led to incorrect actions taken during execution of the purge drive steps taken prior to ignition.

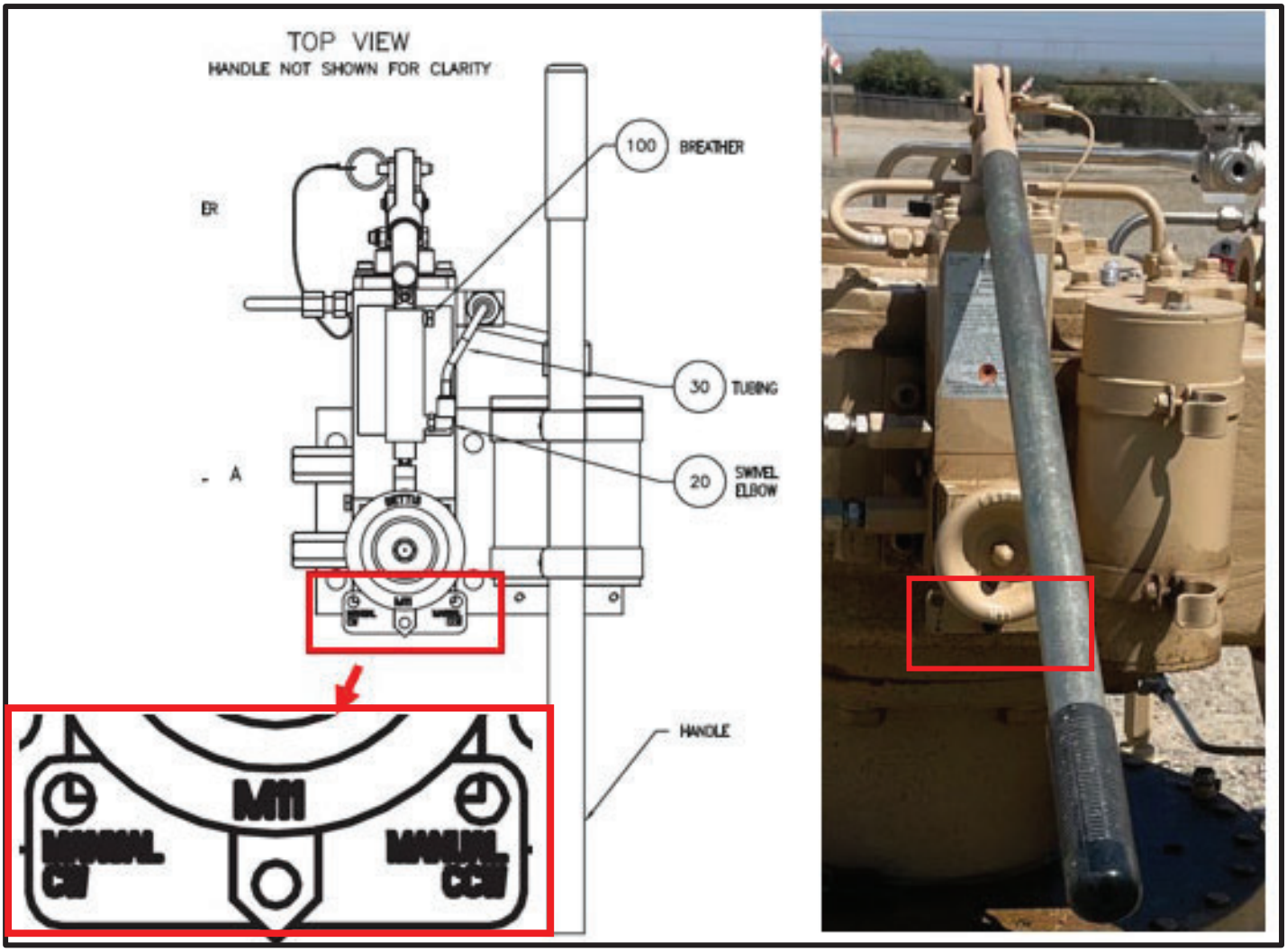


Figure 27: Position switch location and valve position indicator

- Figure:22 shows V-90's position switch that must be positioned prior to opening or closing the valve. A review of the vendor manual is required prior to operating to confirm which position to select to open or close the valve. The actual image of V-90 currently in the field, shows no text on the plate below to help the operator know which position to select. It is suspected, based on consultation with the valve manufacturer, that V-90 was operated in the closed position instead of the open position, per the clearance instructions. The field condition issue, HU error, and skills and knowledge gaps identified above are not limited to V-90 but is likely applicable to a variety of installed equipment across the gas system where a lack of device specific training is provided. Based on SME consultation, it is not uncommon to have new equipment installed without providing maintenance and operations personnel additional training.

- **Clearance Supervisor 1 (CS1) Training**
  In order to attain Clearance Supervisor 1 (CS1) you must complete the training listed below or have been "grandfathered in" to the title when these training requirements were implemented approximately three years ago. Being grandfathered in was based on prior experience of the coworker. All tasks including sub tasks must be performed seven times before being signed off by a SME (Subject Matter Expert) and Supervisor certifying that the Trainee is competent to perform CS1 tasks independently.

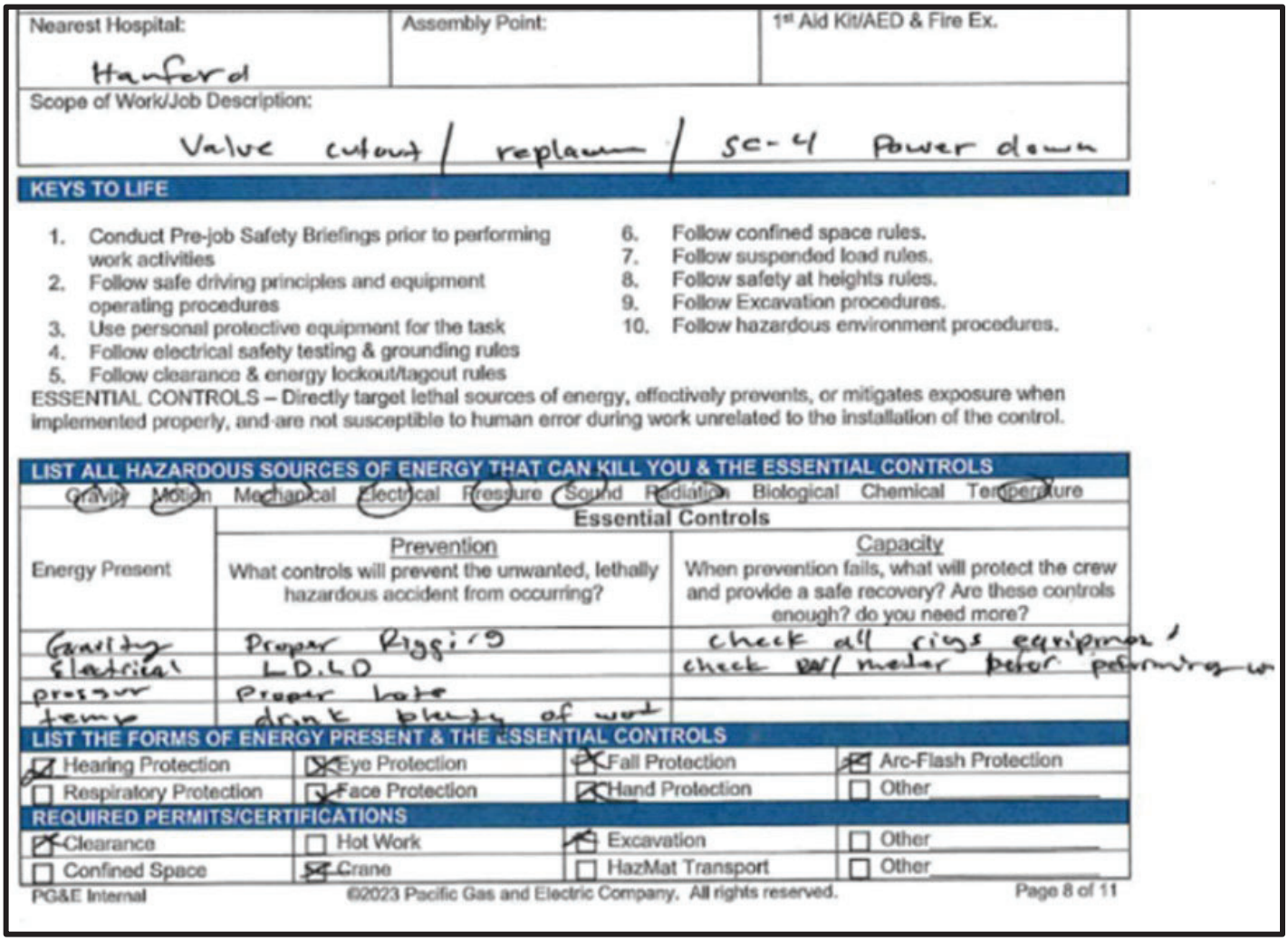
- Web Based Trainings (WBTs) (course pre-requisites):
  - GAS-0867WBT: Hazardous Energy Control / Lockout Tagout
  - GAS-0403WBT: Introduction to Gas Clearances
  - SAFE-6604WBT: Human Performance Tools (30 Min)
- Instructor Led Training (ILT)
  - Gas Clearances (5 Days) Course takes the participant through the entire Gas Clearances process which includes Writing, Endorsing, and Executing Gas Clearances
- On the Job Training (OJT)
  1. Identify relevant standards to clearance being performed.
  2. Describe how changes to system affect upstream and downstream of the change.
  3. Demonstrate safe purging and packing of gas pipelines.
  4. Use Human Performance Tools.
  5. Observe Clearance Supervisor duties on a complete clearance.
  6. Perform Clearance Supervisor duties on a complete clearance.

8.15 **Pre-Job Brief (PJB) / Job Site Safety Analysis (JSSA)**

The Pre-Job Safety Brief was filled out by GCT-2 as required, but it is not clear if he conducted a briefing with all the people involved with the work to be done that day or just the clearance team composed of GPOM and TPCO coworkers. He does mention in his Pre-Job Safety Brief form that there will be gas hazards and a release of gas, but there is no mention of the essential controls in place to mitigate the hazards or of discussions around any applicable documents or procedures relevant to the work.

The Job Site Safety Assessment (JSSA) (figures: 23-25) was completed, but the Person in Charge (PIC) was not listed, and some coworkers present the day of the event failed to sign the form including the injured coworker. The job location was left blank and there was no mention of purging activities. In section 2 of the document, the first 4 questions were all marked N/A, even though each of these questions are related to gas release and were applicable to the job. Coworker interviews indicate that a small number of individuals were aware of deviations from the clearance in V-56 position, the blind flange at V-78 being left off, and in the decision to change from hydraulic to pneumatic controls and that an opportunity to re-tailboard all coworkers and make them aware of the status of the job was missed.

As of July 12,2024, additional guidance was provided by an update of TD-4414P-01.



Nearest Hospital:	Assembly Point:	1st Aid Kit/AED & Fire Ex.
Hanford		

Scope of Work/Job Description: Valve cutout / replacement / SC-4 Power down

KEYS TO LIFE

1. Conduct Pre-job Safety Briefings prior to performing work activities
2. Follow safe driving principles and equipment operating procedures
3. Use personal protective equipment for the task
4. Follow electrical safety testing & grounding rules
5. Follow clearance & energy lockout/tagout rules
6. Follow confined space rules.
7. Follow suspended load rules.
8. Follow safety at heights rules.
9. Follow Excavation procedures.
10. Follow hazardous environment procedures.

ESSENTIAL CONTROLS – Directly target lethal sources of energy, effectively prevents, or mitigates exposure when implemented properly, and are not susceptible to human error during work unrelated to the installation of the control.

LIST ALL HAZARDOUS SOURCES OF ENERGY THAT CAN KILL YOU & THE ESSENTIAL CONTROLS

Gravity Motion Mechanical Electrical Pressure Sound Radiation Biological Chemical Temperature

Energy Present	Essential Controls: Prevention — What controls will prevent the unwanted, lethally hazardous accident from occurring?	Essential Controls: Capacity — When prevention fails, what will protect the crew and provide a safe recovery? Are these controls enough? do you need more?
Gravity	Proper Rigging	check all rigs equipment /
Electrical	L.O.T.O	check DVI meter before performing wo
pressur	Proper lote	
temp	drink plenty of wat	

LIST THE FORMS OF ENERGY PRESENT & THE ESSENTIAL CONTROLS

☒ Hearing Protection	☒ Eye Protection	☒ Fall Protection	☒ Arc-Flash Protection
☐ Respiratory Protection	☒ Face Protection	☒ Hand Protection	☐ Other

REQUIRED PERMITS/CERTIFICATIONS

☒ Clearance	☐ Hot Work	☒ Excavation	☐ Other
☐ Confined Space	☒ Crane	☐ HazMat Transport	☐ Other

Figure 28: Pre-Job Brief completed on day event, July 10, 2024

Appendix A, Pre-Job Safety Briefing

Page 2 of 2

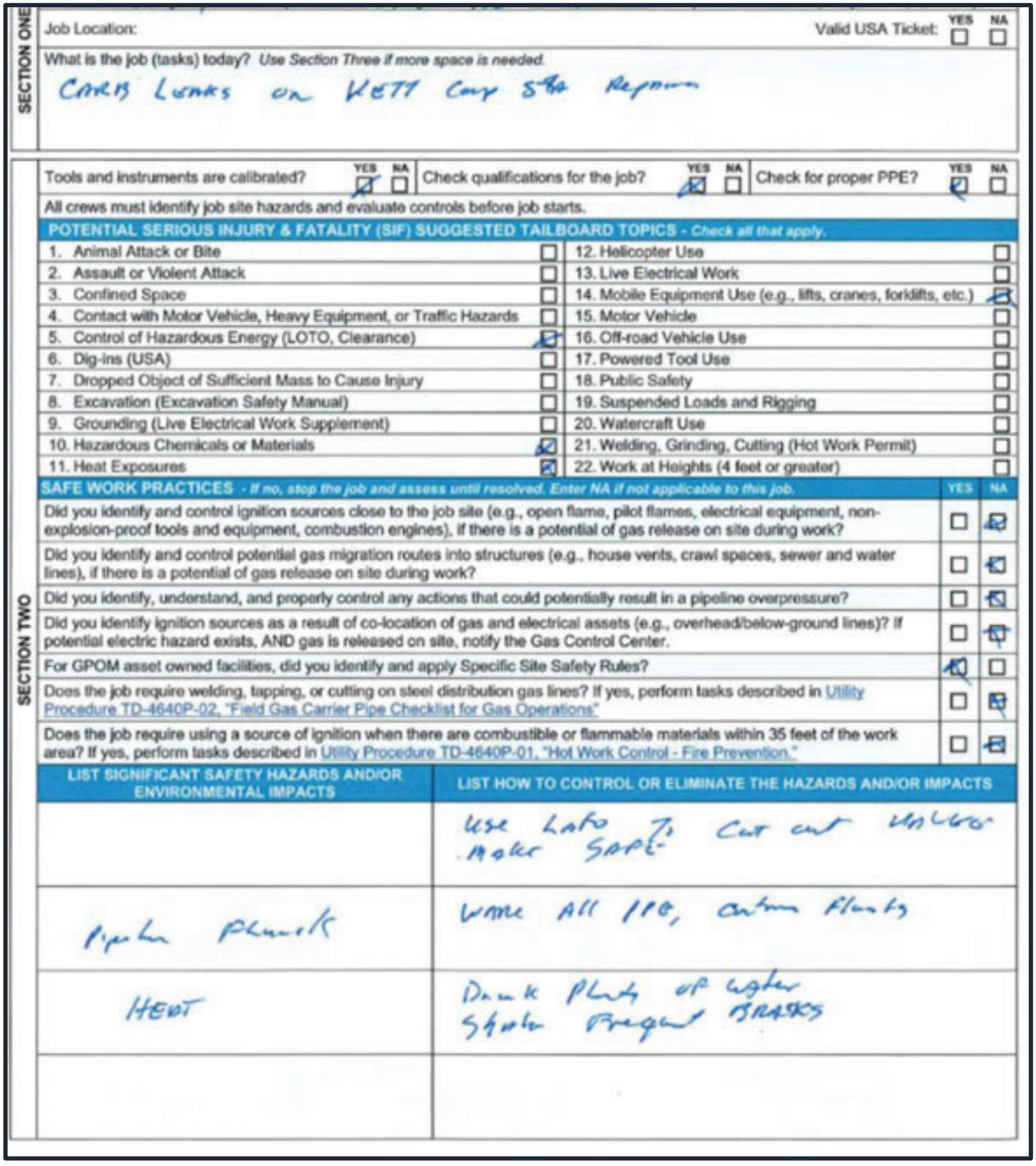
Pacific Gas and Electric Company®	Pre-Job Safety Briefing	Publication Date: TBD Effective Date: TBD

Do not start any work until all these life-safety checks have been completed and you have the controls and resources in place to safely manage all life-threatening job task hazards.

- [X] Do I have the experience, qualifications, and competency necessary to identify all lethal hazards in the task about to be performed.
- [X] What are the things at this worksite that can kill me or another person?
- [ ] X After all job task lethal hazards have been identified, can any be removed or deenergized? If not, what essential controls do I need to put in place before I start work to ensure when a failure occurs, I and others will have the capacity to safely recover?

IDENTIFIED HAZARDS		IF YES, WHAT ESSENTIAL CONTROLS IS IN PLACE?
General Hazards		
Driving/Parking	[X] Yes [ ] No [ ] N/A	designated parking area
Uneven ground surface/slope	[X] Yes [ ] No [ ] N/A	Excavator
Slip, trip & fall	[X] Yes [ ] No [ ] N/A	Wear proper footing
Ergonomic hazards	[ ] Yes [ ] No [X] N/A	
Hand & power tools	[X] Yes [ ] No [ ] N/A	all safety feature in good condition
Material handling	[ ] Yes [ ] No [X] N/A	
Safety at heights and ladders	[ ] Yes [ ] No [X] N/A	
Hot work welding & grinding	[X] Yes [ ] No [ ] N/A	Stiff all area
Appropriate PPE	[X] Yes [ ] No [ ] N/A	make sure all PPE are in good condition
Confined space	[ ] Yes [ ] No [X] N/A	
Other: _____	[ ] Yes [ ] No [ ] N/A	
Health Hazards	[ ] Yes [ ] No [X] N/A	
Public Safety Hazards	[ ] Yes [ ] No [X] N/A	
Environmental Hazards	[ ] Yes [ ] No [X] N/A	
Atmospheric Hazards	[X] Yes [ ] No [ ] N/A	
Electrical Hazards	[X] Yes [ ] No [ ] N/A	check w/ meter
Gas Hazards	[X] Yes [ ] No [ ] N/A	there will be release of gas
Excavation	[X] Yes [ ] No [ ] N/A	all excavation must have proper slops
Crane	[X] Yes [ ] No [ ] N/A	spotter at all time
Remote or Lone Worker		**Post-Job Debrief**

Figure 29: Pre-Job Brief completed on day event, July 10, 2024



SECTION ONE

Job Location: | Valid USA Ticket: YES ☐ NA ☐

What is the job (tasks) today? *Use Section Three if more space is needed.*

Check Leaks on KETT Comp Site Repairs

SECTION TWO

Tools and instruments are calibrated?	YES ☒	NA ☐	Check qualifications for the job?	YES ☒	NA ☐	Check for proper PPE?	YES ☑	NA ☐

All crews must identify job site hazards and evaluate controls before job starts.

POTENTIAL SERIOUS INJURY & FATALITY (SIF) SUGGESTED TAILBOARD TOPICS - *Check all that apply.*

1. Animal Attack or Bite	☐	12. Helicopter Use	☐
2. Assault or Violent Attack	☐	13. Live Electrical Work	☐
3. Confined Space	☐	14. Mobile Equipment Use (e.g., lifts, cranes, forklifts, etc.)	☒
4. Contact with Motor Vehicle, Heavy Equipment, or Traffic Hazards	☐	15. Motor Vehicle	☐
5. Control of Hazardous Energy (LOTO, Clearance)	☒	16. Off-road Vehicle Use	☐
6. Dig-ins (USA)	☐	17. Powered Tool Use	☐
7. Dropped Object of Sufficient Mass to Cause Injury	☐	18. Public Safety	☐
8. Excavation (Excavation Safety Manual)	☐	19. Suspended Loads and Rigging	☐
9. Grounding (Live Electrical Work Supplement)	☐	20. Watercraft Use	☐
10. Hazardous Chemicals or Materials	☒	21. Welding, Grinding, Cutting (Hot Work Permit)	☐
11. Heat Exposures	☒	22. Work at Heights (4 feet or greater)	☐

SAFE WORK PRACTICES - *If no, stop the job and assess until resolved. Enter NA if not applicable to this job.*	YES	NA
Did you identify and control ignition sources close to the job site (e.g., open flame, pilot flames, electrical equipment, non-explosion-proof tools and equipment, combustion engines), if there is a potential of gas release on site during work?	☐	☒
Did you identify and control potential gas migration routes into structures (e.g., house vents, crawl spaces, sewer and water lines), if there is a potential of gas release on site during work?	☐	☒
Did you identify, understand, and properly control any actions that could potentially result in a pipeline overpressure?	☐	☒
Did you identify ignition sources as a result of co-location of gas and electrical assets (e.g., overhead/below-ground lines)? If potential electric hazard exists, AND gas is released on site, notify the Gas Control Center.	☐	☒
For GPOM asset owned facilities, did you identify and apply Specific Site Safety Rules?	☒	☐
Does the job require welding, tapping, or cutting on steel distribution gas lines? If yes, perform tasks described in Utility Procedure TD-4640P-02, "Field Gas Carrier Pipe Checklist for Gas Operations"	☐	☒
Does the job require using a source of ignition when there are combustible or flammable materials within 35 feet of the work area? If yes, perform tasks described in Utility Procedure TD-4640P-01, "Hot Work Control - Fire Prevention."	☐	☒

LIST SIGNIFICANT SAFETY HAZARDS AND/OR ENVIRONMENTAL IMPACTS	LIST HOW TO CONTROL OR ELIMINATE THE HAZARDS AND/OR IMPACTS
	Use Lato To Cut out Valves Make SAFE
Pipe Pluck	Wear All PPE, Caution Flagging
HEAT	Drink Plenty of water Shade Breaks

Figure 30: JSSA completed on day event, July 10, 2024

8.16 **Personal Protective** Equipment (PPE)

PG&E Gas workers are expected to use the proper PPE when performing various tasks. The minimum PPE required while working on a jobsite or in a PG&E yard are:

- FR long pants
- FR long-sleeve shirt
- Sturdy work boots
- Safety glasses
- Safety vest
- Head protection
- Gloves
- Hearing protection

PG&E established a PPE Matrix (Gas Operations Personal Protective Equipment Matrix) to identify additional PPE requirements and exceptions that must be evaluated when performing specific tasks (Figure: 26). As seen in the chart below, the additional required PPE for Purging/Blowing down facilities are:

- Work gloves
- Hearing protection
- Kneeling protection

Note: The RCE Team was unable to verify whether the seriously injured coworker was wearing all PPE while performing purge monitoring at V-78. Specifically, post incident evidence collected shows the FR long sleeve shirt had rolled-up sleeves. Work gloves from the seriously injured coworker were not located. The RCE Team also collected a partially melted vest from another coworker positioned by the front right wheel of the manlift also near the edge of the excavation incident site area who received minor burn injuries to the back of both ears.

Rev. 3 2020

Gas Pipeline Operations and Maintenance and LNG / CNG

Report to Work Expectations
- FR Long pants
- FR Long-sleeve shirt
- Sturdy work boots

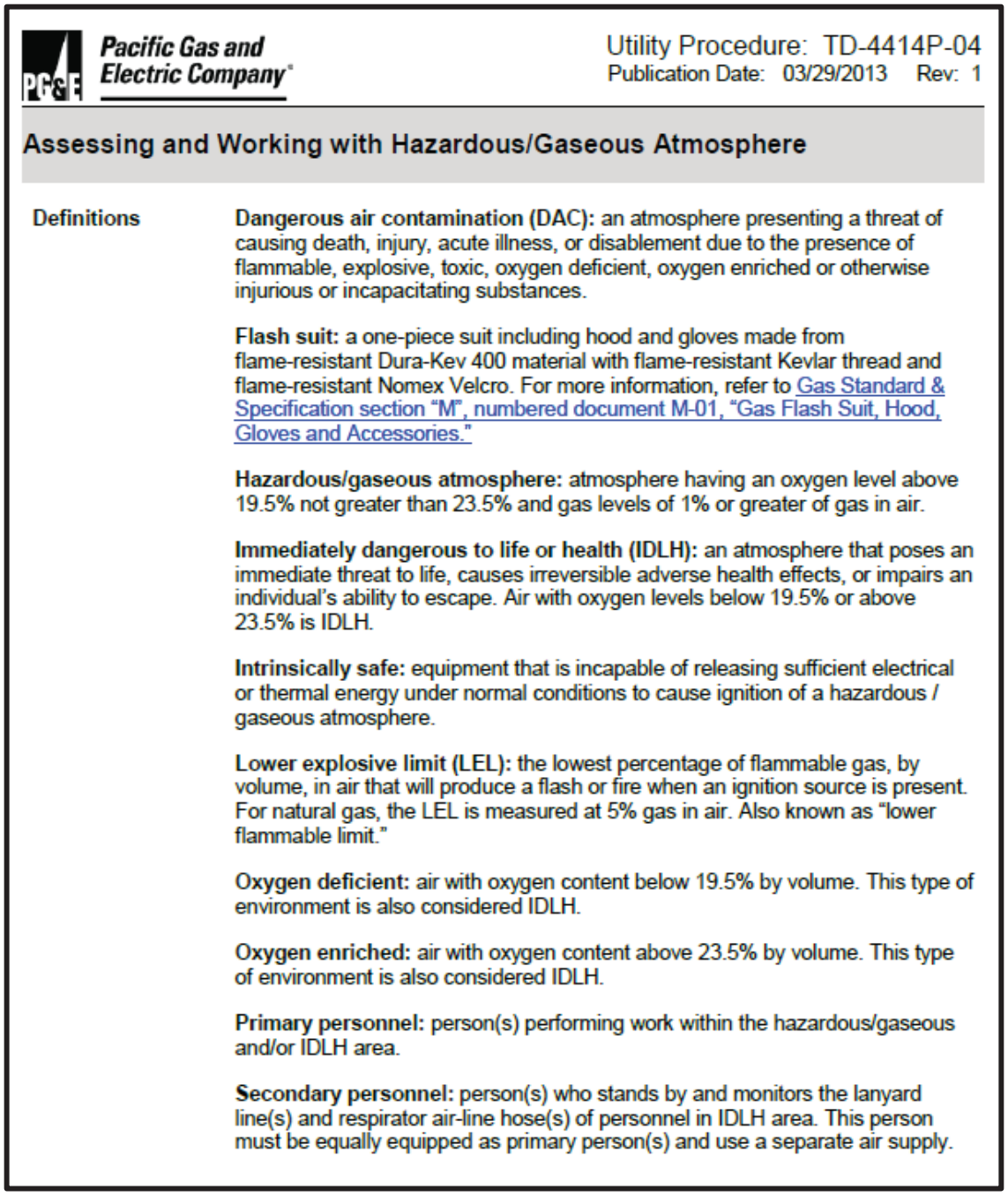
While Working Expectations
- Safety glasses
- Safety vest
- Head protection
- Gloves
- Hearing protection, in addition to the **Report to Work** requirements.

Required PPE for this activity	Work Gloves	Hearing Protection	Helmet and Goggles	Kneeling Protection (Available)	Fall Protection	Electric rated Rubber Gloves with Protectors	Face Shield
LNG/CNG AND GAS PIPELINE OPERATIONS AND MAINTENANCE **Full Time User**							
Excavation/Construction Site PPE	■						
Sub Surface Enclosures	■						
Large Meter Set Maintenance	■			■			
Riser Valve Replacements	■			■			
Regulator Station Maintenance	■	■					
Valve Operation/Maintenance	■						
Responding to Dig-In	■						
Gas Clearances	■						
Meter Change Out	■			■			
Odorant Sampling	■						
Purging/Blowing Down Facilities	■	■		■			
Operating Off-Road Vehicle (Patrol)	■		■				
Compressor Maintenance	■	■		■			
Motor Control Center Maintenance SHC-237 (Electric Hazards)	■					■	■
SCADA Maintenance	■				As Needed	■	

Figure 31: Gas Operations PPE Matrix

8.17 **Hazardous/Gaseous Atmospheres**

Utility Procedure TD-4414P-04 procedure defines hazardous/gaseous atmospheres, describes how to assess a potentially hazardous/gaseous or IDLH atmosphere, and establishes levels of personal protective equipment (PPE) required when working in a hazardous/gaseous and/or IDLH atmosphere. The instruction in this procedure applies to situations where there is a continuous release of natural gas in outside, non-confined-space locations. For the purposes of this report, TD-4414P-04 provides valuable definitions to identify a hazardous/gaseous atmosphere or “hazardous environment.” (Figure: 27)



Pacific Gas and Electric Company

Utility Procedure: TD-4414P-04
Publication Date: 03/29/2013 Rev: 1

Assessing and Working with Hazardous/Gaseous Atmosphere

Definitions

Dangerous air contamination (DAC): an atmosphere presenting a threat of causing death, injury, acute illness, or disablement due to the presence of flammable, explosive, toxic, oxygen deficient, oxygen enriched or otherwise injurious or incapacitating substances.

Flash suit: a one-piece suit including hood and gloves made from flame-resistant Dura-Kev 400 material with flame-resistant Kevlar thread and flame-resistant Nomex Velcro. For more information, refer to Gas Standard & Specification section “M”, numbered document M-01, “Gas Flash Suit, Hood, Gloves and Accessories.”

Hazardous/gaseous atmosphere: atmosphere having an oxygen level above 19.5% not greater than 23.5% and gas levels of 1% or greater of gas in air.

Immediately dangerous to life or health (IDLH): an atmosphere that poses an immediate threat to life, causes irreversible adverse health effects, or impairs an individual’s ability to escape. Air with oxygen levels below 19.5% or above 23.5% is IDLH.

Intrinsically safe: equipment that is incapable of releasing sufficient electrical or thermal energy under normal conditions to cause ignition of a hazardous / gaseous atmosphere.

Lower explosive limit (LEL): the lowest percentage of flammable gas, by volume, in air that will produce a flash or fire when an ignition source is present. For natural gas, the LEL is measured at 5% gas in air. Also known as “lower flammable limit.”

Oxygen deficient: air with oxygen content below 19.5% by volume. This type of environment is also considered IDLH.

Oxygen enriched: air with oxygen content above 23.5% by volume. This type of environment is also considered IDLH.

Primary personnel: person(s) performing work within the hazardous/gaseous and/or IDLH area.

Secondary personnel: person(s) who stands by and monitors the lanyard line(s) and respirator air-line hose(s) of personnel in IDLH area. This person must be equally equipped as primary person(s) and use a separate air supply.

Figure 32: TD-4414P-04 Assessing and Working with Hazardous/Gaseous Atmosphere

9 Analysis

The following methodologies were selected for use. Worksheets for each tool used can be found in the appendices. To support a thorough understanding of tasks and work practices, PG&E Subject Matter Experts (SMEs) were included on the investigation team. Data was collected in the form of personnel interviews, photographs, records, policies, and procedures. Data was analyzed using tools that include Barrier Analysis, Organization Learning Tool (OLT), and Human Factors Analysis Classification System (HFACS).

9.1 Interviews

Coworkers directly involved, provided direction, training, supervisory oversight, witnesses, or subject matter experts were either interviewed by the RCE Team and/or provided written statements (See Appendix E).

Data from these interviews was used to populate analysis tools (Barrier, HFACS, OLT) and the results are contained therein.

9.2 Documents Reviewed

- A-38 – Purging Gas Facilities
- A-38 Attachment 1 – Purge Plan Checklist and Examples
- A-38 Attachment 2 – Distribution Gas Clearance Purge Plan
- A-38 Frequently Asked Questions (FAQ)
- A-38-JA02 Purging Plastic Pipe with CrazeWeld Purge Stand
- A-38-JA01 Purge Calculation Worksheet Instructions
- A-38.1 – Installation and Operation of Air Movers
- A-38.3 – Temporary Vent Stacks
- AGA Purging Principles and Practice, 3rd Edition, 2001
- 24-001 INPO “Proficiency: Advancing Human and Organizational Performance” Rev.0 February 2024
- American Gas Association (AGA) Purging Manual, 4th Edition, 2018
- American Society of Mechanical Engineers (ASME) B31.8, “Gas Transmission and Distribution Piping Systems,” 2018
- American Petroleum Institute (API) Recommended Practice (RP) 1173, “Pipeline Safety Management Systems,” July 2020
- API Standard 579-1/ASME FFS-1, “Fitness-For-Service”, Part 11, “Assessment of Fire Damage,” 2021
- ASME B31Q, “Pipeline Personnel Qualification,” 2021
- Australian Pipelines & Gas Association (APGA), “Industry Guideline – Managing Noise, Gas Dispersion and Ignition Hazards when Venting Natural Gas Transmission Pipelines,” 22nd Joint Technical Meeting on Pipeline Research, April 2019
- Code of Safe Practices (CSP) Section 1304, “Vent Stacks”
- Code of Safe Practices (CSP) Section 1305, “Sources of Ignition or Fire Near Escaping Gas”
- Design Basis – Stations S-1315 Kettleman Compressor Station Carb Leaks Replace Ledeen Actuators, Project ID No. S-1315
- Design Basis – Stations S-1391 Kettleman Compressor Station Carb Leaks Replace Valves – Phase 2, Project ID No. S-1391
- “Pipeline Purging Principles and Practices Research,” Final Report, Southwest Research Institute and Gas Research Institute (GRI), GRI-97/0104. January 1997
- QG-4008, Guide to Operator Qualifications, 5//13/2024
- “Safe and Economical Purging Practices,” AGA Operating Section Proceedings, 1964
- SAFE-01, “PG&E Safety Excellence Policy,” Rev. 2, 9/12/2022

- SAFE-02, “PG&E Safe Start & Stop Work Policy,” Rev.0, 5/24/2023
- SAFE-1009S, Hazardous Energy Control, Revision 2, 6/10/2022
- SAFE-1100S, Series Injury and Fatality (SIF) Standard, Revision 6, 1/02/2024
- SAFE-1064S, Human Performance Tools Standard, Revision 0, 11/2/2023
- SAFE-1005S, Personal Protective Equipment Standard, Revision 3, 5/15/2023
- SAFE-5005S, Organizational Culture and Safety Mindset, Revision 0, 2/22/2024
- SAFE-5005P-01, Organizational Culture and Safety Mindset Procedure, Revision 0, 7/2/2024
- SAFE-5000M, PG&E Safety Excellence Management System Manual, April 2023
- TD-4441S – Gas Clearances
- TD-4441P-10 – System New Clearances for Gas Transmission Facilities
- TD-4441P-20 – Hazardous Energy Control (Lockout/Tagout) for Gas Clearances
- TD-4441P-21 – Tie-In Construction Methods for Gas Clearance
- TD-4414P-01 – Pre-Job Safety Briefing and Job Site Safety Analysis (JSSA) for Gas Operations

9.3 **Barrier Analysis**

A Barrier Analysis was performed by the RCE Team and is summarized below. See Appendix F for the full results. This analysis identified existing and potential barriers that impacted the incident. The following barriers were evaluated for their effectiveness or ineffectiveness at impacting this incident:

- Physical Barriers
- Clearance Process, including Configuration Control
- Training
- Procedures

The results of the Barrier Analysis provided the following key potential causes:

- Lack of a work management process that requires risk and/or readiness reviews prior to proceeded to execution was found to be a missing barrier. This is different than a Project Delivery System that monitors milestone for readiness.
- The Project’s Process Hazard Analysis form completed January 2024 was found to have Item 24 “Hazards or Purging Issues” N/A’d in the form. This was a missed opportunity, in hindsight, to not revisit the PHA when clearance work was swapped between Projects as V-90 was not initially selected for use.
- No Purging JHA had been filled out and what was available had not been widely trained to. This was a failed and missing barrier and also Corrective Action from previous SIF event.
- Ineffective identification and management of high-energy hazards during Planning and Preparing for work. This also existed at the time of the Pre-Job Brief and is a failed barrier for the PJB and missing barrier for early identification of risks or determining what could go wrong.
- Removal of the blind flange downstream of V-78 created an unsafe purge vent configuration, allowing gas to be blown against adjacent equipment also the side of the excavation which established conditions ripe for ignition at the level of personnel. This was a failed barrier as the clearance boundary was breached without knowledge and understanding of the system configuration risks.
- Temporary vent stacks were not installed, a missing barrier that could have allowed the crew to fail safely.
- Lack of ability to utilize the manual hydraulic function for V-90 operation limited the ability to fine throttle the valve and maintain proper purge drive pressure when operating pneumatically. This led to a hazardous air-gas release to occur at V-78.
- Gas coworker fundamental knowledge and proficiency challenges limited ability of crew to purge successfully and fail safely if/when errors occur.

- Lack of formal training on purging and blowdown, no hands-on portion associated with OQ is a missing barrier.
- Clearance Supervisor training not properly preparing coworkers for complex clearance operations is a missing barrier.
- System configuration control is not rigorously applied when executing clearance work as evidenced by the deviation from the approved clearance sequence of operations when the blind flange downstream of V-78 was removed and V-56 was closed.
- Multiple opportunities existed for Clearance endorsers to kick-back the S-1391 Clearance due to no purge plans developed. This is a failed barrier.

9.4 **Organizational Learning Tool (OLT)**

The Organizational Learning Tool (OLT) is used to investigate organizational, programmatic, Leadership, team, jobsite, and worker contributors that may have caused or contributed to a consequential event or issue. (See Appendix H)

The results of the OLT provided the following key potential causes:

- Removal of the blind flange downstream of V-78 was considered a “safe” activity during purge out of service activities performed. However, when work transitioned from purge out of service to purge into service, the risk of creating a hazardous purge environment increased exponentially. This was not realized as high risk by work crews until the purge into service became “uncontrolled,” with the discharge gas plume stirring a large volume of sand and debris inside the excavation.

- During interviews, coworkers described the removal of blind flange downstream of V-78 as increasing safety to allow for a Fresh Air Source (F.A.S.) that would help them achieve acceptable gas LEL while Depressurizing the system. This also correlates to the questions the RCE Team had on why daily walkdowns did not identify the open blind flange at V-78 as a potential hazard. Based on interviews and in consultation with Gas SMEs, the average gas employee would not likely understand nor be trained to identify the inherent risk that a transition in station modes (Out of Service to Return to Service) can potentially pose if there is not a strict adherence to Clearance guidance to maintain strong configuration control.

- Configuration control is not rigorously applied when executing clearance work. Configuration management programs (i.e. Configuration Control) ensure that the construction, operation, maintenance, and testing of the physical facility are in accordance with the design requirements as expressed in the design documentation, and to maintain this consistency throughout the operational life-cycle phase, particularly as changes are being made. During this incident, there were unapproved deviations from the clearance plan that removed an energy isolation point (V-78 flange removal), and a mispositioned valve (V-56 left partially open when clearance specified OPEN) that reduced gas to other piping sections (between 353-90A and Valve 20) that were being used to measure return into service purge gas flow.

- A lack of enforcing programmatic controls on isolating coworkers from high energy sources had the potential to impact multiple coworkers (5-10 persons) with the consequence of serious injury or fatality.

  The clearance work plan of operations, if executed as written, would have placed multiple workers in the immediate vicinity of the purge activity. Minutes before the ignition event, there were two coworkers who were in a manlift working on V-56 directly over the V-78 purge area. These coworkers were wearing fall protection harnesses that would have delayed or precluded their evacuation from the

ignition area. It was only because one coworker in the manlift had to use the restroom on an emergency basis that these coworkers were not in the line of fire during the ignition event.

The original location of the seriously injured coworker was directly within an LEL area that would have severely impeded their ability to evacuate the ignition incident area. Approximately seconds to a minute prior to ignition, the seriously injured employee began to walk away from the V-78 purge location upon the initial accumulation of the dust cloud.

There were also no controls or prohibitions on who could be in the general area near the V-78 purge. In this incident, two coworkers were conducting a discussion in the area near the manlift. One of those workers received burns to the back of their ears and their hi-viz vest partially melted. Based on interviews, it was communicated that it is common for coworkers to perform various work activities nearby active purges, including working in excavations while performing leak testing or other purge related work activities.

9.5 Human Factors Analysis Classification System (HFACS) Causal Factors

HFACS tool is primarily designed to examine four broad categories developed to identify unsafe acts, identify the pre-conditions for the act/s to occur, and determine if supervisory or organizational level influences were present that allowed the event to occur. The HFACS analysis is summarized below. Based on the HFACS analysis, multiple key factors were identified in all four areas (Unsafe Acts, Preconditions for Unsafe Acts, Supervisory Factors, and Organizational Influences) that influenced this event. (See Appendix H)

There were many Human Performance (HU) errors involved in this event, and similar ones related to prior PG&E Gas ignition, purging, and Clearance events. So many in fact, that the RCE team sought to understand the organizational and cultural reasons beyond the guidance provided in the HFACS tool. It was noted, when reviewing industry insights on systemic HU errors and knowledge issues, that evidence of systemic or prolific HU errors will be seen when underlying knowledge, skill, and competency gaps exist. Significant and systemic HU errors will continue to occur until the underlying knowledge and skill issues are addressed.

One of the one most significant HU errors repeated throughout the Kettleman event was lack of “Stopping When Unsure”. The following is noted in SAFE-02 “PG&E Safe Start & Stop Work Policy.”

> *“WHEN to Stop Work*
> *Stop work is initiated at any time a coworker or contractor reasonably believes there is a safety issue, unsafe condition, or an unsafe behavior observed. This can be as simple as pausing work to ensure all Personal Protective Equipment (PPE) is donned properly or pausing when it is discovered that the proper PPE is not in place. Stop work is triggered at any point someone observes an essential control not being in place, disabled or in threat of failing, or when it’s discovered that the job is not going as planned. Displaying a questioning attitude is critical in utilizing stop work effectively; if you see something that does not appear to be safe then do something by stopping the work until it is safe to resume.”*

All coworkers involved in the S-1391 Project work July 8 – 10th, 2024, right up until the time of the ignition, failed to stop work for all examples noted in the above guidance on when to stop work; improper PPE use, when things weren’t going as planned, when an essential control was removed (in the form of the flange downstream of V-78 being removed that breached the clearance boundary). It was noted during interviews that some workers felt they should have spoken up once or twice, while most others did not fully recognize the impact their actions would have on safety of others onsite that day.

According to the AGA guidance on safe purging practices,

"A thorough understanding of the application of these principles for each site-specific situation is required in addition to a well-prepared procedure and hazard assessment detailing the sequence of events, a predetermined rate of introduction of a purge medium and verification of endpoints at properly vented locations. Finally, the steps of the procedure must be followed and carried out by properly trained and qualified individuals."

Contrary to this guidance, no hands-on training exists for purging. Additionally, the current Operator Qualification requirement consists only of a brief paper-exam-based knowledge check of A-38 guidance for both Transmission and Distribution purging. This creates significant risk, when compounded with other unsafe behaviors and HU errors from other field coworkers.

Although the work groups involved in the S-1391 Project Clearance Work have what was described through interviews as a supportive working relationship, it ultimately led to blurred lines between roles and responsibilities of both Clearance Supervisors (the primary CS and the CS who was onsite simply in a support role). The Supporting CS was handling and troubleshooting many issues that arose during the 3-day Clearance work window, attempting to be supportive. This ”can-do” attitude displayed by the supporting CS overtook their ability to recognize when the Clearance and Purging processes were no longer being followed.

The RCE team continued evaluating Supervisory Factors, Organizational Factors, and Cultural Factors. Exacerbating the HU errors made, is a latent organizational weakness related to work practices when transitioning between Depressurization and Purging out of Service phases of Clearing a system for Maintenance and Construction. Currently, the Depressurization window allows for the manipulation of components and equipment outside of any written guidance provided in the Clearance WCD document. When appropriate LEL is achieved as part of depressurization, purging out of service can begin. Purging out of Service requires step-by-step adherence to the Clearance WCD. This seamless transition between not Placekeeping and manipulating components as needed to strict Placekeeping and configuration control with no controls in place to reset the mindset of the Clearance team or to even re-tailboard creates an error-likely situation for field workers and Clearance Supervisors to misposition components, omit or add steps, and make errors in their documentation.

When comparing the factors involved in the Kettleman Ignition event to other previous SIF and Near Hit events from years prior, leadership and organizational Human Performance factors were found to not only correlate but overlap and repeat. Repeating themes and phrases within these past cause evaluations and CAPs such as unsafe behaviors, lack of understanding risk, lack of procedure use and adherence, lack of adequate leadership engagement indicated repeating causes, contributing factors. These were viewed by the RCE team as latent organizational weaknesses due to the ineffectiveness of preventing repeat issues and causes of events.

The HFACS analysis tool was optionally selected by the RCE team to help support and provide additional validation of similar potential causes and contributors identified in the Barrier Analysis and Organizational Learning Tool. Highlights of the HFACS results include:

- UNSAFE ACTS
    - (Shortcuts) Less than adequate Pre-job brief and Job Site Safety Analysis (JSSA) when seriously injured coworker returned to jobsite (SAFE-1062S)
- PRECONDITIONS FOR UNSAFE ACTS
    - Inadequate design of the purge setup not in accordance with A-38.3
- SUPERVISORY
    - Less than adequate handoffs between different working groups (TPCO, GPOM, ENG)

    - Not a clear single point of contact when conducting purge (multiple individuals giving direction other than Clearance Supervisor)
    - Supervisor over Clearance Supervisor was not adequately engaged in the work to ensure the Clearance and Purging process guidance was adequately followed.
- ORGANIZATIONAL
    - Previous 2017 PLS3 incident (CAP# 113072120) called for the elimination of horizontal purging at PG&E facilities, but this was not effectively implemented.
    - Improvement required in hazardous / high risk work planning, coordination, and mitigation across all Gas Operations.

9.6 **Repeating Issues**

Per SAFE-5005S "Organizational Culture and Safety Mindset" (issued February 22, 2024), a key aspect of demonstrating a healthy safety culture is that Issues potentially impacting safety are promptly identified, fully evaluated, and promptly addressed and corrected commensurate with their significance. Identification and resolution of a broad spectrum of problems, including organizational issues, are used to strengthen safety and improve performance.

During the Operational Experience review, the RCE Team identified that since 2017 there are a series of causal evaluations (Root Cause, Serious Injury and Fatality, and Apparent Cause) involving purging incidents with similar or repeat causes and contributors. (See Appendix B)

Repeat SIF and Near Hit Events		
CAP & Title	**Event Date**	**Description**
112633748 Folsom Valve Gas Operations SIF	02/27/2017	**AC1:** Procedure Gap/Adherence **AC2 & CC:** Risk Awareness
113072120 SIF Potential PLS 3 Venting Ignition	07/23/2017	**AC:** Risk Awareness
113756539 L 301G No Gas Event	10/19/2017	**DC:** Configuration Control **AC1:** Procedure Adherence **AC2:** Procedure Understanding
114911966 Hinkley Blowdown SIF Potential Event	08/20/2018	**DC:** Configuration Control **AC1:** Risk Identification/Awareness **AC2:** Work planning and Coordination **CC1:** System and Maintenance Knowledge
118649351 Hollister Station OP Event	03/06/2020	**DC:** Procedure Adherence **RC:** Leadership Oversight and Work Planning **CC1:** Oversight over Supervisors **CC2:** Procedure Gaps
123433871 GO Marina Gas Ignition SIF-P	04/26/2022	**AC1:** Procedure Adherence **CC1:** Risk Awareness
123493078 GO Calistoga Pigging SIF-A Incident	04/29/2022	**RC1:** Risk Identification/Awareness **CC1:** Work planning processes

Figure 33: Previous Event Causes and Contributing Factors

For the examples above, Procedure Use and Adherence (PU&A) was the apparent or contributing cause for four incidents (Folsom, L301G, Hollister, Marina). In the 2022 Marina incident, the team identified less than adequate PU&A as Apparent Cause 1 (AC1). Per AC1:

Normalization of deviation; crews involved report not regularly purging using procedural guidance.

- *The set-up for the purge point did not extend outside the excavation area but was viewed as adequate by injured workers*
- *Approved grounding set-ups were not followed. An example includes the omission of a grounded metallic purging device*
- *Use of squeezers in lieu of approved purge head resulted in loss of purge control after Ignition*

The failure of crews to utilize and reference procedures was identified in this Kettleman incident, where nearly all workers interviewed had not read A-38 or had done so in distant pass and were admittedly not knowledgeable of the guidance details. Many of these same behaviors were identified in the 2022 Marina incident above, such as using unapproved tools and methods, and not following guidance for safe purging practices. The risk awareness and PU&A issues were also present in the 2017 Folsom incident, where workers both failed to understand the risk of their purge configurations (AC2) and to stop when procedural guidance was inadequate to perform work instead of relying on tribal knowledge (AC1). The Hinkley Event of 2018 Apparent Cause 1 cited: *The risk of working on or near a partially constructed blowdown stack was not assessed or controlled prior to commencing additional construction work.*

To address Marina PU&A and risk identification concerns, three main corrective actions were approved by CARB which include:

> *CA-1 addresses DC1: Update list of required job package components. Ensure that job aid from WP-4170-01 is included in general clearance document package for each purge plan document.*
>
> *CA-2 addresses AC-1: Deliver Safety Leadership Training to frontline leaders (Supervisors and Foremen). Focus on reinforcing in the field Procedural Use and Adherence, Personal Protective Equipment, and Keys To Life. Outcome is to empower our leaders to coach coworkers and convey these messages in the field. Teach supervisors what good looks like when reinforcing positive behaviors and coaching for performance gaps.*

Even with these corrective actions, repeat PU&A and risk identification issues continues to be identified in CAPs. This may be a result of corrective actions that do not focus on correcting trends in unsafe worker behaviors but primarily focus on frontline supervision and crews to provide them with communications and with providing field crews with tools that made accessing procedures and field guidance easier.

Risk awareness was also cited in four incidents (Folsom, PLS3, Marina, Calistoga) as causal. For risk awareness, corrective actions to implement programmatic controls were approved by the Corrective action Review Board (CARB). In the case of the 2017 Folsom incident, CA13 specified that the risk level of each type of work activity was to be understood and documented. Per CA13: "*Gas Operations to develop a process that evaluates tasks for hazards in accordance with the requirements of SAFE-1001S Safety and Health Program Standard and SH&C procedure 201 Hazard Evaluation and Control."*

However, the corrective action was later changed to place the focus on frontline worker identification of risks and not the programmatic documentation of risks as approved by CARB. Per CA13: *"After discussion with (redacted name) we will be closing this task as we have developed the process for JHA's (attached in draft form) and have already in place processes (JSSA) and training (TECH-3295) for employees to perform hazard assessments and place controls as needed."*

In the 2022 Marina incident, risk awareness was to be corrected by the following CARB approved action:

> *CA-5 addresses CC-1: See reference to corrective actions developed for Calistoga Pigging RCE. Closure of this action will be performed and documented in CA-2 of CAP 123493078. CA-2 "Develop Job Hazard Analysis Program" when implemented will include the creation of JSSA supplemental documents that address specialized work with known hazards.*

As part of this Kettleman incident, it was identified in the Analysis section under Barrier Analysis that a Job Hazard Analysis was not performed. Further interviews with Process Safety shared that while the JHA Program was a corrective action of Calistoga, it has not received the support and widespread adoption to make it an effective program. In practice, the Gas organization has delegated many of the programmatic aspects of the JHA to field crews and individual workers to identify hazards during the Job Site Safety Analysis (JSSA). The RCE Team concluded that some past corrective actions have either not been performed as initially approved by CARB or were ineffective due to incomplete implementation.

In addition to the more consequential events, it was identified that numerous CAPs have been written since 2014 that document similar repeat causes and contributors. In many cases, the CAPs either did not document adequate closure information or made future promises to resolve the issue. Administrative actions were also common, such as emails and tailboards to alert crews.

Relevant Repeating CAPs (list not all inclusive)		
CAP & Title	**Date**	**Description**
07003574 ILI operations on L-134A	05/09/2014	**Issue:** Tool shot from ILI, possible ignition **Action:** Tailboard
07004900 Purge Procedure A-38 Not Widely Used	7/21/2014	**Issue:** Procedure not used due to lack of training and guidance. **Action:** Tailboard engineers NOTE: Per CAP initiator: "Train/Tailboard reviewers to look for purge/pressures on clearances"
07010750 Near Miss Unsafe Purge Plan	04/03/2015	**Issue:** Unsafe transmission purge plan (per initiator) **Action:** Added section in pre-clearance form and add pipeline engineers to approvers in clearance process
07014008 Arc Flash Ignition DFM 1816-50	07/10/2015	**Issue:** Purge into overhead power lines caused gas ignition **Action:** Closed without action. Proposal to transfer CAP to Electric
07009382 GSE Safety Procedure during Purging Activity	07/11/2016	**Issue:** Purging near public risk of ignition **Action:** Lloyds suggested no smoking signage and exclusion zone. Tailboard implemented to construction in MI/EB divisions. Lloyds issued Scope to Improvement. Bulletin TD-A-39B-001 published and requires no smoking signage. *Note: SMEs were contacted, and interviews performed during this RCE, which indicate it is not currently a wide-spread or routine practice to post signage during purges*
114199318 Clearance Compliance Adverse Trend	01/10/2018	**Issue:** Frequency of crews not complying with the full clearance process, per TD-4441P-01 is consistently high **Action:** Talked through process on a call
114245405 Performing work without a clearance	01/24/2018	**Issue:** Stations were shut in without using a clearance **Action:** Tailboard with team
114246823 Gas Clearance Operations and Procedures	01/24/2018	**Issue:** During purge, air was trapped causing customer outage **Action:** Clearance governing meeting discussed; CAP closed. *Note: Clearance Supervisor position competency concerns identified. No documented resolution*
114434249 Work completed not part of Clearance	03/22/2018	**Issue:** Workers decided not to do steps in a clearance and also added steps not part of the clearance, without authorization **Action:** Had discussion with crew
114677378 Section of pipe not cleared of gas	06/08/2018	**Issue:** Section of pipe not cleared by following proper clearance steps and procedures **Action:** Lessons learned meeting held
114732341 Unqualified Clearance Sup PB-17B	06/27/2018	**Issue:** CS performing complex work they may not have been trained or qualified to perform **Action:** Local Supervisor confirmed individual was confident running the clearance
116581532 GI-Contractor Following Purging Procedures	02/22/2019	**Issue:** Purging leaving air in line, resulting in loss of gas service. Root Cause Performed. Per CAP: "It was determined that the crew and FE agreed to modify the sequence of operations without contacting the GDCC for approval" **Action:** Stand-down performed, and All-Hands Call
114804012 Work Completed Not Part of Gas Clearance	07/20/2018	**Issue:** Work was completed in the field, which was not part of the initial clearance and did not follow guidance for add **Action:** Call with select groups discuss
115773065	01/31/2019	**Issue:** Clearance Supervisor failed to report on a clearance, proceeded

Critical steps not followed		to complete all work **Action:** Tailboard
117050994 Decomm site without WCD	04/17/2019	**Issue:** No clearance in place for decommission of a main **Action:** Tailboarded crew on procedure
117433981 Probes not retracted during ILI	06/11/2019	**Issue:** Sequence of Operations/Tagging List does not include proper steps in the clearance, as was performed in the field **Action:** Meeting with the clearance writer
117644260 Chestnut and Clay Rebuild Clearance	07/26/2019	**Issue:** Inadequate fresh air sources due to clearance supervisor not familiar with system configuration **Action:** Reset expectations of crew and request more supervisor time in field
117809123 OP Near Hit-Kettleman	08/29/2019	**Issue:** Incorrect valve configuration upon station startup **Action:** Implemented PLC change
118285606 Clearance Process not followed	12/18/2019	**Issue:** Monitor setpoints were adjusted without Gas Control being notified of the change **Action:** No additional action - Set point changes to follow OCD process
118434728 Vital Communication w/Gas Control Center	01/15/2020	**Issue:** No communication about completed SCADA work was received **Action:** Tailboarded crew
119318276 Work compl not following clearance process	07/07/2020	**Issue:** The clearance team did not understand the impacts of reducing pressure **Action:** None
120496332 & 120717178 Gas Main Work Completed w/o Clearance	02/03/2021 03/31/2021	**Issue:** New Gas main was activated without using a Gas Clearance **Action:** Tailboard
122291448 Clearance process deviation 2	11/02/2021	**Issue:** Work was completed outside of a clearance **Action:** None
123719322 Work completed without authorization	05/31/2022	**Issue:** Gas Control denied worker who called in to get authorization to proceed with clearance, due to their lack of training. Work completed anyway **Action:** None
123821239 Dangerous nontraditional pigging	06/10/2022	**Issue:** Many unsafe practices, including no clearance for this work **Action:** Multiple discussions.
124491766 Violation of clearance process	09/12/2022	**Issue:** Work on slam shut not performed under a clearance **Action:** incorporate slam shut install and FCO into one process
124536363 Clearance Process Deviation	09/20/2022	**Issue:** Clearance Supervisor deviated from WCD, redlined clearance without calling Gas Control **Action:** Coaching
125901480 Clearance missing key info	04/13/2023	**Issue:** Clearance Supervisor not involved in reviews, clearance missing key protocols for safety **Action:** Small discussion
125940449 Clearance Execution	04/18/2023	**Issue:** Last steps in clearance not completed, Control Room not notified **Action:** Issue discussed during DOR
126960111 Clearance Process Remediation	08/31/2023	**Issue:** Several instances of reporting OFF TEST and clearance closed inappropriately **Action:** Unclear on action
127052680 Swing Check Valves V-88.80 & V-90-54	09/14/2023	**Issue:** During Pre/Post valves were not correctly placed into proper position as noted on clearance document **Action:** No action documented.
127489996 Main Tie In Performed without a Clearance	11/16/2023	**Issue:** Job completed without a planned clearance **Action:** Crew Tailboarded
128131860 Overlooked step in clearance	02/05/2024	**Issue:** second step of the clearance process was overlooked which resulted in the unit not being blown down Action: tailboard with crew
128290048 Clearance/LOTO Keys to Life #5	03/14/2024	**Issue:** Work completed, not under a clearance **Action:** Tailboard with multiple crews

Figure 34: Selected CAPs from 2014 - Present

Serious and significant issues were identified in the CAPs reviewed that, if adequately corrected, would have either prevented or reduced the likelihood of occurrence in the Kettleman incident. For instance, not understanding the impacts and risks of system configuration during clearance work, lack of effective communication with Gas Control, and lack of following clearance standards. In many examples, the clearance

teams are documented as not thoroughly understanding the impacts of reducing pressure, removing equipment, or steps and sequence of activities.

In addition to examples of ineffective corrective actions, the Gas Corrective Action Program lacks an established method or process to identify and arrest negative safety trends. In review of the Gas Corrective Action Program, the RCE team found no formal cross-functionally established trending or performance monitoring process. The last guidance document in place for Gas CAP was at the time ECAP rolled out a single and centralized Standard and Procedure for the execution of the CAP program across all Functional Areas. This lack of an established trending and/or performance monitoring process means that lower significance CAPs are not providing early indications to management of more serious safety issues. To be proactive to issues, the department needs a process to periodically assess for trends needing additional evaluation or corrective action.

There is also a need for robust processes to validate the effectiveness of corrective actions designed to prevent recurrence of significant problems. For significant issues, the Gas Corrective Action Review Board performs reviews of CAP Effectiveness Review Plans (ERP) after corrective action completion. However, these reviews are generally scheduled 3-6 months after action completion. It is recommended by the RCE Team that additional ERP reviews be routinely performed on at least an annual basis for a five-year period to ensure sustainability.

Other opportunities to correct course were provided by the 2021 Federal Monitor report provided to PG&E, which summarized the decline in gas safety as follows:

> *"Overall, the recent history of reform and improvement in Gas Operations is positive. There are two main risk factors to this improvement. The first is the risk of complacency—of assuming that things will remain good when, in fact, every day requires constant vigilance. The second risk is that the people who drove much of the reform and improvement in Gas Operations (including the current Chief Risk Officer, Sumeet Singh) have often been moved to wildfire issues related to Electric Operations. This is to some degree inevitable and prudent given recent lethal problems and issues with wildfires. However, thoughtful analyses and assessments must be made as to when additional resources are needed overall, including in Gas Operations, to prevent cannibalization of the efforts to drive progress in Gas Operations since San Bruno."*

A search in CAP for recent non-Compliance events rendered the following list:

CAPs related to purging (Reported through Internal Review Summary Findings (IRSF) Report)				
CAP#	**Summary**	**Code or Procedure Reference**	**Date(s) or Year(s) of 1st Occurrence**	**District/ Division**
116581532	Purging procedure not followed in field due to modified sequence of operations which resulted in loss of gas for customers. The crews and Field Engineers determined this change without contacting GDCC for approval. A mandatory stand-down occurred on 2/27/19 to address the incident and the correct protocols to prevent reoccurrence of this issue.	192.605 A-38	2019	Sacramento
118557002	Proper procedures for purging pipelines are not being followed when deactivating facilities. Locations: 2444 Encinal Ave, Sacramento (PM 35070990) and 8 Hermès Cir, Sacramento (PM 31329917)	192.727(b)	2019	Sacramento
123176033	On February 17, while purging a newly installed service line to a new home, the crew was unable to detect gas odor. M&C tapped a 2" steel line that was installed in 1966 and connected the new 1" plastic service line. Upon purging, the M&C crew thought purging was complete and was unable to detect any odor. Multiple people were unable to detect odor so someone called Gas Control to make the inform. GPOM or Measurement Services was not made aware of the incident until 2/22. Per the standard TD-4570P-03, under low /no odorant conditions, the supervisor must notify Gas Control and the M&C distribution superintendents. Normal operations can resume after several actions are completed including notifying the Gas	192.605 TD-4570P-03	2022	Central Coast

	Measurement Services Manager. Approximately a week later, GPOM took multiple reads upstream and downstream of the location of the no/low odor and all GIA reads were well within specifications. No no/low odor calls were received in the established neighborhood. It's possible that the service line still had air when GIA samples were taken.			
124636262	Incomplete purge according to PG&E's standards during the K&D clearance executed on 7/8/22 for PM 35216844. Contractor, VPC followed the guidance of PG&E clearance supervisor and was requested to re-purge the deactivated main. The line was not purged properly because the loop was not isolated/severed while blowing air out of all of the purge points/risers. The GDCC does not require a formal purge plan for complex systems on deactivations so there were no actual clearance steps that were missed, and the clearance steps were followed accordingly. The engineer that was running the clearance had the misinformation that isolating the loop was not required during deactivations. Upon review of the documentation, it was noticed there were no separation cuts or pressure control points shown on the loop when reviewing the OCN from the clearance. This brought up the question as to if we were able to effectively blow out all of the gas. The crew was asked to return to the project and take a sample, which revealed there was an unacceptable amount of gas left in the system.	192.727	2022	Sacramento
125904428	Contractor crew (C&C Utility) missed a crucial step in PG&E standard A-34 "Piping Test Design Requirements" (Page 3 of 49. General Test Requirements, bullet #6) while performing an alteration on an existing service line. The process is similar to a Cut, Test, & Transfer procedure. Crew squeezed, purged, and cut the service line at the tee. They installed the missing EFV. Then reconnected and repressurized the service line. The "test" step of the procedure was missed. This service was performed at Laguna Way PM#45053673	192.725	2023	Yosemite
117042247	A Problem-Solving Session was performed to address the concern with Field Service employees not holding the OQ 07-02 qualification as they perform these purging tasks on a daily cadence. Field Service employees currently are not profiled to hold this OQ 07-02.	192.805	2019	Multiple
123433871	A PG&E coworker was purging gas out of a purge point when the gas ignited causing burns to the employee. On 4/26/2022 at approximately 14:30 hours a PG&E co-worker was purging a 2” plastic main utilizing a 1” plastic pigtail at a purge point inside an excavation. While purging, gas had ignited causing burns to the employee’s hands and face. The employee was taken to the hospital where he was given first aid and then transported to another location that is a specialized burn unit.	192.751	2022	Central Coast

Figure 34: CAPs related to purging (Reported through Internal Review Summary Findings (IRSF) Report)

CAPs related to clearances (Reported through Internal Review Summary Findings (IRSF) Report)				
CAP#	**Summary**	**Code or Procedure Reference**	**Date(s) or Year(s) of 1st Occurrence**	**District/ Division**
126367616	Inadequate Clearances - There have been 3 instances submitted related to clearance instructions missing steps/inadequate execution. 125901480 - 04/2023 125940449 - 04/2023 126084921 - 05/2023	192.605(b)(5) TD-4441S	2023	Multiple
127155523	**Clearance not called in for leak repair -** On 9/27/23 crew was scheduled for a leak repair at Oakton Way in Rancho Cordova. Crew pinpointed and excavated the leak to discover leaking fitting on end of a main. The crew isolated the visible end of main and made repairs by installing a new end cap. Crew backfilled the same day. On 9/28/23 crew foreman during process of completing the paperwork realized he had not contacted GDCC and immediately called supervisor. Foreman and Supervisor contacted	192.605 TD-4441S	2023	North Valley

	GDCC to correctly document clearance. Clearance Number: 80240322			
126137745	**Work Without a Clearance -** Set-Point Changes without an approved clearance. Per TD4441S, and clearance is required when impacting gas pressure, gas flow, or gas quality. The set-points were changed without a clearance.	192.605 TD-4441S	2023	Central Coast
123043449	Work deviated from approved work clearance document such as tie-in and cutoff locations. These major changes were not communicated to Gas Control.	192.605 TD-4441P-01	2022	North Valley
123043441	Work deviated from approved work clearance document and sequence of operations such as main cutoff locations and tie in method. Changes were not communicated to Gas Control.	192.605 TD-4441P-01	2021	North Bay
122400086	Third-party (ARB) was working downstream of station and squeezed pipe under clearance too quicky and over pressurized at 33 psi (MAOP 25). Per 192.605(b)(3), "Starting up and shutting down any part of the pipeline in a manner designed to assure operation within the MAOP limits prescribed by this part, plus the build-up allowed for operation of pressure-limiting and control devices."	192.605(b)(5)	2021	East Bay
122291448	These 2 clearances included steps in the sequence of operations to restore the distribution reg station to service after work was complete which was never done. The work was completed and the station remained shut in without revising the clearance steps. WCD 80161991 WCD 80161992	192.605 TD-4441P-01	2021	Stockton
118648650	Redlined operating diagram for OCN 31020654 under Clearance 80095598 was not provided within 24 hours after completing the clearance as required in TD-4441P-10.	192.605 TD-4441P-01	2019	Sacramento
123899993	PGE is unable to meet the 3' clearance requirement in 192.353(c) in densely populated areas where the indoor meter set is being relocated or replaced for Gas Service Replacement Program (GPRP) jobs.	192.353(c)	2022	Multiple
118021345	Operational Change Notice (OCN) not submitted for valve replacement job under clearance 80084399	192.605 TD-4441P-10	2019	Central Coast
119853421	Operational Change Notice (OCN) not followed for PM 84013040 on 9/24/2020 that contained clearance documents that were not provided per TD-4461P-26. The piping, valves and filter in the LVC were replaced. Work clearance number is 80118501	192.605 TD-4461P-26	2020	Peninsula
124732435	On 10/17/2022 A call came into the control room regarding a reported grade 1 leak in Rocklin at Rocklin valve lot @ Independence/Aitken dairy, on Line 173. The leak is on pin-off T. Report is that it is a slow leak not blowing. Gas tech was on site and will make repairs under emergency clearance. SCADA showed a blowdown from approximately 450 PSIG to zero, going flat for about 10 min triggering a LoLo alarm, then pressuring up back to NOP. This work was done without an emergency clearance.	192.605 TD-4441S	2022	Sacramento
118122533	Missing documents for OCN (PM 84008220) 1. Operating Diagram - Redlined to match work performed on clearance. 2. Operating Map - Redlined to match work performed on clearance. 3. Upload in SAP the Value Commissioning Report (VCR) as pdf's.	192.605 TD-4461M	2019	Milpitas
115016298	**Missed SCADA Maintenance, Tracy []** Potential Missed Maintenance for SCADA at Old River PLS. ADD'L NOTES (SAP) - In 2017 the Former Tracy GPOM Supervisor submitted an RW to cancel operations at Old River. In the RW he indicated to only keep the batteries/solar panel and PTs 1 and 5 to call in July. The station was taken out of service so he requested to RPO everything listed on the spreadsheet attached in RW 113264059. Asset Strategy processed the request and	192.605 TD-4560S	2017	Tracy

	verified the maintenance plan would call in July with the specified equipment (Battery/Solar Panels/PT1/PT5). In July # a gas control tech submitted an RW to reschedule annual maintenance for Old River to call in March. Asset Strategy placed the RW in LCHQ for confirmation by GPOM supervisor to reschedule. Upon looking at the RW today, we found that the July PM had N3 notifications backdated to March, with the exception of PT-1. PT-1 is still assigned to a tech that has not completed the operation. We looked through the station binder and found a note from 2017 indicating that SCADA maintenance would not be performed because of a clearance. Current GPOM supervisor and Asset Strategy reviewed all the active eq for Old River and found that the RTU/ZTs were all included in the original RW to RPO and cancel operations. GPOM supervisor advised to reactivate the RTU and ZTs to call annually. We have documentation that PT-5 and the batteries were maintained in March but could not find documentation for the RTU, ZTs and PT-1 since 2016. There is a possibility that PT-1 was calibrated in March and the record could not on an XP laptop # LCHQ is currently trying to retrieve that information. Hence, we decided to submit a potential self-report .			
124636262	Incomplete purge according to PG&E's standards during the K&D clearance executed on 7/8/22 for PM 35216844. Contractor, VPC followed the guidance of PG&E clearance supervisor and was requested to re-purge the deactivated main. The line was not purged properly because the loop was not isolated/severed while blowing air out of all of the purge points/risers. The GDCC does not require a formal purge plan for complex systems on deactivations so there were no actual clearance steps that were missed, and the clearance steps were followed accordingly. The engineer that was running the clearance had the misinformation that isolating the loop was not required during deactivations. Upon review of the documentation, it was noticed there were no separation cuts or pressure control points shown on the loop when reviewing the OCN from the clearance. This brought up the question as to if we were able to effectively blow out all of the gas. The crew was asked to return to the project and take a sample, which revealed there was an unacceptable amount of gas left in the system.	192.727	2022	Sacramento
119555421	During the response to a San Francisco structure fire located at Erie & S. Van Ness on 7/27/2020, local GPOM closed an Emergency Shutdown Zone Valve (valve 3364) without any notification to the GDCC. According to TD-4441S, "All work that affects gas pressure, flow or quality requires a gas clearance." This action bypasses PG&E's process of tracking all operations performed on our gas distribution system. Additionally, without a proper clearance to track the operation, we cannot be sure that the valve has been returned to it's normal OPEN position.	192.605 TD-4441S	2020	San Francisco
117938463	During Clearance #80074020 to isolate and clear a section of Gas Transmission Line 181B for Strength Testing under the T-1430 project (Order # 84008220), an accidental ignition occurred when cutting into pipeline during clearance.	192.751	2019	Central Coast
121671061	Detailed work was not properly documented through the OCNs submitted per TD-4461P-26. The clearance documentation previously received by Gas Transmission Mapping were noted as 'No changes to operating map (OM)', despite the installation of a new Transmission inlet fire valve to station RL-20 & a change in piping configuration leading to the rebuilt station. The installation of the new inlet fire valve was not called out on OCN documentation/Form TD-4461P-26-F01.	192.605 TD-4461P-26	2020	Central Coast
114050122 **114199318**	Cognitive Trend - Not following clearance procedures This CAP notification is being created to document a cognitive trend related to reoccurring issues with the clearance process not being followed. See information below on CAP notifications that were created last year (7039844, 7039846, 7039847, 7039848,	192.605		NA

	7039849, 7039930 and7039931) and 3 created this year (112784026, 113247588, 114045398, 114114895)			
114045398	Clearance Procedure not followed The clearance supervisor on WCD 80049258 PM 31291806 did not follow the clearance process. He decided to execute the clearance in a way other than how it was written in the sequence of operations. Multiple REPORT ON and REPORT OFF phone calls to the GDCC were not made, and thechange in sequence was never communicated to or authorized by the GDCC Job Scope: PM Order 31291806 - Install 3867 ft of 2" plastic main and 1127 ft of 1" plastic stub service	192.605 TD-4441S	2017	Sacramento
119318276	Clearance procedure (TD- 4441P-01) was not properly performed for PM 35067999/Clearance 80092710. • No Preliminary Authorization call made to gas control • No Final Authorization call to gas control • No safety verification check list review with gas control.	192.605 TD-4441S	2020	North Bay
121768404	Clearance 80153298 was written and drawn up with no bypass requirement. The sketch stated the 2" steel main running S/E down alley between S. G St and S. H St. in Madera was tied and the steps did not indicate a bypass was required. As a result, gas was lost to customers.	192.605 TD-4441S	2021	Yosemite
118052829	Clearance 80083389 missing the following in SAP: 1. OCN Form and Drawing/Sketch (OCN) 2. Relined Operating Diagram (OD) 3. Redlined Operating Map (OM) 4. Valve Commissioning Report (VCR)	192.605 TD-4441P-10	2019	North Valley
118084198	Clearance 80077321 is missing the following documents in SAP: 1. Redlined Operating Map (OM) 2. Redlined Operating Diagram (OD)	192.605 TD-4441P-10	2019	North Valley
118069372	Clearance 80077320 is missing both the redlined operating map and operating diagram in SAP.	192.605 TD-4441P-10	2019	North Valley
118048301	Clearance 80073972 is missing OCN form in SAP.	192.605 TD-4441P-10	2019	Diablo
118048249	Clearance 80070014 is missing OCN form in SAP.	192.605 TD-4441P-10	2019	Diablo
123038218	An unplanned outage to 33 customers occurred on 2/25/21 during a clearance for R-1704. It was discovered that 3 district regulator stations installed in 2021 were not mapped on the operating map. There was no E-page for this reportable incident and therefore was not reported to the CPUC.	GO 112F 122.2 192.605(b)(3)	2022	Yosemite

Figure 35: CAPs related to purging (Reported through Internal Review Summary Findings (IRSF) Report)

CAPs reviewed related to purging and clearance from PSSI reviews (Potential Systemic Safety Issue) 2023-2024		
125901480	**Clearance 80217629 Rev0 missing key info** Clearance 80217629 rev 0 was expected to start 4-15-2023. Clearance supervisor walked down station (not involved in prior reviews, now was secondary endorser. Was from out of area) to find missing valves expected for moving air, no sniff holes, second air movin point missing, regulation shut off out of sequence, no release to crew to perform work, additional welding needed not discussed (gauge taps) missing 100# soap test etc.	NSI- Not Systemic Safety Issue (SSI)
124218826	**Audience for Standards and Procedures** This a BIG issue that has been danced around for too long and needs some very clear direction to protect both our internal crews as well as contract partners. There is a large grey area on if and what PGE Standards and Procedures contractors are supposed to follow. In the audience section of some of these documents it clearly states contractors as one of the intended audience groups. In others, it's assumed that contractors need to follow the S&P but there is no mention of contractors in any part of the document. In others, the understanding is contractors are not intendeds to follow that specific S&P. This inconsistency has created a gap between Quality Control, Field Safety, and our Gas Contractors. Take for example, our confined space S&P: There has been a lot of discussion, multiple meetings, etc on whether contractors should have their own confined spaces S&P or is the	NSI- Not Systemic Safety Issue (SSI)

	expectation for them to follow our confined space S&P. A lot of discussion with no real clear answer.To take this a step further, let's say we decide they need to implement their own S&P (using confined space as an example). Who looks at these to decide if their S&P exceed or at least meet our S&P (or OSHA)? Is the expectation that their S&P at minimum meet our S&P? Painting a picture of what it's like currently in the field: Quality Control goes out and has a finding on a contractor for not meeting a requirement in one of our S&P's. I'll use grounding as an example. Our standard calls for the use of specific grounding cables when performing squeezing, taping, purging, etc of plastic gas facilities. We roll out information to our internal groups on grounding expectations and specific PGE grounding cables that are to be used. This information doesn't make it to the contractor side (largely because the greater group doesn't know if they are the intended audience or they are held to that specific standard). Quality Control comes out and has findings because Contractors are using perfectly good grounding cables but they don't meet the specific PGE m-coded grounding cable requirement. Field Safety then helps roll out the information to the best of our ability. While we do this, we get a ton of questions from the contractors on what they are supposed to be following and often we simply can't give them a cut and dry answer. On top of that, you'll attend a meeting one week where it will be discussed that contractors should develop and follow their own S&P's, then jump on another meeting that is discussing the importance of Contractors following PGE S&P's. The bottom line is, THIS NEEDS TO BE CUT AND DRY, with no gaps or grey area. This is too important to leave up to interpretation and allow for finger pointing after god forbid someone gets seriously injured or dies because there wasn't clear and concise expectations.	
127127559	**LOTO for Gas Clearances Implementation** High Risk recommended (1) Safety-1.a., Assets-2.c., Reliability-3.b., Regulatory/Compliance-5.b.) Inconsistent Implementation of Hazardous Energy Control (Lockout/Tagout) for Gas Clearances Procedure while performing work on Distribution Regulation Stations. During field visits for the Operational Risk Validation Large Overpressure Event Risk Assessment, three different work locations with three different work crews in three different divisions were identified as either not using LOTO procedure or not fully making use of the procedure (operation of valves while in LOTO, not using correct LOTO tags, not physically securing tags to energy device per procedure, loose tag moved from one valve to another, etc.) during clearances. Relevant Leadership have been provided additional details related to the observations.	NSI- Not Systemic Safety Issue (SSI)
124169727	**Lock out tag out training and adherence** We are encountering crews in the field who seem to have little if no experience with the Lock Out Tag Out procedures while performing clearance operations. This is a major issue considering it is part of our Keys to Life and is a critical safety procedure. Many employees and crews no longer seem to have any equipment and there are many signs that the procedures area not being followed, especially for Distribution work. This should be addressed ASAP!	NSI- Not Systemic Safety Issue (SSI)
128702174	**Non-PG&E assets used with Gas Clearances** During the endorsement/approval process of a gas clearance document (WCD) the clearance writer identified that we do not have good guidance on how to tag or lock customer assets. There are times when the Customer/Utility needs to operate their assets to aid us in our gas clearances. We use the Customer/Utility owned assets in our gas clearance in the following examples: Valves for our isolation points and used as part of our LOTO process or in other cases we use the Customer/Utility owned assets to open an upstream crosstie to support our capacity concerns. I would like to point out that this problem applies to in state Customers/Utilities and out of state Customers/Utilities. When reviewing our clearance documents for Gas Clearances I was unable to locate any information regarding how to Tag or Lockout Customer/Utility owned assets. The documents I reviewed are TD-4441S, TD-4441P-01,02,03,04,05,10,11,15,20,21. Below is a list of concerns/questions that needs evaluating for resolution so that we are consistent in how we write and execute gas clearances: Note there can be other concerns not listed below. . PG&E employees do not operate Customer/Utility owned equipment, the question is do we tag or Lock Customer/Utility owned equipment? . How do we apply LOTO to Customer/Utility owned assets when used as isolation points? . What happens when the Customer/Utility needs to us our equipment for their clearance work? . How does the Customer/Utility apply LOTO to our company owned assets when used as isolation point? . Do we allow the customer to Tag or Lockout our assets? . Do we need to have a clearance drafted when the Customer/Utility needs to have our assets place in an abnormal state? . Do we have this problem when it applies to Gas Distribution clearances? The clearances that this issue was identified in WCD# 80257287 & 80257288 included step to tag Customer/Utility owned assets with caution tags.	NSI- Not Systemic Safety Issue (SSI)

129028269	**LVCR Clearances** When we take clearances on LVCRs, sometimes we have to blowdown customer equipment, clear customer equipment, and purge back into customer equipment. We rely on customer personnel knowledge, operation of equipment, tagging their equipment, and the general conditions of the customer assets. Clearance SME's are looking for more concrete direction on how to execute this type of work. Please reference CAP - 128662093 <* How Might this Issue be Avoided or Solved ? *> Can we safely execute LVCR type clearances within the current clearance development and execution process, or does a more robust system need to be put in place?	NSI- Not Systemic Safety Issue (SSI)
128662093	**Large Volume Customer- Houseline Issue** Large volume Customer Meter sets (LVCM's) are having project work performed for various reasons that often result in cutting into the customers houseline. There is not an approved process for blowing down the customers line and then welding/performing work, then safely re-introducing gas to these large volume customers. Often times these are large facilities that do not have accurate records of where their houseline goes or what it feeds. This creates a safety issue for the customer and puts the crews performing the clearance in a bad situation. I feel PG&E is putting itself at risk by trying to complete these projects by having TPCO or GPOM walkdown customer owned equipment and tell them what needs to occur even though they (including the customer) may not know of all customer piping. This currently is being handled by the clearance process but it is inadequate and an official process needs to be developed and published. <* How Might this Issue be Avoided or Solved ? *> I believe a stand down is needed on this work until Codes & Standards can issue a safe procedure to follow to ensure that customer and employee safety can be properly accounted for.	NSI- Not Systemic Safety Issue (SSI)
129273439	**Training for OQ-0701 Purging with Gas.** Current academy training classes for Transmission Mechanics and Gas Control Technicians does not address the knowledge and skills required to safely perform the following OQ tasks: OQ-0701 Purging with Gas and/or Air, OQ-0703 Inert Purging and OQ-0704 Air mover operations. These skills could be safely simulated in the flowlab at the Gas Safety Academy. Teaching best practices for these activities and re-enforcing the current standards will result in a safer field workforce. <* Who should be assigned to address this issue? *> Gas Academy Curriculum Development. <* How Might this Issue be Avoided or Solved? *> All OQ's should have a required element of formal classroom training before any attempt to test either physical or written.	NSI- Not Systemic Safety Issue (SSI)
128942645	**Unqualified People Running Clearances** Upper management is allowing people who are not qualified to run clearances. This puts our employees, and contractors at risk for severe injury or possibly death. GPOM has been on a clearance for 4 days, 24 hours a day and the line is still reading gas levels within the explosive range, and they are still moving forward with allowing contractors to perform hot work/cutting/welding on the pipeline. Not only is this unsafe, but it's also not cost effective. How might this issue be solved or avoided? Utilize the department that was created to execute clearances. Their entire existence was based on their ability to dedicate all their time reviewing clearances, pipeline purging, pipeline clearing techniques and procedures and clearance logistics. This knowledge has been passed down from people who had been doing this work for over 40 years. The attached picture is Gas Ranger read after running an air mover for over 72 hours.	Systemic Safety Issue (SSI) Review Pending

Figure 36: CAPs reviewed related to purging and clearance from PSSI reviews (Potential Systemic Safety Issue) 2023-2024

9.7 Leadership and Organizational Responsibilities for Correcting Issues

While not all encompassing of Gas Leadership, the Gas Corrective Action Review Board is responsible for approving corrective actions for all significant safety events (SIF ACE and SIF Root Cause). Utility Standard: GOV-6102S Enterprise Cause Evaluation is the standard followed within Gas to approve and implement corrective actions and is designed to achieve the following:

- *"The objective of this standard is to establish a framework governing the timing, training required, delivery, and documentation of CEs relating to work related safety, compliance, quality, and performance issues, to prevent or minimize the probability of recurrence, and to apply continuous improvement measures."*

Gas CARB is also responsible for ensuring the effectiveness of past completed corrective actions via the Effectiveness Review process contained in GOV-6011:

- *"3.11.4 EFFRs must be reviewed and approved by FA CARB."*

GOV-6011, Table 2. Roles and Responsibilities Matrix, lists CARB Members as responsible to "Provide oversight, review, and approval of all RCEs, ACEs, and EFFRs." Further, CARB Members are defined in GOV-6011 in the Definitions section as:

- *"Corrective Action Review Board (CARB): A senior level management board in each FA that provides oversight for the Corrective Action Program. CARB promotes behaviors throughout the organization that support effective problem identification, quality cause evaluation, corrective action tracking and timely issue correction. Includes FA representatives from Regulatory Compliance & Quality Assurance, Safety, Asset Strategy, Operations, and CAP."*

GOV-6011 also discusses the responsibility to ensure program implementation as:

- *"IMPLEMENTATION RESPONSIBILITIES*
  Each officer and director are responsible for implementing the Enterprise Cause Evaluation Standard within their organization."

These GOV-6011 Leadership responsibilities align with American Gas Association Safety Culture Statement (AGA SCS), which establishes a "Commitment by Management" to identify and resolve issues. Per the AGA SCS:

- *MANAGE RISKS: A positive safety culture expects employees to understand the inherent risks presented by their activities serving customers and operating natural gas assets. These risks must be effectively managed through appropriate programs and management systems designed to safeguard the public as well as employees and contractors.*

- *IDENTIFY HAZARDS: A positive safety culture expects its employees and those providing services to identify hazards and act on them. Any potential situations that could affect employee, customer, public, or pipeline safety should be promptly identified, fully evaluated and appropriately addressed. Identified hazards and near miss incidents should also be shared across the organization so that others may learn of a possible hazard.*

- *COMMITMENT BY MANAGEMENT: A positive safety culture begins with the organization's top leaders. Management must emphasize and demonstrate that the safety of employees, customers, the public and our pipeline systems is a value that is paramount. All decisions must take into account the importance of safety. For example, production, cost, and schedule goals should be developed, communicated and implemented in a manner that demonstrates that employee, customer, public and pipeline safety is an overriding priority.*

9.8 **Recent Operational Experience - Since Initiating the RCE**

During this Root Cause Evaluation, the team was notified of two separate issues related to blowdown and purging: CAP #129428181 "CHEM POISON/TOXIC EFFECT" and CAP #129344575 "Venting gas at safe distance & height".

On 8/03/2024, while responding to a cross-bore incident near the San Francisco Bay area, crews were performing emergency blowdown activities on an 8-inch pipeline. One crew member onsite, who was part of this RCE who was also responding to the incident, noticed a riser / stack extension was not in place at the time blowdown was to begin. The work was stopped and did not proceed until a proper stack extension was installed. This was considered a good catch as no injury or consequence occurred.

Figure 37: Blowdown Riser locations before stack added (after, on right)

(Only preliminary details are available) On 8/21/2024, while performing distribution purging a coworker passed out and received minor injuries. Evidence supports the absence of some essential controls mandated by purging procedure A-38 that were missing from this job. In this incident, a coworker purging new construction distribution line was potentially exposed to a hazardous atmosphere (lack of oxygen due to gas accumulation) and collapsed. A-38 contains requirements on how to safely dissipate escaping gas away from the coworker to atmosphere and prevent worker asphyxiation, to include the use of purge stands and not purging into an excavation. As an interim corrective measure of the Kettleman RCE, a stand-down in A-38 guidance was distributed to all crews that perform purging activities. It is not yet known why the A-38 required essential controls covered in this stand down were not implemented in this recent 8/21/2024 purge incident. There is a concern by the RCE Team that gaps in safety behaviors shared between the Kettleman and recent 8/21/24 incident will continue unless effectively abated by Leadership.

Figure 38: Distribution purge incident locations 8/21/2024

10 Evaluation Conclusion

The analysis resulted in the following conclusions and identified causal factors:

10.1 Root Cause

Root Cause: Failure to achieve effective change in safe behaviors and the implementation of essential controls to mitigate high-energy hazards.

In recent years, Corrective Actions were implemented with the intent to improve safety performance and change behaviors while performing Gas Clearance and Purging Work. Despite Gas organization efforts, Leadership has not been successful in setting and enforcing expectations for job task hazard awareness, reinforcing desired safe behaviors, and maintaining a culture of continuous learning. Subsequent Leadership has also been ineffective coaching to standards adherence and communicating safety direction.

PG&E no longer defines Safety as the absence of events, but by the presence of controls that provide workers the capacity to fail safely. Standards and guidance are in place for high energy hazard recognition, Organizational Culture & Safety Mindset (Safety Culture), and Human Performance Tools. Contrary to the expectation that all PG&E Functional Area Leaders prioritize high energy controls and the capacity to fail safely, Gas Leaders are inconsistently reinforcing these processes, principles, and tools. This issue spans across all departments within Gas Operations and is evident within multiple data sets such as CAP, industry assessments, and Cause Evaluations. Examples include lack of adherence to critical safety procedures, lack of stopping when conditions change, lack of processes to plan for high-risk work activities, and ineffective leadership engagement in the field. Collectively, actions from previous events have failed to correct these organizational weaknesses impacting coworker safety and prevention of repeating near hits and significant events.

10.2 Contributing Causes

Contributing Cause 1: “Configuration control is not rigorously applied when executing clearance work.”

Configuration control is defined as the ability to take a component, portions of a system, or an entire system out of service in a way that maintains precise control of energy and design thresholds throughout the evolution. Prior to purging into service, gas coworkers failed to recognize a high energy essential control had been disabled (removed) during the purge out of service. This allowed high-energy to be released in a hazardous manner and prevented the coworkers from failing safely. Over relying on the human performance of Gas coworkers in the field to identify and address system configuration risks, such as preventing hazardous air / gas mixtures while purging, fails to demonstrate a collective focus on safe outcomes and high energy hazard mitigation.

Contributing Cause 2: “Gas coworker fundamental knowledge and proficiency challenges”

Routine Human Performance errors and repeat causes of ignition, purging, and Clearance events indicate ongoing gaps in adherence to these standards as well as knowledge and skills gaps related to safe Clearance and purging practices. This is evident among coworkers and leaders who oversee and directly support Clearance Work. Currently, no adequate hands-on training exists for purging, which is a critical aspect of building competency. This applies broadly to work groups such as Gas Clearance Writers, Endorsers, Approvers, Clearance Supervisors, Project Managers, Engineering, Operations, Maintenance, and associated leaders. Additionally, wide-spread gaps were discovered in worker and leader knowledge of system design, which impacts the ability to maintain configuration control during Clearance Work activities.

Contributing Cause 3: “Failure to Recognize Risk and Address Causes of Repeating Events”

Despite a strong reporting culture within Gas, issues potentially impacting safety are not consistently addressed and corrected commensurate with their significance. Identification and resolution of a broad

spectrum of problems, are not adequately identified through trending and assessment to improve performance, including organizational issues.

10.3 RCE Team Concluding & Cultural Insights:

Insights on the Gas safety Journey

Since PG&Es San Bruno Pipeline Explosion event of 2010, the Gas Organization has been on a journey to improve programs, process, and coworker behaviors. A watershed moment in the history of PG&E Gas and an advent for important change, it remains at the forefront of discussions regarding safety throughout the organization. The event was so impactful, even today's newest Gas coworkers, who were not part of the Gas Organization at the time of the event, can recall and share the learnings. Soon after the San Bruno event, Gas partnered with Officers from across PG&E to share best practices and respond collectively. As a result of this collaboration, three major improvements were implemented which are now foundational to PG&E: the Corrective Action Program, Speak Up initiative, and the Employee Conduct Program. By 2013, a fully functioning Gas Corrective Action Program (Gas CAP) had been designed and implemented within SAP. In addition, a campaign to "Speak Up" for safety was launched as well as a company-wide Employee Conduct Program (ECP) to support coworkers who felt retaliated against for speaking up and raising safety concerns.

Issues found to be causal and contributing in the Kettleman Ignition event, such as Clearance program gaps, unsafe purging practices, ignition, valve maintenance and operation proficiency, leadership engagement, and human performance errors such as lack of adherence to standards, have been reported in CAP since early 2014. These and similar topics account for roughly 1-2% of all Gas CAPs submitted since then with many examples of CAPs closed to no action, closed to promises, or resolved with tailboards and 5 Minute Meeting communications. These issues continue to repeat through 2017 when the first consequential SIF events were reported relating to purging, venting, and system clearing. At the time of these events, CAP was rolling out Enterprise-wide (ECAP), due to how Gas CAP was embraced after San Bruno, and PG&E wildfire response began. The impact of PG&Es wildfire litigation and settlement spanned another several years and resulting in bankruptcy, enterprise-wide reprioritization of work, VSP, and years of turnover in Senior and Officer-level Leadership.

Between 2017 – 2022, the number of consequential SIF events appeared to subside, but events without serious injury continued with the same causes resulting in issues such as Gas Transmission system over-pressure events such as a large Central Coast customer outage in 2017 and a Hollister Over Pressure event of 2020. In 2022, a Gas Distribution ignition SIF event occurred that resulted in a coworker burn injury. After reviewing the results of these evaluations and others from the same time, the RCE team identified nearly identical causes and contributing causes between all event. Areas of consistent challenge include (see section 8.16 Repeating Issues):

- Front-line leadership oversight / reinforcement of standards and desired behaviors
- Knowledge, proficiency, and training for workers
- Mitigation of high energy risks when purging and venting (hazardous air / gas mixtures)
- Verification of work readiness and pre-job planning
- Human Performance Tool use, such as Procedure Use and Adherence and Stop When Unsure
- Clearance work and safe purging and venting practices
- System Configuration Control during Clearance Work

Recently, efforts were made to counteract some of these gaps. Specifically, actions were taken to establish elevated Clearance reviews, risk ranking of Clearance, initiating a 2022 Clearance Program Self-Assessment (never assigned ownership and remains incomplete), reviewing Clearances requested 48-hours prior to the start of work, and notably the centralization of a Clearance Operations Department within System Operations to establish a point of accountability for decision making and improvements. An Audit was initiated in 2024 to

evaluate the end-to-end Clearance program, including the roles and responsibilities of Clearance Supervisors. This Audit is still underway. Additionally, the need for specialized training for Clearance Supervisors was recognized and Human Performance Tool Use Principles were introduced and embedded within Gas System Operations & Maintenance (GPOM) work practices. Despite these efforts, causes and corrective actions associated with prior SIF events continue to repeat with planning and coordination for work, risk awareness, adherence to standards, and inadequate leadership engagement. These are not isolated to any one prior event, but rather, are seen throughout all SIF and Near Hit event evaluations reviewed as part of this RCEs OE search.

Although only one member of the Kettleman Station crew was seriously injured, two others received minor injuries. Had these coworkers remained in their planned positions at the time of ignition, the extent of injuries would likely have included one or more fatalities. Per SAFE-5005S “Organizational Culture and Safety Mindset” issued February 22, 2024, a key aspect of demonstrating a healthy safety culture is that issues potentially impacting safety are promptly identified, fully evaluated, and promptly addressed and corrected commensurate with their significance. Identification and resolution of a broad spectrum of problems, including organizational issues, are used to strengthen safety and improve performance. Today, Gas coworkers continue to use CAP to document concerns, despite no formal trending process. Quality Management should aid in identifying these types of organizational weaknesses as a last line of defense.

Proposal for Next Steps: A Shared Vision of Safety

Isolating people from high energy is critical and universal across all industries. Maintaining adherence to Clearance and LOTO program requirements is an organization-wide responsibility. The process must be robust, yet clear, and provide coworkers with necessary knowledge and capabilities to fully comply. Coworkers must be aware of high energy risks and how the Clearance and LOTO Program keeps them safe prior to and during Clearance work activities. Contrary to this, the S-1391 Clearance team members were not aligned on all risks associated with the complexity of the Clearance beforehand due in part to lack of adherence to the Project Clearance Work planning process for coordination and alignment. Tool designed to help prepare for high-risk work such as Job Hazard Analysis (JHA), Process Hazard Analysis (PHA), and Purge Plans per A-38, were neither utilized, reinforced, nor validated for completeness before starting work. Therefore, despite compounding Human Performance errors made in the field once work began, the S-1391 Clearance team was not set up to succeed prior to initiating Clearance work on July 8th.

Recent reflections on serious incidents within the utility industry are indicating that no amount of focus on use of Human Performance Tools will fix fundamental knowledge and proficiency gaps, which were found to be causal in all Gas SIF events over the last ten years. The RCE team learned the conditions leading to this ignition event were neither unique to Kettleman Compressor Station nor the coworkers who were onsite that day. Rather, exist throughout the Gas territory and can be seen through execution of other complex project Clearances.

The RCE team took a brief look at what sets apart high-performing Organizations that achieve long-term sustained performance compared to lower-performing peers. This type of achievement can be directly attributed to specific core cultural values demonstrated throughout at all levels of an organization: placing value on long-term views and strategic focus, leadership and talent development, very high-performance standards, continuous learning, and ability to see and correct their own problems. In effect, possessing and demonstrating deep-seated beliefs in continuous improvement and the pursuit of excellence. Placing focus on the development of a Gas Safety and Culture Achievement Plan, with a goal to ultimately sustain a healthy culture long-term, would demonstrate setting effective direction which is a foundational responsibility of Leadership. This will also drive clarity, where there is currently uncertainty of the roles of Leaders in maintaining a healthy safety culture.

Since completing actions from the 2010 San Bruno ignition event, Gas Leadership has not effectively prevented the incremental erosion of behaviors and lack of priority and discipline around high energy risk mitigation, leading to repeat Clearance and Purging events. When Gas Leaders, recognized by the RCE Team

for their talent, capabilities, and dedication, are aligned on a shared vision of what it means to fail safely, they will collectively drive a culture of accountability, collaboration, and continuous improvement across the organization. United by a common set of goals, leaders will prioritize safety in every decision and action, setting clear expectations, and leading by example. This will correct the repeating challenges of the past and as a result, the organization will experience significant improvements in safety performance, reduction of incidents, and foster a lasting safety culture.

10.4 Cause and Corrective Action Matrix

Root Cause (RC)		***Failure to achieve effective change in safe behaviors and the implementation of essential controls to mitigate high-energy hazards*** *In recent years, Corrective Actions were implemented with the intent to improve safety performance and change behaviors while performing Gas Clearance and Purging Work. Despite Gas organization efforts, Leadership has not been successful in setting and enforcing expectations for job task hazard awareness, reinforcing desired safe behaviors, and maintaining a culture of continuous learning. Subsequent Leadership has also been ineffective coaching to standards adherence and communicating safety direction.*		
Cause No.	**Cause Statement**	**CAPR**	**Action Owner**	**Due Date**
(RC CAPR1)	Root Cause Statement: ***Failure to achieve effective change in safe behaviors and the implementation of essential controls to mitigate high-energy hazards.*** NERC Cause Code: A04B01C09: Corrective action for previously identified problem or event was not adequate to prevent recurrence.	**Title:** Develop Safety and Culture Achievement Plan **Hierarchy of Control:** Administrative **Action:** • **Part 1:** Develop and implement a 5-year Gas Organization Safety and Culture Achievement Plan. The Plan should provide a unified vision, direction, and goals that will enable all Gas Coworkers to achieve high standards for the prioritization of safety. Desired outcomes of this Plan include demonstration that all levels of the Organization are aligned on the definition of safety, that coaching to safety standards is widely practiced, and that essential safety behaviors are both measured and monitored on a routine basis. To achieve a synchronized vision of safety and culture across Gas, this Plan should acknowledge and unify new and existing culture and SIF prevention initiatives. Leadership should champion and drive the adoption of this Achievement Plan and its goals, in partnership with high-risk program owners, field leads, and grassroots-led teams. The goals incorporated in this Plan should: o Place emphasis on behavior-based action with targeted goals at the worker/crew lead, Supervisor, Manager, Director, and Officer level. o Include routine monitoring, to identify early signs of decline in safety and cultural performance. o Leverage Safety Culture Monitoring, per SAFE-5005P-01, to confirm desired changes in behaviors are established and sustaining. o Define triggers for response in the event progress waivers or performance declines over time. o Specify review of results with the Gas Corrective Action Review Board (CARB) and Gas Risk and Compliance Committee (RCC). • **Part 2:** Establish a Leadership Development program for all Gas leaders, including those who play a critical role in managing work in the field such as Crew Leads, Clearance Supervisors, Project Engineers, and Project Managers. This should be designed as an annual opportunity to align Leaders on essential safety behaviors and actions and provide them with the capability to model, teach, and enforce standards. At minimum, the objectives should include achieving and sustaining core competencies amongst all levels of Gas Leaders in the following areas: o Commitment to PG&Es definition of Safety o High-energy hazard recognition & Essential Controls o SAFE-5005S “Traits of a Healthy Safety Culture” o Coaching and reinforcing to standards o Leadership & Coworker accountability o OE / Lessons Learned from significant Gas events, recent and historic **Deliverables to show completion:** Performance of annual Leadership Development Program and documented progress toward 5-year Achievement	Austin Hastings	09/01/2030

		Plan goals and actions.		
(RC CAPR2)	Root Cause Statement: ***Failure to achieve effective change in safe behaviors and the implementation of essential controls to mitigate high-energy hazards.*** NERC Cause Code: A04B01C09: Corrective action for previously identified problem or event was not adequate to prevent recurrence.	**Title:** Establish Exclusion Zones **Hierarchy of Control:** Elimination **Action:** In alignment with industry guidance and best practice, implement purging exclusion zone criteria such that no people, impedances, or sources of ignition are in the direct vicinity of a hazardous air/gas plume while performing any type of blowdown and purging work. Clear and simple guidance should be developed for field and engineering use. This may include use of diagrams, drawings, and other visual tools to clarify exclusion zone distance, plume diagrams, and any other requirements such as delineation and signage. Protocols should be included for situations when people or obstructions are determined to need to be within established exclusion zones, such as increasing height of blowdown stack, selecting alternative purge locations, equipment limitations, or use of specialized PPE. **Deliverables to show completion:** Exclusion zones established via Engineering guidance documentation.	[redacted]	09/01/2025
(RC CAPR3)	Root Cause Statement: ***Failure to achieve effective change in safe behaviors and the implementation of essential controls to mitigate high-energy hazards.*** NERC Cause Code: A04B01C09: Corrective action for previously identified problem or event was not adequate to prevent recurrence.	**Title:** Install and Stage Vent Stacks **Hierarchy of Control:** Engineering **Action:** Install permanent vent stacks where exclusion zones, coworker safety, or public safety may be challenged. In locations where permanent stacks cannot be installed, stage engineered piping in the immediate vicinity to ensure the stack extension is readily available for planned or emergency clearance work. **Deliverables to show completion:** Approval and installation of permanent vent stacks and engineered piping staged.	[redacted]	09/01/2025
(RC CAPR4)	Root Cause Statement: ***Failure to achieve effective change in safe behaviors and the implementation of essential controls to mitigate high-energy hazards.*** NERC Cause Code:	**Title:** Implement Risk Identification and Readiness Reviews **Hierarchy of Control:** Administrative **Action:** Develop and implement an action plan to improve early coordination of risk identification, high-energy hazard mitigating actions, and adherence to Clearance and Purging work preparation processes. This should include: • Elevated Review Process for flagging high-risk and complex Project Clearance Work for enhanced readiness review. • Accountability measures for adherence to high-risk safety milestones for Project and Clearance Work. • Confirm roles and responsibilities for the planning and preparation of Clearance and Purging work execution, which may include Supervisory review of relevant procedure with teams, Supervisors and SME participation in pre-job planning, and post-job quality reviews.	[redacted]	09/01/2025

	A04B01C09: Corrective action for previously identified problem or event was not adequate to prevent recurrence.	**Deliverables to show completion:** Implement the action plan.		

Contributing Cause 1 (CC1)	***Configuration control is not rigorously applied when executing clearance work*** *Configuration control is defined as the ability to take a component, portions of a system, or an entire system out of service in a way that maintains precise control of energy and design thresholds throughout the evolution. Prior to purging into service, gas coworkers failed to recognize a high energy essential control had been disabled (removed) during the purge out of service. This allowed high-energy to be released in a hazardous manner and prevented the coworkers from failing safely. Over relying on the human performance of Gas coworkers in the field to identify and address system configuration risks, such as preventing hazardous air / gas mixtures while purging, fails to demonstrate a collective focus on safe outcomes and high energy hazard mitigation.*			
Cause No.	**Cause Statement**	**CA or CAPR #**	**Action Owner**	**Due Date**
(CC1 CA1)	Contributing Cause Statement: ***Configuration control is not rigorously applied when executing clearance work.*** NERC Cause Code: AXB02 Maintenance Modification Configuration LTA	**Title:** Develop Configuration Control Devices **Hierarchy of Control:** Administrative **Action:** In partnership with Gas Engineering, design and develop "Configuration Control Devices" (CCDs) to be used as unique and distinct Clearance Operations robust tagging devices that prevent inadvertent operation or removal of equipment and components within a clearance boundary (e.g., use of CCD clamp on blind flanges that have permanently affixed vent valves). These CCDs will also serve as an additional control to aid in maintaining configuration control when transitioning through phases of Clearance work. **Deliverables to show completion:** Evaluate and procure devices.	[redacted]	09/01/2025
(CC1 CA2)	Contributing Cause Statement: ***Configuration control is not rigorously applied when executing clearance work.*** NERC Cause Code: AXB02 Maintenance Modification Configuration LTA	**Title:** Evaluate Clearance Supervisor Roles and Responsibilities **Hierarchy of Control:** Administrative **Action:** In partnership with IBEW, evaluate Clearance Supervisor classification to determine if opportunities exist to further refine and/or delineate roles and responsibilities: • GPOM IBEW LOA 14-40-PGE 9/18/2014 • TPCO IBEW LOA R1-13-47-PGE **Deliverables to show completion:** Evaluation complete and recommendations documented.	[redacted]	09/01/2025
(CC1 CA3)	Contributing Cause Statement: ***Configuration control is not rigorously applied when executing clearance work.*** NERC Cause Code: AXB02 Maintenance Modification Configuration LTA	**Title:** Implement Clearance and Tagging Event Monitoring Process **Hierarchy of Control:** Administrative **Action:** Implement Clearance and Tagging performance monitoring process with criteria for classifying Clearance-related events. The goal is to encourage prompt reporting, learning, and communication after Clearance events that had the potential to or did result in exposure to hazardous energy. **Deliverables to show completion:** Develop criteria for classifying, acting, and communicating learnings following Clearance Events.	[redacted]	09/01/2025

Contributing Cause 2 (CC2)		***Gas coworker fundamental knowledge and proficiency challenges*** *Routine Human Performance errors and repeat causes of ignition, purging, and Clearance events indicate ongoing gaps in adherence to these standards as well as knowledge and skills gaps related to safe Clearance and purging practices. This is evident among coworkers and leaders who oversee and directly support Clearance Work. Currently, no adequate hands-on training exists for purging, which is a critical aspect of building competency. This applies broadly to work groups such as Gas Clearance Writers, Endorsers, Approvers, Clearance Supervisors, Project Managers, Engineering, Operations, Maintenance, and associated leaders. Additionally, wide-spread gaps were discovered in worker and leader knowledge of system design, which impacts the ability to maintain configuration control during Clearance Work activities.*		
Cause No.	**Cause Statement**	**CA or CAPR #**	**Action**	**Due Date**
(CC2 CA1)	Contributing Cause Statement: ***Gas coworker fundamental knowledge and proficiency challenges***. NERC Cause Code: A03B03C06 Individual underestimated the problem by using past events as basis	**Title:** Implement Training for Clearance Operations **Hierarchy of Control**: Administrative **Action**: Develop and Implement training for General Clearance and LOTO Awareness, Clearance Writing, and Clearance Supervising of complex Clearances. Establish a plan for both initial and refresher training. **Deliverables to show completion:** Clearance training is developed and implemented.	[redacted]	11/01/2025
(CC2 CA2)	Contributing Cause Statement: ***Gas coworker fundamental knowledge and proficiency challenges.*** NERC Cause Code: A03B03C06	**Title**: Develop A-38 Job Aid and Purging Training **Hierarchy of Control:** Administrative **Action:** Develop and issue Field-based A-38 Job-Aid and accompanying training for Gas Transmission blowdown, purging, and venting work. The job aid should be a field-friendly document, utilizing diagrams and visual images to help enable success in adherence to A-38. Beyond initial review of the Job Aid and participation in training, ongoing opportunities to refresh knowledge and skills should be proactively maintained. (*A-38 Purging Training – pending final training needs analysis*) **Deliverables to show completion:** Develop and publish A-38 Job Aid and implement associated training for Gas Transmission blowdown, purging, and venting work.	[redacted]	11/01/2025

Contributing Cause 3 (CC3)		***Failure to Recognize Risk and Address Causes of Repeating Events*** *Despite a strong reporting culture within Gas, issues potentially impacting safety are not consistently addressed and corrected commensurate with their significance. Identification and resolution of a broad spectrum of problems, are not adequately identified through trending and assessment to improve performance, including organizational issues. (Note, CAPR1 and CAPR4 implement critical leadership engagement and accountability improvements necessary to address aspects of CC3).*		
Cause No.	**Cause Statement**	**CA or CAPR #**	**Action Owner**	**Due Date**
(CC3 CA1)	Contributing Cause Statement: ***Failure to Recognize Risk and Address Causes of Repeating Events.*** NERC Cause Code: A04B01C06 C06 Previous industry or in-house experience was not effectively used to prevent recurrence	**Title**: Implement Trending and Performance Monitoring **Hierarchy of Control:** Administrative **Action**: Implement gas cross-functional trending of CAP for topics including, but not limited to, occupational safety, process safety, and organizational culture that indicate strengths and opportunities. Engage Gas Leadership on results and communicate trend analysis for Gas-wide organizational learning. **Deliverables to show completion**: Implement trending and routine communications for of trend results for learning.	[redacted]	03/30/2025
(CC3 CA2)	Contributing Cause Statement: ***Failure to Recognize Risk and Address Causes of Repeating Events***. NERC Cause Code: A04B01C06	**Title**: Establish Quality Improvement for High-Risk Programs **Hierarchy of Control:** Administrative **Action:** Develop Quality Improvement Plan Process. Identify critical or high-risk processes that require a Quality Improvement Plan and determine appropriate improvement plan cycle for each. The process should require process owners to perform self-assessments, with a focus on high-risk tasks. Assessment results should inform Quality Improvement Plans that could include actions for Process Improvement, Quality at the source and Quality management. Assessments and Plans shall be reviewed approved by QPIC and entered in CAP **Deliverables to show completion:** Critical Programs identified, and plans established.	[redacted]	03/26/2025

11 Prudent Action Matrix

Action Type	CAP or Action	Description	Action/Issue Owner	Due Date
Prudent Action 1	129510657	Evaluate for more effective FR Vests (non-synthetic) for purging, FR job site materials (canopies, tools, containers, excavation planking, etc.), and reduction of combustibles on Gas jobsites site. Should be specified based on the work performed onsite during Clearance and Purging work. For instance, whether 100% synthetic FR vests should be replaced with natural fiber FR safety vests due to potential for static electricity build up.	[redacted]	03/26/2025
Prudent Action 2	129510750	Perform an assessment of typical / routine Gas jobsites, looking for opportunities to improve industrial safety practices. This may include targeted safety engagements for 3-6mo looking specifically for opportunities to improve topics like safe excavations and shoring, fall protection, ladder use, working at heights, signage and use of barricades, and safe pathways for pedestrians/workers/traffic in yards and stations.		03/26/2025
Prudent Action 3	129510753	Consider use of burn gel blankets in emergency preparedness burn response kits (in lieu of water) and other fire mitigation and response best practices.		03/26/2025
Prudent Action 4	129510754	Evaluate addition of Operating Experience into annual Web Based refresher training (specific training to be determined).		03/26/2025
Prudent Action 5	129510755	Refresh 2022 Clearance Program Self-Assessment, by reviewing for today's issues. Track resolution in CAP.		09/11/2024
Prudent Action 6	129510802	Coordinate update of Clearance guidance (TD-4441S and applicable procedures) to simplify guidance where possible but maintain guidance as robust yet easy to follow.		07/1/2025
Prudent Action 7	129510803	Coordinate update of Clearance guidance (TD-4441S and applicable procedures) with the requirement for Purge out of Service Plans, Purge into Service plans, and Air Movement Plans. This need to be in alignment with revisions to A-38. Issue Clearance and associated plans in synchrony with Engineering Design change process.		07/1/2025
Prudent Action 8	129510804	Coordinate update of Clearance guidance (TD-4441S and applicable procedures) to issue Clearance and associated plans in synchrony with Engineering Design change process. Will require update to Design and Project Management Processes.		07/1/2025
Prudent Action 9	129510805	Coordinate update of Clearance guidance (TD-4441S and applicable procedures) to eliminate acronyms in clearance documents issued to the field.		07/1/2025
Prudent Action 10	129510806	Coordinate update of Clearance guidance (TD-4441S and applicable procedures) to address inconsistent use of "Caution Tag" vs "No Tag" on blind flanges in clearance documents. Update other relevant forms to ensure consistency.		07/1/2025

Prudent Action 11	129510807	Address lack of communication of incidents with Engineers (e.g., emerging issues, near hits not shared with Engineering, etc.), by evaluating an Operations and Engineering emergent issue communication process to ensure Gas-wide alignment on critical and emerging issues. (See PG-1901P-01)	[redacted]	07/1/2025
Prudent Action 12	129510808	Implement risk and readiness reviews for all clearance work executing through end of 2024. These reviews should be cross-functional and include reviews of upcoming high risk and complex Transmission Clearance work to validate mitigations are in place, that workers possess appropriate training for clearance tasks, and that procedural expectations for performing clearance tasks have been followed.		09/11/2024
Prudent Action 13	129510809	Evaluate Operator Qualification for Clearance Supervisor.		03/26/2025
Prudent Action 14	129510850	Redefine the function of Clearance Coordination group, also known as Clearance Approvers, to include an added step to verify Clearance Supervisors and Maintenance / Construction crews have completed Prerequisites for both Purging out of Service work and Maintenance / Construction work. Suggested function is “Work Control and Clearance Authorization”. Prerequisites to confirm as part of this Authorization include but may not be limited to: ▪ Endorsed Clearance ▪ Purge out of Service Plan, per A-38 ▪ Purge into Service Plan, per A-38 ▪ Air Mover / Fresh Air Movement Plan ▪ Training and OQ verification		03/26/2025
Prudent Action 15	129510851	Root Cause Eval tool hindering investigation During first week information briefing SAFE-1004S and GOV 6102P-10 timing. Evaluate restructuring deliverables and roles within first 7 days following major events or injuries.		07/1/2025
Prudent Action 16	129510852	Consider adding clearance rejection rate to PSI dashboard (Gas Operations Process Safety Indicator Dashboard).		03/26/2025
Prudent Action 17	129510853	Perform cross-functional benchmarking with the Pipeline, Hydro Generation, and Nuclear Generation industries to determine other best practices related to safe purging operations. This must include purging and venting work done with and without a clearance. Once complete, align key stakeholders on results and document any decisions made to improve PG&E Gas purging practices, guidance, and training.		07/1/2025
Prudent Action 18	129510854	Evaluate inclusion of purging incident in emergency preparedness drills and/or hands on purging training.		07/1/2025
Prudent Action 19	129510856	Establish guidance for functional area trending within Enterprise Corrective Action Program guidance documentation.		03/26/2025
Prudent Action 20	129510858	To improve configuration control and safe execution of work in the field, evaluate the need for Gas Transmission Systems and Field Configuration training / learning		03/26/2025

		among work groups such as: Clearance Operations, GPOM, Project Management, Engineering, etc.		
Prudent Action 21	129510859	Implement a Job Hazard Analysis (JHA) Program within Gas, to proactively identify high-risk work and perform ongoing reviews to validate effectiveness of their essential controls.	[redacted]	03/26/2025
Prudent Action 22	129510890	To improve Gas Leadership alignment and prioritization of safety and culture topics, evaluate existing process architecture framework, identify any gaps in high-risk task ownership related to STKY and present recommendations to gas leadership for review and approval.		03/26/2025

12 Effectiveness Review Plan (ERP)

As a result of repeating events, and the inability of previous RCE Effectiveness EFFRs to sustain long term change in safety behaviors and high energy risk mitigation, the Effectiveness Review Plan for this Kettleman Ignition Investigation will require greater engagement, commitment, and collaboration with key Leadership and the Gas Corrective Action Review Board. It is expected that this RCE EFFR will span a 5-year period to monitor, assess, and verify effective behavioral and cultural change.

Criteria	Effectiveness Review Plan Description	
Attributes	Organizational and Leadership (safety) Repeating events (safety) Knowledge and Proficiency High Risk Work Planning Configuration Control	129510758
Method	Due to the complexity and long-standing repeating issues and cultural challenges found to be causal in this event, a 5-year Effectiveness Review Plan is being implemented to monitor change overtime and provide assurance of effective change. Cultural change, in the form of worker behaviors, leadership behaviors, and organizational decision-making, can take years to implement and even more time to monitor and adjust. Therefore, the following is being proposed and is captured by Causal topics below: • **EFFR – Organizational Achievement & Leadership Development Plan** Implementation: Perform routine department leadership observations of complex transmission work (minimum 2 per month) to ensure high safety standards are being reinforced in the field • **EFFR - High Risk Planning** Implementation: Review 25% of transmission purge clearances for a 12-month period for the following: ○ Risk and readiness reviews ○ Complex Project Clearances had a blowdown/purging out of service and purging into service plans • **EFFR - Configuration Control** Perform safety observations of purge activities that also include watching for inadvertent operation or removal of equipment and components used as clearance points in a clearance boundary. • **EFFR - Repeating events** Implementation: Review 12-month incident CAPs for repeat purge safety events related to clearance planning, configuration control, or knowledge and proficiency (A-38) gaps. • **EFFR - Knowledge and Proficiency** Implementation: Perform safety observations of purge activities focused on worker knowledge and skills of A-38 (sample of 20% of transmission purge clearances).	Austin Hastings
Success	Organizational Achievement & Leadership: • Verify organizational behaviors, such as peer to peer coaching, is sufficiently effective to drive adherence to safety standards with no significant missed opportunities in Keys to Life (measure of success 90%). High Risk Work Planning:	

	• Per Elevated Review Process, Projects requiring complex transmission Clearance work had a risk and readiness review in advance of executing work, to validate high risks have been documented and mitigated. (measure of success 95%) • All reviewed complex Project Clearances had a blowdown/purging out of service and purging into service plans, per A-38, and include Engineering calculations and review. (measure of success 95%) Repeating Events: • No repeat SIF-P or SIF-A purging events for lack of A-38 proficiency, knowledge, or failure to utilize procedure (procedure use and adherence). Knowledge and Proficiency: • No Safety observations that document significant deviations from A-38 guidance (i.e. purge configurations that place coworkers at risk of high energy exposure). Configuration Control: • No safety observations of purge activities that identify inadvertent operation or removal of equipment and components used as clearance points in a clearance boundary.	
Timeliness	After completion of the associated corrective actions and at least 12 months of data are available, perform effectiveness reviews for each attribute. Verify that the success criteria are met and that reviews are not delayed unnecessarily until all corrective actions are in place. These reviews are scheduled and monitored on an annual basis for the next five years, until sufficient evidence of organizational effectiveness in safety behaviors can be established with the goal of future sustainability. Of note, the Gas CARB and Functional Area Risk and Compliance Committee has committed to reviewing effectiveness in addition to the EFFR process.	Due Date: Annually, through 2030. First EFFR due on 12/15/2025; final EFFR review after last CAPR completed by 12/16/2030.

13 Hierarchy of Controls Analysis

Hierarchy of Controls	Potential Corrective Action	Specific	Measurable	Achievable	Reasonable	Timely	Recommend CA? (Y/N)
Elimination	• Eliminate purging	Y	Y	N	N	N	**N**
	• Remove workers from purge location / exclusion zones (CAPR2)	Y	Y	Y	Y	Y	**Y**
Substitution	• Permanent blow down stacks (CAPR3)	Y	Y	Y	Y	Y	**Y**
	• Inert Gas purging	Y	Y	Y	Y	Y	**Y**
	• Purge recapture	Y	Y	Y	Y	Y	**Y**
Engineering	• Use Configuration Control Devices (CC1)	Y	Y	Y	Y	Y	**Y**
	• Systems redesigned to only allow for specific purge locations	Y	Y	N	N	N	**N**
Administrative	• Work Management Adherence (CAPR4)	Y	Y	Y	Y	Y	**Y**
	• Gas Culture Achievement Plan (CAPR1)	Y	Y	Y	Y	Y	**Y**
	• A-38 Training (CC2)	Y	Y	Y	Y	Y	**Y**
	• Field Guide for purging (CC2)	Y	Y	Y	Y	Y	**Y**
	• Trending / Performance Monitoring (CC3)	Y	Y	Y	Y	Y	**Y**
Personal Protective Equipment (PPE)	• Arc flash / robust PPE for purging	Y	Y	Y	Y	Y	**N**
	• No combustibles in purge zone	Y	Y	N	Y	Y	**N**

14 Appendices

14.1 Appendix A: Training

Code	OQ-0206	OQ-0701	OQ-0703	OQ-0704	OQ-0403	OQ-2217	OQ-1701
OQ Title	Abandon/deactivate pipeline facilities	Purging with Gas and/or Air	Inert Purging	Air Mover Operations	Leak Test at Operating Pressure	Steel Pipe Joining: Flanged Joints	Valve Operation and Maintenance
Task Guidance	This task includes the inspection, preparation, purging, and capping of abandoned / deactivated facilities.	This task includes purging air from facilities using GAS as a medium AND/OR purging gas from facilities using AIR.	This task includes purging gas from evacuated facilities using INERT GAS as a medium.	This task includes maintaining a gas free environment by using air mover equipment during welding procedures and during work procedures. Air movers cannot be used to purge pressurized lines.	Typically, a "soap test"	This task qualifies a successful candidate to complete the assembly of flanges, bolting in sequence, and torquing, as specified.	This task qualifies a successful candidate to perform visual inspection, maintenance, partial or full operation (function test), valve type identification and lubrications of valves per company procedure. The task also includes the operation of pin-off tees for work on HPR sets.
Work that can be Performed	This task includes the inspection, preparation, purging, and capping of abandoned / deactivated facilities.	This task includes purging air from facilities using GAS as a medium AND/OR purging gas from facilities using AIR	This task includes purging gas or air from facilities utilizing nitrogen as a medium to separate the gasses.	. This task includes maintaining a gas free environment by using air mover equipment during welding procedures and during work procedures. Air movers cannot be used to purge pressurized lines.	May also include a CGI (i.e. Gas Ranger), DPIR, RMLD, HFI, etc. Checking for gas leakage while facility is operational at operating pressure. (i.e. OQ'd for 09-01, or 09-02, or 09-03	Any connection that uses flanges.	Grease Guns, Valve Servicing, Valve Identification, Lubrication and Inspection of Valves, Adjustments & Flushing Documentation. Operate only pin-off tee.
Duration of Qualification	3 Years	3 Years	3 Years	3 Years	5 Years	5 Years	3 Years
Span of Control	1;1	1;1	1;1	1;1	1;1	1;1	1;1
Test Method	**Written**	**Written**	**Written**	**Written**	Performance	Performance	Written & Performance
Guidance Documents	A-38 Rev. 1e A-81 Rev. 2 TD-9500P-16 Rev. 1f	A-38 (Rev 1g) A-38.3 (Rev 0a) TD-4150P-01 (rev 1b) TD-4170P-01 (rev 0)	A-38 (rev 1f) A-38.3	A-38.1 (rev #02)	A-34, M-13.4, TD-6100P-13, TD-6100P02, TD-4110P-09, TD-4008S ATT 1, S4446	B-45 Rev 3, B-45.4 Rev 0c, B-46 Rev9a, TD-4008S Attachment 1 Rev 0a	FG-4521(Rev 0), TD-4521P-01 (Rev 0a), TD-4150P-130 (Rev 2), TD-4521P-02 (Rev 0), TD-4521S (Rev 2), TD-4008S, Attachment 1

14.2 Appendix B: Operating Experience

Operating Experience Summary:

The review of internal and external operating experience concluded that working around the stored energy used during purging operations can be highly hazardous if controls to protect employees are not implemented. Internal CAP notifications highlighted gaps in clearance processes, coworker purging knowledge, and mispositions of valves (left partially open or partially closed) that may have contributed to unsafe conditions.

External events reviewed indicate that ignitions while purging have occurred within the gas industry. The RCE Team noted that in most cases, external event notifications do not provide sufficient information for PG&E to evaluate for applicability. This limits the potential to learn from others and improves our internal processes.

Internal OE:

A search for relevant internal events was conducted to determine whether the condition(s) resulting in this incident occurred previously inside PG&E. This historic data review provides the opportunity to review previous corrective actions (CAs) for effectiveness, and whether the proposed CAs are like previous CAs.

The following search criteria were queried within PG&E's Corrective Action Program (CAP) database against all open and closed events submitted to CAP between 01/01/2013 and 07/31/2024.

The search output yielded the following results: 617 CAPs with approximately six relevant event results.

A-38	LEL
activation energy	M11 hydraulic failure
AGA Purging Manual	NFPA 77
area classification	plume study
Autoignition	Purge
G.D.S.	Purge inlet control valve selection
G.D.S. A-38.3	Purge stack
Gas ignitions	Purge vent locations
Gas valve failures	Purging
Gaseous environment ignition	Purging into service with air displacing flammable gas
Horizontal purging	Purging with pneumatic actuated valves
horizontal purging	static / static electricity
ignition	UEL
Ignition during inerting of gas pipelines	Venting gas in air mixture
Ignition from static electricity during purge	

Below is a breakdown of relevant internal events and their CAP issues.

CAP Issue #	Event Title / Location	Event Date	Evaluation Type
112633748	Folsom Valve Gas Operations SIF	02/27/2017	ACE
Summary of Incident	During one of the last steps in the tapping process for a transmission pipeline, a temporary vent stack was installed using an offset joint to discharge the metal drill shavings prior to the final step of installing a completion plug and cap. Upon opening the control valve, the force of the escaping gas caused the offset joint to rapidly rotate unexpectedly striking the tapping technician causing multiple serious injuries.		

Identified Causes	AC-1	There is no standard procedure to remove metal shavings from 2-inch Save-A-Valves to prevent thread impediment of the completion plug at installation. This procedural gap was addressed by implementing a field solution established to blow gas through a temporary vent stack to eject the shavings.
	AC-2	The hazards and associated risks of fabricating, installing, and operating temporary vent stacks were not fully understood and being controlled.
	CC-1	The hazards associated with the task of hot tapping and the installation and use of temporary vent stacks were not adequately identified due to the absence of a procedure to evaluate tasks using tools such as a Job Hazard Analysis (JHA).
	CC-2	The repair procedure in TD-4100P-05 did not adequately address the defect orientation, local job site conditions and additional work needed to complete the task safely; this resulted in minimal repair instructions that placed employees in a position of having to make adaptive decisions that could be better addressed during repair planning.

CAP Issue #	**Event Title / Location**		**Event Date**	**Evaluation Type**
113072120	SIF Potential PLS 3 Venting Ignition		07/23/2017	ACE
Summary of Incident	On Sunday, July 23, during clearance WCD #80038416 for a Hydrotest and In-Line Inspection (ILI) upgrade project at Pressure Limiting Station (PLS) 3A, gas was being vented from blowdown stack B per the clearance, when the gas ignited. There were no injuries and minimal property damage occurred. This is considered to be a Serious Injury or Fatality (SIF) potential event.			
Identified Causes	AC-1	The hazards and associated risks of venting gas horizontally at transmission pressure were not fully understood and controlled.		

CAP Issue #	**Event Title / Location**		**Event date**	**Evaluation Type**
113756539	L 301G No Gas Event		10/19/2017	ACE
Summary of Incident	On Thursday, October 19th, 2017, PG&E Gas Operations identified a no gas event affecting approximately 3600 customers in the Central Coast area. This is a potential safety risk to company assets, employees, and the general public. Exponent was retained by PG&E to investigate the cause of the incident.			
Identified Causes	DC-1	Air was left in L-301G due to an incomplete purge caused by a significant flow restriction. • Flow restriction during purge was due to Valve A not being fully opened at Dunbarton Station AND/OR MLV-11.31 was left in the closed (and leaking) position. • As a result of the low rate of flow, virtually all of the air between Hollister and Anzar remained in L-301G after the line was purged into service.		
	AC-1	Field practices for purging are not aligned with the requirements in Gas Design Standard A-38. • Field personnel report that throttling blowdown valves is common practice due to noise concerns. • Purge procedures and standards rely on blowdown valves being in the fully open position. • Field personnel report that A-38 purge tables are generally not used to determine purge pressure.		
	AC-2	Field personnel involved in the incident did not have a consistent understanding of a major vs. minor clearance revision as defined in TD-4441P-10 Rev 0b. • Definition of a major vs minor revision includes subjective descriptions. • Steps required for minor revisions were not followed by field personnel. • Certain changes in the field qualified as major revisions but were categorized		

		as minor changes. • Changes to purge plan were not reviewed as part of clearance revision.

CAP Issue #	Event Title / Location	Event date	Evaluation Type
123433871	GO Marina Gas Ignition SIF-P	04/26/2022	ACE

Summary of Incident	On April 26, 2022, near the intersection of Telegraph Blvd. and 5th Ave. in Marina CA, two Gas Co-workers were purging a 2-inch plastic main utilizing a 1-inch plastic pigtail at a purge point inside an excavation area. While purging, gas ignited causing moderate burns to Injured Coworker-1's hands and face, and mild burns to Injured Coworker-2. A nearby Foreman used a fire extinguisher to extinguish the flames and brought additional Mustang squeezers to stop the flow of purging gas. Injured Coworker-1 was taken to the local hospital where he was given first aid and then referred to another location with a specialized burn unit. This incident had the potential to result in a serious injury or fatality. • Requirement or Management Expectation: Per Code of Safe Practices, Section 1304, workers are to purge in a manner to minimize the hazard of releasing gas in the work area. • Standard A-38, Purging Gas Facilities, requires that vents should be temporarily extended outside of the excavation area to safely dissipate the purged gases into the atmosphere. • Deviation or Defect: Gas unexpectedly ignited inside the excavation area. • Consequence of Deviation or Defect: Two coworkers were injured, with one requiring medical attention and lost workdays. • Significance of Deviation or Defect: This incident had the potential to cause serious injury or be fatal.	
Identified Causes	DC-1	M&C crew did not set-up purge equipment and associated grounding per procedural guidance.
	AC-1	Normalization of deviation; crews involved report not regularly purging using procedural guidance • The set-up for the purge point did not extend outside the excavation area but was viewed as adequate by injured workers • Approved grounding set-ups were not followed. An example includes the omission of a grounded metallic purging device • Use of squeezers in lieu of approved purge head resulted in loss of purge control after ignition
	CC-1	Reduced level of hazard awareness (i.e., routine risk) due to infrequency of gas ignition occurrence. • Injured Coworker did not wear gloves (PPE) or removed between task steps. The lack of PPE resulted in more severe injuries • JSSA did not discuss hazard of gas ignition associated with purging operations
	AF-1	A-38 "Gas Design Standard Purging Gas Facilities" and A-38.3 lack specific guidance for how to set-up purge device for plastic distribution main. In A-38, there is a lack of cross-references to grounding procedure.
	AF-2	WP4170-01 "Grounding Polyethylene (PE) Pipe to Control Static Electricity" needs to be updated to modernize and reflect field conditions for plastic distribution piping.

CAP Issue #	Event Title / Location	Event date	Evaluation Type
123493078	GO Calistoga Pigging SIF-A Incident	04/29/2022	RCE

Summary of Incident	On April 29, 2022, a Gas Transmission General Construction (GTGC) crew was performing pipeline drying as part of strength test project T-1448B. The GTGC crew was running drying pigs from Location H to Location A, when two pigs (one foam and one poly), became stuck near Location H. In an attempt to dislodge the pigs, backpressure was applied from Location A to reverse the direction of the pigs. While two GTGC coworkers were located in front of the launcher door at Location H, the pigs became unstuck and one or both of the pigs struck the two GTGC coworkers in the head. One coworker received injuries to their face and was later released from the hospital. The second coworker sustained fatal injuries.	
Identified Causes	DC-1	The launcher isolation valve was open when the launcher door was opened, resulting in a release of stored energy (air pressure) and ejection of the pigs following stuck pig mitigation efforts.
	DC-2	Coworkers were physically in the line of fire without proper identification and isolation of hazardous energy.
	RC-1	Hazards and risks of performing out-of-service pigging were not properly identified and mitigated when planning, preparing, and executing work.
	CC-1	Work planning processes failed to identify and mitigate coworker safety risks for out-of-service pigging, including failure to associate the known and similar risks of in-service pigging.
	CC-2	Work preparation process weaknesses led to challenges related to use of proper tools, materials, and training.
	CC-3	Effective communication practices were not adhered to when executing the work.
	CC-4	Lack of knowledge and experience led to improper utilization, reinforcement, and adherence to procedures.

2023 CAP Program Trending Exercise – PSEMS Element Issues

Top At-Risk PSEMS Element	Event	Insights
PSEMS Element #5: **Operational Control**	GO Merced SPMVI RCE (Sept 2022)	• No adequate controls for operating vehicle • Concerns with roadway entry / visibility around yard but unable to partner with City to improve conditions • Did not follow Safety Driving KTL
	SIF-P GO Stockton PMVI	• Risks of microsleep not well communicated or understood • Cause Evaluations points to gaps in risk management and assessment as well
	GO Morgan Hill Vault Ladder Failure	• Equipment & design not up to normal design/spec standards • Did not follow standard design processes for design and procurement of ladders in multiple locations • Concerns with design and materials had been raised via MPR process, but follow-up actions were not adequate
	MVI: PG&E Rear Ended 3rd Party	• Did not follow Safe Driving KTL, safe following distances and defensive driving techniques
	GO Berkeley PMVI / Vehicle Roll-over foot	• Did not follow Safe Driving KTL, performing 360 walk arounds, honking horns. • Safety culture concerns with many PG&E standards not followed by all crew members leading to this incident
	Lincoln Truck Vs Cycle MVI SIF-P	• Did not follow Safe Driving KTL, did not challenge looking in both directions multiple times before making a left hand turn into an intersection.
PSEMS Element #3: **Risk Assessment**	Contractor Backhoe Incident (Dec 2022)	• Did not follow KTL, did not identify hazards prior to performing work, history of incidents that could have been indicators of more significant events to come
	Avila Traffic Contractor MVI/Struck by	• (Has not yet been reviewed by CARB) • Preliminary concerns with not having more robust direct controls in place for traffic workers inside cone zones. • Lack of understanding / mitigating worst case scenario during work activity.

Figure 39: Top At-Risk PSEMS Element

External OE:

A search for relevant external events was conducted to determine whether the condition(s) resulting in this incident occurred previously outside of PG&E. The search output yielded the following results:

Columbia Gas in Hocking County, OH (TCPL)

On May 20, 2024, four (4) TC Energy Technicians and two (2) third party contractors were working to install a skillet blind flange as part of the isolation plan for an outage and project work on pipeline SR-538, Columbia Gas Transmission, LLC. The SR-538 project is a 2-mile pipe replacement project. The intent of the work was to achieve double block and bleed to isolate the line for replacement. As the crew was working to set the skillet, gas began to leak through the 6-inch valve. To reduce the leak, grease was added to the valve utilizing a motorized grease gun. During the greasing activity, an ignition/flash fire occurred resulting in burns to two (2) TC Energy technicians and both third-party contractors. Injured workers were immediately taken for medical evaluation and treatment. An investigation to identify contributing factors that may have contributed to the event is underway.

Transco – East Feliciana Parish, LA (Williams)

On May 8, at station 60, third-party contractors were getting ready to dismantle and renovate valves. At around 5:50 A.M., air movers were turned on. As contractors prepared to start work, an ignition occurred near the main unit valves, resulting in a third-party contractor injury. A root cause investigation is ongoing. A supplemental report will be filed.

Marathon (liquid) – Lavaca County, TX

A pigging contractor was in the process of receiving a pig on the Comanche 1H when the pig trap caught fire. Local EMS and fire department responded to the scene. The contractor was evaluated onsite by EMS and then transported to Cuero Hospital for further evaluation. The fire was extinguished by outside resources, and the site was secured for further investigation.

American Gas Association (AGA) Peer & Other External Assessments

Source	Action/Finding	Status/Ris	CAP Number	CAP Owner
AGA Peer Review	Reduce complexity of procedures. Feedback that the procedures are lengthy and complex, causing employees to deviate from them during high-stress events. Furthermore, field employees feel that they are not being consulted as subject matter experts before the implementation of procedures that directly affect them.	Closed	126502381	[redacted]
AGA Peer Review	Recommended consideration of using Nitrogen purge for receipt of all ILI tools, rather than smart tools only. Discussion held around one company having a safety incident with ignition related to receiving of ILI tools.	Closed	126663020	
LRQA Audit	The Gas Operations business is to introduce a clearance to proceed process for Distribution in July 2014, similar to the process for transmission. The assessment team will look for evidence of implementation at the next surveillance visit	Closed	No CAP entered	GDCC
LRQA Audit	Project 1273 to install an automated shut off valve on the ammonia tank has been deferred. This is an important installation and the LRQA assessors will review progress at future surveillance visits	Closed	127430818	
LRQA Audit	While it is recognized that valves can be identified using drawings, it was not possible to perform a cross reference at the Los Medanos facility since many if their valve identification tags had been painted over during maintenance work. The organization should decide if these tags are required and, where they are, and ensure that they are legible.	Closed	7008981	
LRQA Audit	At the Kettleman Station the calibration books have been partly completed with information but in many cases the data was incomplete particularly with respect to the item serial number and type. PLM contains the Full calibration information and should either be considered as the sole means of information or the individual books should be consistent with PLM.	Closed	7004497	
LRQA Audit	It is unclear in the Procedure for Purging Gas Facilities A-38 if the of the use of a squeeze off tool is acceptable to control the purging of a new network. Reference is made to opening and closing valves and a squeeze off tool is not mentioned. The business should consider if the use of a squeeze off tool is appropriate and capture this in the purging procedures.	Closed	115505860	
LRQA Audit	It was noted that the individual Operating Diagram books were held by a number of Operatives but clear that these had not been consistently updated and did not match the master copy. This needs to be addressed to remove the risk of an out of date diagram being used.	Closed	No CAP entered	
LRQA Audit	The PG&E requirement under Piping Design and Test Requirements A-34 6a is to test service pipework after it has been installed; however the testing work at Burns Drive was carried out away from the trench prior to installation. PG&E must ensure clarity and consistency in procedures and approach.	Closed	113182092	
LRQA Audit	The PIG traps at Arvin have been installed contrary to the original design drawing and no formal approval could be identified for the change to the Issue for Construction pack. Furthermore, having identified the error it did not appear that a CAP had been raised to record the error. This is a weakness in the Management system.	Closed	114151422	
LRQA Audit	During the operation to replace the gas main in San Leandro, the team were required to vent a section of main. It was noted that the ignition risks posed by passing vehicles or smoking pedestrians were not controlled. The business may wish to consider the use of a controlled zone and No Smoking signs during purging activities.	Closed	No CAP entered	
LRQA Audit	Consideration should be given to the risks that may impact asset families with adjacent facilities. For example the impact upon storage if a compressor fails	Closed	7010840	Christine Cowsert
LRQA Audit	PG&E should consider the safety implications of having operatives in close proximity to gas pipework that is being subjected to a pressure test.	Closed	113181782	[redacted]
LRQA Audit	When questioned, site based staff could not confirm the hazardous area for the operation, what equipment is or is not intrinsically safe and what the minimum distance is required between gas emission source and a.) intrinsically safe equipment or b.) non-intrinsically safe equipment, while either are running. PG&E should consider confirming the minimum distances for non-intrinsically safe apparatus and	Closed	114233162	
LRQA Audit	During the site induction at Arvin (SV7) it was stated that there was a 50ft hazardous area surrounding the pig trap door and vent and that no source of ignition was allowed within this area. During the site inspection, it was noted that the lighting rigs were within that distance and when questioned if the lighting rigs were intrinsically safe it could not be confirmed. Further discussion revealed that there was confusion	Closed	114741886	
LRQA Audit	The testing procedure for distribution pipework has been amended and these amendments call for additional testing time based upon the volume and size of pipe installed. The business should consider if pipework under test pressure for longer periods represents an additional safety risk due to the possibility of fittings and/or other equipment, such as bolts or test sets, detaching from the pipework and becoming	Closed	115505960	
MOC Audit	Enhance Clearance Training and provide two different levels of training depending on clearance supervisor tasks. One for Maintenance related Clearances and one for Project related clearances. This will ensure someone is properly trained prior to assuming the critical clearance supervisor role	Closed	118532357	

Figure 40: American Gas Association (AGA) Peer & Other External Assessments

AGA Survey Reviews of Purging Practices:

Two recent AGA Survey's on member companies' purging practices were reviewed as part of the Operating Experience and benchmarking efforts associated with this RCE. The first survey, requested by Exelon in May of 2019, focused on the following topics:

- Technical basis for purging procedures and calculations of purge velocity and purge flowrates, and purge endpoints
- Differences in purging procedures with respect to main, services, and purge mediums (nitrogen)
- Safety requirements, including use of flaring and purge piping material standardization

The second survey, requested by NiSource in April of 2023, focused on the following topics:

- Approved tools used for purging and blowdown operations
- Purge and blowdown stack height, materials, connection methods, and engineering design for support/bracing
- Safety protocols used during purging and blowdown operations

A high-level summary of the responses is provided below in table and chart format, with some key differences between PG&E's current practices and the industry norms highlighted.

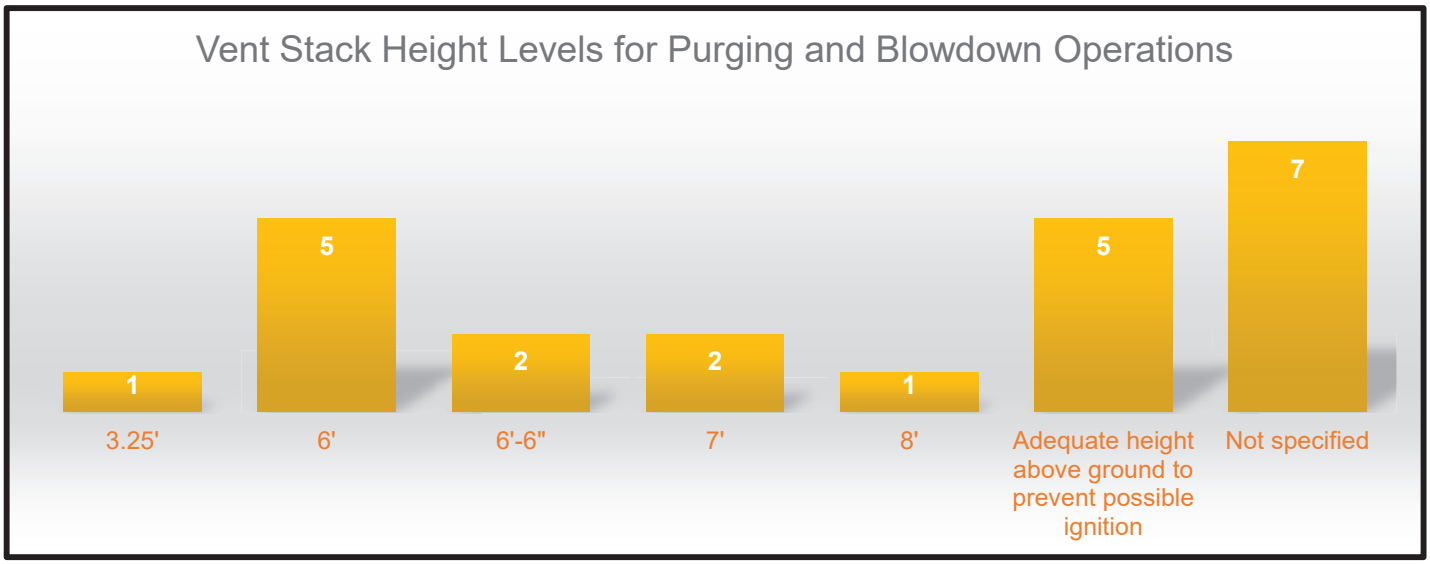


Figure 41: Vent Stack Heigh Levels for Purging and Blowdown Operations

As shown above, 6-feet or greater vent stack heights are required by 10 of the 23 respondents from the 2023 NiSource survey. PG&E falls in the "Not Specified" category along with 7 of the 23 operators, as the most explicit guidance in the Code of Safe Practices Section 1304 simply states, "*Vent stacks shall be of sufficient size and height to minimize the hazard of releasing gas.*"

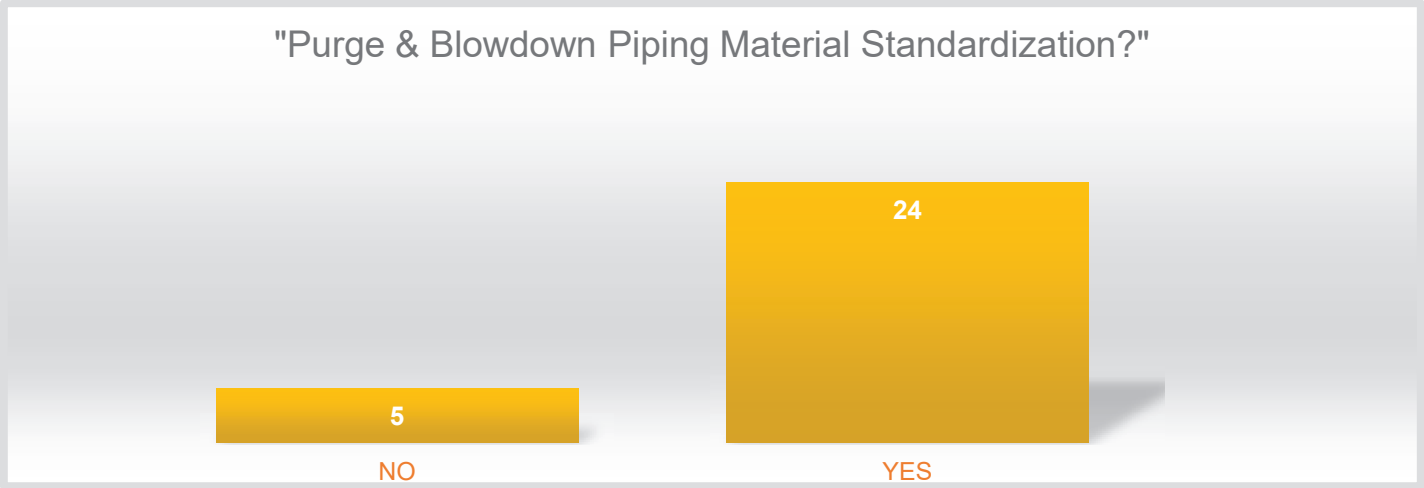


Figure 42: Purge & Blowdown Piping Material Standardization

The above chart shows data from the 2019 Exelon AGA survey, with 24 of the 29 respondent operators stating that they have standardized their materials for purging and blowdown piping. While PG&E provides guidance on aluminum and steel piping for temporary vent stacks, and recently introduced a new purge stand for distribution purge operations after a SIF-A incident in Marina in 2022, additional material and bracing/support design standardization for purging into service on the transmission side would place PG&E more in line with peer operators.

Ad Hoc Operator Survey:

As part of the Kettleman Compressor Station Ignition RCE, an ad-hoc survey was developed and sent out to several peer operators for input with a focus on the following:

- Remote valve operating equipment for blowdown and/or purging operations
- Grounding methods to control static discharge
- Training for employees for blowdown and/or purging operations
- Clearance execution oversight
- Ignition events related to blowdown and/or purging operations

Given the quick turnaround requested, we have received responses from only two operators to date but expect to hear from more in the coming weeks and will ensure results are shared with our engineering and benchmarking teams as they come in. The below table summarizes the results received to date.

	Question	Company 1	Company 2
1	**How many miles of transmission and/or distribution pipelines does your company operate?**	490 miles of Transmission pipeline 59,500 miles of Distribution main	28 miles of Transmission pipeline 13,100 miles of distribution main 845,000 services
2	**Does your company use any remote gas-in-air monitoring equipment for purging operations?**	Yes, both internal and contractor	No, not at this time
3	**Does your company use any remote valve operating equipment for blowdown (depressurization) operations?**	Remote controls may be utilized in reducing pressure in a particular system to support high pressure and/or transmission purging operations	No, not outside of the ESD at our LNG plant

4	**Do you have concerns for static electricity caused ignitions during air to gas, or gas to air purging operations for steel piping systems? If so, do you use standard grounding methods to control or other measures?**	Static control is a factor considered in standardized distribution purging procedures and specifically written purge plans for high pressure/transmission	Yes, there is concern for static electricity. This is mitigated by grounding rods
5	**Do you have a specific hands-on training for blowdown and purging into and out of service? If so, can you briefly describe duration and any curriculum details?**	Purging is a specific, required OQ covered task and as an associated module that includes training and testing. Applies to all internal employees and applicable to contractor classifications	Yes, we have hands on training for purging. We train on simple and complex as-builts for planning purposes. And for hands-on we've set up 100' of 4" pipe with risers for nitrogen injection and purging training
6	**Who is responsible for leading the clearance (isolation of the pipeline and blow down) and purging operation? Is it a subject matter expert from gas engineering, gas field personnel, or a company management employee?**	Appropriate lead, or delegate qualified individual for "routine" purging operations of distribution systems. Company requires a written purge plan, prepared by engineering for any operation six-inch distribution and high pressure facilities. These plans require identification of individual responsible for execution of plan in the field and has a documented purge plan review of all employees and/or contractors involved in the execution of the plan. Out of service and place in service are 2 distinct and separate purge plans. additionally high pressure plans have been standardized and under an established "MOC" protocol	Gas field personnel lead the blowdown and purging operation, with support from engineering if needed.
7	**Has your company had any recent ignition events during purging or blowdown operations? If yes, could you briefly describe the event and root or apparent causes?**	No	No recent ignition events during purging or blowdown operations. There was a recent ignition event that occurred after the purging/blowdown operation at a limit station. After purging was complete, gas leaked by a closed valve and ignited during construction. There was not one root cause, but several factors that contributed to this event
8	**Would you be willing to share your internal purge procedure or operations & maintenance manual section covering blowdown and purging into and out of service operations?**	NDA required	No response

Figure 43: Ad Hoc Operator Survey

14.3 Appendix C: Extent of Condition

Object	Worker performing Gas non-vertical purging that enables the creation of a hazardous air/gas mixture with potential for ignition.
Defect	Ignition of a hazardous air/gas mixture while purging or venting at a Gas Transmission Location.
Similar Object	Worker performing any Gas venting or purging that enables the creation of a hazardous air/gas mixture with potential for ignition.
Similar Defect	Ignition of a hazardous air/gas mixture while purging or venting at any Gas Transmission or Distribution Location.

EOC Actions (Implemented for all EOC results)	6. Stand Down on horizontal Purging and venting activities unless authorized per Engineering and O&M Director approval. 7. Publish interim field guide and training on A-38 (Blowdown and Purging). 8. Eliminate horizonal purging and venting excluding fixed engineered purging and venting systems. 9. Approve pre-engineered vent stack use for depressurizing and vent / filter blowdown. 10. Eliminate pneumatic operated valves during manual purging (non-automatic). 11. Establish emergency response guidance and actions for how to respond to an injured coworker and isolate energy source should ignition occur.
Results	CAPs initiated Electric Operations and Power Generation to evaluate similar conditions and risks.

14.4 **Appendix D: Extent of Cause**

Root Cause: Failure to achieve effective change in safe behaviors and the implementation of essential controls to mitigate high-energy hazards.

In recent years, Corrective Actions were implemented with the intent to improve safety performance and change behaviors while performing Gas Clearance and Purging Work. Despite Gas organization efforts, Leadership has not been successful in setting and enforcing expectations for job task hazard awareness, reinforcing desired safe behaviors, and maintaining a culture of continuous learning. Subsequent Leadership has also been ineffective coaching to standards adherence and communicating safety direction.

PG&E no longer defines Safety as the absence of events, but by the presence of controls that provide workers the capacity to fail safely. Standards and guidance are in place for high energy hazard recognition, Organizational Culture & Safety Mindset (Safety Culture), and Human Performance Tools. Contrary to the expectation that all PG&E Functional Area Leaders prioritize high energy controls and the capacity to fail safely, Gas Leaders are inconsistently reinforcing these processes, principles, and tools. This issue spans across all departments within Gas Operations and is evident within multiple data sets such as CAP, industry assessments, and Cause Evaluations. Examples include lack of adherence to critical safety procedures, lack of stopping when conditions change, lack of processes to plan for high-risk work activities, and ineffective leadership engagement in the field. Collectively, actions from previous events have failed to correct these organizational weaknesses impacting coworker safety and prevention of repeating near hits and significant events.

Extent of Root Cause: The RCE Team determined that similar weaknesses exist within Gas Operations and Engineering. Job task hazard awareness and identification are inadequate, and where repeat high energy incidents with similar causes have occurred.

RC: Failure to achieve effective change in safe behaviors and the implementation of essential controls to mitigate high-energy hazards.

The extent of cause is applicable and relevant not just within Gas System Operations but extends across all Gas Operations and Engineering. The CAPRs in place to address this Root Cause will be applied broadly across the entire Gas Organization and specifically, Gas Leaders.

Object or Standard: **(From Problem Statement**	Gas Purging per A-38	**Defect or Deviation:** **(From Problem Statement)**	Unsafe behaviors and inadequate high energy hazard mitigation.
Tier	**Object of Standard**	**Defect or**	**Conclusion and Containment and Interim Actions**

		Deviation	
Same / Same	Return to service gas purging using A-38	Inadequate high-energy hazard mitigation	EOC Evaluation: Applicable to all gas facilities that utilize A-38. Actions contained in CAPRs 1-4.
Same / Similar	Return to service gas purging using A-38	Unsafe behaviors gas purging	Applicable to all gas facilities that utilize A-38. Actions contained in CAPRs 1-4.
Similar / Same	Out of service gas purging using A-38	Inadequate high-energy hazard mitigation	Applicable to all gas facilities that utilize A-38. Actions contained in CAPRs 1-4.
Similar / Similar	Out of Service gas purging using A-38	Unsafe behaviors gas purging	Applicable to all gas facilities that utilize A-38. Actions contained in CAPRs 1-4.

14.5 Appendix E: Interviews

Report Code	Actual Position	Assigned Role for WCD #80252165
FE-1	Facility Engineer (Kettleman)	Endorser for clearance document.
GCC-1	Gas Clearance Coordinator 1	Assumed clearance writing duties after Gas Clearance Coordinator 3 changed roles. Created the approved WCD #80252165 being executed on 7/10/2024.
GCC-2	Gas Clearance Coordinator 2	Assisted Gas Clearance Coordinator 1 with revisions to WCD #80252165 after incident on 7/10/2024
GCC-3	Gas Clearance Coordinator 3	Involved in initial draft of WCD #80252165
GCT-1	GPOM Gas Control Technician 1 (Kettleman)	Assumed CS duties on WCD #80252165 after purge ignition event on 7/10/2024.
GCT-2	GPOM Gas Control Technician 2 (Kettleman)	Stationed at V-90 performing purge drive pressure throttling at time of ignition event on 7/10/2024.
GCT-3	GPOM Gas Control Technician 3 (Kern)	Roving support during clearance execution 7/8/2024 through 7/10/2024.
GCT-4	GPOM Gas Control Technician 4 (Kern)	Roving support during clearance execution 7/8/2024 through 7/10/2024.
GCT-5	GPOM Gas Control Technician 5 (Rio Vista)	Performed stem seal and gland plate repairs on V-56 while isolated and blown down on 7/9/2024.
GMC-1	GPOM M&C Coordinator (Kettleman)	Attended clearance meetings for S-1391 and developed WCD #80252165 with Clearance Writers 1 and 2. Stationed at V-56 prior to ignition occurring on 7/10/2024.
GOM-1	GPOM Operator Mechanic 1 (Kettleman)	Stationed at V-78 performing sampling of gas during purge into service (seriously injured coworker).
GS-1	GPOM Supervisor (Kettleman)	PG&E management oversight of Kettleman GPOM personnel. Not present on site when ignition occurred on 7/10/2024.
GSP-1	Gas System Planning Engineer (L-300 Backbone)	Endorser for clearance document.
GTM-2	GPOM Transmission Mechanic 2 (Kettleman)	Clearance Supervisor (CS) leading the purge into service operation on 7/10/2024. Stationed at V-90 when ignition occurred.
PE-1	Project Engineer (S-1391)	Endorser for clearance document per TD-4441P-10, however, not included in clearance routing.
SNF-1	Snelson Welding Foreman	Led Snelson welding crew for tie-in of V-54 on 7/9/2024 and 7/10/2024.
TLM-1	TPCO Lead Mechanic Welder In-Service (South)	Stationed at V-J air mover and gas sampling location during purge out of service on 7/9/2024.
TLT-1	TPCO Lead Gas Control Technician 1 (South)	Roving clearance support during the clearance execution. Replaced as Clearance Supervisor (CS) prior to start of clearance work. Directed throttling of V-90 remotely during purge into service while monitoring flow at purge vents.
TTM-1	TPCO Transmission Mechanic 1 (South)	Air mover operation and purge gas sampling at the V-94 permanent vent stack during purge out of service. Assisting at V-90 during purge into service and ignition on 7/10/2024.
TTM-3	TPCO Transmission	Stationed at V-78 and V-54 during purge out-of-service work, including removal of

	Mechanic 3 (South)	blind flange at V-78 on 7/9/2024.
TTM-4	TPCO Transmission Mechanic 4 (Central)	Performed stem seal and gland plate repairs on V-56 while isolated and blown down on 7/9/2024.
TUW-1	TPCO Utility Worker 1 (South)	Roving support during clearance execution 7/8/2024 through 7/10/2024.
TUW-2	TPCO Utility Worker 2 (South)	Assisting TPCO Transmission Mechanic 1 at V94 air mover and gas sampling location during purge out of service on 7/9/2024.

Figure 44: Coworkers and Assigned Role for WCD #80252165

14.6 **Appendix F: Barrier Analysis Worksheet**

The RCE Team determined there were areas of each barrier that did not work as intended. The performance of these barriers is summarized below:

Physical Barriers:

- Six-inch ASME Class 600 Blind Flange downstream (d/s) of V-78 was missing as it was removed during the purge out-of-service sequence of operations.
- Half-inch vertical vent valve (vent d/s of V-78) on six-inch ASME Class 600 Blind Flange d/s of V-78 was missing as it was removed during the purge out-of-service sequence of operations.
- The M-11 Bettis Manual Hydraulic Override System on Valve V-90 provided a barrier by allowing fine throttling as required to safely purge, however, this barrier failed due to high differential pressure across the valve.
- Not implementing a Temporary Purge Vent Stack d/s of V-78 is a missing barrier. if installed, could have provided a barrier allowing gas to dissipate to a safe location.

Clearance Process, including Configuration Control:

- Clearance changes that impact the purge plan required re-submittal for approval, however this barrier failed as the clearance was not redlined and submitted for re-approval.
- Clearance endorsement process failed to identify that the purge plan did not meet requirements of GDS A-38, including purge drive pressure and expected purge duration.
- Configuration control failed when the six-inch Blind Flange d/s of V-78 was removed, and V-56 was positioned outside the requirements of the clearance document.

Training and Operator Qualifications (OQs)

- PG&E's OQ program for purging (OQ-0701, OQ-0703, OQ-0704) failed, as qualified workers did not recognize abnormal operating conditions (AOCs) and hazards present nor demonstrate understanding of the referenced gas design standards (A-38, A-38.1, and A-38.3)
- PG&E's training and apprenticeship program for coworkers performing purging does not include hands-on instruction, which is considered a failed barrier. Purging proficiency is primarily based on institutional knowledge and on-the-job (OJT) training.
- PG&E's clearance endorser training and other technical trainings failed to educate the engineering endorsers adequately and critical purge plan information was not provided

Procedures

- Gas Design Standards A-38, A-38.1, and A-38.3 provide a barrier in the form of requirements to calculate and monitor purge drive pressure, properly size air movers and fresh air sources, and install temporary vent stacks to safely disperse gas to atmosphere.
- Utility Procedure TD-4441P-10 provides a barrier in the form of change management for the clearance process and endorsement requirements, which failed as they were not followed by the clearance team.

Barrier Analysis Worksheet

CAP #: 129207510

Title: HSIF Kettleman Gas Ignition Incident, (RCE)

Hazard:	**Unintended Ignition of Natural Gas During Purging/Blowdown**
Target:	**PG&E personnel and the public**

What Were the Barriers?	How did the Barrier Perform?	Why did the Barrier Fail?	How did the Barrier Affect the Occurrence?	Context
Physical Barrier				
Equipment Design				
Blind flange D/S of V-78. (The blind flange has an integrated half-inch tap and vent valve, D/S of V-78)	Missing	It was purposefully removed during line clearing (purge out of service) for more fresh air and was not reinstalled.	Allowed purge gas to be vented in an unsafe manner. Horizontal release of gas into an obstruction (blind flange approx. 18'' directly in front of the purge vent opening).	The original clearance called for the blind flange to remain in place, however, the decision was made to remove it during the purge out-of-service sequence.
Temporary Purge Vent Stack	Missing	Not installed	Allowed hazardous gas-air mixture to develop and ignite engulfing personnel.	A purge vent stack could have been added to the six-inch flange downstream of V-78
Pneumatic controls on V-90	Worked as intended	Did not fail, not capable of fine throttling (selection issue)	Greatly exceeded purge drive pressure, created conditions for hazardous gas-air mixture that ignited and engulfed personnel	Hydraulic operator was initial choice, however it failed to turn valve under high differential pressure and team pivoted to use of the pneumatic control system.
Hydraulic controls on V-90	Failed	Due to high differential pressure across the closed valve	Required crew to make decision to use pneumatic control system	When the hydraulic control system failed to turn the valve, personnel chose to use the pneumatic system that was not capable of fine throttling
Engineered Safety Feature	**How did each Barrier Perform?**	**Why did the Barrier Fail?**	**How did the Barrier Affect the Occurrence?**	**Context**
Save-a-Valves or other means of providing Fresh Air Sources (F.A.S) during purge out-of-service.	Failed	Inappropriately located on the isolated pipeline section.	Did not protect workers. Impeded purge on 7/9/24 that led to removal of the V-78 blind flange to allow additional fresh air to enter the isolated section during purge out-of-service.	Utility Procedure TD-4441P-21, "Tie-in Methods for Gas Clearances" and GDS A-38.1, "Installation and Operation of Air Movers"
Half-inch Vent D/S of V-78 installed in a vertical position	Missing	It was removed	If used it would have limited the gas-air mixture vented and directed it vertically limiting the potential for ignition	The intent was to use the vertically directed half-inch vent. After being removed for more fresh air it was not re-installed. This was a failed barrier as the clearance boundary was breached without knowledge and understanding of the system configuration risks.
Engineered Safety Feature	**How did each Barrier Perform?**	**Why did the Barrier Fail?**	**How did the Barrier Affect the Occurrence?**	**Context**
Gauge downstream of V-90 to monitor purge drive pressure	Missing	Not implemented	Operator at V-90 was unaware that purge gas flow was likely adequate. This may have prevented the valve operator from additional "bumping" of pneumatic actuator controls V-90 when requested by others.	Per GDS A-38, a gauge is required to be installed to monitor purge drive pressure to ensure adequate purge velocity and a safe/timely purge into service.
Valves positioned according to	Failed	Valve 56 (V-56) in incorrect position during	This changed the purge route and forced additional gas to V-	V-56 minimally opened as based on drone photo evidence and

approved clearance document		purge operations, closed instead of open.	78 when V-90 was bumped too far open.	interview data. See requirement in GDS A-38 "Purging Sequencing and Guidelines" Section: "All open valves must be fully open except those used for isolation or purging."
Administrative Barrier	**How did each Barrier Perform?**	**Why did the Barrier Fail?**	**How did the Barrier Affect the Occurrence?**	**Context**
Contractor and PG&E Safety Ownership	Failed	GPOM selected locations were less than adequate to provide fresh air source (FAS) points	Required us to remove V-78 d/s blind flange as fresh air source. This defeated configuration control.	Construction crew was not setup for success due to lack of fresh-air sources and sniff hole distances.
TD-4441P-21 Section 2.2 Clearance Supervisor (CS)	Failed	CS is expected to ensure fresh air sources are installed but are not trained on purge out-of-service techniques and air mover operations.	CS removed V-78 d/s blind flange without understanding that a clearance point was being removed.	Removal of the flange changed this purge from vertical to horizontal setup. Purge vent outlet changed from half-inch to six-inch
Roles & Responsibilities of Construction Supervisor TD-4441S, Section 5.6 TD-4441P-21 Section 2.3	Failed	Clearance Supervisor was not involved in the selection of fresh air or sniff locations for the V-54 tie-in work	Impacted the ability of the clearance crew to adequately complete the purge out-of-service	For PG&E, Construction Supervisor is a General Construction (GC) Supervisor, M&C Supervisor, or designated Crew Lead. For contractors, Construction Supervisor is the Welding Foreman.
Administrative Barrier	**How did each Barrier Perform?**	**Why did the Barrier Fail?**	**How did the Barrier Affect the Occurrence?**	**Context**
Clearance Revision Process	Failed	Management of Change (MOC) process for revisions to clearance not enforced for fresh air sources (FAS)	Permitted CS to authorize removal of V-78 blind flange, creating an unsafe purge vent orientation	CS are permitted to identify fresh air sources without drawings or documentation.
Clearance Writing Process	Failed	Clearance Writer did not have proper understanding of purge plan requirements.	Clearance Writer knowledge of need for purge drive pressure monitoring and inclusion of purge drive pressure in the special instructions/steps would potentially have prevented V-90 from being opened further.	Clearance writer did question selection of V-90 as purge inlet control valve, but it is unclear why purge drive pressure and gauging were not included. Ineffective identification and management of high-energy hazards during Planning and Preparing for work. This also existed at the time of the Pre-Job Brief and is a failed barrier for the PJB and missing barrier for early identification of risks or determining what could go wrong.
Clearance Endorsement Process	Failed	Engineering and GPOM/TPCO endorsers did not have proper understanding of purge plan requirements or had allowed normalization of deviance to affect behavior. Gas Control as final approver did not enforce purge plan requirements prior to issuing approval, also potential normalization of deviance.	Any one of the endorsers or approvers could have identified need for purge drive pressure monitoring, preventing V-90 from being opened further.	If a purge drive pressure gauge was installed, Gas Control Technician may have been aware that additional "bumping" of the pneumatic actuator was not necessary. Multiple opportunities existed for Clearance endorsers to kick-back the S-1391 Clearance due to no purge plans developed. This is a failed barrier.
Clearance Training	Failed	Purge plan details or	Lack of understanding allowed	Current clearance endorser

for Endorsers		examples are not included in the training, nor are hazards of inaccurate/incomplete purge plans.	clearance to be endorsed without required purge plan information.	training focus on SAP and TD-4441-series guidance documents and not engineering/safety information related to
Risk/Readiness Reviews	Missing	Lack of a work management process that requires risk and/or readiness reviews prior to proceeded to execution	There were other missing or deficient barriers (lack of appropriate purge source, inadequate tie-in plan, missing JHA, deficient PHA) that should have	This is different than a Project Delivery System that monitors milestone for readiness.
Administrative Barrier	**How did each Barrier Perform?**	**Why did the Barrier Fail?**	**How did the Barrier Affect the Occurrence?**	**Context**
Project Hazard Analysis (PHA)	Missing	Item 24 “Hazards or Purging Issues” N/A’d in the form	This was a missed opportunity, in hindsight, to not revisit the PHA when clearance work was swapped between Projects as V-90 was not initially selected for use.	PHA Form completed January 2024 but missing Item 24 Purging review.
Job Hazard Analysis (JHA)	Missing	Not used	Missed opportunity to identify hazards and controls specific to purge into service	No Purging JHA had been filled out and what was available had not been widely trained to. This was a failed and missing barrier and also a Corrective Action from previous SIF event.
Personal Protective Equipment (PPE) – Flame Resistant (FR) clothing	Worked as intended	Personnel had sleeves rolled up	Allowed more severe burns to occur to employee’s arms	Sleeves were rolled up due to the excessive high temperatures on site at Kettleman Compressor Station
PPE – Gloves	Missing	Not used	Allowed more severe burns to occur to employee’s hands	Gloves may not have seemed like they were required for task of monitoring purge
PPE – Safety Glasses	Worked as intended	Did not fail	NA	Protected eye areas
Gas Design Standard A-38 (including Code of Safe Practices CSP Section 1304 and 1305)	Failed	Personnel not familiar with the guidance document.	Lack of a temporary vent stack allowed the hazardous air-gas mixture to engulf nearby personnel	The Code of Safe Practices 1305(d) states “Gas shall not be blown against the side of an excavation; it must be vented upward.”
Gas Design Standard A-38.3	Failed	Personnel not familiar with the guidance document	Lack of a temporary vent stack allowed the hazardous air-gas mixture to engulf nearby personnel	Requires temporary vent stacks to be installed vertically or engineered to prevent ignition hazards from impacting personnel/public.
Job Site Safety Analysis (JSSA)	Failed	Not comprehensive, did not cover all applicable hazards	Lack of situational awareness	
Work Clearance Document (WCD)	Failed	Personnel did not follow or misunderstood the intent of the WCD in Step 38	Removal of the Blind Flange (BF) allowed a hazardous gas-air mixture to exit the pipeline from a fully open six-inch nominal diameter weld neck flange oriented at an obstruction, creating the conditions for a powerful ignition.	In Step 38, the “Vent D/S of V-78” was supposed to be opened for a Fresh Air Source (F.A.S). Instead, the blind flange was removed completely, exposing the full six-inch nominal diameter opening instead of the half-inch vent valve on the drilled/tapped blind.
Work Clearance Document (WCD)	Failed	Failed to contact Gas Control after changing condition that impacted purge plan.	Prevented additional conversations on unintended impacts of blind flange removal at V-78	
Work Clearance Document (WCD)	Failed	No steps to close or open V-56 in clearance.	Prevented additional conversations on unintended impacts of closing V-56 for repairs	
Administrative	**How did**	**Why did the Barrier Fail?**	**How did the Barrier Affect the**	**Context**

Barrier	each Barrier Perform?		Occurrence?	
Tie-in Work Plan	Failed	Lack of knowledge or direction on how to complete.	Led to CS authorizing removal of V-78 blind flange for an additional fresh air source (FAS), which was the ignition location.	TD-4441P-21 covers how to complete the Tie-in Work Plan and roles/responsibilities.
Pre-Job Brief	Failed	Ignition hazard not addressed or discussed.	General awareness not reinforced with workers.	Ineffective identification and management of high-energy hazards during Planning and Preparing for work. This also existed at the time of the Pre-Job Brief and is a failed barrier for the PJB and missing barrier for early identification of risks or determining what could go wrong.
SAFE 1100S SIF Program / Essential Controls	Missing	Coworker at V-78 not provided a way to fail safe.	Coworker received serious injuries requiring lifesaving treatment.	
Purging OQ	Failed	Operator was not aware how valve would function with high pressure differential. Lack of proficiency purging using pneumatic controls.	Operator did not know how valve would perform or expected flow rate when multiple pneumatic actuations were performed.	
Purging OQ	Failed	PG&E's training and apprenticeship program for coworkers performing purging does not include hands-on instruction.	Workers lacked proficiency when performing purging activities.	Purging proficiency is primarily based on institutional knowledge and on-the-job (OJT) training.
Clearance Supervisor (CS)	Failed	Lack of accountability and ownership of the safety/hazard identification aspect of the CS role	CS is responsible for the safety of those on the clearance team, hazard identification not performed at purge vent d/s of V-78	CS had taken over clearance supervisor role from previously assigned CS despite not being part of the planning process
GPOM Supervisor	Failed	Lack of accountability and ownership of the safety/hazard identification aspect of the Supervisor role	Supervisor is accountable for the safety of those on the clearance team, hazard identification not performed at purge vent d/s of V-78	
TPCO/GPOM Technicians and Mechanics	Not well, lack of experience / expertise on valve capability for throttling using pneumatic system. Lack of hazard identification at V-78 prior to start of purge.	Training/OQ quality to properly prepare personnel for tasks to be executed on clearance.	Decision to utilize V-90 as the purge into-service throttle valve played a role in the ignition. Lack of purge vent stack was a missing essential control to protect the coworker sampling gas at V-78.	No hands-on portion associated with purging Operator Qualification or apprenticeship training for Gas Control Technicians.
Facility Engineer	Not adequately	Potential knowledge gap on purge plan requirements per GDS A-38, A-38.1.	Lack of a purge plan and drive pressure may have influenced the decision to use V-90 hydraulics and remove Blind Flange at V-78.	
People/ Supervision	**How did each Barrier Perform?**	**Why did the Barrier Fail?**	**How did the Barrier Affect the Occurrence?**	**Context**
Project Engineer	Missing	Project Engineer was not included as an Endorser on the clearance routing.	May have identified the need for purge plan information when endorsing the clearance.	

14.7 Appendix G: Organizational Learning Tool (OLT)

<table>
<tr><th colspan="4">1.0 ISSUE DESCRIPTION</th></tr>
<tr><td>CAP #</td><td>129207510</td><td>Evaluation Type</td><td>RCE</td></tr>
<tr><td>CAP Title</td><td colspan="3">Gas Operations Kettleman Compressor Station Ignition RCE</td></tr>
<tr><td>Problem Statement</td><td colspan="3">Object / Standard: Utility Worker/ Standard A-38: Gas Design Standard Purging Gas Facilities
• Safety: 1. Vented natural gas and air/gas mixtures must be diffused into the air without hazard to company personnel, the public, or property
C. Consider buildings, equipment, overhead electric lines, wind direction, aircraft landing patterns, and other obstructions or sources of ignition when determining the locations for venting the gas.
D. When a vent is located in a vault, in an excavation, near a structure, or near a source of ignition, temporarily extend the vent to safely dissipate the purged gasses into the atmosphere.
Defect / Deviation: Gas was purged in a configuration that allowed the gas to accumulate and create a hazardous air/gas mixture. This does not meet the expectation of “diffused into the air without hazard.”</td></tr>
<tr><td>Event / Issue Summary</td><td colspan="3">A cross-functional team of PG&E Gas and contract coworkers (CWs) was supporting valve replacement work at Kettleman Compressor Station [redacted] Plymouth Ave., Avenal, CA 93204) under Project S-1391 and work clearance document (WCD) #80252165. The clearance included blowing down and purging gas from the system (establishing clearance), to allow the contract team to perform construction work, then purging air from and reintroducing gas back into the system (removing clearance to restore the system). Gas Operations conducts clearance and purging work per TD-4441S Gas Clearances and A-38 Purging Gas Facilities respectively.

On the morning of July 9, 2024, while purging out-of-service (clearing the system) in preparation for construction, crew members, concerned about reaching acceptable gas-in-air levels, influenced the team to shift from their clearance document steps. During troubleshooting, a blind flange, downstream of Valve 78 (V-78), was removed to provide an additional fresh air source for the air movers. This blind flange was ultimately not reinstalled. The flange removal was neither a step in the existing clearance, nor was it added using the red line clearance revision process detailed in TD-4441P-10 “System New Clearances for Gas Transmission Facilities” Section 3.8 for Revising an Active Clearance.

On July 10, 2024, following completion of construction, clearance activities to re-introduce gas and purge air from the system, initiated:
• The approved clearance required V-56 to be “checked open” for purging, however, it had been closed for stem seal replacement work on July 8, 2024 and only partially opened prior to the purge – operations that had not been documented nor approved as part of the sequence of operations in the clearance.
• Gas was re-introduced to the system from a 34” control valve (V-90), a clearance point with 618 psig differential (per trending data gathered via Cimplicity)
• There are two ways to operate V-90, manual hydraulic and manual pneumatic.
• When attempting to manually operate V-90 hydraulically, oil unexpectedly discharged from the actuator’s manual hydraulic override system relief valve and the valve failed to operate.
• V-90 was then partially opened using the manual pneumatic controls. This method is not effective for fine throttling as required for purging in Design Standard A-38.
Gas from V-90 began to displace air at multiple vent locations per the established clearance plan. It is suspected that as a result of the partial open position of V-56, a greater amount of gas flow was directed toward V-78. Instead of gas exiting the ½” vertical vent valve downstream of V-78 as approved in the clearance, gas exited the full 6” pipe opening horizontally where the blind flange had been removed on July 9. Gas flowed directly into an opposing blind flange roughly 20” away at V-79. This resulted in deflection in all directions, including into the excavation below. Within minutes, a hazardous air-gas plume developed. At approximately 18:42 hours, the air-gas plume ignited, resulting in serious burns to one coworker and minor injuries to others nearby.

Other CWs in the area immediately responded, attending to the seriously injured CW and extinguishing various spot fires using pre-staged fire extinguishers. A CW at V-90 closed the valve to shut in the gas shortly before ignition, allowing the flame to extinguish within about one minute. The ignition source is currently being investigated by ignition experts and specialists. The seriously injured CW received 2nd and 3rd degree burns and was airlifted to a specialized burn unit. The CW has since been released and remains off work.</td></tr>
<tr><td>Consequence / Impact
Yes / No
☒ / ☐</td><td colspan="3">Is there a potential or real consequence/impact as a result of this event?
(Recommendation: Fill out sections 2-7 before determining consequence)
☒ Worker Safety
☒ Operational
☒ Regulatory</td></tr>
</table>

		☐ Organizational			
Team Members		N/A			
Other Personnel Interviewed		N/A			
Preparers / Approvers (Minimum of two required)					
Evaluator	[redacted]			**Date**	*08/16/2024*
Reviewer	*<Print Name>*	☒ N/A		**Date**	*MM/DD/YYYY*
Cross-Functional Review	*<Print Name>*	☒ N/A		**Date**	*MM/DD/YYYY*
Issue Owner/Manager (required)	[redacted]			**Date**	*08/16/2024*

2.0 EQUIPMENT ISSUE ANALYSIS CHECKLIST

This section is for equipment issues, including; failures, unexpected equipment performance, conditions, or results. If this is not an equipment issue, skip to Section 3, Human Performance and complete the remainder of the OLT.

- If a statement can be answered as a **Yes**; document the basis/why for this determination below the question.

Yes	No	Classification / Maintenance Strategy
☐	☒	Is this failure expected and consistent with the classification and maintenance strategy applied to the equipment? Expectations are: ☐ Critical - Zero failures ☒ Non-Critical - Failures should be expected periodically ☐ Run to Maintenance – Failures should be expected

2.1 Prevention

Yes	No	N/A	Attribute	Additional Information
☐	☒	☐	Parts / Vendor Quality	**A. Did the quality of parts, shipping, handling or storage contribute to or cause this event?** (Include review of manufacturing defects, workmanship of parts, vendor workmanship, shelf life, storage environment, shipping issues) *If yes, basis:*
☒	☐	☐	Operation	**B. Did equipment operation contribute to or cause this event?** (Review operating procedures and practices and other operations tasks that may interface or impact equipment such as operator rounds. Was equipment operated outside its vendor or design?) *If yes, basis: Hydraulic and pneumatic manual operation at high differential pressure 688 psi. Loss of fine throttle control. Email from manufacturer Cameron states potential valve damage can be caused by throttling at small valve openings with high differential.*
☐	☒	☐	Design / Design Changes	**C. Did an inadequate design contribute to or cause this event?** (Original design was not adequate, component was not appropriate for its configuration/application, design change by staff inadequate, design change by vendor inadequate) *If yes, basis: No, not identified in initial packages. Removal of 46R and 50R without updating associated documentation resulted in blind flange at 78 existing.*
☐	☒	☐	Preventive Maintenance	**D. Did this event result from lacking or inadequate maintenance strategy?** (PM did not exist, inappropriate frequency or scope, inadequate basis or feedback not implemented incorrect ER classification) *If yes, basis:*
☒	☐	☐	Operating Experience	**E. Is there a deficiency in how OE applicable to this component was evaluated and applied?** (Both internal and industry OE) *If yes, basis: Multiple repeat incidents related to purging. Corrective actions were approved but not all were effectively implemented.*
☒	☐	☐	Risk Management	**F. Was this event due to inadequate risk management?** (untimely or ineffective bridging, mitigating or corrective measures) *If yes, basis: Risk of purging activity was not identified in clearance planning process. Should have questioned if Valve90 as purge driver and is capable of fine control per A-38. Clearance implementers did not adequately manage risk commensurate with hazards presented.*
☐	☒	☐	Long Range Plan	**H. Was this event due to inadequate aging / obsolescence plans, asset management or life-cycle management plans? Did this event occur because of untimely implementation of previous business planning related items?**

				If yes, basis:

2.2 Detection

Yes	No	N/A	Attribute	Additional Information
☐	☒	☐	PMT	**A. Was functional testing or post maintenance/modification testing ineffective in detecting the failure or precursors?** (Note: Inadequate or missing PMT design is captured in Prevention.) *If yes, basis:*
☐	☒	☐	Performance or System Monitoring Implementation	**B. Was system/component monitoring ineffective in identifying equipment degradation?** (Scope, frequency, walkdowns or operator rounds?) *If yes, basis:*
☒	☒	☐	Trending and Asset Management	**C. Was system or component health monitoring deficient in identifying equipment degradation?** (Scope, frequency or implementation of strategies to address aging, obsolescence, trends, margin, aggregate risk) *If yes, basis:*
☒	☐	☐	Troubleshooting	**D. Was troubleshooting of a degraded condition inadequate?** *If yes, basis: When M11 hydraulic operator failed, it was immediately pivoted to pneumatic controls without in-depth troubleshooting.*

2.3 Correction

Yes	No	N/A	Attribute	Additional Information
☒	☐	☐	Untimely Action	**A. Was this issue due to untimely implementation of corrective actions?** (Note: This includes untimely containment actions, or open corrective actions.) *If yes, basis: Horizontal purging prohibited as part of the corrective actions identified in an ACE for ignition event but was not implemented or enforced.*
☒	☐	☐	Ineffective Actions	**B. Have previous issues not been adequately addressed?** (Containment and corrective actions) *If yes, basis: Prior purging incidents did not correct similar Kettleman transmission ignition issues.*

3.0 HUMAN PERFORMANCE – WORKER BEHAVIORS

This section investigates worker behaviors that lead to the event and identifies problems that will assist in establishing corrective actions to resolve the issues.

- If a statement can be answered as a **Yes;** document the basis/why for this determination below the question.

This sections uses select HFACS terminology. Click here to reference the HFACS handbook.

3.1 Task Preparation

Yes	No	Additional Information
☒	☐	**A. Should a pre-job brief have been performed for this task, but was not?** *If yes, basis: PJB performed on first day of project; however, was less than adequate*
☒	☒	**B. Did the pre-job brief fail to identify error-precursors or fail to identify adequate mitigations?** *If yes, basis: Procedure A-38 not discussed. Clearance required purging per A-38. Daily tailboard did not discuss Abnormal Operating Condition with V-56 being partially opened, and the V-78 flange having to be removed as a result of needing Fresh Air Source the previous day.*
☐	☒	**C. Should a Job Hazard Analysis (JHA) have been performed for this task, but was not?** *If yes, basis:*
☒	☐	**D. If a Job Hazard Analysis (JHA) was performed, did it fail to identify hazards or fail to identify adequate mitigations?** *If yes, basis: Ignition and purging risks not identified and discussed.*
☒	☐	**E. Was there a problem identifying or understanding critical steps?** *If yes, basis: Clearance performed out of sequence and unapproved changed steps.* *If yes, see Section 8.1 for Performance Analysis.*
☒	☐	**F. Was there a failure to put proper controls in place to ensure critical steps were performed as intended?** *If yes, basis: A-38 contains critical steps essential for safe purge operations that were not implemented. These missing controls include fine purge control, purging into a safe direction and not into an obstruction or excavation, gauge indication, and vent stacks for purges that cannot be safely isolated from coworkers and other equipment.*
☒	☐	**G. G. Was there a failure to apply relevant operating experience for this task?** *(Was there internal OE related to the performance of this task?)* *If yes, basis: Previous purging events not discussed.*

3.2 Task Performance		
Yes	**No**	**Additional Information**
☒	☐	**A. Was the proficiency of the work performer insufficient?** (First time performance, not performed recently, never performed alone, etc.) *If yes, basis: V-90 operator was unfamiliar and inexperienced with pneumatic operation. Clearance supervisor was not adequately trained or prepared to oversee a complex clearance. Clearance planning and reviews were inadequate when selecting purge driver.* *If yes, see Section 8.1 for Performance Analysis.*
☒	☐	**B. Was the task initially assumed to be a simple task but turned out to be more complex during execution?** *If yes, basis: Troubleshooting was performed and team was not able to hydraulically operate the valve as intended due to activation of relief valve.* *If yes, see Section 8.1 for Performance Analysis.*
☒	☐	**C. Should this task have required governance/written instructions, but did not?** *If yes, basis: Clearance required A-38 but not utilized. There was a lack of a standalone purge plan (outside the clearance) and an adequate tie-in plan with sufficient detail to safely return to service.*
☒	☐	**D. Did the task occur over multiple shifts or across multiple workgroups?** *If yes, basis: Project work – multiple days planned for blow down, purging gas out, purging air out*
☒	☐	**E. Were there problems with the turnover of the task?** (unclear communications, information shares, etc.) *If yes, basis: Clearance supervisor changed roles within last week before event.*
3.3 Procedure Use and Adherence		
Yes	**No**	**Additional Information**
☐	☒	**A. Was the written standard or work document defining the task incomplete, vague, confusing, or inaccurate?** *If yes, basis:*
☒	☒	**B. Was the written standard or work document not followed in accordance with procedure use and adherence standards?** *If yes, basis: Procedure A-38 and clearance process for red line changes not reviewed or followed.*
☒	☒	**C. Would place keeping tools or flagging have helped with task performance, but was not used?** *If yes, basis: There were configuration control issues (valve position V-56) that impacted clearing and system restoration. The clearance document, if performed and place kept as written, may have precluded this event.*
3.4 Verification Practices		
Yes	**No**	**Additional Information**
☐	☒	**A. Was there a failure to receive a peer-check, concurrent verification, or independent verification that was required by the written standard for the task?** *If yes, basis:*
☐	☒	**B. Would using a peer-check, concurrent verification, or independent verification for this task have resulted in a successful outcome?** *If yes, basis:*
3.5 Communication Practices		
Yes	**No**	**Additional Information**
☒	☐	**A. Was the information conveyed during this task incomplete or incorrect?** (Written, verbal or other communication modes) *If yes, basis: Communication was a challenge as there were multiple work sites, high noise levels, and coworkers who were moved from task to task as jobs were completed. Text messages were used to communicate between the V-90 operator and the previously assigned Clearance Supervisor (TPCO Lead Gas Control Technician 1 (South)). This introduced time delays between field requests for additional purge gas flow from V-90. However, both*
☒	☐	**B. Did the work performer(s) fail to use accepted clear communication practices?** *If yes, basis: Both TPCO and Clearance Supervisor were directing work independent of each other.*
3.6 Human Performance Errors		
Yes	**No**	**Additional Information**
☒	☐	**A. Were there any incorrect or omitted actions during the performance of this task?** (Skill-based error) HFACS *If yes, basis: Selection of valve not capable of fine throttling, non-adherence to clearance process or purge process.*
☒	☐	**B. Was there improper technique applied by the performer during this task?** HFACS *If yes, basis: Deficiencies in purging. Pneumatic operation of valve for purging.*

		If yes, see Section 8.1 for Performance Analysis
☒	☐	**C. Was there inadequate information gathering, situation assessment or action/response by the performer or individuals involved?** (Decision error) HFACS *If yes, basis: Purge driving pressures not calculated nor monitored per standard. Removal of clearance point by removing blind flange for fresh air source when trouble-shooting elevated gas indications.* *If yes, see Section 8.1 for Performance Analysis*
☐	☒	**D. Was there inadequate visual, auditory, tactile or haptic processing that resulted in or contributed to this issue?** (Perceptual error) HFACS *If yes, basis:*

3.7 Personnel Conditions

Yes	No	Additional Information
☐	☒	**A. Did inattention, memory failure, confusion or inaccurate expectations result in or contribute to this issue?** HFACS *If yes, basis:*
☒	☐	**B. Did complacency, overconfidence, boredom, frustration, or drowsiness result in or contribute to this issue?** HFACS *If yes, basis: The V-90 purge drive source and selection of V-78 blind flange as purge location.*
☐	☒	**C. Did illness, dehydration, circadian dysrhythmia, or other physiological factors result in or contribute to this issue?** HFACS *If yes, basis:*
☐	☒	**D. Did inadequate strength, stature, dexterity or other physical factor(s) result in or contribute to this issue?** (Refers to conditions of individual at time of event) HFACS *If yes, basis:*
☐	☒	**E. Did a permanent physical or mental condition result in or contribute to this issue?** (Refers to permanent condition(s) of individuals). HFACS *If yes, basis:*
☐	☒	**F. Were there activities performed off the job, that resulted in or contributed to this issue?** (Refers to physical fitness, working a second job, limited sleep, overexertion, etc.) HFACS *If yes, basis:*

3.8 Routine Violations

Intentional bending of the rules, habitual deviation from the rules and tolerated by leadership. HFACS

Yes	No	Additional Information
☒	☐	**A. Were there routine short-cuts taken that resulted in or contributed to this issue?** (Working around established processes, skipping steps intentionally) HFACS *If yes, basis: Removing blind flange without clearance change. Venting through horizontal 6" opening. (NOTE: The decision to perform these actions was intentional; however, there was likely not an intention to break or bend rules. These actions were viewed as acceptable practices).*
☒	☐	**B. Were tools or technology routinely used in an inappropriate manner that resulted in or contributed to this issue?** HFACS *If yes, basis: Vent stack NOT utilized creating hazardous condition.*
☒	☐	**C. Were directions/instructions routinely disregarded which resulted in or contributed to this issue?** HFACS *If yes, basis: A38 seldom referenced or used. The clearance document and clearance standard was also not followed*

3.9 Exceptional Violations

Isolated deviation from the rules but NOT indicative of one's behavior or tolerated by leadership.

Yes	No	Additional Information
☐	☒	**A. Were personnel unqualified to perform a task which resulted in or contributed to this issue?** HFACS *If yes, basis:*
☐	☒	**B. Were personnel behaviors disruptive which resulted in or contributed to this issue? (***Fighting, arguing, equipment abuse, etc.).* HFACS *If yes, basis:*
☐	☒	**C. Were personnel involved participating in excessive risk taking that resulted in or contributed to this issue? *** HFACS *If yes, basis:*

**If any questions in Section 3.9 are marked "yes", inform Leadership and Human Resources immediately.*

4.0 JOB-SITE CONDITIONS

This section investigates the job-site conditions that may have contributed to this event.

- If a statement can be answered as a **Yes**; document the basis/why for this determination below the question.

4.1 Task Preparation

Yes	No	Additional Information
☒	☐	**A. Was there confusion about the roles and responsibilities during the work activity?** *If yes, basis: Multiple individuals giving instructions. CS role was often deferring to TPCO who was assisting with job.*
☒	☐	**B. Were there environmental or ergonomic conditions which contributed to this problem? (Inadequate housekeeping, lighting, workplace design or condition)** *If yes, basis: Temperature was extremely hot (110+), metal tools were described as too hot to touch without gloves. Workers would take turns returning to vehicles to cool off.*
☒	☐	**C. Were there workarounds during task performance that were not mitigated by the job package, procedures, or work planning?** *If yes, basis: Removal of blind flange outside of clearance, Operation of V-56 outside of clearance, Horizontal purging, pneumatic control at V-90.*
☒	☐	**D. Was the condition of the equipment at the job site different than was expected?** *If yes, basis: Mechanical issues at V-90 and suspected leaking valves (later determined to be inadequate fresh air source placement) required troubleshooting. Save-A-Valve locations inadequate placement led to delays and decision to remove V-78 blind flange. V-78 blind flange removal not in clearance. Closure of V-56 not in clearance. Partial closed V-56 likely caused restricted gas flow to vent location at V-J resulting in request to increase gas flow from V-90.*
☐	☒	**E. Were there labeling deficiencies with the equipment?** *If yes, basis:*
☒	☐	**F. Were there instrument indications at the job site that were different than expected?** *If yes, basis: Pressure gauge not installed per A-38.*

5.0 ORGANIZATIONAL FACTORS

This section investigates organizational or programmatic contributors that led to the event.

- If a statement can be answered as a **Yes**; document the basis/why for this determination below the question.

5.1 Process Weaknesses

Yes	No	Additional Information
☐	☒	**A. Did leaders establish unreasonable or low standards or expectations for this task?** *If yes, basis:*
☒	☐	**B. Did unacceptable or inappropriate behavior for this task go uncorrected?** *If yes, basis: Inadequate PJB, prohibited purge configuration used, worksite safety in excavation violated multiple safety issues (high energy exposure, workers in manlift working directly over purge location , workers chatting and residing in purge area unnecessarily.)* *The clearance work plan of operations, if executed as written, would have placed multiple workers in the immediate vicinity of the purge activity. Minutes before the ignition event, there were two coworkers who were in a manlift working on V-56 directly over the V-78 purge area. These coworkers were wearing fall protection harnesses that would have delayed or precluded their evacuation from the ignition area. It was only because one coworker in the manlift had to use the restroom on an emergency basis that these coworkers were not in the line of fire during the ignition event.* *The original location of the seriously injured coworker was directly within an LEL area that would have severely impeded their ability to evacuate the ignition incident area. Approximately seconds to a minute prior to ignition, the seriously injured employee began to walk away from the V-78 purge location upon the initial accumulation of the dust cloud.* *There were also no controls or prohibitions on who could be in the general area near the V-78 purge, including two coworkers having a discussion near the manlift. One of those workers received burns to the back of their ears and their hi-viz vest partially melted. Based on interviews, it was communicated that it is common for coworkers to perform various work activities including leak testing or "soap testing" nearby active purges, including those performed in excavations.* *This lack of programmatic controls on isolating coworkers from high energy sources had the potential to impact multiple coworkers that day.*
☒	☐	**C. Were there conflicting priorities that negatively influenced the work performance?** *If yes, basis: Crew were trying to complete work to turnover to contractors and meet CARB requirements.*
☐	☒	**D. Did the organization fail to provide adequate resources for this task?** *If yes, basis:*
☒	☐	**E. Were there weaknesses in the knowledge or skill of the performer?** *If yes, basis: Valve operator unfamiliar with pneumatic purging. Local Kettleman selection of V-90. Clearance*

		supervisor did not adequately execute their CS responsibilities. M&C Coordinator position training does not cover complex clearances specifically on large transmission products. *If yes, see Section 8.1 for Performance Analysis.*
☒	☐	**F. Have supervisors or group leaders failed to provide adequate coaching on how to successfully perform this task?** *If yes, basis: Purge configuration does not meet A-38 standards. Lack of adherence to clearance standard. No purge plan generated.*
☐	☒	**G. Are there positive reinforcements or rewards for performing inappropriately?** (Are we rewarding poor/bad behaviors even if inadvertently)? *If yes, basis:*
☒	☐	**H. Were there inadequate quality control inspections in place?** *If yes, basis: No QM for the work being performed in this incident.*

6.0 PROGRAMMATIC INVESTIGATION

This section investigates organizational or programmatic contributors that led to the event.

- If a statement can be answered as a **Yes**, the evaluator should document the basis/why below the question.

6.1 Process Weaknesses

Yes	No	Additional Information
☐	☒	**A. Are there deficiencies in the standard/work instruction describing all activities needed to successfully complete the task?** *If yes, basis:*
☒	☒	**B. Does the standard have excessive implementation requirements that make it hard to use?** *If yes, basis: A-38 is too complicated for some in field to implement, job aid or training suggested.*
☒	☐	**C. Are there weaknesses in the standard that impede the implementation of regulatory or required standards?** *If yes, basis: N There are standards that require proper use of air mover locations - TD4441P-21 and A38.1. Ensure air movers are located at positions in the pipeline system that are sufficient to meet the following - purge entire isolated system per GDS a38.1. A potential gap is the lack of specification of Sav-A-Valve minimum distance locations or guidance.*

6.2 Interface Between Controlling Processes

Yes	No	Additional Information
☒	☐	**A. Are interface(s) missing in all written standards/ instructions when multiple documents are required to accomplish the task or goal?** *If yes, basis: There are engineering and clearance processes that are not clearly defined (validation of fresh air sources and air mover locations, to include Sav-A-Valve placement) and other safeguards processes that were inadequately or not performed (Purge plan / Tie-In Plan)*
☐	☒	**B. Are there conflicting requirements between 2 or more written standards / instructions?** *If yes, basis:*

6.3 Organizational Problems with Program Execution

Yes	No	Additional Information
☒	☐	**A. Are there problems with clear ownership of a process or program?** *If yes, basis: Clearance supervisor role is often shared between TPCO and GPOM. There are blurred lines at times for who performs what roles especially during execution in the field. Confirmed through Letter of Agreement review.*
☒	☒	**B. Are the roles or responsibilities of the implementing organization poorly defined or not understood?** *If yes, basis: TD-4441P-10 Clearance endorser and approver roles and responsibilities are somewhat unclear.*
☐	☒	**C. Are there insufficient resources or a lack of authority to implement the process or program?** *If yes, basis:*
☒	☐	D. **Are there weaknesses in program monitoring such that problems were not detected?** (e.g., metrics, self-assessment, condition reports, trending, quality control/hold points, etc.) *If yes, basis: Horizontal purging was restricted was in 2017; however it is still performed and has not been identified by oversight bodies. Lack of Quality Management processes for clearance activities.*
☐	☒	**E. Are there difficulties in correcting known problems in the program?** *If yes, basis:*
☐	☒	**F. Are there other challenges in program implementation?** *If yes, basis:*
☒	☐	G. **Is there inadequate independence in implementing supplemental oversight?** (i.e., QC inspections either within the contractor organization or PG&E)

		If yes, basis: Lack of QM for clearance activities.
☐	☒	H. **Is there too much confidence in the contractor work process?** (i.e., insufficient project oversight or QC inspections either within the contractor organization or PG&E) *If yes, basis:*

6.4 Coordination Between Work Groups

Yes	No	Additional Information
☐	☒	**A. Was there a lack of effective stakeholder participation?** *If yes, basis:*
☐	☒	**B. Was there a lack alignment around a common goal?** *If yes, basis:*
☒	☐	**C. Was there a lack of understanding about ownership, roles, or responsibilities between work groups?** *If yes, basis: Both TPCO and GPOM were giving instructions to workers, unclear who was acting as CS.*
☒	☐	**D. Did resources, physical workspaces, technology, or infrastructure affect the ability for work groups to effectively interface?** *If yes, basis: Workers were approximately 500 feet apart in loud environment.*
☒	☐	**E. Was there inadequate communication between work groups?** *If yes, basis: The work groups involved: clearance writing, clearance supervisor, construction, clearance team. In this incident, there are examples of miscommunication around system configuration and work execution plan.*

6.5 Problems within a Work Group

Yes	No	Additional Information
☐	☒	**A. Is there a lack of resources?** *If yes, basis:*
☒	☐	**B. Is there inadequate supervisory oversight?** *If yes, basis: Clearance Supervisor instructed individual to remove clearance point remove blind flange.*
☒	☐	**C. Is there inadequate communication within the work group?** *If yes, basis: Crews did not know or review the clearance adequately.*
☐	☒	**D. Is there a problem with the work group's vision, values, or standards?** *If yes, basis:*

7.0 LEADERSHIP AND TEAM INVESTIGATION

This section investigates leadership and teamwork behaviors or attributes that contributed to the event.

- If a statement can be answered as a **Yes**; the evaluator should document the basis/why below the question.

7.1 Set Direction

Yes	No	Additional Information
☒	☐	**A. Are goals unclear or unrealistic; are there shortcomings involving tactical or strategic goals intended to address equipment health or proficiency of people?** *If yes, basis: Purging training (A-38) under CS-1 is inadequate based on limited instruction provided. Some workers lack proficiency in selection of drive sources and understanding adequate setups.*
☒	☐	**B. B. Are there conflicting departmental priorities which have not been properly resolved amongst team members that affect the ability to meet stated goals; have rewards or incentives been established that reinforce the wrong behaviors?** *If yes, basis: Overarching culture of "Can Do Get it Done." In some examples, workers are not taking time to safely establish purge setups and vent stacks. Evidenced by lack of vent stacks available and their infrequent use.*
☒	☐	**C. Is there a misalignment in the organization around the stated vision, goals, metrics, and priorities?** *If yes, basis: Safety is considered paramount; however, unsafe purging activity and behaviors are pervasive and have not been corrected even after similar past events.*
☐	☒	**D. Did supervisors, managers, or executives' direct actions that were not aligned to the FA direction or priorities?** *If yes, basis:*

7.2 Maximize Competence

Yes	No	Additional Information
☒	☐	**A. Did workforce planning negatively impact performance?** (Workforce planning functions include hiring strategies, pipelines, personnel development, diversity, knowledge management or organizational change management.) *If yes, basis: Insufficient personnel development as exhibited in gaps in fundamental gas worker knowledge*

		and proficiency, to include purging and fresh air source activities. *If yes, see Section 8.1 for Performance Analysis.*
☒	☐	**B. Did the organization fail to provide adequate well-qualified, prepared candidates with the behaviors necessary?** *If yes, basis: Workers were not proficient in purge activities using equipment provided.*
☒	☐	**C. Did the organization not adequately incorporate industry best practices; have leaders not applied lessons learned from operating experience?** *If yes, basis: PLS3 (2017) identified but failed to implement horizontal purging ban. PLS3 ignition event very similar to Kettleman event. The Hollister OP (2020) RCE yielded similar root causes yet corrective actions have not yet materialized since the investigation.*
☒	☐	**D. Were there weaknesses in the skills of supervisors or managers that directly impacted performance of a task?** *If yes, basis: Local GPOM Clearance Supervisor deferred much of planning and supervision to TPCO. Onsite Kettleman Supervisor was also covering for superintendent. This required them to perform both roles and may have contributed to their absence during purge activity.* *If yes, see Section 8.1 for Performance Analysis.*

7.3 Engage the Workplace

Yes	No	Additional Information
☐	☒	**A. Are there issues with timely, accurate, and transparent flow of information?** *If yes, basis:*
☐	☒	**B. Do workers express concerns about morale, do not believe their work is valued or important; leaders do not create an environment where people believe their work is appreciated.** *If yes, basis:*
☒	☐	**C. Do supervisors inconsistently reinforce, and coach expected behaviors; field interactions between workers and supervisors are not routine, and supervisors are not skilled at providing feedback?** *If yes, basis: Workplace safety and purge standards not enforced or coached to.* *If yes, see Section 8.1 for Performance Analysis.*
☐	☒	**D. Do supervisors *not* hold personnel accountable for behaviors that deviate from standards?** *If yes, basis:*
☐	☒	**E. Are there problems with how people listen, act, and communicate which impacts trust?** *If yes, basis:*
☐	☒	**F. Is feedback delivered in ways that does *not* reinforce positive behaviors; candid feedback on performance and development areas is not provided?** *If yes, basis:*

7.4 Cope with Risk

Yes	No	Additional Information
☐	☒	**A. Are the roles and responsibilities of decision-making *not* clear and the ultimate responsibility for a decision is not identified; technical expertise and diverse skill sets are not employed?** *If yes, basis:*
☒	☐	**B. Are people *not* encouraged or expected to identify risk?** *If yes, basis: Workers are assigned from job to job and are not identifying issues before starting work.*
☒	☐	**C. Does the organization allow long-standing or aggregate issues to go unrecognized or uncorrected?** *If yes, basis: Dangers of horizontal purge setups known but left uncorrected.*
☐	☒	**D. Does the organization fail to identify differing views which affects decision-making?** *If yes, basis:*
☒	☐	**E. Were there problems associated with coordination/planning between cross-functional work groups to address infrequently performed, high-risk activities?** *If yes, basis: Equipment selected to perform purge was not acceptable. Safer alternatives were readily available but not identified. Inadequate placement of fresh air sources/air mover locations. Inclusion of preventative maintenance activities within clearance without proper communication for activities required for maintenance i.e. closing the valve before reporting on.*
☒	☐	**F. Were there problems with the integration of risk elimination/mitigation activities with business planning processes at the department, site, or enterprise levels?** *If yes, basis: Risk mitigation for high-risk activities is limited and ineffective.*
☐	☒	**G. Is the organization too risk adverse as to not adequately investigate a problem or perform work, thereby inadvertently increasing risk?** *If yes, basis:*

7.5 Achieve Sustainable Results

Yes	No	Additional Information
☐	☒	**A. Does the organization fail to act with enough urgency when declines in performance are identified?** *If yes, basis:*
☒	☐	**B. Are there shortfalls in behaviors and actions that impede achieving the desired results?** *If yes, basis: Potential self-induced time pressures to complete and hand over work to contractor over safe execution. Multiple opportunities to stop work ignored potentially due to unacceptably high tolerance for risk "i.e. thought what they were doing was safe."*

CONCLUSIONS

Ensure causes and corrective actions address the problem statement: Gaps, Drivers, Actions That Get Results and that actions are Specific, Measurable, Achievable, Relevant and Timely (SMART).

Note: If this OLT is being performed as a part of a Root Cause Evaluation (RCE) or Cause Evaluation (CE), some of the information below may be contained in the RCE/ACE documents/report and is not required to be duplicated below in sections 8.1 or 8.2. Please refer to the RCE/CE documents/report for the applicable information.

8.1 GAPS, Drivers, Actions, and Results

- Problem Statement (Gap)(Restated from Section 1): A gap is a specific deviation from an expected level of performance and, if addressed, will have a significant contribution to achieving a desired end state.
- Causes and Contributors (Drivers): A driver explains why the gap exists. By fixing the driver, the gap is closed with high confidence. List only the attributes marked as 'Yes' above which are considered key drivers (causes and contributors) of this event.
- Actions: An action is only that which directly addresses the driver(s). Actions must be SMART: Specific, Measurable, Achievable, Relevant, Timely.
- Results Expected: Result is the desired performance demonstrating that the gap is closed. It is typically a measurable parameter. The most effective result measures are those that directly correlate to the actions and provide a line of sight to the driver and gap.

Document the conclusions from Section 8.2 in the CE report.

Problem Statement (Gap):

Standard: GDS A-38 (Gas Design Standard Purging Gas Facilities) – Safety: 1. Vented natural gas and air/gas mixtures must be diffused into the air without hazard to company personnel, the public, or property.

Deviation/Defect: Gas was purged in a configuration that allowed the gas to accumulate and create a hazardous air/gas mixture. This does not meet the expectation of "diffused into the air without hazard."

Consequence: The air/gas mixture ignited, and coworker was injured with second- and third-degree burns. Two additional coworkers received minor injuries related to the incident.

Significance: Unacceptable purging configurations can result in conditions that lead to gas ignition. Ignited gas may result in serious injuries or fatalities, damage to facilities, and regulatory impacts.

Causes and Contributors (Drivers) and Actions:

The results of the OLT provided the following key potential causes:

Removal of the blind flange downstream of V-78 was considered a "safe" activity during purge out of service activities performed on 7/9/24. However, when work transitioned from purge out of service to purge into service, the risk of creating a hazardous purge environment increased exponentially. This was not realized as high risk by work crews until the purge into service on 7/10/24 became "uncontrolled," with the discharge gas plume stirring a large volume of sand and debris inside the excavation.

During interviews, coworkers describe the removal of blind flange 78 as increasing safety to allow for a Fresh Air Source that would help them achieve acceptable gas LEL during the 7/9/24 purge out of service. This also correlates to the questions the RCE Team had on why daily walkdowns did not identify the open blind flange at V-78 as a potential hazard.

Based on interviews and in consultation with Gas SMEs, the average gas employee would not likely understand nor be trained to identify the inherent risk that a transition in station modes (Out of Service to Return to Service) can potentially pose if there is not a strict adherence to Configuration Control.

Configuration control is not rigorously applied when executing clearance work.

Configuration management programs (i.e. Configuration Control) ensure that the construction, operation, maintenance, and testing of the physical facility are in accordance with the design requirements as expressed in the design documentation, and to maintain this consistency throughout the operational life-cycle phase, particularly as changes are being made. During this incident, there were unapproved deviations from the clearance plan that removed an energy isolation point (V-78 flange removal), and a mispositioned valve (V-56 left partially open when clearance specified OPEN) that reduced gas to other piping sections (between 353-90 and Valve J) that were being used to measure return into service purge gas flow.

A lack of enforcing programmatic controls on isolating coworkers from high energy sources had the potential to impact multiple

coworkers (>5 persons) with the consequence of serious injury or fatality.

The clearance work plan of operations, if executed as written, would have placed multiple workers in the immediate vicinity of the purge activity. Minutes before the ignition event, there were two coworkers who were in a manlift working on V-56 directly over the V-78 purge area. These coworkers were wearing fall protection harnesses that would have delayed or precluded their evacuation from the ignition area. It was only because one coworker in the manlift had to use the restroom on an emergency basis that these coworkers were not in the line of fire during the ignition event.

The original location of the seriously injured coworker was directly within an LEL area that would have severely impeded their ability to evacuate the ignition incident area. Approximately seconds to a minute prior to ignition, the seriously injured employee began to walk away from the V-78 purge location upon the initial accumulation of the dust cloud.

There were also no controls or prohibitions on who could be in the general area near the V-78 purge. In this incident, two coworkers were conducting a discussion in the area near the manlift. One of those workers received burns to the back of their ears and their hi-viz vest partially melted. Based on interviews, it was communicated that it is common for coworkers or contractors to perform various work activities nearby active purges, including working in excavations while performing leak testing, tie-in and cleanup activities.

Note: Root Cause(s) and Contributors available in the final approved report.

82. Prudent Actions

There may be items marked as 'Yes' which were present but did not cause or contribute to this event. Determine if these need to be addressed. If so, write a separate notification and list the notification here.

1. N/A, to be determined in Final RCE report.

14.8 Appendix H: Human Factors Analysis and Classification System (HFACS) Worksheet

Human Factors Analysis and Classification System (HFACS) Worksheet

Human Factors Analysis and Classification System (HFACS) is a method designed to identify factors that influence the outcome of a task. The goal of HFACS is not to attribute blame to a worker but rather to understand what underlying factors failed and drove the outcome. Employee Actions begin at the lowest level of the classification system and are where you start to learn what underlying factors caused the outcome. When complete, causal factors should be able to show a logical correlation.
Reminder: You should always be able to understand what informed and drove employee decisions or actions. The objective is to understand what failed, not who. Preconditions and Supervisory/Organizational are the underlying Factors intended tohelp understand and identify what failed.

Instructions for the "HFACS Framework factors and definitions" Column:
Please read each definition, ask questions that help answer and point to what factors apply to your incident. If none of the factors under each category apply to your incident, mark the N/A box provided. If at least one factor under each category applies, do not check the N/A box and just check the applicable factor on the right side column.

Instructions for the "HFACS worksheet required documentation" Column:
Please provide the required documentation:
- Check all that apply
- Cite all specific finding from your investigation as applicable and note supporting evidence for each checked box.
- Document N/A for any unchecked boxes.

UNSAFE ACTS	
HFACS Framework factors and definitions	**HFACS worksheet required documentation**
ERRORS	
N/A ☐ **Skill-based Errors -** Often occur during the performance of highly practiced activities that do not require much concentration	
☒ **Incorrect Action –** inadvertent, misordering, mistiming of response ☒ **Omitted Action** – missing steps in a procedure, place-losing, forgetting intentions ☒ **Improper technique –** inappropriate performance method for the situation (speed/timing/positioning)	☒ **Incorrect Action** • Removal of blind flange from V-78, this step was not clearly spelled out in the clearance document "remarks" (Work Clearance Document (WCD) 80252165 Step 15; "OPEN" with remarks "B/D iso piping"). Based on the review of the group text thread for the work, the opening of V-78 was likely done out of sequence with the approved work clearance document. • Blind flange on V-78 was not reinstalled for gas to air purge operation. WCD 80252165 Step 38 was not followed, "OPEN – vent d/s of V-78" with remarks stating "F.A.S." and no mention of removal of blind flange. • V-56 was closed to facilitate the replacement of the stem seal and gland plate. This likely increased the difficulty of clearing the piping after blowdown and could have contributed to the decision to remove the blind flange downstream of V-78. WCD 80252165 has no steps to position this valve and it is checked open on step 18 of the tagging steps. • V-56 was only partially opened when prepping for the purge. Based on the indicator it is unclear whether the valve is open far enough allow the passage of gas. This is contrary to the guidance provided by A-38 and resulted in increased gas flow through V-78 during the purge. It also could have contributed to the request for more gas at V-J as documented in the text thread. ☒ **Omitted Action** • Team did not install or monitor a drive pressure gauge or device per GDS A-38 "Purging Sequence and Guidelines" #7 and #8 (page 21 of 27). • Coworker that returned to work at approximately 1800 on 7/10 did not receive a pre-job brief per SAFE-1062S ☒ **Improper technique** • Use of pneumatics on valve instead of going with the decision to stop work after hydraulic method failed for operating V-90. The use of "bumping" of the three-way valve on the pneumatic control system was not a fine-throttling technique as required by A-38. • Coworkers were in the line of fire without isolation from the energy source
N/A ☐ **Decision Errors –** Often occur during the performance of diagnostic or problem-solving tasks that require conscious effort	
☒ **Inadequate information gathering –** limited search, disregarding/ignoring relevant cues ☒ **Inadequate situation assessment** – failure to recognize patterns/relationships among cues; focusing on irrelevant information ☒ **Inadequate action/response selected –** inaccurate/risky action chosen; failure to	☒ **Inadequate information gathering** • Failure to adhere to information provided in Gas Standard A-38 and A-38.3. • Lack of understanding of the flow characteristics of large bore valves at high differential pressure. ☒ **Inadequate situation assessment** • Use of V-90 for purge drive pressure due to size and flow characteristic of valve. • Sampling technique at horizontal V-78 blind flange as purge sample location placed coworker in the line of fire and was not capable of getting an accurate gas-in-air reading. • No recognition of STKY hazard present. • Lack of recognition of the impact that the V-56 closure would have on clearing and purging the line.

prioritize actions	• Lack of proper pre-job brief and tailboard for coworkers arriving to the job. ☒ **Inadequate action/response selected** • Desire to increase purge drive (request for "more gas" in text thread) after a purge had been established. • Inadequate response in going with pneumatic operation from hydraulic operation of V-90. • Decision to select V-90 as the purge inlet control valve was inadequate due to its inability to perform fine throttling required by GDS A-38.
N/A ☐ **Perceptual Errors -** Often occur during the performance of tasks that rely heavily on one's senses for detecting/interpreting stimuli in the environment	
☐ **Inadequate visual processing –** misjudged height/distance, misinterpreted text/numbers, misperceived colors/shapes ☒ **Inadequate auditory processing**– misinterpreted speech, misperceived tones/sounds ☒ **Inadequate tactile/haptic processing –** misestimating weight/force/pressure	☐ **Inadequate visual processing** ☒ **Inadequate auditory processing:** • Potential that Lead Gas Control Tech was relying on his auditory perception to make his request for "more gas" described above. This would be considered a misconception of how purge inlet control done per GDS A-38 using an approximately 1 psig purge inlet control pressure at V-90. This also could have been impacted by the closure of V-56 limiting gas flow to the V-J purge point. ☒ **Inadequate tactile/haptic processing** • Misestimating drive force from V-90 during purge the force required to "bump" the valve and the pressure differential effects across V-90. Partially due to the lack of communications outside of the group text thread, such as radios or noise-canceling earbuds/headphones. No gauge was installed to monitor purge drive pressure.
VIOLATIONS / DEVIATIONS	
N/A ☒ **Routine Violations –** Intentional "bending" of the rules; habitual deviation from the rules and tolerated by management	
Check all that apply ☒ **Short-cuts –** working around established protocols, intentionally skipping steps in a procedure ☒ **Inappropriate use of tools/technology** – disabling alarms, removing safety guards ☒ **Disregarding orders/direction –** ignoring supervisor's instructions, noncompliance with safety warnings ☒ **Procedure Violation**	☒ **Short-cuts:** • Lack of pre-job brief when coworker returned to jobsite, per SAFE-1062S. • Pre-job brief and Job Site Safety Analysis (JSSA) was not adequately filled out and did not identify the hazard of venting gas or the potential for explosive mixtures. • Direction was being provided to crewmembers performing work by multiple people onsite other than the clearance supervisor. ☒ **Inappropriate use of tools/technology** • The pneumatic control system was an inappropriate use of technology for control of purge driving pressure at V-90. ☒ **Disregarding orders/direction:** • Not adhering to WCD 80252165, Step 38. For example, in addition to opening the vent d/s of V-78, also removing blind flange though not directed by WCD. • Closure of V-56 for stem repair in contradiction to WCD 80252165 step 18. ☒ **Procedure Violation** • Lack of a proper ventilation stack at Valve78 violates CSP 1304 and A-38.3. • TD4441P-10 not followed for clearance purge plan changes (dropping V-78 flange). • Project engineer was not listed as a clearance endorser as required.
N/A ☒ **Exceptional Violations –** Isolated deviation from the rules but NOT indicative of one's behavior or tolerated by management	
☐ **Unqualified actions –** performing activities without license/credentials ☐ **Disruptive behavior**– arguing, physical altercations, abusing equipment ☒ **Excessive risk taking –** actions that pose unreasonable risk of harm, negligence	☐ **Unqualified actions** ☐ **Disruptive behavior** ☒ **Excessive risk taking:** • Lack of proper use of PPE, CW had sleeves pulled up and was not wearing gloves as required by PPE matrix. NOTE: Motivation for sleeve rollup and gloves removal may been caused by excessive outdoor weather temperatures at time of incident (110 degrees).
PRECONDITIONS FOR UNSAFE ACTS	
SITUATIONAL FACTORS	
N/A ☐ **Physical Environment –** Refers to the setting in which individuals or teams perform their work	
☒ **Suboptimal ambient environment –** poor lighting, temperature, noise ☒ **Suboptimal workplace design** – poor layout, location/distribution of materials ☐ **Suboptimal housekeeping –** cluttered, disorganized, unclear	☒ **Suboptimal ambient environment** • Temperatures reaching 105F+, extended work hours. Very low humidity, not ideal for potential ignition of purged gas-in -air mixture. ☒ **Suboptimal workplace design** • V-78 was not set up for ergonomic operation, nor checking gas percentage. • Work location was in an excavation without scaffolding for monitor at V-78 purge point. • V-78 monitor did not have an adequate means to stay away from the high energy line of fire. ☐ **Suboptimal housekeeping**
N/A ☐	

Tools/Technology – Refers to the materials, software and documents individuals and teams use to perform their work	
☒ **Inadequate design –** confusing, cumbersome, inflexible, incompatible ☒ **Inadequate condition** – outdated, poorly maintained, malfunctioning	☒ **Inadequate design: Several factors to address, including:** • Sequence of clearances limiting options for purge inlet control valves • To accommodate the upcoming L-300B work there was a planned transition to another clearance without clear indication at what point in WCD 80252165 this would occur. • Gas Design Standard A-38 allowed for horizontal purging post PLS-3 SIF-P Ignition, clarity on purging into-service versus purging out-of-service, • Gas Design Standard A-38.3 is specific to blowdown venting and is silent on if it applies to purging • No field guide material is available for transmission purging, similar to the Purge Stand Job Aid, to help the field understand this task • Lack of design guidance in the IFC package to ensure materials and supports for purge vents and blowdown stacks were adequate • Guidance to clearance writers on use of caution tags for blind flange removal or other purge / blowdown vent locations ☒ **Inadequate condition:** • The M-11 hydraulic operator was unable to position V-90 due to oil bypass. • Group text for three-way communication during purging likely delayed the transmission of information during the purge.
CONDITION OF OPERATORS	
N/A ☐ **Mental States –** Refers to mental conditions that may negatively affect performance	
☒ **Cognitive Factors –** attention/memory failures, confusion, inaccurate expectations ☒ **Motivation/Arousal** – complacency, haste, overconfident, boredom, frustration, drowsiness	☒ **Cognitive Factors** • CW was switched to from air mover operations to gas monitoring operations. CW was also not expected by supervisor to report for duty. ☒ **Motivational/Arousal** • Complacency around monitoring gas due to its monotonous nature, normalization of deviance around hazards of escaping gas. • PPE not properly worn due to heat. • Workers congregated around excavation during purge near manlift. Possible lack of awareness around hazards of escaping gas (many years between ignition incidents). • High heat may have hastened work urgency. • Previous CS was scheduled for vacation the day after incident. New CS was assigned and may have relied on or been complacent that old CS that was onsite would fully understand scope of work and help run clearance
N/A ☒ **Physiological States –** Refers to the individual's medical/physiological condition at the time of the event	
☐ **Physiological Factors –** illness dehydration, hypoglycemia, circadian dysrhythmia ☐ **Physical Factors –** muscle fatigue, inadequate stature, strength, dexterity	☐ **Physiological Factors** ☐ **Physical Factors**
N/A ☐ **Physical/Mental Limitations –** Refers to permanent physical/mental disabilities that may adversely impact performance	
☐ **Physical Limitations –** obesity, injury, disability, sensory deficits ☒ **Mental Limitations –** lack of experience, knowledge, or aptitude	☐ **Physical Limitations** ☒ **Mental Limitations:** • Gas Control Tech had limited experience operating pneumatic controls (V-90) for purge driving.
PERSONNEL FACTORS	
N/A ☐ **Communication, Coordination and Planning –** Refers to the interrelationship among team members	

Check all that apply
 	
☒ **Failure to provide/request information –** shared or request information is incomplete, delayed, or unclear
 	
☒ **Failure to confirm information** – failure to ensure that information sent/received as understood
 	
☒ **Inadequate planning –** failure to prepare, conduct briefing, or ensure role clarity
	☒ **Failure to provide/request information**
	• Three-way communication during purging used group text, which likely delayed the transmission of information during the purge.
	☒ **Failure to confirm information**
	• Improper use of the following Human Performance tools:
	  ○ 3-way communication using group text threads (key Human Performance Tool).
	  ○ Place Keeping,
	  ○ Questioning Attitude,
	  ○ Situational Awareness
	  ○ Stop When Unsure as well
	  ○ Procedural Use and Adherence
	  ○ Keys to Life #5 "Follow Clearance Procedures & LOTO"
	☒ **Inadequate planning:**
	• Clearance planning should have identified V-90 as inappropriate purge inlet pressure / driving pressure control location.
	• Removal of six-inch blind flange on V-78 was not part of the clearance.

☒ **Inadequate monitoring/backup** – failure to support team members or assist others in performing activities	• Requirement to close V-56 for stem seal repair was not identified during clearance planning. • Failure to provide enough gas rangers to accurately monitor the purge into service in a timely fashion. • Changes in clearance supervisor ahead of project work. • Multiple people in the field providing direction on clearance activities. • Failure to recognize the risk associated with V-90 as a purge driver and purging into an obstruction. ☒ **Inadequate monitoring/backup** • Clearance planning should have identified V-90 as inappropriate purge inlet pressure / driving pressure control location. Purge location, and plan to remove six-inch blind flange on V-78 is not clear if it was part of the clearance planning. Failure to provide enough gas rangers to accurately monitor the purge into service in a timely fashion. • TPCO versus GPOM conflict of interest in certain areas, regions, or districts. For example, clearance supervisor assignment.
N/A ☒ **Fitness for Duty –** Refers to activities performed off the job that influence an individual's ability to perform their work safely	
☐ **Poor dietary/health practices –** consuming too much alcohol, not maintaining weight/health, too little exercise ☐ **Failure to get adequate rest –** working a second job, limiting sleep, overexertion	☐ **Poor dietary/health practices** ☐ **Failure to get adequate rest**
SUPERVISORY FACTORS	
N/A ☐ **Inadequate Supervision –** Refers to the performance of basic supervisory activities	
☒ **Failure to provide adequate guidance –** inadequate mentoring/coaching, failure to communicate policies, procedures, performance expectations ☒ **Failed to provide adequate oversight** – inadequate monitoring of work activities, lack of presence within the work environment, failure to stay engaged with the workforce ☒ **Failed to provide adequate training –** inadequate instruction/education, failure to ensure staff qualifications, currency, and training	☒ **Failure to provide adequate guidance:** • For clearance supervisor and GPOM/TPCO supervisors, inadequate guidance provided on GDS A-38 with respect to purge driving (fine-throttling), safety of purge vents, understanding of hazards/potential ignition sources. • Multiple people directing work during clearance activities other than the clearance supervisor. ☒ **Failed to provide adequate oversight:** • To comply with GDS A-38 a gauge must be installed on the purge-side of V-90 to ensure the proper purge driving pressure of 1 psig was maintained which was not completed. • Inadequate oversight of purge sampling operation at V-78. • Difficult to access valve handwheel and blind flange could have been addressed with adequate scaffolding or other access measures. • Inability of supervisory personnel to properly identify hazards and risks to employees on jobsite, may not receive adequate support to oversee safety aspect of the work but focus on execution. ☒ **Failed to provide adequate training:** • Inadequate training on purge operation overall. Includes all coworkers in GPOM, TPCO, and Gas Construction. Existing qualification is written only, open book, without a hands-on portion. GAS-1102WBT "Safely Executing Clearances & Tie-Ins" discusses items related but is not profiled. • Gas-9658 "Gas Clearances" contains details on purging at an introductory level (at present this is at discretion of supervisors training available but not required) for all executors, writers, and endorsers. All Gas Control Apprentices are expected to take this course.
N/A ☐ **Planned Inappropriate Operations –** Refers how staff and work activities are managed	
☒ **Inadequate staffing/scheduling –** failure to ensure enough staff are available, requiring staff to work excessive overtime or unreasonable shift rotations ☒ **Inadequate workload assignment** – failure to match staff competency with tasks, assigning unreasonable workload or tempo	☒ **Inadequate staffing/scheduling:** • Multiple handoffs between TPCO and GPOM. Initial CS went on vacation replacement CS took over week before S-1391 start date. Kettleman local M&C Coordinator attended most project meetings. • Clearance changed mid June. • Clearance supervisor swap week prior between TPCO and GPOM. TPCO had been attending coordination meetings, GPOM was under assumption TPCO would be CS. ☒ **Inadequate workload assignment:** • Control tech operating V-90 did not have had prior experience using pneumatic valve for purging. • Response to AOC (throttling V-90 using pneumatic three-way valve for purging). • Supervision did not assess or monitor proficiency of coworkers based on lack of identifying purge configuration issues. • Clearance writer changed over the course of the project. • Clearance writer competency; missed 12" manual valve C & D.
N/A ☐ **Failure to Correct Known Problems –** Refers to the correction of known deficiencies by the supervisor	
☒ **Failed to correct inappropriate behavior –** not enforcing the rules, failure to address suboptimal performance, failure	☒ **Failed to correct inappropriate behavior:** • Quality of pre-job brief / JSSA don't meet the intent. Specific hazards of purging gas and potential explosive atmosphere were not identified.

to resolve staff conflicts ☐ **Failed to correct workplace problems** – failure to adequately maintain/repair equipment, failure to review and revise policies/procedures	• A-38 not reviewed or used to purge per Clearance. • Rolled up sleeves/FR PPE. • The clearance document revision process was not followed when substantive changes were made mid process. (V-78 flange removal and V-56 closure) ☐ **Failed to correct workplace problems:**
N/A ☒ **Supervisory Violations –** Refers to supervisor's intentional disregard for rules	
☐ **Authorizing noncompliance–** instructing staff to circumvent procedures, requiring staff to engage in unsafe practices ☐ **Supervisor noncompliance** – performing supervisory activities that intentionally break the rules, such as falsifying records	☐ **Authorizing noncompliance** ☐ **Supervisor noncompliance**
ORGANIZATIONAL INFLUENCES	
N/A ☐ **Organizational Culture –** Priority placed on safety relative to organizational goals/initiatives	

☒ **Values –** revenue generation supersedes safety, limited recognition/rewards for safety performance or for reporting safety hazards
 	
☒ **Commitment** – compliance with safety regulations is primary goal, proactive safety initiatives received minimal support
 	
☒ **Transparency –** adverse events are concealed, lessons learned from mistakes are not shared throughout the organization
	☒ **Values:**
	• Lack of focus on protection of the worker facilitated a culture that failed to recognize the risk associated with several repeated significant events. In addition, their corrective actions (while strong at the time of issuance) were not effectively implemented. Here is a listing of similar purge, blowdown, or hazardous energy control related events:
	  ○ PLS 3 SIF-P Ignition Event (2017; CAP# 113072120),
	  ○ Central Coast Purge Gas Outage (2017; CAP#113756539)
	  ○ Folsom BD Stack SIF (2017; CAP#112633748)
	  ○ Calistoga Pigging SIF (April 29th, 2022; CAP# 123493078), which identified related issues with hazard recognition and risk assessment as well as skill gaps with field personnel. Refer to Root Cause -1: Hazards and risks of performing out-of-service pigging were not properly identified and mitigated when planning, preparing, and executing work.
	  ○ Marina Purge SIF (April 16th, 2022; CAP# 123433871)
	• PG&E training and OQ programs for gas coworkers do not adequately prepare gas coworkers to fully understand high-energy hazards and mitigations for those hazards (GDS A-38, Purging and Air Mover OQs). Focus is on skill development not on real-world or site-specific high-energy hazards. Consequently, by not including physical demonstration of concepts such as ignition of flammable gas-in-air mixtures or providing lasting appreciation for the hazards present during purging/blowdown operations. As a result, purging/blowdown activities continue with risks at play.
	• Organizational reliance on tribal knowledge and past experience resulting in risky behavior without recognitions of these conditions. Exemplified by V-90 selection, removal of V-78 blind flange and positioning of V-56.
	☒ **Commitment:**
	• Significant proactive changes after near-hits and SIF-potential incidents, such as the PLS-3 Blowdown Ignition SIF-P in 2017, were not successfully committed to by the organization to prevent the Kettleman Purge Ignition SIF. Despite regulatory scrutiny and a coworker fatality in 2022, further proactive changes to protect coworkers were not made.
	• Competing priorities related to CARB greenhouse gas emissions, limited flexibility to do multiple clearances/blowdowns of gas to atmosphere to protect the environment and comply with CARB regulations.
	☒ **Transparency:**
	• Lessons learned from the operating experience above were not effectively shared to the line until a later date. The lessons of PLS-3 were not readily shared or understood by functional areas impacted. In many instances, lessons from previous SIF events are not sustained via continuous learning.
	• Organization's lower value mandated training, such as Office Hazard Waste Management, has taken priority over higher value training on relevant Operating Experience related to significant incidents such as fatalities and associated learnings that have occurred at PG&E; inadequate commitment toward being a "learning organization."

N/A ☐ **Operational Process –** Refers to how an organization plans to achieve its objective	
☒ **Strategic planning –** conflicting priorities, competing initiatives, unrealistic objectives ☒ **Policies / Procedures** – conflicting or ambiguous policies, limited development or dissemination of procedural guidance ☒ **Corporate oversight –** lack of	☒ **Strategic planning:** • Ineffective communication of lessons learned from prior Operating Experience (OE) such as the PLS-3 Blowdown Ignition SIF-P (CAP# 113072120) in 2017. • Sequencing and coordination of project clearances impacted the ability to select an appropriate purge inlet control valve. • Conflicting expectations in the Project Delivery System (PDS) between Engineering, Project Management, and GSOM/Gas Construction teams related to clearance planning. Roles and responsibilities related to clearance planning/clearance endorsement, including design, materials, etc. required for blowdown and purging operations, are not clearly defined and

leadership engagement or appreciation of risks	organized to ensure safe execution of the project objective. • Competing priorities related to project completion and CARB greenhouse gas emissions, limited flexibility to do multiple clearances/blowdowns of gas to atmosphere to protect the environment and comply with CARB regulations. ☒ **Policies / Procedures:** • Information in GDS A-38 is adequate, however it is not well known, disseminated, or understood by coworkers performing the work. Changes were made to A-38, but were not understood by the functional areas. • Cause of PLS3 Incident (CAP # 113072120) and its corrective action "Eliminate Horizontal Purging" were not effectively implemented. • See above related to project delivery system (PDS) expectations and roles/responsibilities between engineering, GSOM, and construction teams. • Management of Change (MOC) requirements for clearances may not be rigorous enough to catch safety risks created from the change. • Lack of specificity and guidance between blowing down and purging gas. While these activities are similar in nature there are distinct differences with the forces that can be generated while blowing down from high pressure vs. the hazardous atmosphere risk created while purging with low drive pressures. ☒ **Corporate oversight:** • Less than adequate field safety engagements, lack of coaching and implementing safety in the field.
N/A ☐ **Resource Management –** Refers to the support provided to accomplish the objectives of the organization	
☒ **Human resources –** poor practices associated with recruiting and retaining personnel ☒ **Equipment / Facility resources** – limited acquisition of necessary equipment/technology ☒ **Monetary resources –** budgetary constraints, excessive cost cutting, unfunded mandates	☒ **Human resources:** • Turnover within Gas organization, including, technicians, frontline supervisors and senior leadership, are organizational concerns. • Institutional knowledge transfer between experienced personnel and incoming personnel is not prioritized by the organization. Gas control tech throttling V-90 for purge operations did not have experience performing that operation. • Multiple handoffs between TPCO and GPOM during the clearance planning process and execution of the clearance work. Original Clearance Supervisor (TPCO) handed over to new Clearance Supervisor (GPOM) due to a vacation but had not attended the clearance planning meetings. Kettleman coordinator attended most of the clearance planning meetings for Kettleman District GPOM. ☒ **Equipment / Facility resources:** • Equipment to fabricate proper purge and blowdown vent stacks are not prioritized by engineering during design and clearance planning. Purge stands are now available (refer to GDS A-38-JA01) as a result of the Marina SIF mentioned above but may require modification to meet the needs of higher-pressure / larger diameter pipeline purge operations. ☒ **Monetary resources** • Monetary resources have been identified as a challenge when attempting to update/modernize PG&E Learning Academy training courses. • Continual churn around project execution due to re-prioritization and budget challenges results in unclear project timelines. This results in changing personnel with varying levels of knowledge around the subject project. • Staffing levels in the GPOM organization require workers to support critical maintenance work as well as project work resulting in inconsistent support and knowledge around project details, scope and current milestone.

14.9 Appendix I: Drone Footage Overlay Diagrams

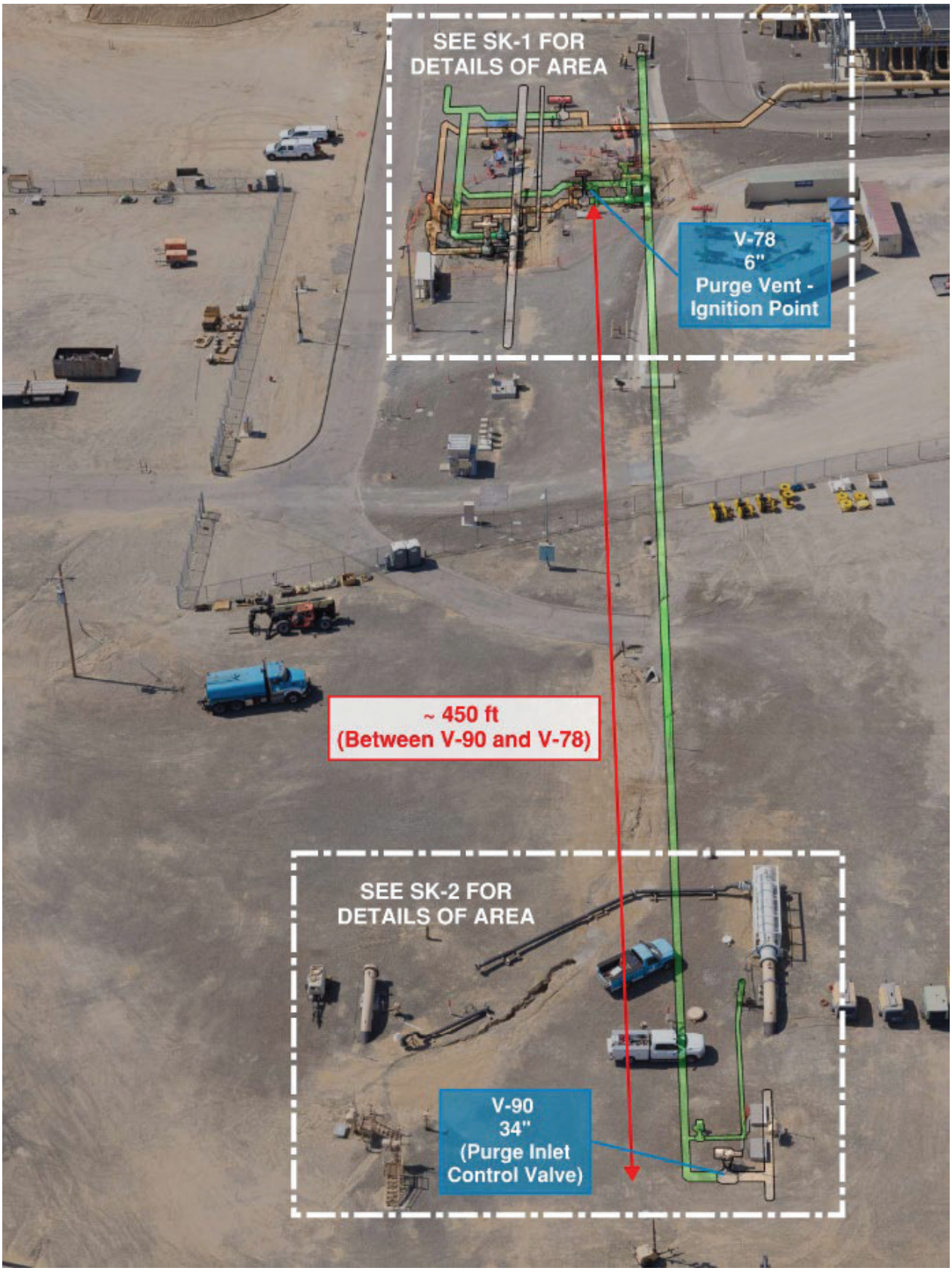
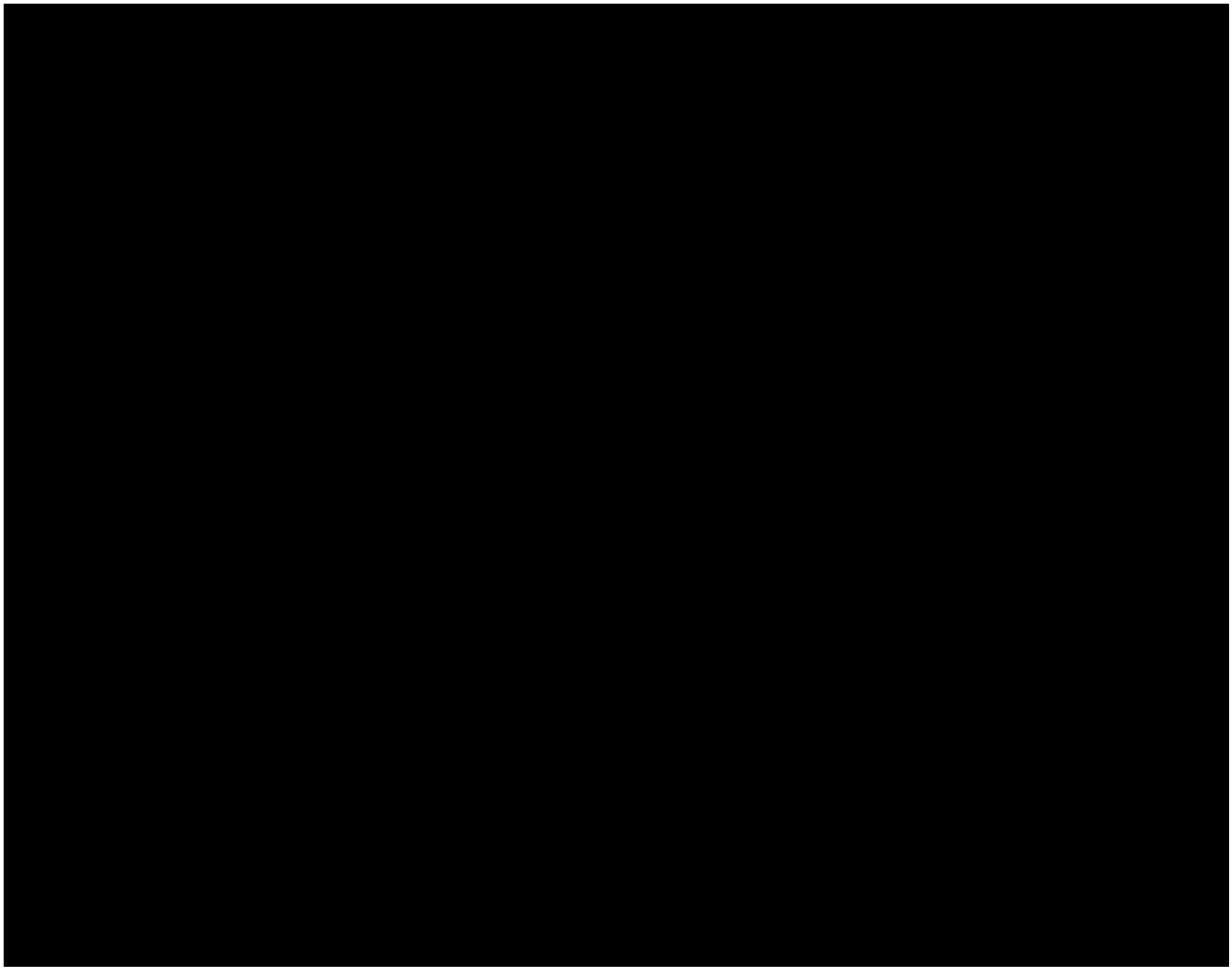
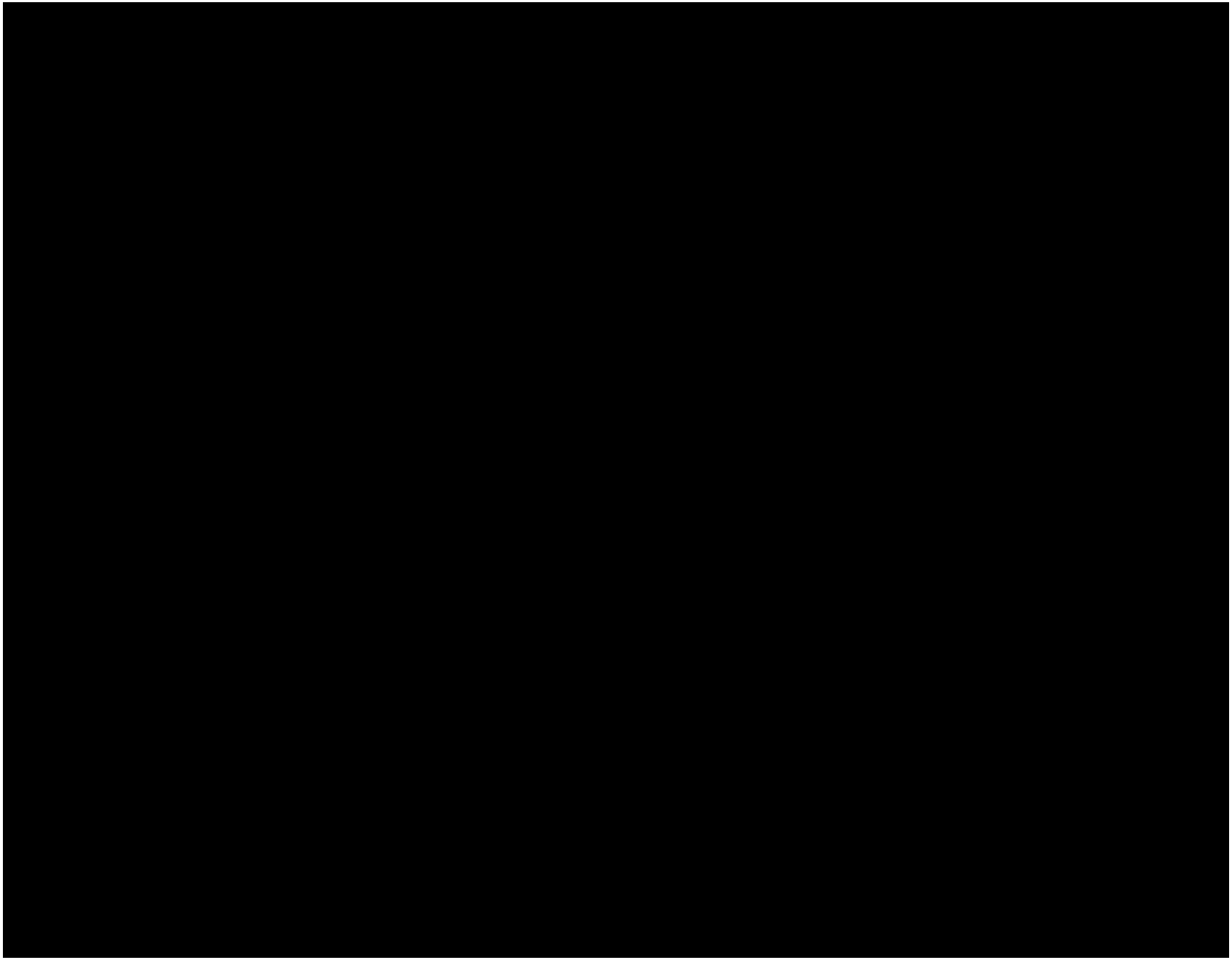


Figure 45: Drone Footage Overlay Diagrams

Figure 46: Drone Footage Overlay Diagrams

Figure 47: Drone Footage Overlay Diagrams





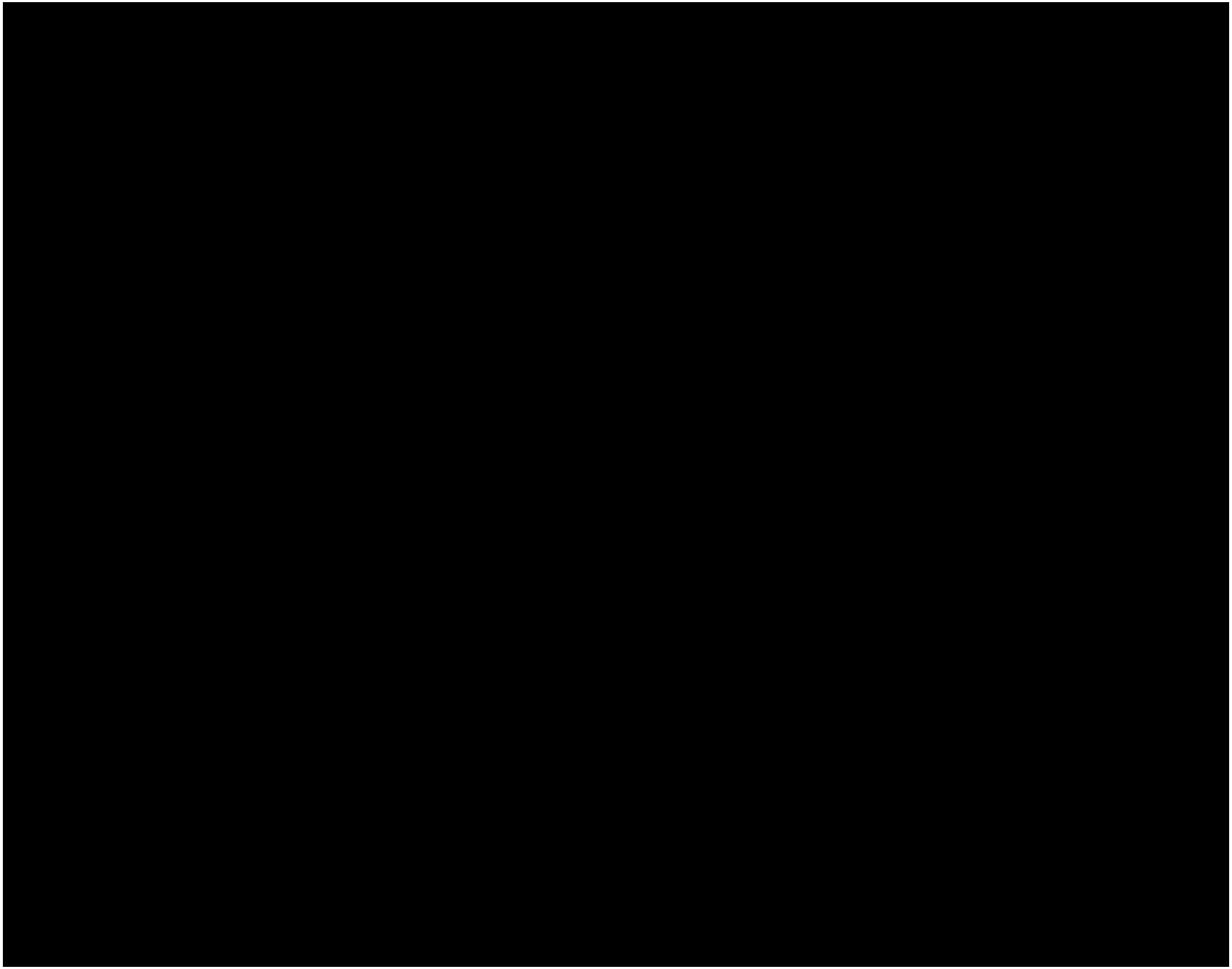


Figure 51: Drone Footage Overlay Diagrams

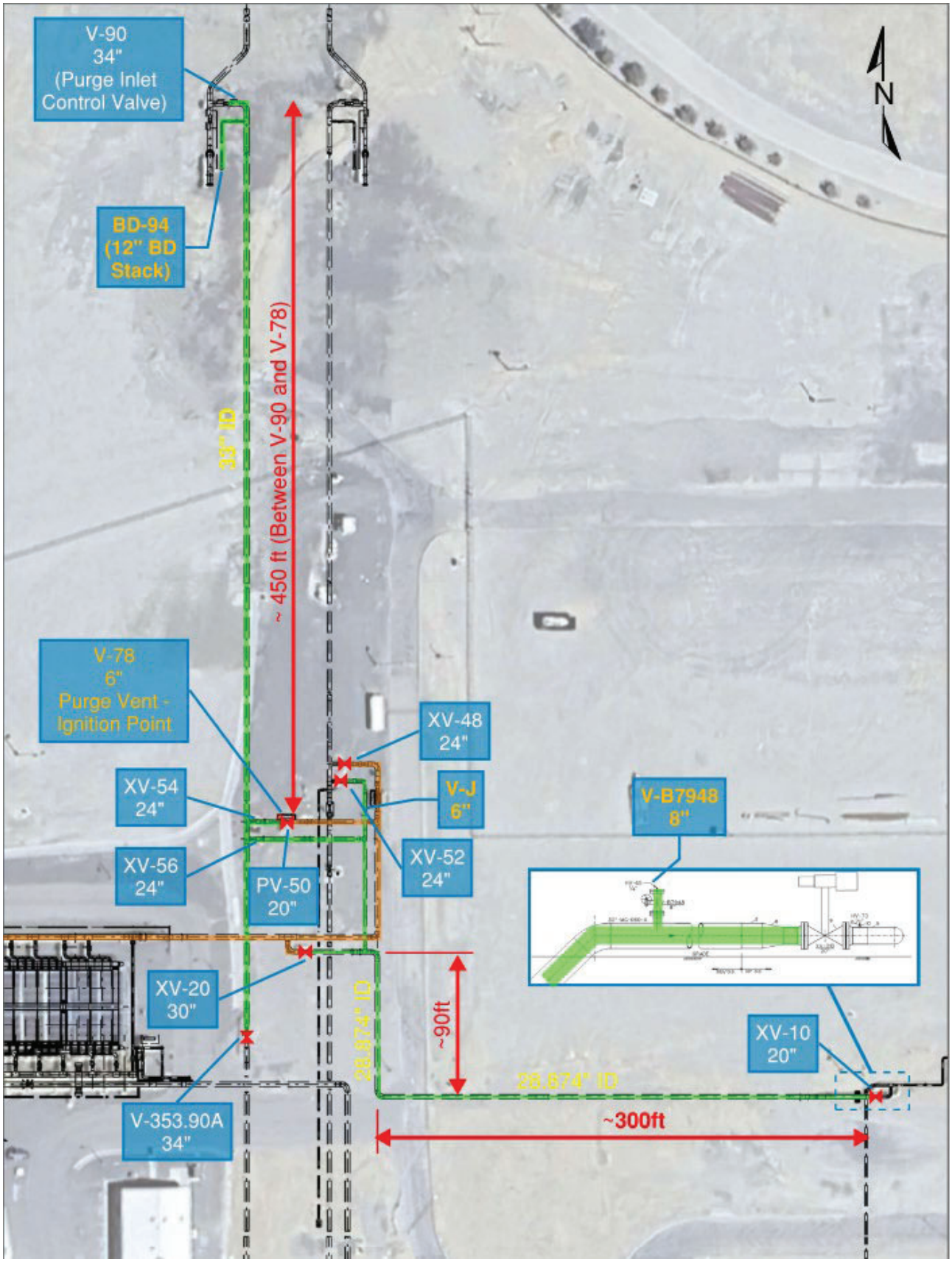


Figure 52: Drone Footage Overlay Diagrams

14.10 Appendix J: Historical Timeline of Clearance Program

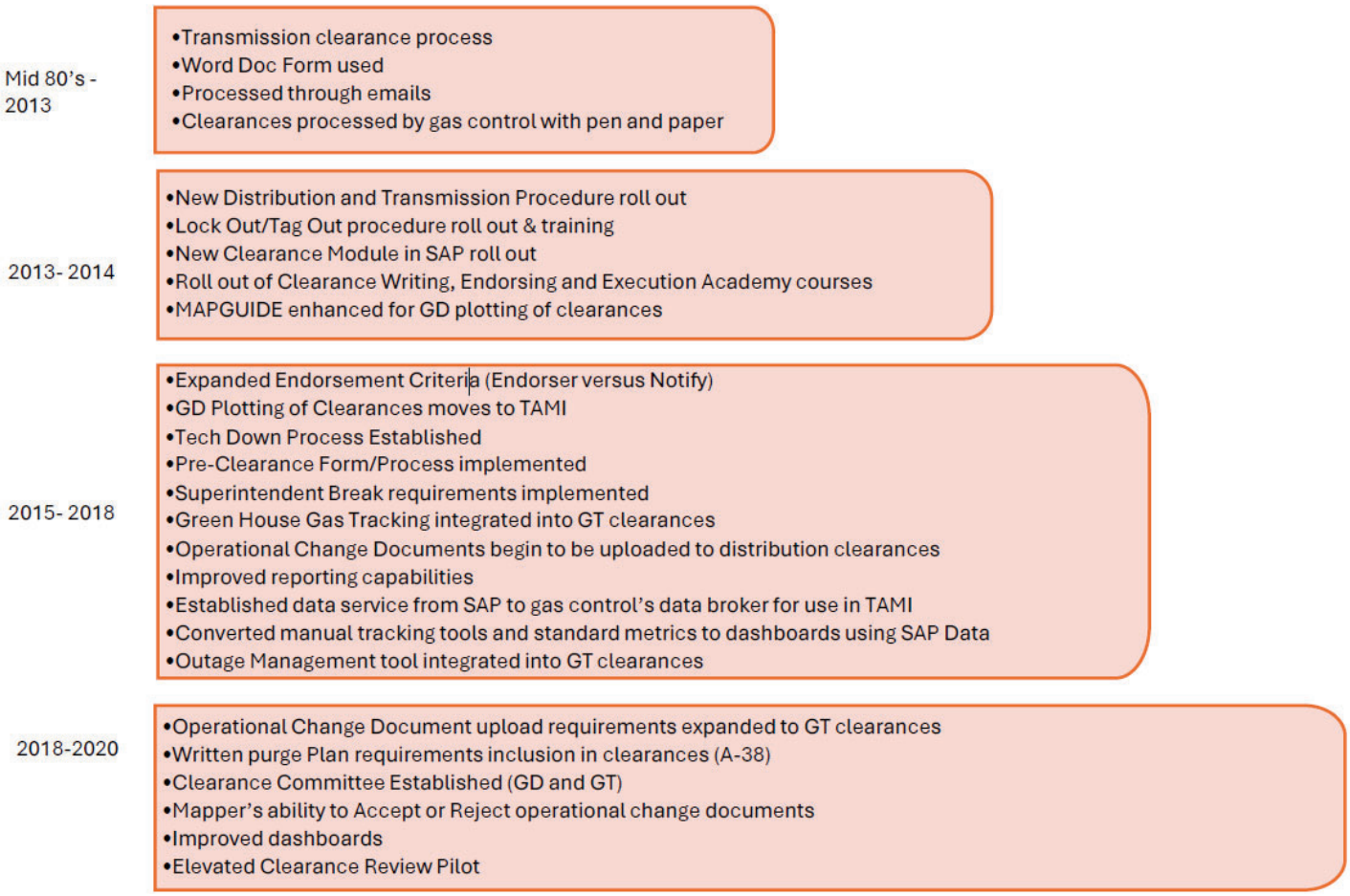


Figure 53: Historical Timeline of Clearance Program

14.11 **Appendix K: Coworker PPE**

Figure 54: Injured Coworker FR Shirt

Figure 55: Injured Coworker FR Shirt

Figure 56: Injured Coworker FR Shirt and Safety Vest (Back)

Injured Coworker FR Shirt and Safety Vest (Front)

Figure 57: Injured Coworker FR Shirt and Safety Vest (Front)

Figure 58: Second Injured Coworker Safety Vest