CALIFORNIA PUBLIC UTILITIES COMMISSION
Safety and Enforcement Division
Gas Safety and Reliability Branch

Incident Investigation Report

Report Date: 4/5/2017

Incident Number: Courtesy Notification

Utility: Pacific Gas and Electric (PG&E)

Date and Time of the Incident: 12/27/2015, approximately, 0930 hours

Location of the Incident: Discovery Bay and Byron System

Summary of Incident:

The California Public Utilities Commission (CPUC) was informed by PG&E on 12/27/2015 through a courtesy notification about the loss of gas service to the customers in the Discovery Bay/Byron system; a total of 5,892 customers were affected. CPUC followed up on this incident and PG&E reported restoration of service to 90% of the customers by 12/29/2015. The rest were not available at home and PG&E restored service to these customers at a later date.

Before the incident, PG&E observed the pressure drop via Supervisory Control and Data Acquisition (SCADA). Operations personnel responding to the call from Gas Distribution Control Center (GDCC) observed that the district regulating station was frosted over and that the pressure was erratic. The primary and standby pressure regulating runs were unable to maintain a steady downstream pressure. To ensure the safety of downstream customers, the district regulation station was isolated, resulting in the loss of gas supply to customers in the Discovery Bay and Byron communities. PG&E inspected and replaced, as needed, regulator station components at the Bixler Road regulator station. Subsequent to this work, the regulator station was put back into service.

PG&E's investigation revealed that the valve, V-35 at Whisky Slough Station (WSS) with normal position 'close' during the withdrawal remained in the open position from 0700 on 12/26/15 until 0300 on 12/27/15. This resulted in sending un-dehydrated gas to the system through Line 57B and to the Bixler regulator station. As a result of the wet gas in Line 57B, the cold temperatures, and the large pressure cut at the district regulation station within the Bixler Road pressure limited station (PLS), hydrates were formed in the pilots of the Mooney regulators and working monitors, causing erratic

pressure control at this station. This required PG&E to shut down the regulator station for safety purposes, which resulted in the loss of gas to the customers.

PG&E's 'Root Cause Evaluation Report' does not provide a definite conclusion on how the valve remained open during this time. There were two clearance jobs performed on 9/30/2015 and 11/13/2015, it appears that these did not contribute towards the incident. In addition, a 'well rework' project was carried out from December 21-24, 2015. During the rework project, valve V-35 was opened for reinjection. It is likely that the valve was left open during this period during which wet gas entered into the Bixler system and caused the incident.

PG&E's Whisky Slough Station Operating Procedure Section 3.0 Station Withdrawal (080661) requires that the position of valve, V-35 must be checked to make sure that it is closed. PG&E failed to do so and hence is in non-compliance for not following its own operational procedure.

Casualities: Fatalities: 0 Injuries: 0

Property Damage: None

Utility Facility Involved: Bixler Regulating station

SED Staff:

	Name	*Title*	*Phone*
1.	Sikandar Khatri	Senior Utilities Engineer	415-703-2565
2.	…		

Witness:

PG&E employees providing the information including those present during the meeting on 2/28/2017 (# 1- 6 were in meeting) are:

1. Stephen Ramos – Gas Engineer, Regulatory Compliance
2. Terry White – Director, Facility Integrity Management (FIMP)
3. Sherkan Eshraghi – Gas FIMP Engineer
4. Steve Brian Bautista – Compliance Specialist
5. Mike McFarling - Supervisor, Gas T&D Pipeline Operations & Maintenance (on phone)
6. Pedro Torres - Supervisor, Gas T&D Pipeline Operations and Maintenance (on phone)
7. Jonathan Lo, Gas FIMP Engineer

8. Matthew Pace, Supervisor, Gas Measurement & Control
9. Kimberley Corona, Quality Operations Specialist, Expert
10. Katie Calais, Process Safety Engineer
11. Bennie Barnes , Chief Engineer - Transmission Integrity Management
12. Laurence Deniston, Gas Regulatory Compliance (retired)

Evidence:

Source	***Description***
1 PG&E	Courtesy Notification
2 PG&E	Email correspondence and discussion
3 PG&E	Records received
4 PG&E	Root Cause Evaluation Report

Observations and Findings:

The un-dehydrated gas from the well at Whisky Slough Station (WSS) at McDonald Island (MDI) entered into the system. Due to moisture in gas, weather conditions and pressure drop at Bixler regulating station, hydrates were formed at the regulating station. This resulted in erratic pressure conditions and loss of pressure as observed by SCADA control. PG&E shut down the station for safety reasons, and in the process 5,892 customers in the Discovery Bay and Byron areas lost the service.

PG&E did the required work at the Bixler regulation station and put it back in the service. The customers were relighted.

Based on the available information, following observations were made:

(1) A valve, V-35, at the Whisky Slough Station (WSS) that under normal conditions during withdrawal remains close was found to be open. This allowed wet gas from the well to flow in the system bypassing the dehydration process.

(2) Due to low temperatures and large pressure cut at the regulator station, this resulted in formation of hydrates at Bixler regulating station, resulting in the incident.

(3) The system was not capable of handling the unexpected situation.

It was noticed that two clearance work projects were carried out on 9/30/2015 and 11/13/2015 which involved operation of valve, V-35. However, these were performed well before the incident. In addition, a well rework project was carried out from December 21-24, 2015 which occurred close to the date when this event happened.

Well rework operation is performed routinely on gas storage wells to replace malfunctioning downhole safety valves (DHSV) and evaluate production casing conditions; well rework helps to maintain well injection and withdraw performance to meet customer demands for pipeline system operations. During this rework project, due to low demand, the Gas Transmission Control Center (GTCC) requested the MDI Operators that all gas withdrawn from the rework well be re-injected back into the gas storage system, an operation that would require V-35 to be open. During this re-injection operation, V-35 would have been open in order to send the gas back into the storage wells. It should have been closed when the field was set up for withdrawal operations on December 24, 2015. There is no check list or other information available for the process during this operation. It is likely that the valve was left open at that time which is also indicated by the events analysis carried out by PG&E. It is for this reason that since the valve was open during the withdrawal operation as opposed to being closed as required, wet gas entered into the Bixler system and caused the incident.

In addition, the root cause analysis performed by PG&E found that:

(1) Moisture analyzer at the Bixler station had scaling error and therefore there was a mismatch between the actual readings taken by the moisture analyzer at the station and the values seen by GTCC.

(2) The asset and risk management practices at PG&E's did not adequately consider the risks posed by liquid or moisture intrusion into the gas system.

(3) The operating procedure manual at WSS was found not to have clear step-by-step instructions. For example, the manual did have instructions on checking that valve, V-35 is closed, but detailed instructions were not available such as to do manual check or otherwise.

(4) During the Investigation, PG&E team found that enough alarms and controls were not present for automatic control of valve positions and for GTCC visibility of the conditions at the site.

(5) During the Investigation, PG&E team found that operators at McDonald Island complained about the requested corrective actions not being addressed in a timely manner.

(6) During the investigations, MDI operators raised concerns about the controls and indications provided in the WSS control room. One example is that PG&E investigation team on 1/20/16 found that 11 of 15 valve status indication lights on the WSS Plant Mimic Board were not working. Specifically the status indication light for V-35 was not working.

(7) The level of training for the staff at McDonald station was not at par with the controllers in the main control room at PG&E's Gas Control Room in San Ramon.

PG&E's Root Cause Analysis:

A team consisting of PG&E staff and contractors (Southwest Research and Exponent) collected the information regarding events leading to the incident and analyzed the situation to determine the causes. Following was identified:

Root Cause 1:

PG&E's asset and risk management practices did not adequately consider the risks associated with liquid or moisture intrusion into the gas system.

Root Cause 2:

An ineffective corrective maintenance system at McDonald Island (MDI) led Whiskey Slough Station (WSS) operators to distrust the controls systems and to accept a normalization of deviation.

Root Cause 3:

Current control room practices at Whisky Slough Station were not sufficient for a facility which has this level of complexity and risk.

Corrective Actions Identified by PG&E:

Based on the Root Cause Analysis, PG&E has identified following corrective actions which are planned to take place during 2016-2021.

(a) Root Cause 1:

CA1 – Complete assessment and revise liquid management program as necessary to support site specific requirements. Include analysis of moisture analyzer locations, database of moisture/liquids locations, actions to be taken when liquids/moisture are found, as well as predictions of locations that might have moisture/liquids intrusion into the system.

CA2 – Complete a design Failure Modes and Effect Analysis (FMEA) for Design Standard H-14; per the results update H-14 accordingly.

CA3 – Review and revise as needed the Regulation Station Design Manual ensuring it addresses the risk of excessive moisture/liquid in the system.

CA4 – Utilize process safety methodology to evaluate the level of protection and control at WSS based on the risk posed by operating the facility; per the results, update as

necessary to address the findings. Include an evaluation of V-35 (i.e. the need for out of position alarms and indications) and other key routing of valves at this station.

CA5 – Make temporary ERX for DFM a permanent installation with communication to SCADA.

CA6 – Make temporary moisture analyzer at WSS a permanent installation with communication to SCADA.

(b) ***Root Cause 2:***

CA7 – Identify, prioritize and complete all open high risk corrective work for control systems at Whisky Slough Station. Identify and complete other high risk issues that have not been entered in our corrective maintenance system.

CA8 – Implement a prioritization system for transmission corrective work (i.e. a work and compliance matrix).

(c) ***Root Cause 3*:**

CA9 – Review, and update on-going operator training as necessary for station operators at MDI. Include system, alarm response training and refresher training.

CA10 – Determine the scope of implementing select Control Room Practices (CRM) principles at manned facilities. Implement based on leadership guidance.

CA11 – Revise and update operation procedures and develop addition tools (i.e. develop a check list) for critical operations.

Preliminary Statement of Pertinent General Order, Public Utilities Code Requirements, and /or Federal Requirements:

Title 49, Federal Code of Regulations, §192.605(a) states:

General. Each operator shall prepare and follow for each pipeline, a manual of written procedures for conducting operations and maintenance activities and for emergency response. For transmission lines, the manual must also include procedures for handling abnormal operations. This manual must be reviewed and updated by the operator at intervals not exceeding 15 months, but at least once each calendar year. This manual must be prepared before operations of a pipeline system commence. Appropriate parts of the manual must be kept at locations where operations and maintenance activities are conducted."

PG&E's Root Cause Evaluation report states that:

"*Upon examination of the Operating Procedures for WSS, the Whisky Slough Station Operating Procedure Section 3.0 Station Withdrawal (080661) does include a step to "CHECK CLOSE Station Block Valve, V-35." However, the Operating Procedure does not include further details on how to check close the valve (i.e. check close using Cimplicity, the Plant Mimic Board, or field verification)"*

It is evident that the PG&E's operating procedure requires that the position of the station block valve, V-35 must be checked to make sure that it is closed. PG&E failed to check the position of valve, and hence failed to comply with its operational procedure.

Conclusion:

The incident took place due to entry of wet gas into the system and caused formation of hydrates at Bixler station. The station was shut down due to safety reasons, and thus resulted in loss of gas to the customers.

From the information available, it appears that the valve V-35 which caused entry of wet gas into the system was open during the withdrawal whereas it is required to be closed to let the gas pass through dehydration process before it enters the system. It is likely that it was left open during the well rework project carried out prior to this event and thus resulting in the incident.

PG&E failed to check that valve V-35 is closed as required by PG&E's Whisky Slough Station Operating Procedure Section 3.0 Station Withdrawal (080661). Hence, PG&E is in non-compliance for not following its own operational procedure.

Follow-up on the Corrective Actions and Recommendations:

SED is in contact with PG&E to follow-up on the identified corrective actions and recommendations. The responses received regarding corrective actions in October 2016, 1/17/2017 and 3/17/2017 are presented in table below:

Corrective Action ID	Root Cause 1	
	Description	**Update**
1	Complete assessment and revise liquid management program as necessary to support site specific requirements. Include analysis of moisture analyzer locations, monitor feedback and actions to be taken when liquids/moisture are found, as well as, predictions of locations where risk from moisture/liquids intrusion into the system is high.	PG&E is currently reviewing the existing moisture analyzer system for: • Appropriateness of locations. • Actions to be taken when high moisture readings are identified or initiate an alarm. • Enhancement of existing tools for display of current moisture conditions and threats to the gas system operations. <u>Update on 3/17/2017:</u> PG&E has completed its assessment of the system to determine areas of elevated risk for liquids and/or moisture, as well as the review of appropriateness of current moisture analyzer locations and identification of potential gaps. PG&E is continuing the review of its existing moisture analyzer system for potential enhancements in response to identified moisture conditions and threats to gas system operations. Existing PG&E Utility Procedure TD-4580P-07, "Gas Quality Monitoring and Response," provides direction on the response to gas quality events or emergencies on the PG&E gas transmission system.
2	Complete a design Failure Modes and Effect Analysis (FMEA) for Design Standard H-14; per the results update H-14 accordingly.	PG&E is compiling this information and will provide it as soon as it becomes available. <u>Update as of 1/17/2017</u>: In consultation with the Process Safety team, it was determined that a Process Hazard Analysis (PHA) was the more appropriate technique, which was

		completed in December 2016. Accordingly, PG&E design standard H-14 is scheduled to be revised in Q3 2017 and will incorporate the results of the PHA.
3	Review and revise as needed the Regulation Station Design Manual ensuring it addresses the risk of excessive moisture/liquid in the system.	PG&E is on track for delivering the revisions (as needed) to the Regulation Station Design Manual in 2017.
4	Utilize process safety methodology to evaluate the level of protection and control at WSS based on the risk posed by operating the facility; per the results, update as necessary to address the findings. Include an evaluation of V-35 (i.e. the need for out of position alarms and indications) and other key routing of valves at this station.	PG&E's Process Safety team, responsible for integrating process safety principles into company processes, has been engaged to evaluate the approach and develop a plan of action to analyze the level of protection and control at Whisky Slough Station (WSS). Additionally, a consultant has been engaged to assess the electronic control systems in use at the McDonald Island (MDI) facilities. <u>Update on 3/17/2017:</u> The Process Hazard Analysis (PHA) for Whisky Slough Station (WSS) has been completed, and the report and recommendations are being finalized. The pending final report from the WSS PHA will be an input to the assessment of electronic control systems used at the McDonald Island (MDI) facilities.
5	Make temporary ERX for DFM a permanent installation with communication to SCADA	A temporary Electronic Pressure Recorder (ERX) is currently in place, which provides communication to SCADA for the DFM's operating conditions. A project for a permanent installation is currently in development.
6	Make temporary moisture analyzer at WSS a permanent	A project to install a permanent moisture analyzer at Whisky Slough

	installation with communication to SCADA	Station (WSS) has been approved for execution. <u>Update as of 1-17-2017:</u> A project to install a moisture analyzer at Turner Cut Station (TCS) and Whisky Slough Station (WSS) is scheduled for 2017. Please note PG&E completed installation of a temporary moisture analyzer at the Master Meter to McDonald Island in November 2016. The temporary moisture analyzer is fully functional with Station and Gas Control alarms in place.
	Root Cause 2	
	Description	**Update**
7	Identify, prioritize and complete all open high risk corrective work for control systems at Whisky Slough Station. Identify and complete other high risk issues that have not been entered in our corrective maintenance system.	A review of high risk corrective items was performed at Whisky Slough Station (WSS) and resolved, as necessary. Additionally, a department-wide survey was distributed to determine any additional potential high risk items. PG&E has received the survey results and is currently analyzing the results and findings. The analysis results and any findings will be submitted into PG&E's corrective action program for tracking and resolution, as appropriate.
8	Implement a prioritization system for transmission corrective work (i.e. a work and compliance matrix).	PG&E is compiling this information and will provide it as soon as it becomes available.

	Root Cause 3	
	Description	**Update**
9	Determine the scope of implementing select Control Room Practices (CRM) principles at manned facilities. Implement based on leadership guidance.	PG&E is compiling this information and will provide it as soon as it becomes available. <u>Update as of 1-17-2017:</u> PG&E's Gas Control Strategy and Support (GCS&S) team is working to identify process improvements for McDonald Island Storage Facility, Los Medanos Storage Facility, Hinkley Compressor Station, and Topock Compressor Station. GCS&S engaged Human Centered Solutions (HCS), an industry expert that specializes in analyzing work processes, behaviors and providing recommendations for improvement, to develop best practices for the above-mentioned manned facilities. As a result of this effort, PG&E has identified best practices which include a shift-change process, change management, fatigue mitigation, and training; PG&E has developed a schedule to implement such changes, beginning with the storage facilities.
10	Review, and update on-going operator training as necessary for station operators at MDI. Include system, alarm response training and refresher training.	In collaboration with a third-party consultant, a control room management evaluation was performed. The results of the evaluation are being reviewed and a comprehensive plan is being formulated, which includes (but is not limited to) alarm response and training.
11	Revise and update operation procedures and develop addition	PG&E is currently developing a revised approach for operating

	tools (i.e. develop a check list) for critical operations.	procedures in complex facilities. Update on 3/17/2017: PG&E is in the process of validating and updating existing McDonald Island Compressor Station operating procedures and is scheduled to be complete by the end of Q1 2017. The operating procedures for WSS and Turner Cut Station (TCS) are targeted for completion by the end of 2017. Concurrently, PG&E is updating its standards and procedures to provide additional clarification on the creation of operating procedures for its storage facilities and manned compressor stations.

Recommendation Number	Extent Evaluation: Extent of Condition	
	Description	**Update**
1	Implement a program for routine pigging downstream of high risk potential sources or known intrusion of liquid in the system.	PG&E is compiling this information and will provide it as soon as it becomes available. <u>Update on 3/17/2017:</u> During the month of November 2016, PG&E's In-Line Inspection (ILI) team met with an ILI vendor who specializes in tools designed for pipeline cleaning and liquids removal, to discuss the current and future needs of PG&E's "operational pigging" program; this program will be centered around removing liquids from any portions of the pipeline system that have a potential for accumulating liquids. PG&E plans to have the program defined as early as Q3 of 2017 with implementation by Q4 of 2017.
2	Identify locations for immediate installation of heaters, based on increased likelihood of liquids or moisture.	A study is planned to identify high priority locations for heater installations to prevent moisture problems from affecting equipment operation. <u>Update on 3/17/2017:</u> Based on PG&E's identification of areas of elevated risk for moisture and/or liquids (see Corrective Action ID 1), a program to deploy mitigation measures to high priority locations is under development.
3	Using the results of CA1, install moisture monitoring strategically throughout the system and consider analyzer redundancy, and perform manual moisture readings as a short-term barrier.	A long-term system moisture analyzer enhancement plan will be developed based on the new moisture risk assessment tool. As a short term barrier, stain tubes, used to perform manual moisture readings, are planned

		for periodic use in critical locations where a permanent installation is needed. PG&E has engaged a consultant to review the current short-term plan. Update on 3/17/2017: A proposed long term moisture analyzer enhancement plan is currently undergoing internal subject matter expert review prior to being finalized. Based on PG&E's identification of areas of elevated risk for moisture and/or liquids (see Corrective Action ID 1), a manual moisture reading program for deployment in critical locations pending permanent moisture analyzer installation is under development.
4	Confirm that other moisture analyzers within the system are scaled and calibrated properly.	PG&E is compiling this information and will provide it as soon as it becomes available. Update as of 1-17-2017: PG&E completed verification that the moisture analyzers within the system are scaled and calibrated properly in August 2016 Update on 3/17/2017: The scaling and calibration of existing moisture analyzers within the system is complete.
5	Complete a design review of moisture analyzer installations to ensure adequacy.	Please see update to Extent of Condition Recommendation Number 3. Update on 3/17/2017: Please see update to Extent of Cause Recommendation Number 3.

Recommendation Number	Extent Evaluation: Extent of Cause	
	Description	**Update**
1	Consider completing a design FMEA for other design standards. (RC1)	PG&E is compiling this information and will provide it as soon as it becomes available. Update as of 1-17-2017: Consideration to completing a FMEA (or other process safety analysis) will be embedded into the process when any guidance document is undergoing a major revision.
2	Complete assessment of design standards to see if there are any other standards that provide conflicting information. (RC1) Evaluate the effectiveness of the process to compare new/updated procedures with existing procedures.	PG&E is compiling this information and will provide it as soon as it becomes available. Update as of 1-17-2017: There are approximately 12,000 pages of guidance documents utilized by PG&E Gas Operations; this assessment will be completed in two phases: PHASE 1: A review of PG&E documentation systems by subject matter experts will be completed searching for any known conflicts that could result in a compliance or safety risk. These potential conflicts will be reviewed and revisions (or updates) will be made to PG&E documentation where required. PHASE 2: PG&E commits to developing and following a guidance document revision process that (during a major revision) will review any proposed changes with existing guidance documents in order to identify and correct any conflicts before publication.

3	Evaluate existing stations based on the assessment results obtained from CA1. (RC1)	PG&E plans to conduct a design review of the existing moisture analyzer sites; the assessment will include a drawing review, site examinations, and produce a report on the findings. If any design inadequacies are identified on the existing moisture analyzer installations, PG&E will develop action plans to address the deficiencies. <u>Update on 3/17/2017:</u> PG&E is on track to complete the design reviews of existing moisture analyzer sites by the end of Q1 2017. Based on the results of the design review, PG&E will identify design inadequacies of existing stations and develop action plans to address deficiencies.
4	Complete system-wide assessment for open corrective work for control systems at all other stations. Identify and complete other high risk issues that have not been entered in our corrective maintenance system for other manned stations. (RC2)	Please see PG&E's update to Corrective Action 7 (for Root Cause 2).
5	Complete assessment of level of concern at other manned facilities. Combine with CA4, use a survey for both issues, undocumented issues, and distrust of controls.	PG&E has received the survey results and is currently analyzing the results and findings. The analysis results and any findings will be submitted into PG&E's corrective action program for tracking and resolution, as appropriate.