

*Pacific Gas and
Electric Company*

2018 GAS SAFETY PLAN



MARCH 15, 2018



*Pacific Gas and
Electric Company*[®]

March 15, 2018

Dear Reader,

We continue to make strides towards our goal of becoming the safest, most reliable gas utility in the United States. The 2018 Gas Safety Plan provides a high-level, programmatic view of both the work we accomplished in 2017, and our plan moving forward to achieve this goal. The plan continues to build upon the framework PG&E set forth in 2016 and strives to present important Gas Operations information in a manner that is accessible to a broad audience.

PG&E submits this plan in accordance with General Order 112-F Section 123.2(k), and Public Utilities Code §§961 and 963.

The 2018 Gas Safety Plan includes a major new subsection describing how PG&E is applying best practices to address greenhouse gas emissions. Section I.3, Natural Gas Leak Abatement, addresses PG&E's compliance with Leak Abatement OIR Decision (D.) 17-06-015, including Attachment 1, a complete copy of PG&E's Compliance Plan with respect to the 26 Best Practices adopted in that decision (see Attachment 1).

In 2017, PG&E's efforts to mature our commitment and approach to providing affordable gas to our customers with an unwavering commitment to safety began to deliver tangible results. This plan introduces two new sections, the Gas Stewardship (Section VII.1) and Lean Capability Center sections (Section VII.4) that describe some of our to-date successes and our philosophy to engage our workforce to maintain safe work performance while continuously improving. We are working every day to streamline processes and drive efficient and effective work.

We are proud of our commitment and progress towards Gas Safety Excellence and continue to strive towards being the safest, most reliable gas utility in the United States.

A handwritten signature in blue ink, appearing to read 'Sumeet Singh', written over a horizontal line.

Sumeet Singh
Vice President, Gas Operations,
Portfolio Management and Engineering
Pacific Gas and Electric Company

PACIFIC GAS AND ELECTRIC COMPANY GAS SAFETY PLAN

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I. INTRODUCTION

Pacific Gas and Electric Company (PG&E or the Company) works every day to safely transport natural gas under pressure through about 6,600 miles of transmission and 42,700 miles of gas distribution pipelines. This natural gas serves millions of Californians, and PG&E's employees work around the clock, 365 days a year to keep the general public, customers, contractors, and employees safe. As part of the daily mission, PG&E focuses on continuously improving all aspects of its business that affect safety. While there is more work to do in PG&E's mission to provide safe, reliable, affordable, and clean energy, this plan provides a comprehensive view into the safety activities PG&E pursues every day.

The 2018 Gas Safety Plan (Plan) reports on the progress PG&E has made on its goal to become the safest, most reliable gas company in the United States (U.S.). PG&E's Gas Safety Excellence Program permeates every aspect of the Company's gas operations. Some Gas Safety Excellence elements include understanding PG&E assets and the threats those assets face; prioritizing risks; making sure employees and contractors have the tools, training, procedures, and records they need to safely and effectively perform construction, operations and maintenance (O&M) on the system; and resourcing the workload for today and tomorrow.







The purpose of PG&E's Plan is to demonstrate PG&E's commitment to safe and reliable operations. In alignment with California's regulatory framework,¹ this Plan explains how PG&E puts the safety of the public, customers, employees and contractors first, and how the Company has made safety investments in processes and infrastructure that are consistent with best practices in the gas industry.

While more remains to be done, PG&E has made great progress in achieving Gas Safety Excellence over the last seven years. Figure 1 provides a summary of PG&E's performance in key areas that demonstrates PG&E's commitment to safety, whether for emergency response, maintaining a safe system or modernizing the system. PG&E continues to improve its performance in key safety areas. Notably, excavation damage per 1,000 excavation tickets continued its downward trend from 2.11 in 2016 to 1.89 in 2017 and, in 2017, PG&E made an additional approximately 154 miles of its gas transmission pipeline capable of accepting an in-line inspection tool.





Gas Operations “See Our Progress”

Gas Operations progress since 2011 demonstrate our commitment to becoming the safest, most reliable gas company in the country.

	GAS ODOR RESPONSE TIMES	2010	2017
	Average response time in minutes	33.3	20.4
	Percent response within 60 minutes	94.4%	99.6%
	SCADA VISIBILITY AND CONTROL POINTS		
	Transmission pressures and flows	1,300	2,841
	Transmission Control Points	870	1,583
	Distribution pressures and flows	290	2,785
	LEAK BACKLOG		
	Open Grade 2 and 2+ leak indications	12,203	65
	DIG-IN REDUCTION		
	Excavation damage/1,000 excavation tickets	3.5	1.89
	GAS TRANSMISSION	2010	2011-17
	Miles of pipeline replaced	9	>200
	Miles of pipeline hydrotested	0	>1,090
	Miles of pipeline made piggable	130	>850
	Automated valves installed	0	291
	GAS DISTRIBUTION		
	Miles of main replaced ¹	27	>585

SINCE 2011 PG&E HAS ALSO

	Completed GPS survey for 100% of the accessible transmission pipeline system using highly precise mapping tools
	Opened a state-of-the-art Gas Control Center in San Ramon, California
	Opened its world-class Gas Safety Academy located in Winters, California
	Opened the Center for Gas Safety and Innovation located in Dublin, California
	Certifications received for gas operations:
	<ul style="list-style-type: none"> In 2014, PG&E became one of the first utilities ever to earn two of the highest internationally recognized asset management certifications—the International Organization for Standardization (ISO) 55001 and Publicly Available Specification (PAS) 55-1. Gas Operations was recertified for both of these standards in 2017. In 2015, PG&E became the first company in the U.S. to receive compliance for the industry standard on pipeline safety management system, the American Petroleum Institute Recommended Practice (API RP) 1173. In 2016, PG&E became the first utility to receive the chemical industry’s RC14001® management system standard. RC 14001 was developed as a standard issued through the American Chemistry Council for process safety; community communications; product safety; occupational safety, health, environmental and security practices.

¹In 2014 all known remaining cast-iron pipe was decommissioned.

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Figure 1 – Key Gas Performance Metrics

This 2018 update reiterates PG&E’s commitment and vision to become the safest, most reliable natural gas system in the nation. PG&E relies on its Gas Safety Excellence framework to fuel this commitment and vision. The following sections of the Plan provide more information on how PG&E is achieving Gas Safety Excellence, including updates on the Company’s safety goals and commitments to public, customer, employee, and contractor safety.

The Plan describes PG&E’s goals in pursuit of Gas Safety Excellence. Safety culture, process safety, and asset management are the bedrock of these efforts and include key programs such as the Corrective Action Program (CAP) and PG&E’s safety committees. The Plan reviews how PG&E manages risk—both the inherent risk of the assets *and* the risk of working on those assets safely. PG&E describes how it achieves safety through asset management by discussing how the Company identifies risk, prioritizes risks and then works to mitigate them, highlighting the three major categories of gas system risk the Company manages: loss of containment, loss of gas supply, and inadequate emergency response.

The Plan also reviews how PG&E qualifies, trains, and engages the workforce to mitigate risk by working on its assets safely and performing the work such that rework is not needed. This section includes information about PG&E’s workforce training and qualifications programs, and how PG&E ensures compliance. Finally, the Plan presents PG&E’s efforts to continuously improve over time.

The following section describes how PG&E sets its strategic goals. Ultimately, PG&E’s progress in achieving Gas Safety Excellence is dependent on effective and clear organizational goals.

1. THE PURSUIT OF GAS SAFETY EXCELLENCE

Gas Safety Excellence is PG&E’s strategic framework within gas operations to achieve the vision of becoming the safest, most reliable gas utility in the nation. This framework is designed to improve safety, manage risk, drive continuous improvement, and help guide the long-term strategy for Gas Safety.

Gas Safety Excellence is demonstrated by:

- Putting **SAFETY** and people at the heart of everything
- Investing in the **RELIABILITY** and integrity of PG&E’s gas system
- Continuously improving the effectiveness and **AFFORDABILITY** of PG&E’s processes



Figure 2 – PG&E Gas Safety Excellence Framework

PG&E's Gas Safety Excellence is an overlapping combination of three key standards-based programs: Safety Culture, Process Safety, and Asset Management.

2. PG&E'S GOALS

Gas Operations' annual goals are developed through the "Line of Sight" process. This process incorporates Integrated Planning Executive Guidance with key themes and strategies developed through PG&E's annual, multi-year strategic and work plan development processes, Session D, Session 1 and Session 2.² "Line of Sight" aligns business strategy with six key themes: Safe, Reliable, Affordable, Customer, People, and Compliance. This planning process results in strategic goals to drive action throughout the business. Related goals and metrics are cascaded throughout the organization to provide each employee a line of sight for how their actions support PG&E's vision and commitment to be the safest, most reliable gas utility in the nation. These items are discussed in more detail throughout this update.

a) PUBLIC SAFETY

In 2017, PG&E had success in three primary safety areas: In-Line Inspections, Emergency Response Time, and Third Party Dig-Ins.

- **In-Line Inspection:** In 2017, PG&E increased pigability to roughly 28 percent of the approximately 6,600 miles of the Gas Transmission system, and used in-line inspection tools to inspect over 308 miles of transmission pipeline. Approximately two-thirds of PG&E's transmission system (about 4,100 miles) has been or will be upgraded to accept in-line inspection tools by the end of 2026.
- **Emergency Response Time:** PG&E exceeded its target and achieved first quartile performance with a 20.4 minute average response time to gas odor calls, responding to 137,927 gas odor calls in 2017.
- **Third Party Dig-In:** PG&E set a 2017 target of 1.92 dig-ins per 1,000 Underground Service Alert (USA) tickets. In 2017, PG&E experienced 1.89 dig-ins per 1,000 tickets and out-performed its target.

b) WORKFORCE SAFETY

PG&E depends on its trained, knowledgeable, and capable workforce to provide safe, reliable, and affordable service to customers. As such, PG&E's goal is to provide a safe and secure workplace where each employee is appropriately trained and equipped to complete their work right the first time without incident. PG&E's goal is zero safety incidents. In 2017, Gas Employees were involved in 36 Lost Time

Injuries (a 22% increase over the prior year) and 14 Serious Preventable Motor Vehicle Incidents (a 75% increase over the previous year). In 2017, the Occupational Safety and Health Administration (OSHA) recordable rate increased by 24.4 percent. This is likely due to PG&E's increased emphasis on the twenty-four hour, seven days a week Nurse Care Line and early reporting. This renewed emphasis on reporting should ultimately have a positive effect on workforce injuries. Through consistent application of the preventative efforts, the serious lost time injuries are expected to begin to follow the OSHA recordable curve and show improvement. To reduce workplace incidents and continue towards PG&E's goal for an incident free workforce, PG&E designed the 2017 Safety Action Plan using an analysis of the leading drivers of injury. This multi-year plan was based on a statistical analysis of the leading drivers of injuries and lost time. PG&E is optimistic on the positive effects these initiatives will have in reducing OSHA recordable injuries and motor vehicle incidents. [See Section: *Safety Projects page 57*].



Figure 3 – PG&E Gas Employees Engage in a Safety Huddle

c) REWARDING SAFETY EXCELLENCE

PG&E's performance goals reinforce expectations regarding management decisions and allocation of resources. In 2015, PG&E revised its performance goals and a portion of its compensation (known as the Short-Term Incentive Plan) for non-represented employees. Safety is the single largest factor in performance goals, representing 50 percent of the total. The remaining two factors, customer satisfaction and financial performance, are each weighted at 25 percent.³ Our safety weighting is the highest for available comparator utility, while data shows the average is 8 percent.

3. NATURAL GAS LEAK ABATEMENT

On January 22, 2015, the California Public Utilities Commission (CPUC or Commission) opened Order Instituting Rulemaking (R.) 15-01-008 (OIR) to implement the provisions of Senate Bill (SB) 1371 (Statutes 2014, Chapter 525).⁴ SB 1371 requires the adoption of rules and procedures to minimize natural gas leakage from Commission-regulated natural gas pipeline facilities consistent with Pub. Utilities Code § 961(d), § 192.703(c) of Subpart M of Title 49 of the Code of Federal Regulations (CFR), the Commission's General Order (GO) 112-F, and the state's goal of reducing greenhouse gas (GHG) emissions. In the June 16, 2017 Phase 1 Leak Abatement OIR Decision (D.) 17-06-015,⁵ the Commission adopted 26 Best Practices related to natural gas leak abatement. PG&E's gas leak abatement program

includes annual methane emission tracking reporting, and a biennial best practice compliance plan submission. **Attachment 1** to this plan is the first biennial best practice compliance plan prepared in accordance with the Commission’s decision. The first annual methane emission tracking report will be served separately on June 15, 2018.

II. SAFETY CULTURE

The first pillar of Gas Safety Excellence is safety culture. When it comes to safety, we believe that our job is never done. PG&E’s continued commitment to strengthening our safety culture and performance is reinforced in the Company’s updated Mission, Vision, and Culture. Figure 4 illustrates PG&E’s mission, vision and culture statements, updated in 2017, that are the foundation of our decision-making process.

The imperative to put safety first drives everything we do, to create a clear understanding by our employees that their actions every day must reflect that priority. Companywide efforts such as the creation of new safety committees, the redefined Contractor Safety Program, the enterprise-wide CAP, and our Speak-Up Program reinforce and enable our employees’ and contractors’ commitment to improving safety culture and performance.



Figure 4 – PG&E’s Mission, Vision, and Culture Statements

We measure our safety culture progress in a variety of ways. For example:

We have continued to pursue independent third-party verification of our Company’s systems and processes, including the American Petroleum Institute’s (API) Recommended Practice (RP) 1173, Pipeline Safety Management System Requirements.⁶ PG&E earned a certificate of compliance to the requirements of API RP 1173 from an independent third-party auditor in November 2015. PG&E is the first company to earn this distinction.

Additional safety culture indicators include employee surveys and use of our CAP program.

- The bi-annual employee survey, with a strong participation rate of approximately 84 percent of Gas Operations’ Engineering, Construction and Operations employees, includes specific dimensions focused on safety culture such as do employees feel comfortable flagging problems to Officers and Directors and conditions at PG&E make it safe to challenge the status quo.

- The Corrective Action Program, as discussed in the 2017 plan, has now been implemented across the entire company. One CAP metric we use as an indicator of safety culture health is the number of anonymous submittals. In 2017, the average anonymous submission rate was 2 percent of all issues submitted to CAP. Of the issues submitted to CAP that were related to Gas Operations, 2.4 percent were anonymous. CAP's low anonymous submission rate is a clear indication that employees are willing to speak up and be recognized for their concerns and ideas [see Section: *Corrective Action Program page 8*].

While the progress we've made has been significant, we know that there is more we can do and will do to reduce risk and improve safety culture and performance.

1. EMPLOYEE ENGAGEMENT

Demonstrating to all employees that the Company values their ideas, input, and personal development leads to an engaged workforce. PG&E has created a strong line of sight between organizational objectives and the work performed. By aligning corporate strategies and work plans, PG&E supports a fluid bottom-up flow of ideas and feedback to enable continuous improvement in the business.

Gas Operations' executive leadership team members routinely visit offices and field locations to speak directly with employees and hear firsthand their thoughts on what PG&E is doing well and where improvements are needed. However, talking to and listening to employees alone is not enough to demonstrate to employees that PG&E's leadership wants their input and ideas on how to improve. To show the focus on engagement, PG&E leadership has created specific engagement activities around key aspects of work, leveraging employee feedback and facilitating the development of initiatives based on the feedback. For example, Gas Operations Field Services employees helped to implement a series of initiatives designed to increase safety and health awareness for fellow employees which included the development of wrenching charts, using penetrating oils before starting the job, alternative ergonomic wrenches and equipment, and equipping people to do internal ergo assessments and recommend corrections to employees. As a result, the field services organization saw a decrease in repetitive stress injuries.

PG&E opened its new Gas Safety Academy on September 27, 2017, which serves as the primary training center for employees learning to operate and maintain every aspect of the company's natural gas infrastructure. The 30-acre academy was designed and constructed to specifications resulting from extensive employee feedback and benchmarking. It features the latest training technologies, including heavy equipment simulators, virtual learning resources, a model neighborhood for emergency response and leak detection, and educational programs on industry-leading safety protocols. Each week, the

academy will host about 150 gas employees and will provide nearly 36,000 hours of training every year. The center offers a wide range of curriculum and field training for gas Transmission and Distribution (T&D) pipelines, meter maintenance, heavy equipment operation, welding, pressure control, customer service, gas appliance operation, excavation and education on safety standards and procedures.

The Company is continuing work to close the feedback loop by expanding the acceptance and use of CAP. In 2017, PG&E set a goal of use by 40 percent of the gas team. By year-end, more than 49 percent of the gas team had used CAP, an increase of almost 10 percent compared to 2016. In 2017, Gas Operations employees participated in the Pulse Survey which is administered once per quarter with 25 percent of each line of business sampled.⁷ Employees indicated that they feel free to stop work if conditions are unsafe by responding over 90 percent and up to 95 percent favorably on this question in the survey each quarter. In addition to face-to-face meetings, group input, and surveys, PG&E also has established gas technical teams that include: front-line employees who meet to review and provide input on updates to standards and procedures; and Grassroots Safety teams, representing first line employees raising safety issues and solutions. These teams provide additional input and recommendations on Gas Operations' processes from the perspective of people who perform the work. The end goal for PG&E's approach to employee engagement is to incorporate direct input from the workforce into operations decisions.

a) CORRECTIVE ACTION PROGRAM

Gas Operations launched the Corrective Action Program (CAP) in 2013 to offer employees a simple method to identify and report issues related to gas assets and processes. In 2017, the CAP program was deployed to all lines of business. The types of issues submitted include employee concerns or suggestions, operational events, audit findings, or issues with facilities, tools, records, training, and safety.

The CAP process employs a standardized approach (Figure 5), including a CAP Review Team, composed of subject matter experts from various Gas organizations, that meets daily to review CAP issues submitted the previous day. The team's function is to categorize each issue, assess it for risk, and assign it to an owner. The role of the issue owner is to investigate and identify the causes underlying the issue and to address them appropriately by implementing corrective actions to mitigate risks or prevent recurrence. Initiators receive an email when the item they submitted is assigned and again when it is closed. The CAP provides real-time data and ensures transparency and accountability. The system is designed to provide trending capabilities and a continuous improvement loop to capture lessons learned and to improve the safety and reliability of PG&E's operations.

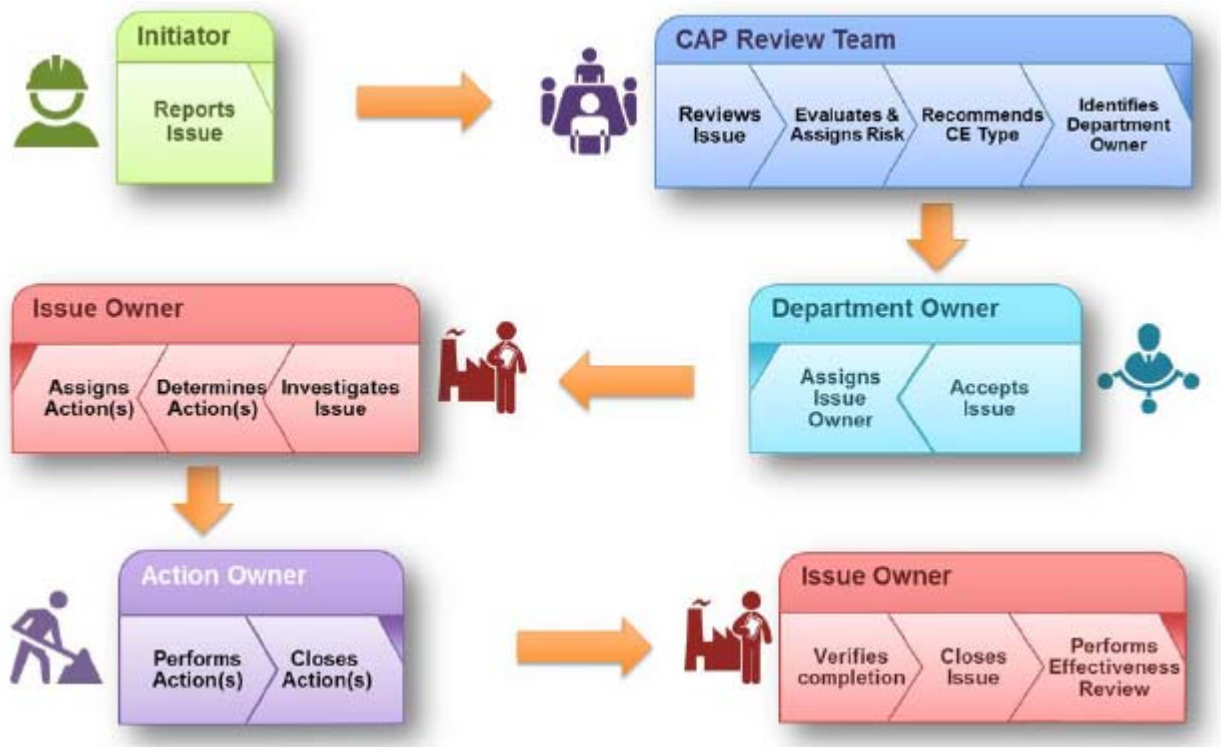


Figure 5 – Corrective Action Program Process

In 2017, Gas Operations employees submitted 14,660 issues – averaging just over 1,200 per month—and closed 13,180 issues. Nearly half of the issues were mapping corrections (Figure 6).

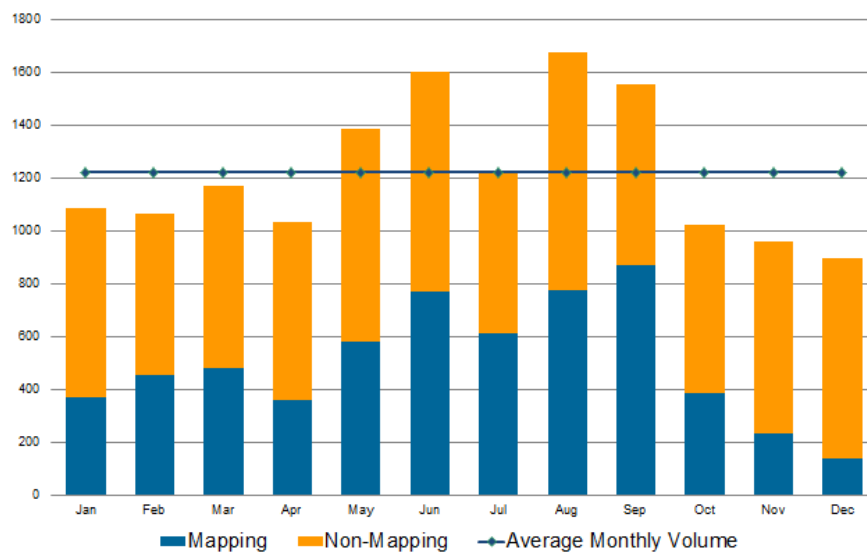


Figure 6 – Corrective Action Program Metrics

The CAP team routinely conducts monthly quality closure reviews on all high and medium risk issues, as well as a sampling of low risk issues. These closure reviews are performed to confirm that issues are adequately addressed and properly documented.

In 2017, the CAP team hosted regular user group forums to identify user needs and preferences as well as CAP enhancement opportunities. Additionally, members of gas leadership attended over 50 Cap

Review Team meetings to provide input on the CAP process. Face-to-face CAP training was also provided to field employees at safety summits, all-hands meetings, and other employee meetings and training sessions. A web-based CAP training module is available for all employees, and real-time data are available on the CAP dashboard. The CAP process continues to mature and serves an important role in Gas Operations to identify and correct safety issues and implement process improvements.

b) COMPLIANCE AND ETHICS HELPLINE

PG&E's Compliance and Ethics (C&E) Helpline is a toll-free telephone number available to employees, contractors, consultants, suppliers, and customers 24 hours a day, 7 days a week. The C&E Helpline, managed for PG&E by NAVEX Global, enables a person to request guidance or make a good-faith report of violations of our Code of Conduct, accounting issues, or illegal activity. Callers may remain anonymous. In addition to calling, other methods to contact C&E to request guidance or submit a report include making a web-based report (also managed for PG&E by NAVEX Global) or mailing C&E directly.

Concerns raised with C&E through its Helpline or any other method are documented and tracked to closure. PG&E has a strict policy against retaliation against anyone who speaks up or is involved in an investigation. The C&E Helpline is part of PG&E's commitment to fostering a workplace where everyone feels safe to ask for guidance, share ideas or raise concerns—and one where everyone is confident that those concerns will be heard and taken seriously.

In 2018, C&E will continue its ongoing efforts to promote a Speak Up, Listen Up, Follow Up culture. Highlights include the launch of a new employee Code of Conduct and training and toolkits to help leaders listen up and follow up.

c) MATERIAL PROBLEM REPORTING

In addition to the Helpline and CAP, PG&E encourages employees to report and act on problems with any materials, tools, gas/electric/other equipment or infrastructure through the Material Problem Reporting (MPR) system. PG&E also leverages the CAP reporting process to route material related problems to the MPR system. The MPR process is cross-functional and relies on employees at all levels of the business to identify potential safety issues stemming from material problems.

MPRs can be identified from two different sources: A material arrives at PG&E's facilities, the PG&E team may identify "Incoming MPRs." As work is performed with materials, personnel may identify "Field MPRs." Incoming MPRs that are quality tested and found to fail at receipt prompt the creation of a Supplier Corrective Action Request (SCAR), requiring the manufacturer to resolve the issue. In 2017, this process had an average short cycle time of 15 days, with a target of 20 days.

Field MPRs tend to be more complex, and as a result, can require more time to resolve. They require collecting the part from the field, shipping it to engineering, performing an investigation and interviews

on method of installation, and material testing in a test lab to validate method of failure. After the conditions and method of failure are determined, the material may be sent back to the manufacturer if it is proven to be a material defect. In 2017, Field MPR resolution had an 87-day average cycle. In 2018, PG&E is setting a target of 70 days for field MPRs.

2. PG&E CORPORATE SAFETY COMMITTEES

PG&E’s safety governance structure drives a consistent safety culture and aligns to PG&E’s safety strategy and results. Table 1 illustrates the interrelationship between PG&E’s Corporate and Gas Operations safety committees.

Table 1 – Safety Committees	
Board of Directors Safety and Nuclear Oversight Committee	Oversees matters relating to safety, operational performance and compliance. Conducts an annual evaluation of PG&E’s performance in accordance with its Corporate Governance Guidelines.
Executive Safety Committee	Provide overall governance of safety; guide the enterprise safety strategy and philosophy; and assure continuous improvement of public, employee, and contractor safety performance. This Committee replaces the Chairman’s Safety Council, the Safety Culture Steering Committee, and the Enterprise Corrective Action Program Steering Committee.
Gas Operations Safety Council	Sponsors initiatives to improve Line of Business safety. Monitors Line of Business safety performance and initiatives so that safety initiatives adequately address risks.
Grass Roots Safety Teams	Employee-led efforts to identify opportunities to improve safety, define and validate possible solutions, and implement and promote safety initiatives.

The charters for the Board of Directors Safety and Nuclear Oversight Committee, and the Executive Safety Committee were submitted with the 2017 Gas Safety Plan⁸.

III. PROCESS SAFETY

The second pillar in Gas Safety Excellence is implementing Process Safety Management.⁹ Process Safety Management focuses on preventing low frequency, high consequence incidents and mitigating the consequences. The Process Safety Management system is used for engineering new facilities, modifying existing facilities, maintaining equipment, and ensuring safe operation.

The Process Safety Management System contains four foundational blocks (Figure 7): Commit to Process Safety, Understand Hazards and Risk, Manage Risk, and Learn from Experience. PG&E is improving Process Safety performance by strengthening performance in each of these areas.

When process safety performance gaps are identified, plans are developed and implemented to close them. Targets are set for the future and improvement plans are implemented. A follow-up assessment is conducted to ensure progress toward goals and verify performance improvement.



Figure 7 – The PG&E Process Safety Method

Process Safety Highlights from 2017 include:

Commit to Process Safety: Guided by the elements set for by CCPS, PG&E’s commitment in implementing process safety led to certification to chemical industry standard RC 14001® (Responsible Care® and International Standards Organization (ISO) 14001)¹⁰ in 2016, which we successfully maintained in 2017. The team performs field location visits to involve the workforce in improving the management system components and conformance. In 2017 and carrying through 2018, the team is focused on increasing the number of shorter, topic-specific training offerings.

Understand Hazards and Risk: Process Safety Management is a key component in reducing PG&E’s Operational Risk Exposure. In 2017 PG&E used Process Safety principles in its large overpressure (OP) event reduction initiative. [See Section *Mitigating Loss of Supply: Overpressure Elimination Initiative page 45*]. 2017 activities additionally focused on maturing design risk assessments and simplifying project design-phase Process Hazard Analysis activities. In 2018, the team is working towards driving increased consistency in risk estimation.

Manage Risk: Process Safety efforts support risk mitigation. In 2017 and continuing this year, risk mitigation continues through management of change process improvements at staffed Compression and Processing (C&P) or Measurement and Control (M&C) facilities.

Learn from Experience: PG&E strives to continuously improve in Process Safety. Process Safety engineers support and lead incident investigations as part of the CAP process. Apparent and Root Cause

Evaluation studies are conducted in the instance of Gas Incidents, with significant input from process safety, based on the level of consequence and probability (risk). These evaluations include the identification of the cause(s) and identification and implementation of corrective actions so that PG&E can reduce the likelihood that a similar incident will occur. Corrective actions resulting from PG&E's causal analyses are being implemented every day to strengthen the safeguards.

IV. ASSET MANAGEMENT

PG&E builds, operates, and maintains natural gas infrastructure to transport, store, and deliver gas to customers over Northern and Central California. PG&E faces inherent risks associated with operating an asset system that passes through populated areas and a wide variety of terrain. The three primary risks confronting PG&E's natural gas system are a loss of gas containment, a loss of gas supply, and an inadequate response to emergencies. As part of PG&E's Gas Safety Excellence Program, PG&E created its third pillar of Gas Safety Excellence, an asset management system to address these three categories of risk and find balance between asset risk, cost, and performance. The basis of achieving safety through asset management is to know PG&E assets and their condition, understand the risks to those assets, implement risk reduction strategies, and optimize asset risk, cost, and performance. The following section describes PG&E's asset management system, the asset families, how PG&E's Gas Operations manages risk, and provides an overview of the current risk portfolio.

1. ASSET MANAGEMENT SYSTEM

Asset Management is the third pillar of Gas Safety Excellence. PG&E has implemented an asset management system to help drive the business toward achieving its commitment to the safe, reliable, affordable management and operation of PG&E's gas assets. Using the international PAS 55-1 and ISO 55001 standards as guidance, PG&E's asset management system focuses on:

- Identifying and reducing operational and enterprise risk;
- Maintaining an asset management framework and directing organizational focus on the most important asset risks and opportunities;
- Proactively managing the condition of gas assets; and
- Meeting or exceeding the requirements of federal, state, and local codes, regulations and requirements in an environmentally sustainable manner.

The Asset Management Policy (TD-01) (provided with PG&E's 2017 Gas Safety Plan) lays the foundation for PG&E's Gas Asset Management system while the vision and strategy for enhancing the system is documented in the Strategic Asset Management Plan. PG&E also maintains risk-based Asset Management Plans for each of its eight gas asset families. Finally, PG&E reports regularly to the CPUC on its safety and reliability investments.¹¹

2. ASSET FAMILY STRUCTURE

Since assets can face different types of risk, PG&E developed an asset family structure to recognize and manage these differences, yet drive consistency in the way PG&E thinks about and addresses risks. PG&E identified eight asset families within Gas Operations which are illustrated in Figure 8:

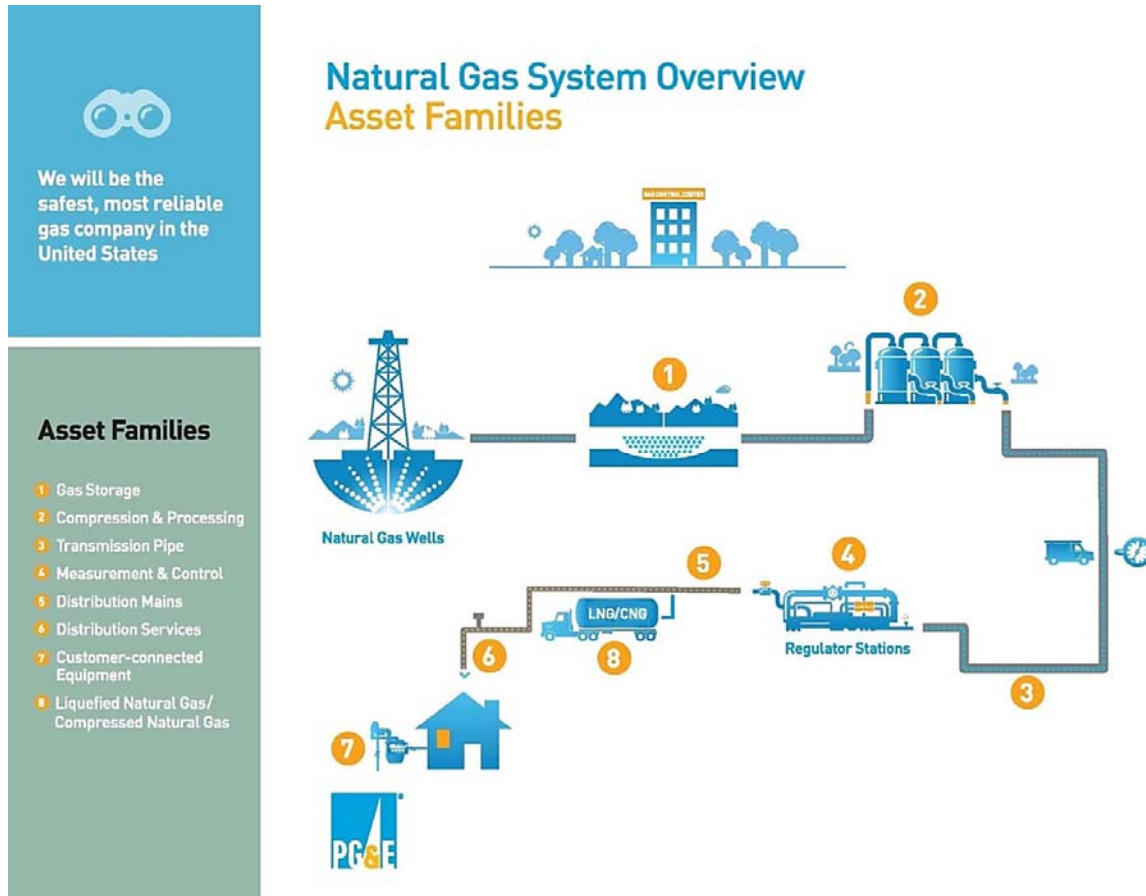


Figure 8 – Natural Gas System Overview – Asset Families

Each asset family has an Asset Family Owner who is responsible for knowing the asset condition, the risks to the assets, and for developing a risk-based Asset Management Plan, which is a 5-year plan for managing gas assets. For changes to PG&E's Asset Management Plans, please see **Attachment 2, page 1-13**. Full versions of the Asset Management Plans are available upon request; please email GasOpsRegulatoryStrategySupport@pge.com to request these documents electronically.

By associating each asset with a family, and designating an Asset Family Owner, Gas Operations works to (1) adequately identify each threat; (2) appropriately assess the condition of the asset and the quality of the data about the asset; (3) identify and assess the threats and risks facing the asset; and (4) develop and execute effective mitigation efforts. The Asset Family Owner leads the preparation of the Asset Management Plan for each asset family that describes:

- Asset inventory and condition
- Asset threats and risks

- Desired state for the assets and strategic objectives for achieving desired state
- Programs and risk mitigations
- Areas for continual improvement

These Asset Management Plans are living documents evolving as new asset information becomes available. The following section summarizes the types of assets in each family, the function these assets serve in the gas system, and progress towards achieving Asset Management Plan objectives.

a) **GAS STORAGE**

The Gas Storage Asset Family includes PG&E's owned and operated underground natural gas storage facilities at McDonald Island, Los Medanos, and Pleasant Creek. These storage facilities allow PG&E to store natural gas for high-demand periods or take advantage of seasonal gas pricing. In concert with the C&P Asset Family, these assets perform a key role in system reliability. The primary assets within this family include 115 storage wells, 14 miles of transmission pipe, 87 downhole safety valves, 214 uphole safety valves, 177 well meters, and 3,404 acres of storage reservoirs with over 102 billion cubic feet of working gas capacity.

The Gas Storage Asset Management Plan (AMP) describes the strategy for mitigating and managing risk for this asset family and achieving the established asset management objectives. Examples of key objectives included in the AMP are shown in Table 2.

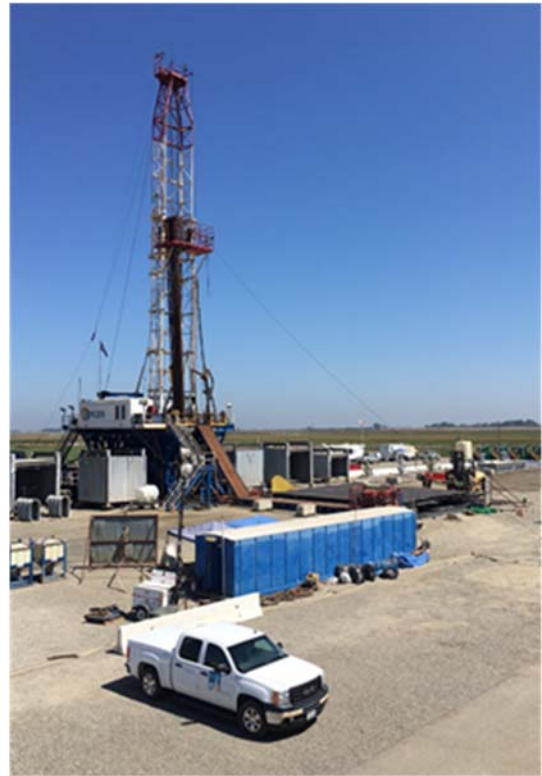


Figure 9 – Well Rework: Rig on Well

Table 2 – Gas Storage Asset Management Plan Objectives and Progress To Date	
Overall Objective/Goals	Progress Towards Goal
Complete baseline well production casing assessments on 115 wells by 2025	Number of baseline assessments performed: 2013 – 2016: 27 wells 2017 – 8 wells
Evaluate and incorporate Well Integrity Management Plan (WELL) enhancements	2016 – Submitted final WELL documentation to the California Division of Oil, Gas and Geothermal Resources (DOGGR) for approval and identified improvements to WELL to incorporate in scheduled revisions of the publication 2017 – Published updates of WELL to include enhanced design
Assess work on transmission pipeline through Transmission Integrity Management Program (TIMP)	2016 – Completed written monitoring and assessment plans; Began development of 10-Year Storage Pipe Plan to assess pipe integrity 2017 – 2019 GT&S submission included funding request for strength testing pipeline in the Storage Asset Family
Continue Process Hazard Analysis (PHA) and Pre-Startup Safety Reviews (PSSR) on all well, surface equipment, and pipeline in storage asset family	Number of PHAs and PSSRs complete: 2014 – 2 PHAs and 0 PSSRs 2015 – 3 PHAs and 7 PSSRs 2016 – 4 PHAs and 11 PSSRs 2017 – 2 PHAs and 10 PSSRs

The Gas Storage Asset Management Plan describes these objectives in detail. PG&E’s Gas Storage Safety Report, filed on August 22, 2016, provides information on the Los Medanos, Pleasant Creek, and McDonald Island storage facilities.

b) COMPRESSION AND PROCESSING

PG&E’s C&P facilities contribute to the safe and reliable delivery of gas by moving gas from receipt points to customer delivery locations as well as providing for injection and withdrawal of gas at PG&E’s underground gas storage facilities. Gas processing equipment provides gas that is free from particulates and is sufficiently dehydrated and odorized so that it meets quality requirements when transported to the gas T&D systems.



Figure 10 – District Regulator Station — Above Ground

The C&P asset family includes nine transmission compressor stations; storage compressors are also installed at PG&E’s three underground storage facilities. Major assets include the 38 company-owned compressor units, as well as associated equipment such as filter-separators, pumps, motor control centers, station piping, among others. Additionally, this asset family includes approximately 100 gas odorizer units installed system-wide. These stations support the system’s reliability and the odor added to gas helps keep PG&E customers safe when gas arrives at their service point.

The Compression and Processing Asset Management Plan describes PG&E’s roadmap for achieving strategic objectives related to the C&P assets. Key strategic objectives for C&P assets include the following:

Table 3 – Compression and Processing Asset Management Plan Objectives and Progress To Date	
Overall Objective/Goal	Progress Towards Goal
Use Long-Term Compression Investment Plan information to inform the 2019 Gas Transmission & Storage (GT&S) Rate Case.	Plan revised in 2017 and used to inform 2019 GT&S, filed November 17, 2017.
Reduce total number of compressor unscheduled shutdowns by 10% over three-year average.	Target met. Number of unscheduled shutdowns per year: 2015 Actual = 330 2016 Actual = 162 2017 Target = 253; 2017 Actual = 188
Evaluate 100% of transmission total station features by end of 2019.	Improved actual/target production ratio from 2016 to 2017. Resolving more stations through above-ground inspections than digs, resulting in lower costs and lower risks to assets.
Apply Facility Integrity Management principles to all stations by 2025.	Maturity model was developed in 2015. FIMP at 32% complete in 2016; 37% complete in 2017.
Complete physical security upgrades at critical facilities by 2023.	Station completion on schedule.
Complete critical documents defined and required by TD-4551S, Station Critical Documentation, for all transmission facilities by 2021.	Completed pilot facilities and starting large scale production in 2018.

The Compression and Processing Management Plan describes these objectives in more detail.

c) TRANSMISSION PIPE

The Transmission Pipe asset family consists of approximately 6,600 miles of line pipe and major components, such as valves and fittings, used in transporting natural gas.¹² PG&E’s Transmission Integrity Management Program (TIMP) governs how PG&E identifies and evaluates risks, reduces risk through risk mitigation activities, and assesses integrity performance within the Transmission Pipe asset family. TIMP is a core foundation of PG&E’s ongoing efforts to provide safe and reliable service, consistent with industry best practices, and based on the federal TIMP regulations.¹³ The Transmission Pipe Asset Management Plan describes the roadmap for mitigating and managing risk for this asset family and achieving the established asset management objectives. The plan’s objectives include the following:



Figure 11 – Line 173 in Rocklin, 2017

Table 4 – Transmission Pipe Asset Management Plan Objectives and Progress To Date	
Overall Objective/Goal	Progress Towards Goal
Apply integrity management principles to transmission pipelines covering 100% of population living along transmission pipelines by 2030	43% of population within PIR covered with IM principles Updated and implemented Risk Assessment and Threat Identification Processes for Stress Corrosion Cracking (SCC) Implemented the TIMP Quantitative Risk Model Achieved ILI progress targets. 28.4% of system is now piggable
Meeting 100% of system capacity obligations, and eliminating high risk manual operations, and reduce medium risk manual operation in Abnormal Peak Day (APD) conditions by 2021	Eliminated 14 high risk manual operations. Completed the Line 407 project, providing increased capacity to the growing Sacramento Valley region transmission system.
Update PG&E’s gas transmission SCADA assets and technology to improve recognition and response to significant transmission incidents by 2021	See Section 7.a for additional information on system visibility progress. The Online Pipeline Simulator was completed and deployed in Gas Control. Installed 23 automated valves.
Industry leading damage prevention program	See page 27 for more information on PG&E’s Damage Prevention Program and progress. See page 41 for more information on line marker progress.

The Transmission Asset Management Plan describes these objectives in more detail.

d) MEASUREMENT AND CONTROL

PG&E’s M&C assets assist in the safe and reliable delivery of natural gas by providing control of pressure and flow within the gas T&D systems. The assets in this family perform a critical role in system safety by protecting downstream assets from system pressure excursions. Additionally, in concert with the Compression and Processing Asset Family, these assets perform a key role in system reliability.

The physical assets within this family include three gas terminals, 389 gas transmission stations (both simple and complex), 100 large volume customers with primary regulation, 64 automated valve sites, 2,468 distribution district regulator stations, 2,357 distribution high pressure regulating sets,



Figure 12 – A Simple Station – Vaulted

25 large customer meter sets, and 48 gas quality analyzers. PG&E’s M&C equipment is located both above and below ground as well as in vaults. Example of M&C simple transmission stations are shown in Figure 12.

The M&C Asset Management Plan describes PG&E’s roadmap for achieving strategic objectives related to the M&C assets. Key strategic objectives for M&C assets include the following:

Table 5 – Measurement and Control Asset Management Plan Objectives and Progress To Date	
Overall Objective/Goal	Progress Towards Goal
Apply Facility Integrity Management principles to all T&D stations by 2025.	Maturity model was developed in 2015. FIMP at 32% complete in 2016; 37% complete in 2017.
Eliminate large Over Pressure events by 2022.	Large Over Pressure events per year: 2014 – 7; 2015 – 7; 2016 – 10; 2017 – 11. Significant progress made towards understanding causes and locations of events; installation of secondary over pressure protection at high priority stations underway.
Complete physical security upgrades at critical facilities by 2023.	Station completion on schedule.
Accomplish obsolescence management based on condition, maintaining regular turnover of the fleet.	Published revision to obsolete equipment standard; continuing station rebuilds; developing process to manage controls obsolescence.
Complete critical documents defined by TD-4551S for all transmission facilities by 2021 and distribution facilities by 2025.	Completed pilot facilities and starting large scale production.
Evaluate 100% of transmission total station features by 2019.	Improved actual/target production ratio from 2016 to 2017. Resolving more stations through above-ground inspections than digs, resulting in lower costs and lower risks to assets.

The Measurement and Control Asset Management Plan describes these objectives in more detail.

e) DISTRIBUTION MAINS AND SERVICES

Distribution Mains and Services asset families have been combined for asset management planning purposes into a single plan. This combined asset family includes over 42,700 miles of pipeline that connects to the gas M&C asset family on the upstream side and transports natural gas to customers throughout the service area. It also includes over 3.4 million service lines that deliver gas from the distribution mains to the assets in the Customer Connected Equipment (CCE) family on the downstream side. The programs associated with the Distribution Mains and Services asset family are focused on the inspection, analysis, and replacement of Distribution Mains and Services assets. PG&E continues to identify and assess threats to Distribution Mains and Services assets and works to mitigate those threats, including through its Distribution Integrity Management Program (DIMP), in a continuous effort to maintain a safe system. Some key strategic objectives include the following:



Figure 13 – Distribution Main Replacement Project

Table 6 – Key Distribution Mains and Services Metrics	
PG&E's Commitment to Safety	Progress Towards Goal
Reduce third-party dig-ins to first quartile by 2016	PG&E set a 2017 target of 1.92 dig-ins per 1,000 tickets. In 2017, PG&E experienced 1.89 dig-ins per 1,000 tickets and outperformed its target for 2017.
Achieve a replacement rate that limits asset age to 100 years by 2030	2013: 69 miles installed 2014: 66 miles installed 2015: 102 miles installed 2016: 120 miles installed 2017: 144.9 miles installed (exceeded the target of 130 miles)
Identify all potential cross-bores and remediate by 2023	Inspections planned 2013 through 2017: 140,570 Inspections completed 2013 through 2017: 135,385

The Distribution Mains and Services Asset Management Plan describes these objectives in more detail.

f) CUSTOMER CONNECTED EQUIPMENT

The CCE Asset Family comprises approximately 4.5 million meters and associated regulators, over-protection devices, shut-off valves, piping, and fittings that connect the gas distribution service to the customer. Customer meters are used to measure gas usage to support the billing function.

The CCE Asset Management Plan provides an overview of the CCE assets, threats to these assets and efforts underway to manage these threats. The plan presents the asset inventory, an assessment of condition and overview of key risks to the CCE assets. The plan also includes long term strategic objectives and an overview of the key programs in progress to mitigate these risks. The plan's key objectives are included in Table 7:



Figure 14 – PG&E Employee Working on CCE

Table 7 – Customer Connected Equipment Asset Management Plan Strategic Objectives and Progress To Date	
PG&E's Commitment to Safety	Progress Towards Goal
Reach a steady state backlog of 60,000-70,000 non-hazardous meter set leaks for repair annually	2017 Beginning Year Inventory: 63,301 Influx of work: 40,934 Completed: 44,425 2017 End of Year Inventory: 59,424
Identify and remove problematic regulators by 2018	898 replaced in 2017 vs 1295 planned

The Customer Connected Equipment Asset Management Plan describes these objectives in more detail.

g) LIQUEFIED NATURAL GAS AND COMPRESSED NATURAL GAS

The Liquefied Natural Gas/Compressed Natural Gas asset family consists of portable assets that provide natural gas supplies to offset or supplement pipeline flowing supplies for planned outages, winter peak load shaving, unplanned outages, and in emergency situations. The Liquefied Natural Gas/Compressed Natural Gas asset family consists of over 200 portable Liquefied Natural Gas and

Compressed Natural Gas units. In 2017, there was one loss of containment incident for portable assets – See Table 8.

The Liquefied Natural Gas/Compressed Natural Gas asset family consists of 32 Compressed Natural Gas station assets to supply the natural gas that fuels PG&E and third-party vehicles, and provides very high pressure gas supply to the portable Compressed Natural Gas equipment. Over the last few years, PG&E has instituted an industry-leading inspection program to assure the integrity of customer Compressed Natural Gas vehicle fuel systems. In 2017, 77 percent of PG&E’s natural gas fueling customers submitted their 3-year vehicle certificates of inspection. In 2017, there was no significant loss of containment incident for Compressed Natural Gas Station assets.

Table 8 – Liquefied Natural Gas/Compressed Natural Gas Safety Success	
PG&E’s Commitment to Safety	Progress Towards Goal
Driving towards zero significant liquefied natural gas/compressed natural gas loss of containment incidents	<p>2017: A minor incident occurred during portable CNG operations as a result of CNG regulation failure. Maximum Allowable Operating Pressure (MAOP) was never exceeded but over pressure protection using relief valves resulted in loss of containment as part of asset design.</p> <p>2017 Activities: Maintenance of Liquefied Natural Gas/Compressed Natural Gas equipment and assets. Liquefied Natural Gas/Compressed Natural Gas equipment training development and operating training.</p>
Implementing an industry-leading inspection program to improve safety inspection certifications from less than 20% to 99% of Compressed Natural Gas fuel customer vehicles	2017: 77% of natural gas fueling customers presented 3-year cylinder certification.
Reduce risk of portable natural gas transportation traffic incidents by reducing equipment issues through an improved maintenance program	2017: Continued maintenance of Liquefied Natural Gas/Compressed Natural Gas portable over-the-road assets by dedicated fleet mechanics have resulted in continued decrease of transport incidents.

The Liquefied Natural Gas and Compressed Natural Gas Station Asset Management Plan describes these objectives in more detail.

3. RISK MANAGEMENT PROCESS

Transporting natural gas involves moving a flammable product under pressure where PG&E’s customers live, cook, heat their homes, and warm their offices. As a result, risk management is an important part of the natural gas business. PG&E’s Risk Management team prioritizes risks based on how likely an incident is to occur and how severe it might be. This team provides direction to PG&E’s gas operations employees who work 365 days a year to mitigate these risks. Success is determined by having a robust process, making continuous improvement in the process and in risk mitigation progress, such as meeting PG&E’s long-term goal to make its system capable of In-Line Inspection.

While the hazards and risks associated with natural gas are inherent, PG&E can and does build layers of protection into company processes and plans. While any one process may fail in a way that presents hazards, multiple layers of protection placed on top of one another safeguard against the failure of any one layer. This is why, in many instances, PG&E implements multiple mitigations or layers of protection. For example, for the loss of containment risk and the threat of excavation damage, PG&E manages multiple mitigation programs such as pipeline markers, locate and mark of facilities, and stand-by during excavation.



Figure 15 – PG&E’s Risk Management Process is designed to identify and address the inherent risks that come with transporting natural gas to customers.

To identify and address risk, PG&E follows a comprehensive enterprise and operational risk management process. PG&E’s Enterprise and Operational Risk Management plans allow PG&E to manage assets and risks at an enterprise and operational level. PG&E defines “Enterprise Risks” as those that potentially could have a catastrophic impact to PG&E. All Enterprise Risks are reported to the Board



Figure 16 – Two PG&E Welders

of Directors each year, where mitigation plans and status of mitigation efforts are discussed. Operational risks are managed at the Line of Business level, with oversight provided by each Line of Business’ Risk and Compliance Committee, which meets monthly. Each of the Committees is charged with oversight of risk management activities within the Line of Business including, but not limited to, reviewing risk assessments, approving risk response plans, and overseeing their implementation, and monitoring risks on the Line of Business’ risk register. By assessing and managing risks from both points of view, PG&E can better manage the interdependencies and drive for consistency in risk management across the Company. In addition, this process increases senior management and board engagement in risk-informed decision-making by involving them in decisions as the process unfolds, and gives those individuals charged with managing specific assets line of sight to other risks in the enterprise. As an example, the enterprise-level risk with the most significant impact on Gas Operations was identified as Transmission Pipeline Failure – Rupture with Ignition from the Transmission Pipe asset family, as part of the 2017 risk assessment process.

Each year, using a consistent methodology in accordance with the Enterprise Operational Risk Management guidelines, Gas Operations identifies, assesses and ranks its risks in a Risk Register. The

development of the Gas Operations Risk Register is governed by the Gas Operations Risk and Compliance Committee. Gas Operations communicates its top risks, identified in the Risk Register, to PG&E's executive leadership team at the Integrated Planning Process "Risk and Compliance Session," typically in the first to second quarter of each year. This process, referred to as "Session D," endeavors to reflect the highest risks to the business, and mitigation of these risks is then addressed in the corporate strategy and the executable investment plans as part of Session 1 and Session 2. Risks, including the key risks for each asset family identified during Session D, are captured within the Asset Management Plans, mitigation programs, and work projects.

a) ENTERPRISE AND OPERATIONAL RISK MANAGEMENT

As part of PG&E's Session D process, the Company develops its enterprise-level risks. Enterprise risks are communicated across the company and undergo additional review and monitoring throughout the year. As the result of the risk refresh process and the 2017 Session D, Gas Operations identified 214 risk drivers, which resulted in 34 risks. Of the 34 Gas Operations risks, nine were enterprise risks. Table 9 reflects the nine Enterprise Risks:

Table 9 – 2017 Gas Enterprise Risks	
Risk	Description of Risk and Risk Drivers
Transmission Pipeline Failure – Rupture with Ignition	<p>Rupture of transmission pipeline may result in loss of containment and/or uncontrolled gas flow leading to potential public safety issues, prolonged outages, property damages and/or significant environmental damage.</p> <p>The drivers of this risk include: External Corrosion, Internal Corrosion, Stress Cracking Corrosion, Manufacturing Related Defects, Welding/Fabrication Related Defects, Equipment Failure, Weather and Related Outside Forces – Land Movement (including Seismic), First, Second, and Third-Party Damage, and Incorrect Operations.</p>
Natural Gas Storage Pipeline or Surface Facility Failure - Loss of Containment with Ignition at Storage Facility	<p>The risk of failure at gas storage facility (related to pipeline or surface equipment) may result in loss of containment with ignition leading to significant impact on public or employee safety, prolonged outages or net replacement of supply, property damage and/or environmental damage.</p> <p>The drivers of this risk include: Internal Corrosion and/or Erosion, External Corrosion, Manufacturing Related Defects, Equipment Related, Third-Party Damage, Seismic, Welding/Fabrication Related Defects and Weather Related/Outside Forces.</p>
Failure to Maintain Capacity for System Demands	<p>The risk of not maintaining adequate capacity to meet customer demand on the gas system may result in customer curtailments, controlled/uncontrolled gas outages, gas surge-backs into homes, serious injury, and possible fatality.</p>
M&C Failure – Release of Gas with Ignition Downstream	<p>The risk of failure at a gas M&C transmission or distribution facility with loss of pressure control may result in loss of containment with ignition downstream at customer location.</p> <p>The drivers of this risk include Incorrect Operations and Equipment Related Defects.</p>
M&C Failure – Release of Gas with Ignition at M&C Facility	<p>The risk of failure at gas M&C transmission or distribution facility may result in loss of containment with ignition.</p> <p>The drivers of this risk include: External Corrosion, Internal Corrosion, Stress Corrosion Cracking, Third-Party/Mechanical Damage, Weather Related/Outside Forces, Welding/ Fabrication Related Defects.</p>
Construction Defect with Release of Gas with Ignition on Distribution Facilities	<p>Construction defect on the distribution pipeline may result in loss of containment, migration and ignition of gas, leading to safety impact and/or property damage.</p> <p>The driver of this risk is Incorrect Operations.</p>
C&P Failure – Release of Gas with Ignition at Manned Processing Facility	<p>The risk of catastrophic loss of containment incident at a manned gas storage processing facility may result in catastrophic safety impacts.</p> <p>The drivers of this risk include: Third-Party/Mechanical Damage, Weather Related/Outside Forces, Manufacturing Related Defects, Welding/Fabrication Related, Defects, Incorrect Operations External Corrosion, Internal Corrosion and/or Erosion Stress Cracking Corrosion.</p>
External Force with Release of Gas on Distribution Facilities	<p>External force to the distribution pipeline may result in loss of containment, migration, and ignition of gas, leading to safety impact and/or property damage.</p> <p>The drivers of this risk include: Third-Party/ Mechanical Damage, Incorrect Operations, Other Outside Force Damage.</p>
Natural Gas Well Failure – Loss of Containment with Ignition at Storage Facility	<p>The risk of failure at gas storage facility (reservoir) may result in loss of containment with ignition leading to significant impact on public or employee safety, prolonged outages or net replacement of supply, property damage and/or environmental damage.</p> <p>The drivers of this risk include: Internal Corrosion and/or Erosion, External Corrosion, Third-Party Damage, Welding/Fabrication Related Defects.</p>

Some risks impact more than one Line of Business; these are called Cross-Cutting Risks. These risks also follow the enterprise and operational risk management process. The cross-cutting risks are owned by a single Line of Business with other impacted Lines of Business providing their input and subject matter

expertise during the risk management process. The gas business is impacted by several cross-cutting risks owned by other Lines of Business as displayed in Table 10 below.

Table 10 – Enterprise Risk Management: Cross Cutting Risks	
Risk	Description
Business Model Risk	The risk of a regulatory decision or series of decisions, that result in a sustained loss of risk adjusted rate of return.
Records and Information Management (RIM) (Enterprise Shared Risk)	Not implementing fully an effective RIM program and controlling data quality may result in the failure to construct, operate, or maintain a safe system. Additionally, inadequate business processes and system controls related to the collection, maintenance and disposition of records and information can result in non-compliance, security gaps, and insufficient or inaccurate data for critical decision making.
Cyber Attack	Introduction of malware or execution of commands by authorized and unauthorized users or hackers, use of infected removable media, exposure to phishing, visitation to infected websites, or exploitation of remote connections may lead to the disruption of the confidentiality, integrity, and/or availability of business control applications, computing, data, or networks.
Contractor Safety	Failure to comply with contractor pre-qualification and field oversight processes may result in serious injury and/or fatalities.
Motor Vehicle Safety Incident	Failure of a motor vehicle safety program may result in serious injuries or fatalities for employees or the public, property damage, and regulatory fines and citations.
Employee Safety	The inability to fully identify, evaluate, and mitigate workplace exposures may result in serious injury and/or fatalities.
Emergency Preparedness and Response to Catastrophic Events	The risk of inadequate plans and poor response execution to a catastrophic emergency may result in safety concerns, extended outages, regulatory action, and reputational damage. This risk includes business continuity for the enterprise outside of the event.
Skilled and Qualified Workforce	The risk of an employee or non-employee working without meeting appropriate legal, regulatory and PG&E-defined requirements. “Requirements” include qualifications (skills, competencies, abilities, knowledge, certifications) for the defined job or work. This may result in one or more of the following: work procedure errors, legal or regulatory non-compliance, cybersecurity breaches, localized outages, damage to property or assets belonging to PG&E, another corporation, a government organization or a member of the public, injury or death to an employee or member of the public.
Insider Threat	A current or former employee or contractor uses their company issued PG&E access and company knowledge to harm the company through theft, fraud, sabotage, or workplace violence. Such activities may cause loss of assets or information, financial liability, damage to facilities or systems, or harm to individuals, company assets, or reputation.

PG&E continues to improve its risk management process. PG&E is an active participant in the CPUC’s proceedings to advance a “risk-informed” process. In D.14-12-025, the CPUC adopted a risk-based decision-making framework into the Rate Case Plan for energy utilities. The framework includes the Safety Model Assessment Proceeding (S-MAP) and the Risk Assessment Mitigation Phase (RAMP). S-MAP’s focus is on the models each utility is using to evaluate risk with the intent of developing a single model for all utilities. RAMP’s focus is on risk mitigation, alternatives analysis, risk spend efficiency, and a quantitative measure of expected risk reduction. PG&E filed its first RAMP on November 30, 2017. Eight enterprise risks listed above were included in the RAMP submittal. The ninth enterprise risk is the “Natural Gas Storage Pipeline or Surface Facility Failure – Loss of Containment with Ignition at Storage Facility.” During the RAMP model development process, Gas Operations realized that this risk has a similar risk event with similar drivers as the “Transmission Pipe Failure – Rupture with Ignition” risk for

the pipeline assets within Storage facility and the “C&P Failure – Release of Gas with Ignition at Manned Facility” risk for the surface facility assets within Storage facility. As such, this risk was modeled with the Transmission Pipeline and the C&P risks in the RAMP submittal.

4. RECORDS AND INFORMATION MANAGEMENT

PG&E’s Gas Operations records management team, as part of the Enterprise RIM (ERIM) Program, focuses on the deployment of consistent, integrated processes that support records development associated with operational safety, regulatory compliance, and knowledge management. ERIM is responsible for assessing and inventorying physical and electronic records, establishing specialized plans for vital records, and monitoring the process controls for protecting and storing records. Examples of RIM initiatives completed in 2017 include:



Figure 17 – Records and Information Lifecycle

- Communication of nine Enterprise Records and Information Standards providing guidance on the requirements of PG&E’s records management program.
- Publication of GOV-6010S “Enterprise Process Map Standard” which provides guidance for identifying records during the creation of process maps.
- Developed 23 records process maps for identified Gas Operations departments. Provided recommendations on RIM best practices and maintained alignment with Process Excellence and ERIM Standards.
- Conducted data cleanse of 168K drawings moved from engineering drawing libraries to a centralized system of record to support better Electronic Records Management.
- Developed indexing guidelines to have the complete population of consolidated inventory indexed in a consistent manner and transitioned 8,900 boxes of paper records to create one repository of Gas records.

These ongoing recordkeeping initiatives continue to support PG&E’s actions to maintain PAS 55-1/ISO 55001, API 1173, and RC 14001 certifications.

A critical component of the Gas RIM Program is the part-time RIM Ambassador network, which was established in 2014 and continues to be an effective way of getting records management information to Gas Operations personnel. The Gas RIM team provides quarterly training to the ambassadors and supports them as they coach field office employees in meeting PG&E’s recordkeeping requirements. Additionally, the full-time Enterprise RIM Coordinator network supports all lines of businesses and all territories throughout PG&E by providing records management resources to the field. In 2017, the Gas RIM Gas Field Office Monitoring and Continuous Improvement Program interviewed personnel at nearly all Gas Field Locations, 97 field identifying areas, for additional training and support. The ERIM team was able to address 97% of the areas identified areas for improvement.

Gas RIM continues to implement and refine the comprehensive roadmap which was initially launched in May 2014. The Gas RIM roadmap addresses requirements, observations and commitments made around improving records management. Table 11 details some key RIM roadmap initiatives and drivers.

Table 11 – Gas Operations Records and Information Management Roadmap Highlights	
Key Roadmap Initiatives	Roadmap Drivers
Rollout of Disposition Program	<ul style="list-style-type: none"> Records-related remedies and recommendations adopted by the CPUC in the San Bruno Order Instituting Investigation (OII) Penalties decision issued in April 2015 and outlined in PG&E’s Initial Compliance Plan associated with Investigation 14-11-008, an OII associated with PG&E’s gas distribution record-keeping practices ARMA International’s Information Governance Maturity Model Continued certification of PAS 55-1 and ISO 55001, API 1173 and RC 14001
Certification of 2017 Records Inventory	
Implementation of increased Records Management functionality in SharePoint and Documentum	

5. MITIGATING LOSS OF CONTAINMENT

PG&E takes a proactive approach to reducing the loss of containment risk, or the unintended release of natural gas. The mitigation programs and projects to address loss of containment vary significantly in size and scope, from actively promoting “Call Before You Dig” and installing pipeline markers over the assets as visual identifiers, to inspecting, testing, and replacing assets that may be deemed beyond their useful life. PG&E remains focused on identifying the right work to protect the public from a loss of containment incident, both now and into the future.

a) DAMAGE PREVENTION

Damage Prevention consists of multiple processes working together to help prevent damage from incorrect operations and primarily excavation activities. Activities, reviewed annually and described in the next sections, include Public Awareness, Dig-In prevention, and Locate and Mark.

Damage Prevention includes marking the field location of underground facilities as requested through the USA One-Call system—commonly referred to as 811, USA ticket management, investigations associated with dig-ins and damage claims, and Public Awareness. The marking of underground utilities is governed by California Government Code 4216 and the process is driven by industry best practices.



Figure 18 – Woodland Arbor Day Celebration

PUBLIC AWARENESS

PG&E's Public Awareness Program conducts educational outreach activities for professional excavators, local public officials, emergency responders, and the general public who live and work within PG&E's service territory. The program communicates safe excavation practices, required actions prior to excavating near underground pipelines, availability of pipeline location information, and other gas safety information through a variety of methods throughout the year including bill inserts, e-mails, brochures, mass media advertising, press releases and participation in community meetings and events.

PG&E conducted 200 "811 Call Before You Dig" contractor workshops, reaching over 5,000 attendees, representing over 600 excavation companies or municipalities.

PG&E communicates gas safety information multiple times each year, and in 2017, reached approximately 4.2 million paper bill customers and sent over 1.7 million e-mails to those customers who receive paperless billing. In addition to the bill inserts and e-mail campaigns, PG&E also sent a targeted direct mail piece to over 2.2 million businesses and residents within 2,000 feet of a PG&E gas transmission pipeline, explaining their proximity to the transmission line, information about how to locate nearby gas pipelines, damage prevention measures (811), how to identify gas leaks, and what to do in the event of a gas leak. Additional targeted mailings were sent to school administrators, excavators, emergency responders, public officials, landscapers, sewer and plumbing companies, farmers, homeowner associations, master meter accounts, and those who live or work near PG&E's un-odorized pipelines or storage and compressor facilities. Table 12 identifies highlights from the Program's 2017 activities.

Table 12 – Public Awareness Highlights

Executed three social media campaigns targeting homeowners, landscapers and farmers, promoting the importance of calling 811 before digging. These campaigns reached over 631,000 customers and led to over 9,000 additional visits to 811express.com, the online ticket submittal website.

PG&E continued to conduct targeted outreach in cities with a high number of dig-ins. The outreach included job site visits, 811 training for top damaging companies and meeting with local leadership to discuss continued partnership for community safety. These targeted efforts resulted in over 10,000 field visits.

Completed 9 bilingual 811 workshops, with a total of 256 participants (farmers, day workers and unlicensed/soon-to-be contractors).

Partnered with California ReLeaf and the US Forest Service to sponsor 49 educational Arbor Day Celebration events, across 20 communities, which included tree plantings, tree care sessions, tree tours and other hands on activities to educate participants on how to plant the right tree, in the right place.

The 811 Ambassador Program provides a response mechanism for PG&E employees to take corrective action when they observe excavation with no delineation or markings. Employees learn how to identify excavation-related delineations and utility operator markings as required by the California One Call Law. If an employee observes excavation without the required marks, they call the Damage Prevention Hotline and in response, a Dig-in Reduction Team (DiRT) member is dispatched to the job site to assess whether the excavation is in compliance with California's One Call Law. If the excavation is found to be in non-compliance with California's One Call Law, the DiRT member takes several actions. S/he requests all excavation be stopped, educates the excavator about the requirements of California's One Call Law and the reason for the non-compliance, provides excavation safety materials, and instructs the excavator to correct the noncompliance activity prior to continuing any excavation. In 2017, Damage Prevention received 4,257 calls (58% increase from 2016).

PG&E continues to participate in the Gold Shovel Standard. PG&E began this program that is now run by a third-party and available to utilities across the nation. The program sets safety criteria that second-party contractors are required to meet in order to be eligible to do work on behalf of the utility. The Gold Shovel Standard became an internationally recognized program, with companies in Canada adopting and implementing its certification requirements. The Gold Shovel Standard program is one way that PG&E is making its own communities safer, but also bringing best safety practices to the industry.

DIG-IN PREVENTION

PG&E continues to push for improved performance in dig-in prevention by determining the root causes of excavation damage to PG&E's facilities, identifying process improvements to reduce damages, and actively pursuing cost recovery from contractors responsible for excavation damage. Dig-In Prevention is a proactive program that directly and positively affects public and employee safety by striving to reduce the number of potentially dangerous excavation damage incidents. PG&E's Dig-In Prevention programs were instrumental in reducing the average number of dig-ins per 1,000 tickets from 2.02 in 2016 to 1.89 in 2017.



Figure 19 – PG&E Advertisement

Table 13 below provides information on some dig-in prevention projects or process improvements.

Table 13 – Dig In Prevention	
PG&E’s Commitment to Safety	Promoting Safety
DiRT	Deploying investigators to oversee and enhance PG&E’s ability to investigate dig-ins, patrol active dig-ins and excavations, and intervene when non-compliant and unsafe activities are identified.
Gold Shovel Standard*	Require contractors excavating on behalf of PG&E to obtain the Gold Shovel certification. Acknowledge all contractors who practice safe excavation; monitor offenders who fail to demonstrate safe practices. Unsafe contractors lose their certification.
811 Ambassador Program	PG&E employee program to identify unsafe excavation activities and take appropriate intervention measures.
Pipeline Patrol	Identifying and intercepting threats to the transmission system via aerial and ground patrolling.
811 Workshops	Conducting safe digging workshops throughout the service territory.
Damage Prevention Manual & Training	Providing clear and concise instruction around dig-in prevention measures like troubleshooting “difficult to locate” facilities.

* Beginning January 1, 2016, contractors who wish to excavate or subcontract out excavation work for PG&E must obtain Gold Shovel Standard Certification by making a commitment to safe digging practices in accordance with the California “One Call Law” (California Government Code 4216) and the Common Ground Alliance best practices for excavation.

LOCATE AND MARK PROGRAM

The Locate and Mark Program is designed to mitigate the potential risk of damage to underground facilities by identifying and marking assets for potential excavators within a 48-hour window. Federal pipeline safety regulations¹⁴ and California state law¹⁵ require that PG&E belong to, and share the cost of operating, the regional “one-call” notification system. Builders, contractors, and others planning to excavate, must use this system to notify underground facility owners, like PG&E, of their plans to excavate. PG&E then provides the excavators with information about the location of its underground facilities, both natural gas and electric. Information is normally provided by having a PG&E locator visit the work site and place color-coded surface markings to show where pipes and wires are located. Because of its large service territory, PG&E belongs to two regional one-call systems which share a common toll-free, 3-digit “811” telephone number. The California one-call systems are commonly referred to as USA. In 2017, PG&E received over 987,718 USA tickets.¹⁶

b) DISTRIBUTION PIPELINE REPLACEMENT

An important element of providing safe gas distribution service is replacing aging or at-risk assets. PG&E uses relative risk in prioritizing its pipeline replacement projects. Risk factors include age, material type, leak history, cathodic protection, seismic impact, proximity to the public, and other operational factors. In addition to gas main replacement, the program covers related service replacement and meter relocation work.

PG&E has three pipeline replacement programs to improve distribution safety: Gas Pipeline Replacement Program (GPRP), Plastic Pipe Replacement Program, and Main Replacement Reliability Program. PG&E’s objective is to achieve an asset age limited to less than 100 years.

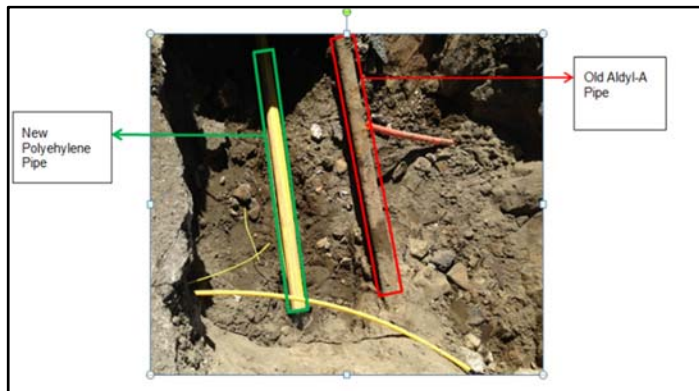


Figure 20 – Old Aldyl-A Pipe and New Polyethylene Replacement

Table 14 – Pipeline Replacement		
Gas Pipeline Replacement Program	Plastic Pipe Replacement Program	Main Replacement Reliability
Over the past 30 years the GPRP Program, focused on the replacement of cast iron and pre-1940 steel pipe, has enabled PG&E to deactivate all cast iron main (over 830 miles of pipe). GPRP is now focused on replacing pre-1940 steel pipe. In 2017 the GPRP Program replaced 36 miles of pipe.	Since PG&E began its Plastic Pipe Replacement Program in 2012, PG&E has replaced about 340 miles. In 2017, approximately 95 miles of Aldyl-A were replaced. PG&E continues to increase the replacement of Aldyl-A year-over-year in recognition of the approximately 5,400 miles of known inventory.	The Reliability Main Replacement Program focuses on the replacement of pipeline not covered by the GPRP or Aldyl-A programs and will continue to help move the distribution systems average age closer to the national average. In 2017, PG&E replaced 14 miles of distribution pipe through this program.

c) CROSS-BORE MITIGATION

A cross-bore¹⁷ is a gas main or service that has been installed unintentionally, using trenchless technology, through a wastewater or storm drain system. PG&E has an inspection program to identify and remediate gas cross bores, and a public outreach program that provides safety information to PG&E customers, sewer districts, and public works agencies. In addition, PG&E has implemented a Gas Cross bore Prevention Program that uses video camera inspections to verify no damage has occurred to sewer lines when using trenchless construction methods on new construction projects.

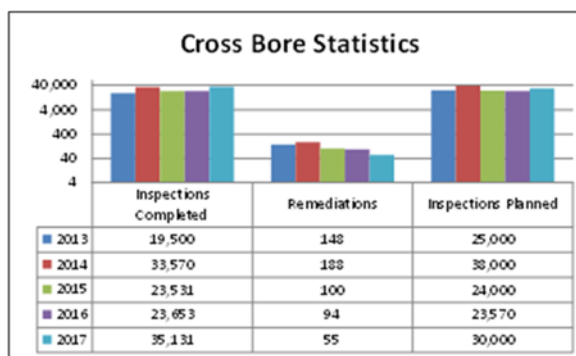


Figure 21 – Cross-Bore Statistics

The goal of PG&E’s Cross-Bore Inspection Program is to identify cross-bores by completing inspections of potential conflict locations and repairing all occurrences as they are discovered.

PG&E completed 35,131 inspections in 2017 (135,385 inspections since 2013). In 2017, PG&E found approximately 2 cross bores per 1,000 inspections — below the reported industry benchmark of about 6 cross bores per 1,000 inspections.

d) STRENGTH TESTING

PG&E’s transmission pipeline strength testing program is designed to allow PG&E to find pipeline defects that could subsequently cause a rupture or leak, and then repair these defects or anomalies in the pipeline. The hydrotesting process, a form of strength testing, takes a pipeline out of service, clears it of gas, cleans it internally, then fills it with water to pressures usually at or exceeding 1.5 times the MAOP. This process also results in a test record that establishes the operating pressures the pipe can withstand. A secondary benefit of hydrotesting for PG&E is that the pipeline is typically upgraded to allow for



Figure 22 – Pipeline segment replacement following a strength test.

navigation of the cleaning tools (pigs), allowing PG&E to run inspection tools at later dates [See Section: *In-Line Inspection page 34*]. Thus, hydrotesting is one tool PG&E uses to maintain margin of safety for the transmission pipeline, and reduces the likelihood of future loss of containment incidents that could pose a risk to public safety.

PG&E’s ultimate goal is to strength test or replace untested transmission pipeline by the end of 2026. Once completed, PG&E will have a test record for its entire gas transmission pipeline. In 2017, PG&E completed approximately 253 miles of hydrotesting (Table 15). This work brings PG&E to a total of approximately 1,095 miles hydrotested since 2011. The pipeline miles strength tested in 2017 were prioritized based on a risk informed mix of integrity management threats and testing untested pipe or pipe lacking a record of a test.

Table 15 – Hydrostatic Strength Testing Program							
Strength Test (miles)	2011	2013	2014	2015	2016	2017	Total
PSEP		539	135	N/A	N/A	N/A	674
Subsequent Testing		0	0	79	89	253	421
Total		539	135	79	89	253	1,095

PG&E’s 4-year hydrotesting goal (2015-2018) is 680 miles.¹⁸ In 2017 and 2018, PG&E will concentrate on long-line testing to meet the 680-mile goal, and shorter pipeline segment tests will be

spread over a longer period. Looking ahead, PG&E proposes in its 2019 GT&S rate case to complete 37 miles per year or approximately 110 miles of hydrostatic testing between 2019 and 2021.

e) VINTAGE PIPE REPLACEMENT

A significant portion of PG&E’s natural gas transmission pipeline system—approximately 47 percent—was designed, manufactured, constructed, and installed before the advent of California’s 1961 pipeline safety laws. While age alone does not pose a threat to pipeline integrity, PG&E has determined, consistent with industry practice, that some vintage pipeline features, in particular pipeline with certain welds, bends, and fittings located in areas subject to land movement, are most appropriately managed through replacement.



Figure 23 – Crew Replaces Vintage Pipe in San Francisco

In 2017, PG&E updated its risk methodology which changed our strategic risk prioritization approach to replacing pipe. PG&E redefined high-risk land movement areas, prioritized projects based on total risk, and redefined pipe with lower risk to be monitored for risk change through our ILI and Geohazard programs in lieu of replacement. Due to the revised risk methodology, PG&E has now identified approximately 164 miles (Tier 1 and Tier 2) of transmission pipe,¹⁹ with some of the characteristics that make it more susceptible to certain construction threats. Of those 164 miles identified, PG&E further identified approximately 80 miles (Tier 1) of high risk pipe targeting replacement where vintage fabrication and construction threats interact with high likelihood of land movement in populated areas.²⁰ Additionally, PG&E is monitoring an additional approximately 1,316 miles of pipeline with girth welds through in-line inspections or the Geohazard program. In 2017, approximately 3.5 miles of pipe were replaced and 11.9 miles were retired.

Table 16 – Vintage Pipe Replacement Program		
	Miles Complete/Target	% High Risk Mileage Addressed ²¹
Pre 2015	16 miles	16%
2015	10 miles	27%
2016	9 miles	37%
2017	15 miles	52%
2018 Target	20 miles	87.5%
Program Target:	80 miles	100%

As PG&E continues to monitor and assess characteristics of vintage pipelines interacting with land movement through improved data quality and collection, its replacement is prioritized by replacing

sections of pipeline closest to highest density population areas with a high likelihood of ground movement. At PG&E’s current and planned rate, the program will address the risk of pipe containing vintage fabrication and construction threats that interact with high risk of land movement for high population density areas by 2027.

f) IN-LINE INSPECTION

PG&E’s In-Line Inspection Program uses technologically advanced inspection tools, often called “smart pigs,” to reliably assess the internal and external condition of transmission pipe so that action can be taken when issues are identified. Prior to running an In-Line Inspection tool in a pipeline, a pipeline must be modified with portals called “launchers” and “receivers” and pipeline features that would obstruct the passage of the tool to make the pipeline piggable must be replaced. After the pipeline is upgraded



Figure 24 – ROSEN Electro Magnetic Acoustic Transducer (EMAT) Tool After an Inspection on L-300B

to accommodate an In-Line Inspection tool, cleaning and inspection “runs” are conducted to collect data about the pipe. This data is analyzed for pipeline anomalies that must be remediated through the Direct

In-Line Inspection is the MOST RELIABLE pipeline integrity assessment tool currently available to natural gas pipeline operators to assess the internal and external condition of transmission line pipe.

Examination and Repair process where the anomaly is exposed, examined and repaired as necessary. The information from Direct Examination and Repair is used to generate mitigation activities to improve the long-term safety and reliability of the pipeline.

before to reach the goal of 66 percent total system mileage piggable by 2026. As of 2017, approximately 28 percent of the system is piggable. Much of PG&E’s pipeline was installed decades before in-line inspection was invented. Today, about 35 percent of the PG&E system is not capable of supporting the running of traditional In-Line Inspection

The Traditional²² In-Line Inspection Program is ramping-up to complete more projects in the next nine years than ever

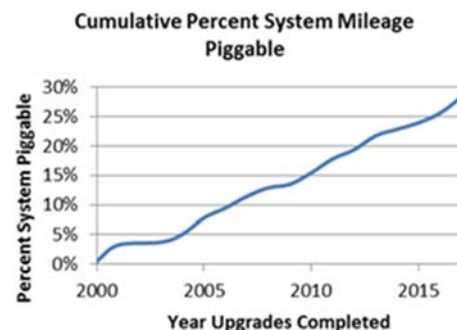


Figure 25 – Cumulative % Transmission System Mileage Piggable

tools because of design elements like low pressure and/or low flows, small diameter pipelines, and short sections of pipeline or facility configurations, such as drips or blow downs. Figure 25 details PG&E's progress to-date to upgrade pipelines to make them capable of accepting traditional In-Line Inspection tools.

g) CORROSION

All of PG&E's metallic assets are susceptible to corrosion—a natural, time dependent process where

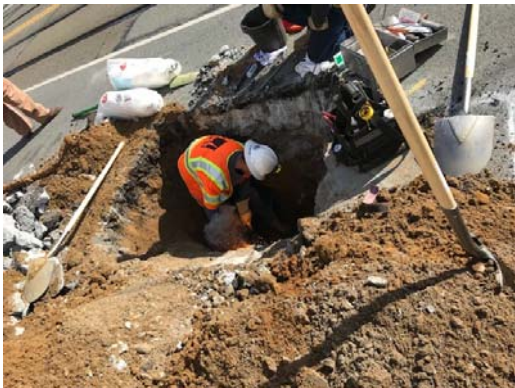


Figure 25 – PG&E Employee Installing a Galvanic Anode

metal degrades (rusts) due to its interaction with the environment. Gas transmission, storage, and distribution assets primarily comprised of steel pipe carrying compressed natural gas may experience degradation due to external corrosion, internal corrosion, or stress corrosion cracking. External corrosion is degradation of the pipe due to interaction of the steel with the atmosphere, soil (buried piping), and/or water (submerged piping). Internal corrosion

is degradation of the pipe due to interaction of the steel with the natural gas being transported. SCC is degradation of the pipe due to cracks induced from the combined influence of tensile stress²³ and a corrosive environment. The material degradation associated with all forms of corrosion may reduce the integrity of steel assets and threaten PG&E's ability to safely and reliably transport natural gas. PG&E assesses the risk of External Corrosion, Internal Corrosion, and SCC independently because each requires a different form of mitigation.

Given the risk profile associated with corrosion, PG&E has sought out highly qualified corrosion experts from around the country, enhanced procedures, and incorporated systematic, risk-informed methodologies to its corrosion control approach. PG&E's efforts are resulting in more accurate data on which to make decisions related to the identification and mitigation of corrosion risks, improving the safety and reliability of PG&E's assets.

For example, PG&E mitigates the threat of External Corrosion by installing assets with appropriate coatings and by applying cathodic protection to buried or submerged structures. Cathodic Protection mitigates corrosion through administering direct current through the soil and/or water to steel piping. Coatings mitigate corrosion by forming a barrier between the steel and environment. As coating systems on buried and submerged piping systems cannot readily be inspected for degradation, the use of cathodic protection in conjunction with coatings provides additional protection for buried or submerged assets.

PG&E also monitors for conditions that may limit the ability to maintain adequate levels of cathodic protection on buried or submerged assets. Such conditions include electrically shorted casings and electrical interference from electric transmission equipment, municipal rail systems, and other operators' corrosion control systems. Overall, corrosion control at PG&E consists of the programs below:

Table 17 – Corrosion Control Programs	
Program	Program Description
Atmospheric Corrosion	Addresses deterioration of coating systems on assets designed for above ground use. Program includes field inspections and mitigation. PG&E has remediated 510 out of 641 spans, and 347 out of 489 stations from 2013 through 2017.
Casings	Identifies and remediates electrically shorted cased crossings. PG&E is targeting to mitigate 83 casings by the end of 2018.
Cathodic Protection (CP New, CP Replace, 850 Off)	Designs, installs, and maintains cathodic protection systems to prevent corrosion. PG&E installs new and replaces depleted CP systems. In addition, PG&E is surveying and enhancing Transmission CP levels system wide. 2018 goal is to survey roughly 3,100 miles of Transmission pipe.
Close Interval Survey	Collects survey data pertinent to Cathodic Protection levels, coating condition, and other issues at intervals between test points. PG&E has surveyed approximately 1,000 miles of transmission pipeline, and plans to survey 1,400 miles in 2018.
Corrosion Investigations	Investigates the cause of insufficient cathodic protection levels or other issues and recommends mitigating solutions.
Enhanced Cathodic Protection Resurvey	Evaluates cathodic protection area boundaries and protection status and updates documentation to ensure that Cathodic Protection systems are operating properly. In 2017, PG&E surveyed over 667 miles of distribution pipe and performed 218 casing tests.
Electrical Interference – AC	Mitigates the threat of alternating current interference with investigative modeling and installation of grounding and/or shielding equipment. PG&E performed 3,955 Arc Fault Investigations from 2013-2017.
Electrical Interference – DC	Addresses the risk of direct current interference with investigation and installation of Cathodic Protection, bonding, or other equipment. PG&E closed 241 items between 2013-2017.
Internal Corrosion	Monitors for and mitigates the threat of Internal Corrosion with probe, coupon, and drip monitoring, chemical treatment, Internal Corrosion investigations, non-destructive examination, and other activities. Internal Corrosion Modeling of Meridian and Rio Vista storage field completed in 2017.
Routine Maintenance	Pipeline safety regulations require PG&E to conduct rectifier checks; pipe-to-soil, casing-to-soil, and other reads; and atmospheric corrosion inspections on a regular basis. PG&E continues to grow its crew of corrosion mechanics with training and apprenticeship programs.
Test Stations	Installs test stations in areas where there are inadequate test points along pipeline. PG&E has installed 616 out of 2,530 Coupon Test Stations from 2013-2017.

PG&E continues to advance its goal of building a best-in-class corrosion control program by incorporating industry corrosion control standards, peer operator experience, third party evaluations, and corrosion research into its standards and procedures. PG&E actively participates in corrosion research conducted by the Pipeline Research Council International (PRCI) and supports efforts to incorporate the results of such research into corrosion control regulations and standards through its

participation in National Association of Corrosion Engineers (NACE) International, the Interstate Natural Gas Association of America (INGAA), and the American Gas Association (AGA).

h) EARTHQUAKE FAULT CROSSINGS

PG&E’s Fault Crossings Program addresses the specific threat of land movement at active earthquake faults that subject a pipeline to external loads due to seismic events. The program is consistent with California law that requires natural gas operators to prepare for and minimize damage to pipelines from earthquakes. PG&E performs system wide studies to address both the anticipated geologic movement and pipeline mechanical properties to manage the integrity of the pipe (Table 18). Additional mitigation work is then prioritized, following each study, by taking into account the likelihood of failure (the probability that the fault will trigger a seismic event), and the consequences of failure (including the impact on the local population, PG&E system reliability, and the environment). Mitigation typically includes modified trench designs, trench adjustment, pipe replacement, or installation of automated isolation valves.

Table 18 – Earthquake Fault Crossing Program		
	Studies ¹	Crossings Mitigated ²
Pre 2015	52	24
2015	65	18 ^a
2016	65	6 ^b
2017	20	6 ^c
2018	17	3 ^d

- a. 2015 – 14 crossings were FFS per current design.
- b. 2016 – 3 crossings were FFS per current design.
- c. 2017 – 4 crossings were FFS per current design.
- d. 2018 – 3 planned for mitigation. Crossings deemed as FFS per studies are TBD.

1 Studies are conducted to determine if pipe is fit for service (FFS) with geological, pipe assessments.

2 Crossing is mitigated if pipe meets or is designed, retrofitted, or replaced to satisfy the FFS criteria.



Figure 26 – Pipeline 2BA As-found Condition After the 2014 Napa Earthquake

i) LEAK SURVEY

Pipeline safety regulations require PG&E to conduct routine leak surveys on its gas system to find gas leaks. The frequency of the leak surveys depends on the type of facility, operating pressure, and class location of the pipe.

PG&E outlines current requirements, standards, and guidelines for the Leak Survey and Detection Program in its procedures.²⁴ In 2017, PG&E surveyed over one million, over 15,000 gas transmission pipeline miles for compliance, and performed daily leak surveys on 117 wells in compliance with the

California’s Division of Oil and Gas Resources emergency gas storage regulations.²⁵ Also, PG&E is performing quarterly surveys in compliance with California Air Resources Board regulations. PG&E leak surveys more assets today for reasons including that the implementation of GO-112F changed the survey frequency for some gas transmission pipelines.²⁶ Summaries of PG&E’s 2018 Leak Survey cycles for its distribution and transmission pipeline systems are shown in Table 19 below:

Table 19 – Leak Survey Frequency		
Facility Types		Survey Frequency
All Company facilities w/in business districts and public buildings	Distribution (MAOP <60 psig)	Annual
Buried metallic facilities not under Cathodic Protection and not covered by an annual requirement		3 years
Balance of underground distribution facilities		3 years
DOT Transmission All Odorized Transmission	Transmission (MAOP > 60 psig)	Semi-Annual
Gathering: Class 1, 2, 3 and 4	Transmission (MAOP > 60 psig)	Semi-Annual
Stations: Class 1, 2, 3, and 4	Transmission (MAOP > 60 psig)	Semi-Annual
Perimeter of Enclosed Electric Substations and Switching Stations		Every 6 months
Wellhead, attached pipelines, and surrounding area in 100-ft radius	Gas Storage	Daily
CARB	Gas Storage	Quarterly

In 2015, PG&E fully implemented the use of an advanced leak detection technology (Picarro Surveyor) into a standard leak management operating model called Super Crew.²⁷ PG&E’s Super Crew model is now being used in each division as a standalone process. This has created additional efficiencies and lower overall cost to the company. Using this new model, we have been able to complete our compliance survey in a timelier fashion. The second step in the model’s process is to immediately repair all hazardous leaks identified during the survey and to schedule for repair all identified leaks that meet the schedulable leak criteria. Finally, PG&E bundles the scheduled leak repair job packages allowing a more efficient and effective repair strategy. PG&E continued this process in 2017 and met 75 percent of its 4-year distribution system compliance survey requirements using its local Super Crew/Picarro approach. All repairs were made by local crews by the same bundle approach used in the Super Crew model.

PG&E transitioned from a 5-year gas distribution compliance survey to a 4-year survey cycle in 2017, and is transitioning to a 3-year survey in 2018. PG&E will continue its expanded use of its Super Crew model in all of its divisions, completing at least 75 percent²⁸ of its gas distribution compliance survey using Picarro technology. The expanded use of the Super Crew model and the acceleration of leak survey cycle will continue to support PG&E in its ability to: (1) find and fix more leaks, thereby eliminating more potential hazards to the public; (2) significantly reduce the number of Grade 2 open leaks present on the system at any time (the leaks that occur between surveys); and (3) reduce GHG emissions.

To further enhance its distribution Leak Survey process, initiatives are in progress to support PG&E's transition to a 3-year leak survey cycle including implementing technology to enable an end-to-end paperless leak survey process, and integration with enterprise systems.

j) LEAK REPAIR

Similar to Leak Survey, pipeline safety regulations and guidelines require PG&E to repair certain leaks. In 2017, PG&E's trained and operator-qualified personnel classified leaks into three grades (Grade 1, 2, and 3)²⁹ based on the severity and location of the leak, the risk the leak presents to persons or property, and the likelihood that the leak will become more serious within a specified amount of time. PG&E's leak grading practices for Grade 3 leaks exceed industry guidance, as set by the American Society of Mechanical Engineers (ASME) Gas Piping Technology Committee Guide for Gas T&D Piping systems.³⁰ PG&E also repairs, rather than rechecks, above-ground Grade 3 leaks on its distribution system, and has begun repairing all Grade 3 leaks on its transmission system within 12 months of discovery in accordance with the CPUC's GO 112F. In 2018, PG&E will begin repairing a portion of its below-ground Grade 3 distribution leaks in an effort to further reduce greenhouse emissions.

In 2017, PG&E used its continuous improvement approach to make more efficient how we bundle and schedule leak repairs. Having all of the work required in an area at one time provides opportunity to bundle work locations and effectively maximize the utilization of resources. In 2017, PG&E repaired nearly 24,000 gradable leaks on the gas distribution system. Those repairs aided PG&E in maintaining a low open leak inventory of 65 Grade 2 leaks at the end of the year.

PG&E continues to review and improve its standards, procedures, field processes and equipment in an effort to further reduce the public safety risk of and the emissions from gas leaks.



Figure 27 – PG&E's M&C Crew at Work

k) PIPELINE PATROL AND MONITORING

Pipeline Patrol is a federally required activity that is essential to protecting the integrity of PG&E gas transmission facilities from external threats and, in doing so, helps to increase public safety. Patrol is performed by operator-qualified personnel who observe surface conditions near the Right-of-Way of transmission pipelines and selected distribution facilities. Patrollers identify and report a variety of observations including abnormal operating conditions (AOC), potential threats to pipeline integrity (e.g., digging, farm-field ripping, boring, blasting, etc.), new construction that may affect Class Location or High Consequence Areas, vegetative cover, and structural encroachments.

Exceeding federal requirements, PG&E's Pipeline Patrol Program seeks to conduct patrols of the entire transmission system on a monthly basis.

PG&E primarily utilizes aerial methods to conduct patrols, with ground personnel dispatched to investigate observations made from the air. Exceeding federal requirements, PG&E's Pipeline Patrol Program seeks to conduct patrols of the entire transmission system on a monthly basis, as well as meet an internal goal to patrol pipelines located in High Consequence Areas (populated areas) a second time each month. Special patrols may also be performed following natural disasters or other incidents as necessary. Aerial patrols provide real-time knowledge of on the ground activities and the surveillance helps PG&E to identify and stop unsafe excavation practices before dig-ins occur.

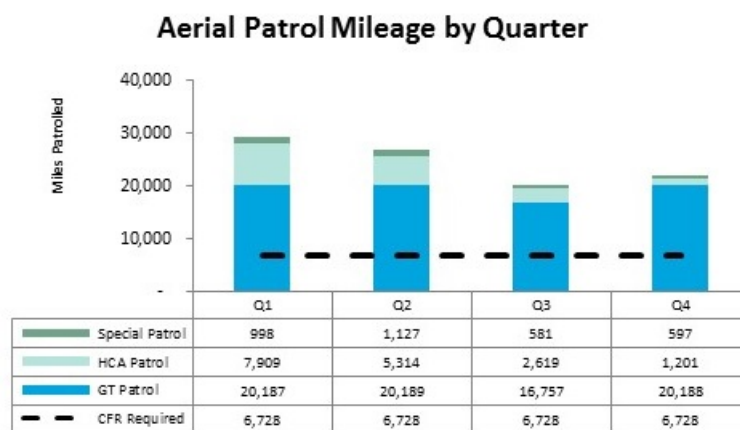


Figure 28 – 2017 Aerial Patrol Mileage by Quarter

In 2017 pipeline mileage covered by aerial patrols totaled more than 97,000. Program goals for 2018 include:

- Leveraging newly installed LiDAR system to benefit other lines of business across PG&E, such as TIMP and Class Location;
- Increasing Patroller headcount to operate LiDAR systems; and

- Using a newly purchased fixed wing plane for patrol and increased LiDAR collection.

1) PIPELINE MARKERS

The single leading cause of damage to underground pipelines, including catastrophic failures, is a “dig-in,” when contact is made with a pipeline, resulting in the release of natural gas. A dig-in is an example of a loss of containment incident. Pipeline markers and indicators are important damage prevention tools used to indicate the approximate location of the respective pipeline along its route. Installing markers is required by pipeline safety regulations because markers contribute to public awareness and damage prevention, which in-turn reduces the risk of loss of containment.

The Pipeline Markers are signs on the surface above or near the natural gas pipelines located at frequent intervals along the pipeline Right-of-Way. The markers are typically found at various important points along the pipeline route including highway, railway, waterway intersections, spans, angle points (bends), and other road crossings. These markers display the name of the operator and a telephone number where the operator can be reached in the event of an emergency. They are meant to be highly visible along the right-of-way and appear in different forms as in the examples in Figure 29.

In the event of an emergency or natural disaster, markers may be the only indication to the public and emergency responders that natural gas pipelines are in the area. A correctly-installed and well-maintained marker serves in this capacity 24 hours a day, 365 days a year.

In 2017, PG&E installed 2,514 pipeline markers and repairs were made to 885 existing pipeline markers. New decals with current telephone numbers were applied, increasing community safety and gas transmission pipeline visibility above ground. Going-forward, PG&E will focus on maintaining its existing marker inventory and adding new markers as needed.



Figure 29 – Crew completing the installation of a new pipeline crossing marker

m) COMMUNITY PIPELINE SAFETY INITIATIVE

The PG&E share-holder Community Pipeline Safety Initiative focused on enhancing safety and reducing risk to PG&E's gas transmission pipelines. The program involves working collaboratively with more than 12,000 customers in more than 380 communities to check the area above PG&E's 6,750 miles of gas transmission pipeline. When structures and vegetation are located too close to the pipeline, they can delay critical access for first responders and safety crews or threaten the integrity of the pipeline. The program was initially anticipated as a five-year initiative ending in December 2017; it has been extended through December 2018 due to long-lead permitting and the amount of time it has taken to reach agreements with some customers and municipalities. A limited amount of work is expected to extend beyond 2018.

This safety program began with a comprehensive centerline survey completed in December 2013 that allowed PG&E to precisely locate and monitor its gas transmission pipelines and input the data into a new Geographic Information System (GIS). Efforts to date have also included replacing damaged or aging pipeline markers and, in some cases, installing new markers throughout PG&E's service area. The remaining Community Pipeline Safety Initiative projects are listed below:

- **Structure Projects** – The program team is working with local municipalities and commercial and residential private property owners to address 360 miles of structures that are located within PG&E rights-of-ways and could interfere with access to the pipeline and its ongoing safe operation. When a structure is identified in the pipeline right-of-way, PG&E works with the local jurisdiction or property owner to remove and/or relocate the structure outside of the right-of-way and away from the pipeline.
- **Vegetation Projects** – The program team is working with cities, counties and private property owners to clear 1,553 miles of vegetation (trees and brush) from the area above the transmission pipeline that could impede access in an emergency or for critical maintenance work or cause potential damage to the pipe. When trees are located too close to the gas pipeline, they can also interfere with PG&E's ability to monitor the area and ensure the pipeline is operating safely. There is also a greater likelihood of third parties digging into the pipeline and causing damage if the pipeline area is not clearly visible. PG&E offers tree replacements and restoration for any trees that need to be removed for safety reasons.



Figure 30 – Vegetation can affect PG&E’s ability to respond to emergencies.

Since the Community Pipeline Safety Initiative began in 2013, PG&E has cleared a total of 352 structure miles and 1,439 vegetation miles, improving the overall safety and reliability of the gas transmission system. Going forward, PG&E is committed to continuing to work with customers to keep the area around the gas pipeline safe and clear, as part of our ongoing pipeline operations and maintenance.

Vegetation Miles Addressed				Structure Miles Addressed			
	Act + Fcst	Cumulative %	Complete		Act + Fcst	Cumulative %	Complete
2013	115	7%	115	2013	5	1%	5
2014	146	17%	146	2014	110	32%	110
2015	380	41%	380	2015	93	58%	93
2016	540	76%	540	2016	114	90%	114
2017	258	93%	258	2017	30	98%	30
2018	114	100%		2018	8	100%	
Total	1,553		1,439	Total	359		352

As of 12/31/17, approx. 93% of vegetation miles have been addressed (1,439/1,553)

As of 12/31/17, approx. 98% of structure miles have been addressed (352/359)

Figure 31 – Overall Community Pipeline Safety Initiative Program Metrics (2013-2017)

6. MITIGATING LOSS OF SUPPLY

In 2017, PG&E transported and delivered about 1,000 billion cubic feet of gas.³¹ To provide context, a cubic foot of gas is enough to fill a basketball and 1,000 cubic feet is enough to meet the needs of an

average home for five days.³² PG&E works year-round to assure system reliability through its management of system pressure, capacity, monitoring, and controls. The following sections discuss PG&E's programs designed to mitigate the risk of losing gas supply.

a) SYSTEM PRESSURE AND CAPACITY

PG&E designs and operates its gas system to ensure safe pressure regulation and adequate gas supplies. PG&E continuously monitors the pressure of its system [See Section: *Gas System Operations and Control page 49*]. Additionally, PG&E measures and works to reduce over-pressure incidents. PG&E's gas systems are designed to meet all expected core demands (residential and small commercial customers), with non-core demand (large commercial, industrial or institutional customers) assumed fully curtailed on a design temperature that is the coldest temperature that may be exceeded one in every 90 years (referred to as an Abnormal Peak Day, or APD). Also, PG&E's gas systems are designed to meet all expected core and non-core demand during the coldest temperature that may be exceeded one in every two years (referred to as a Cold Winter Day, or CWD).

The last time PG&E's gas system was successfully tested in real-time was in December 2013, when the system experienced two days below the one-day-in-two-year Cold Winter Day standard. Sacramento experienced colder temperatures, below the Cold Winter Day criteria for five days. However, PG&E was able to provide continuous gas service to all core customers and, consistent with system planning, requested curtailments of up to 61 non-core customers, customers whose rate agreement includes a curtailment provision.

In October 2017, a major capacity project was placed in service in the Sacramento Valley. The Line 407 Expansion Project comprises 26 miles of 30-inch diameter pipeline from the town of Yolo to the city of Roseville, two Main Line Valve (MLV) Stations, and one Pressure Limiting Station (PLS). The additional capacity from Line 407 will save \$150 million (Net Present Value) over 20 years, eliminate eleven manual operations that were required during cold weather (on APD and CWD conditions), and enable pressure reductions (full Normal Operating Pressure (NOP) reductions) of 441 miles of transmission and 1,350 miles of distribution main.

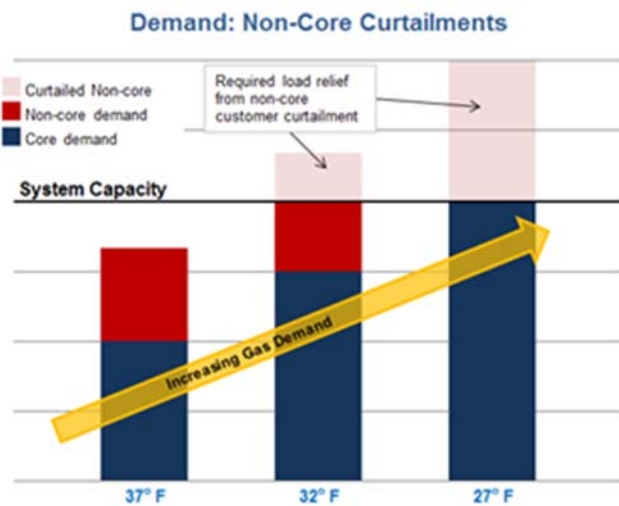


Figure 32 – How Demand for Gas Affects Capacity

Insufficient capacity, resulting in reliability issues, can pose significant public health and safety risks. For instance, a lack of pipeline capacity could lead to a loss of gas service that customers depend on for daily life activities including space heating, water heating, and cooking. In very cold weather, loss of space heating can itself be life-threatening, and can prompt customers to use unsafe heating alternatives. Loss of gas service can also lead to extinguished pilots and the subsequent

potential for un-combusted gas entering affected buildings. In some scenarios, loss of gas service can affect electric generation, which can also result in health and safety concerns.

PG&E drives the quality of its planning effort through a matrix of tools, processes, personnel, standards, internal and external data, and documentation that provide the appropriate level of oversight and control to its management team.

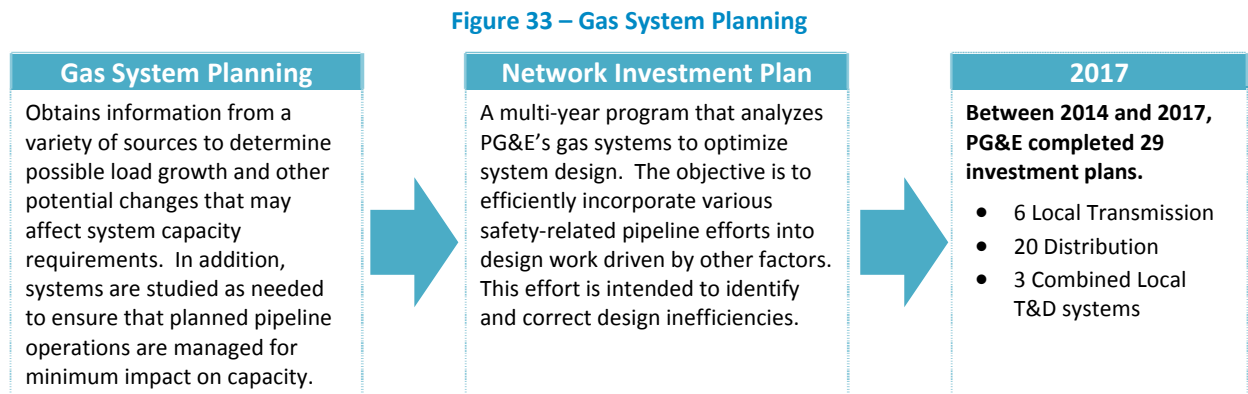


Figure 33 – Gas System Planning

b) OVERPRESSURE ELIMINATION INITIATIVE

A pipeline that operates higher than the MAOP presents an operational risk to the safety of the public, employees and contractors working on the facilities. When a pipeline operates above its MAOP, it is known as an abnormal operating condition and is described as an overpressure (OP) event. OP events have the potential to overstress pipelines and may lead to loss of containment. Large OP events (see Figure 34) pose significant safety and operational impacts to PG&E’s gas system. In 2012, PG&E began an initiative to eliminate

PG&E’s overpressure management achieves top quartile results among benchmarked domestic pipeline.

system OP events and reduce the operational risk. In 2016, PG&E identified human performance and equipment failure as the two most common causes for OP events. Actions to eliminate OP events were implemented, including: station design and construction best practices, lock-out/tag-out process improvements, and information was delivered around associated OP risk factors through training and communication initiatives.

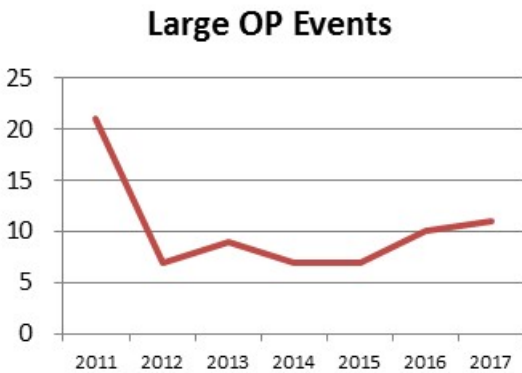


Figure 34 – Large OP Events

In 2017, the focus on corrective actions was directed at human performance and equipment failure. Human performance training rolled out to PG&E’s Gas-Leadership, with communication targeted at sharing OP elimination strategies. PG&E continued to install Supervisory Control and Data Acquisition (SCADA) points annually to increase system real-time visibility in the Gas Control Center, along with equipment to protect downstream systems including

sulfur filters, and secondary OP protection on pilot-operated regulators. An extensive benchmarking project with European operators plus review of European regulations supports the goal to eliminate OP events with this equipment. Large Volume Customer regulation sets also received accelerated inspections. In 2018, we will continue the work streams previously set up to install visibility, reduce risk with equipment, and develop a long-term implementation plan.

PG&E continues to modify operations and upgrade gas system regulation equipment to provide greater separation between normal operating pressures and the MAOP. Each activity builds on the goal to reduce OP events, contributing to system safety.

c) OPERATIONS CLEARANCE PROCEDURE

An important part of public and employee safety is the use of the Gas Clearance procedure. Clearance procedures are an added safety step or layer of protection to confirm that a plan and procedure to protect employee and public safety is in place before work is performed on either the transmission or distribution gas system. The Clearance Procedure is used for all work that impacts gas flows, pressures, remote monitoring and control, or gas quality. All clearances are approved by Gas Control.

In 2015 the separate gas clearances for gas T&D were reviewed and modified to become one single process that would eliminate gaps and improve consistency. In 2016 Hazardous Energy Control was added to the clearance process. Hazardous Energy Control is a lock out/tag out process that adds an extra layer of safety to the clearance process by physically placing locks on equipment being used as

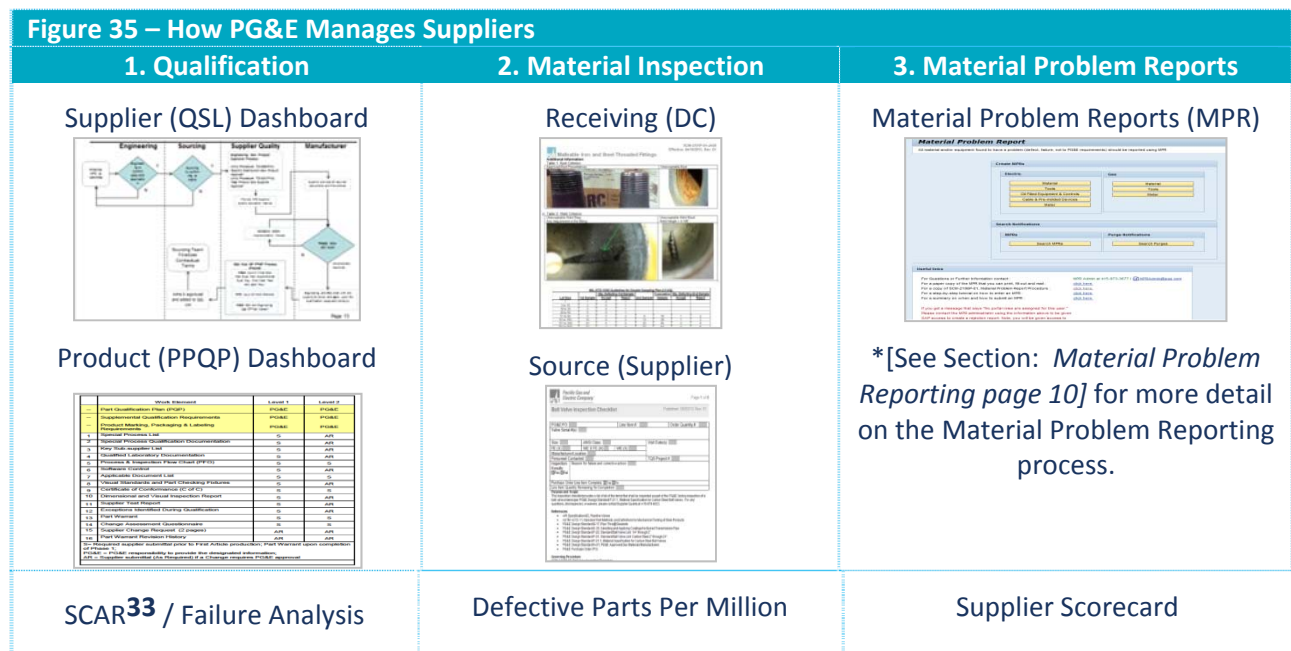
isolation points to ensure the unintended startup or operation of that equipment while employees are working on the clearance.

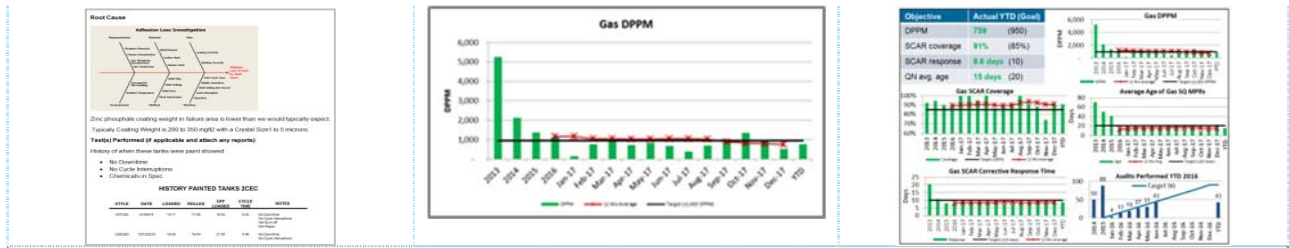
In 2017, the gas clearance team focused on eliminating risks of OP events and at risk behaviors during clearance. Gas clearance team members attended training focused on best practices for putting regulation equipment in-and-out of service. This class focused on identifying risks and refreshing employees on regulation fundamentals and critical thinking. The team also has representation in the cross-functional OP elimination team that seeks to better identify and mitigate OP events and incorporate best practices through a variety of activities including After Action Reviews and mitigation proposals.

d) SUPPLIER QUALITY FOR DISTRIBUTION AND TRANSMISSION

The Supplier Quality Assurance organization is responsible for assuring the safety and quality of material provided by PG&E’s suppliers. If non-conforming material is purchased to be used in pressurized gas systems it might introduce a safety risk to employees, the public and to the gas infrastructure.

PG&E’s Supplier Quality Assurance group collaborates with engineering, construction, and supply chain to create rigorous standards for incoming material, and assures that qualified suppliers provide PG&E material that meets PG&E’s product qualification requirements. While the process for materials and suppliers for gas distribution and transmission are adapted to the unique needs of the business, Figure 35 illustrates the general Supplier Quality Assurance process. Using this process, Supplier Quality Assurance has reduced the rate of defective parts per million (DPPM) by 64 percent over a 3-year period to approximately 759 in 2017. PG&E’s 2018 goal for DPPM is 569, and continues to take a step by step approach towards becoming Six Sigma equivalent DPPM, which is 100.5.





Two continuous improvement efforts illustrate PG&E’s commitment to mitigating supplier risk. First, in February 2016, PG&E achieved certification with the ISO-9001, the international standard for Quality Management Systems (QMS). Second, in winter 2015, Supplier Quality Assurance began to build a web-based electronic system that will make it easier for suppliers to comply with the Supplier Change Request process and continue to confirm that their materials conform to PG&E’s specifications. The project will prevent suppliers from changing the specifications of their products without PG&E’s knowledge and approval. PG&E also continues its Supplier Audit Program. In 2016, PG&E completed 91 supplier audits which encompass approximately 30 percent of its critical and high-risk suppliers, an increase of over 80 percent since 2014.

7. MITIGATING INADEQUATE RESPONSE AND RECOVERY

PG&E has many programs in place to mitigate the risk of loss of containment and loss of supply described in the preceding sections. However, PG&E is fully prepared to respond to and recover from incidents. PG&E’s policies and procedures have been revised to provide effective system controls for both equipment and

Objective	Description
Establish Command	Determine the Incident Commander, set up an Incident Command Post (ICP), activate Emergency Center(s), if necessary
Assess Situation	Gather information about emergency, assess the situation in coordination with appropriate 911 agency(ies) and PG&E Gas Control Center
Make Safe	Make area safe for public, employees and others
Communicate/Notify	Communicate to/notify the appropriate PG&E personnel, regulatory agencies, public agencies such as fire, police, city and county emergency operations, GCC, customers and media
Restore	Restore gas service
Recover	Deactivate ICP and/or Emergency Centers and return to business as usual

Figure 36 – Key Incident Response Objectives

personnel to limit damage from accidents, explosions, fires and dangerous conditions. It is PG&E’s policy to:

- Plan for natural and manmade emergencies such as fires, floods, storms, earthquakes, cyber disruptions, and terrorist incidents;
- Respond rapidly and effectively, consistent with the National Incident Management System principles, including the use of the Incident Command System, to protect the public and to restore essential utility service following such emergencies;
- Help alleviate emergency related hardships; and
- Assist communities to return to normal activity.

All PG&E emergency planning and response activities are governed by the following priorities:

- Protect the health and welfare of the public, PG&E responders, and others;
- Protect the property of the public, PG&E, and others;
- Restore gas and electric service and power generation;
- Restore critical business functions and move towards business as usual; and
- Inform customers, governmental agencies and representatives, the news media, and other constituencies.

PG&E uses the structure of the Incident Command System to complete key steps in responding to incidents. The key incident response objectives in Figure 36 represent a typical process flow through the cycle of an incident. However, incidents may not necessarily follow this exact sequence. For example, it may be appropriate to “Make Safe” at several points during the response process and not just after “Assess the Situation.”

The next section discusses programs in place to mitigate threats that have the potential to prevent PG&E from responding in a timely manner.

a) GAS SYSTEM OPERATIONS AND CONTROL

PG&E’s T&D Gas Control Center monitors and controls the flow of gas across PG&E’s system 24 hours a day, 365 days per year, that natural gas is received and delivered safely and reliably to customers. The Gas Control Center provides near instantaneous visibility on the gas system. This allows PG&E to prevent, quickly react to, and mitigate issues that may pose a safety risk to the public and PG&E employees.

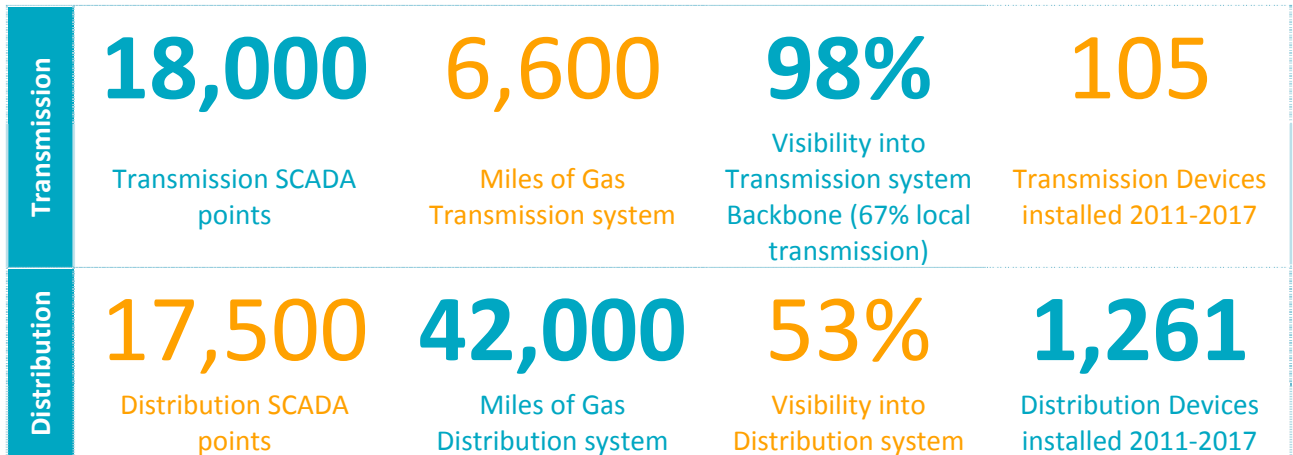


Figure 37 – PG&E’s Progress in Enhancing System Visibility Through SCADA

PG&E’s Gas Transmission Control Center, Gas Distribution Control Center, and Gas Dispatch functions are co-located in a single facility. The co-location of these three functions enables the company to better communicate, share information, and monitor the systems to provide superior emergency response coordination. This visibility, monitoring, control, and response capability is important to PG&E’s Gas Safety Excellence vision. For the Gas Control Center to be effective, a key control need is situational awareness—the ability to identify, process, and comprehend the critical elements of



Figure 38 – PG&E’s Gas Control Center features a 90 foot-long video wall with current operational information to augment the Gas SCADA system

information about what is happening. PG&E’s operators use billions of data records comprising a mix of near real-time gas system operational data, and a variety of geospatial, time dependent, and historical information that relates to the gas system, to provide critical information to Gas Control to aid in decision-making. These data are packaged and alarmed to focus the operators’ attention on abnormal situations as well as easily bundle information to quickly assess a developing issue.

b) CYBER SECURITY

PG&E’s natural gas operations involve significant risk management activities, including those that address the cyber-attack threat. PG&E has developed a unified cyber and physical security program to effectively manage security risk and proactively adapt to evolving threats and changing business needs. PG&E’s program is designed so that the workforce makes informed decisions about risk to support the safe, reliable, affordable, and clean delivery of energy to customers. The mission of the PG&E cybersecurity program is to deliver and maintain an integrated program to safeguard PG&E digital assets by:

- Identifying cybersecurity risks and defining mitigating strategies;
- Building, deploying, and operating effective security technologies and processes;
- Proactively monitoring for and responding to cyber-threats; and
- Collaborating with public and private entities to drive standards and best practices.



Figure 39 – PG&E Actively Partners with Government

PG&E’s cybersecurity organization advises Gas Operations to mitigate cyber-risks to information and operational technology, with a particular focus on control systems. Gas SCADA systems are considered

among the critical digital assets to protect at PG&E with controls improvement investments regularly identified and executed every year. Cybersecurity program elements include risk management, strategy development, security architecture, and developing security business enablement requirements.

PG&E utilizes industry best practices and frameworks such as NIST CSF to ensure the program and controls are suitably robust to identify, protect, detect, respond, and recover from cyber-attacks. The Company applies a defense-in-depth strategy and layered controls so every asset is deployed with multiple protections at each layer of the technology stack (network, application, endpoint, application, and data).

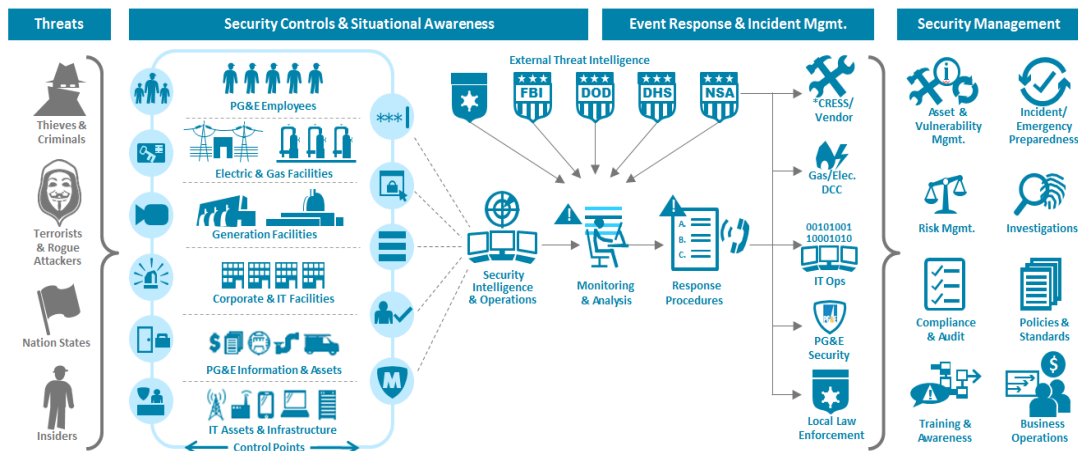


Figure 40 – PG&E’s vision is to develop an industry leading unified cyber/physical security program that effectively manages risk and proactively adapts to evolving threats and changing business needs.

PG&E understands that with an active adversary working against PG&E’s interests, the program’s effectiveness must be constantly monitored and improved. PG&E regularly tests its security controls and emergency response processes by participating in exercises such as the 2017 PG&E Cybersecurity Exercise. The exercise consisted of three parts: (1) a simulated cyber-attack by a foreign nation-state targeting industrial control systems and corporate enterprise networks, enabled by PG&E insiders; (2) an executive table top discussion of key strategic issues to be considered in the wake of a catastrophic cyber-attack; and (3) an external roundtable to spark dialog between company executives and senior industry partners and federal, state, and local officials.

To enable employees to do their part in keeping the Company’s assets and information secure, PG&E has developed an Enterprise Security Communication Strategy focused on maintaining and strengthening PG&E’s security culture. Best practices and security tips are communicated to employees regularly. PG&E’s Security Awareness and Training Program is designed to modify employee behavior, helping employees understand security risks and the importance of securing PG&E information and assets. The program also builds engagement with themes developed based on security assessments and threat intelligence. A Security Advocate Program enlists the workforce to help socialize standards and act as

early adopters and change leaders for improvements in security posture. A phishing program is also used to teach the workforce how to identify phishes and other scams, integrating security awareness into the culture and creating further employee engagement.

c) VALVE AUTOMATION

PG&E’s Valve Automation Program is designed to accelerate emergency response in the event of a gas transmission pipeline rupture. This program builds upon the scope and principles in PG&E’s Pipeline Safety Enhancement Plan. The Pipeline Safety Enhancement plan replaced, automated, and upgraded gas shut-off valves across PG&E’s gas transmission system from 2011-2014 and the Pipeline Safety Enhancement Plan’s scope of work was completed in 2015. In 2017, an additional 23 valves were installed through the 2015-2018 Gas Transmission and Storage Rate Case Valve Automation Program, expanding the Company’s ability to shut-in pipeline sections over widespread urban areas including the San Francisco Peninsula and the North Bay, further providing for public safety in the event of a dig-in or rupture. In the 2019 GT&S Rate Case PG&E proposed reducing the pace of valve automations to 80 valves between 2019 and 2021, which would result in a trajectory that completes this program in 2022.



Figure 41 – Valve Station

Table 20 – Valve Automation							
Valve Automation (units)	2011	2013	2014	2015	2016	2017	Total
PSEP		134	74	9	N/A	N/A	217
2015 – 2018 GT&S Rate Case		0	0	18	33	23	74
Total		134	74	27	33	23	291

The Valve Automation Program allows transmission pipeline to be rapidly isolated through remote and automatic control valve technology. Installation of automated isolation capability on major pipelines in heavily populated areas may reduce property damage and danger to emergency personnel and the public in the event of a pipeline rupture. PG&E’s control room personnel have received training to develop a “bias for action.” This training helps them recognize and act on system conditions warranting immediate isolation of pipeline systems and planned SCADA installations to continue to increase system visibility are ongoing [See Section: *Gas System Operations and Control* page 49].

d) EMERGENCY PREPAREDNESS AND RESPONSE

PG&E’s Gas Emergency Response practice is documented primarily in the Gas System Operations Control Room Management Manual and the Gas Emergency Response Plan (GERP). For changes to PG&E’s Gas Emergency Response Plan, please see **Attachment 2, page 14**. The full document is available

upon request; please email GasOpsRegulatoryStrategySupport@pge.com to request this document electronically.

GAS SYSTEM OPERATIONS CONTROL ROOM MANAGEMENT MANUAL

Gas Control is responsible for the overall operation of PG&E’s gas system, and therefore closely monitors and coordinates emergency notifications, dispatching, system isolations and restorations.

Gas Control personnel primarily use SCADA system data to monitor and control critical assets remotely. The SCADA system alerts Gas Control of gas system irregularities via alarms. When these alarms go off, Gas Control has the ability to immediately initiate and execute shutdown zone plans or direct field personnel to respond to critical locations for the execution of manual valve operations. In addition, Gas Control notifies appropriate 911 agencies and departments within PG&E so that emergency response resources are informed and dispatched.

To maintain compliance and aid in the management of abnormal and/or emergency operating conditions, PG&E regularly trains gas control personnel on the Gas System Operations Control Room Management Manual.

GAS EMERGENCY RESPONSE PLAN

The GERP³⁴ provides detailed information about PG&E’s response to gas T&D, and Storage Facility emergencies. It supports the response to all emergencies broadly as “One PG&E” through the integration with the Company Emergency Response Plan (CERP) and the other lines of business emergency response plan annexes

(e.g., Electric Operations and Logistics).

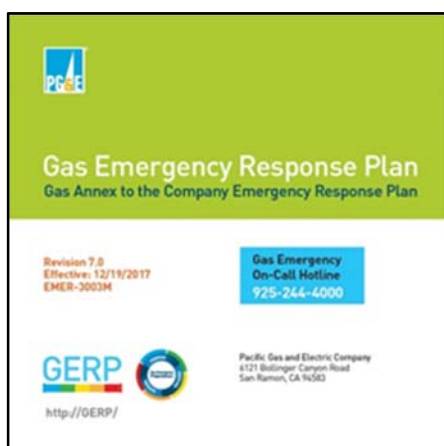


Figure 42 – The Gas Emergency Response Plan as of Dec. 19, 2017

The GERP provides an outline of the Gas Operations organizational structure and describes the activities undertaken in response to incidents. It provides a response structure with clear roles and responsibilities, a communication framework, and identifies coordination and response integration efforts with outside organizations and community first responder agencies.

The GERP outlines gas specific criteria to PG&E’s Incident Levels that are provided in the CERP. The Incident Levels categorize and support PG&E in understanding the complexity of an incident and the actions that may be employed at each level (e.g., emergency center activations, resources requests, etc.). To

ensure a consistent and well-coordinated response to emergencies, the Company has adopted the following incident classification system:

- Incident Level 1 – Routine
- Incident Level 2 – Elevated
- Incident Level 3 – Serious
- Incident Level 4 – Severe
- Incident Level 5 – Catastrophic

COMPANY EMERGENCY RESPONSE PLAN

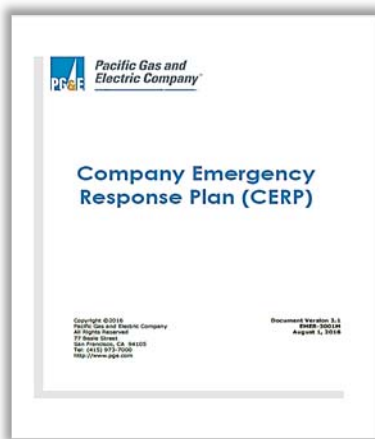


Figure 43 – The Company Emergency Response Plan as of Aug. 31, 2017

The purpose of the CERP is to assist the gas and electric businesses with a safe, efficient, and coordinated response to an emergency. For changes to PG&E’s Company Emergency Response Plan, please see **Attachment 2, page 15**.

The CERP provides a broad outline of PG&E’s organizational structure and describes the activities undertaken in response to emergency situations. The CERP presents a response structure with clear roles and responsibilities and identifies coordination efforts with outside organizations (government, media, other gas and electric utilities, essential community services, vendors, public agencies, first responders, and contractors).

The CERP follows a logical flow from general emergency response concepts and guidelines to specific emergency management organizational structure, roles, responsibilities, and processes. When appropriate, the plan also references supporting procedures and other response materials. In addition, PG&E maintains approximately 24 Business Continuity Plans, which describe how PG&E will continue essential business operations in the event of a disruption to facilities, technology or personnel.

GAS EMERGENCY PREPAREDNESS TEAM

The Gas Emergency Preparedness group assists Gas Operations with emergency planning, preparedness, response, and review. This group maintains the Gas Emergency Response Plan, leads exercises, facilitates after action reviews, and participates in industry activities designed to impart best practices. The group facilitates the use of the Incident Command System, a systematic, proactive approach for all levels of governmental and non-governmental organizations and the private sector to work together during an incident to reduce the loss of life, damage to property and harm to the environment. Further, the team supports the Gas organization’s local emergency centers, called Operations Emergency Centers, and the Gas Emergency Center, which is co-located with the Gas Control Center. These centers are activated according to criteria outlined in PG&E’s Gas Emergency Response Plan.

Throughout 2017, the Gas Emergency Preparedness group:

Conducted 23 instructor led trainings

Facilitated 12 Operations
Emergency Center exercises

Facilitated 5 Gas Emergency Center
exercises (which included senior
leadership participation in command and
general staff Incident Command
System roles)

Supported the response to
35 emergency activations requiring
activation of the local operations
emergency center

Frequent outreach to first responders helps strengthen how PG&E coordinates when emergencies happen. In 2017, Public Safety Emergency Preparedness completed the following efforts in partnership and close coordination with first responders and local governments:

Figure 44 – Delivered 416 First Responder Workshops to more than 7,000 first responders. These workshops train First Responders to safely respond to gas and electric emergencies and exactly how to access the PG&E gas transmission pipeline mapping system.

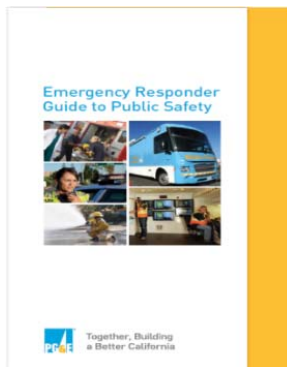


Figure 45 – Met with the 380 fire departments responding to gas incidents. These meetings focused on contingency plans in the event of an emergency.

Figure 46 – Hosted four Public Safety Liaison Meetings across the service territory to share PG&E's emergency response plans. Representatives from federal, state, county and city governmental agencies attended these meetings.





Figure 47 – Public Safety Emergency Preparedness attended and presented Public Safety materials for both gas and electric at 15 Safety Fairs and Conferences reaching over 4,000 people, including first responders and the general public.



Figure 48 – Responded to 38 dig-in incidents. Public Safety Emergency Preparedness acted as an Agency Representative between PG&E and the first responder community.

Figure 49 – Public Safety Specialists supported 252 811 Dig-In Reduction activities in collaboration with the Damage Prevention team to improve safety within PG&E’s communities and reduce the incidents of third party dig-ins.



V. WORKFORCE SAFETY

PG&E’s work requires well-trained personnel to correctly perform work activities. As a result, the Company invests in recruiting and retaining, providing ongoing development and training, and maintaining supportive controls for employee and contractor work. PG&E’s employees fully engaged in the Gas Safety Excellence journey results in field personnel who surface trending problems which can be fixed before they become urgent problems. For example, PG&E employees have worked together to address excavation safety with an enhanced excavation manual, excavation safety workshops and training curriculum updates. PG&E believes that well-trained, fully-engaged employees are a key component of Gas Safety Excellence.

1. WORKFORCE SIZE

An appropriately sized workforce and access to qualified contractors is an important aspect of performing work safely and maintaining the safety of PG&E's gas system. Gas Operations and its human resource partners collaborate to define the workforce needs and recruit qualified employees to perform work safely and efficiently. PG&E has robust training programs to develop its workforce and relies on the unique capabilities of various staff augmentation firms as needed. Safety training starts on day one as part of new employee orientation and continues throughout each employee's career.

In support of pipeline safety and reliability, PG&E focused on key functions, including Locate and Mark, Leak Survey, Corrosion, and Inspections. PG&E's approach to right-sizing the workforce has been to identify ways to execute work in a safe, efficient, and effective manner. As part of a new program in 2017, Reach Every Employee, leaders will meet with every employee one-on-one or in small groups to better understand their safety concerns and suggestions.

With safety as our absolute core value and non-negotiable top priority, we continue to seek ways to consolidate, streamline, and work more efficiently. PG&E is actively engaging employees to solicit new and creative solutions to add value for customers. In developing work plans, PG&E evaluates opportunities for operational efficiencies that allow the Company to consolidate and streamline activities, reduce or eliminate inefficient work while continuing to make progress on PG&E's commitment to improving the safety and reliability of the gas system.

2. SAFETY PROJECTS

In 2017 PG&E deployed a number of projects designed to improve employee safety. Table 21 summarizes four workforce safety projects. In addition, PG&E continues its effective policy of phone-free driving, which has helped to reduce vehicle-related incidents.

Table 21 – Examples of PG&E’s 2017 Workforce Safety Projects

Serious Incidents and Fatalities (SIF)	Safety Leadership Development	Personal Protective Equipment Matrix/Job Site Safety Analysis Revision	Vehicle Safety Technology In Cab Coaching
<p>Program focuses efforts on near hits without management or engineering controls and with potential for serious injury or fatality. Injuries and near-hits evaluated to have potential for serious injury or fatality receives a deeper evaluation and increased management oversight to prevent repeat occurrences.</p> <p>For 2017, we established and measure Timely Corrective Action Completion percentage and Quality of Corrective Actions. A third party validates quality after the Gas Operations Corrective Action Review Board accepts the Causal Evaluation.</p>	<p>Program designed to improve the enterprise safety performance by improving the leadership experience and awareness of safety behaviors. Taught in six all-day workshops over an 18-month period, this program includes one-on-one coaching by Safety Leadership Coaches and 360-degree feedback surveys.</p> <p>At the end of 2017, 86% of the 209 leaders, including supervisors and foremen, started the six sessions of training. In 2018, PG&E will train the remaining 14% of leaders in Gas.</p>	<p>Collaborative development of a field guide, available for use by all employees, to evaluate the correct personal protective equipment for the task being performed. The project team developed a matrix based on the tasks performed by each department with a goal of reducing injuries due to incorrect Personal Protective Equipment.</p> <p>The Job-Site Safety Analysis document was also revised to include Serious Injury or Fatality tasks. If Serious Injury or Fatality tasks are conducted, employees will have additional discussions using the SIF Field Guide to mitigate the additional hazards.</p>	<p>Program focuses on in-cab coaching technology in PG&E vehicles to help us become better drivers. The tool provides real-time, audible feedback to the driver when risky behaviors occur, such as speeding, hard acceleration and hard braking.</p> <p>In 2017, over 2,600 vehicles were equipped with an in-cab coaching device. Across the company over 7,000 vehicles were equipped at the end of 2017.</p>

3. WORKFORCE TRAINING

In August of 2017, PG&E opened a state-of-the-art gas training facility, the PG&E Gas Safety Academy in Winters, California (Figure 50). The facility’s master plan was established following industry benchmarking by and input from a cross-section of PG&E’s technical workforce. Since opening, Gas Operations has trained approximately 4,000 student days.

The facility includes a utility village which provides realistic residential and commercial scenarios for leak survey, leak pinpointing, and emergency response. Other features include an industry-leading M&C flow lab to provide hands-on training for instrumentation and regulation equipment, a construction training area that includes hands-on excavation, shoring, and other construction-related activities, and an excavator simulation room. PG&E continues to enhance and continuously improve the training, so that all classifications in Gas Operations have initial training. As we begin 2018, we are evaluating our needs for refresher training for journeymen-level employees, and expect to begin rolling out new programs later this year. As of December 31, 2017, PG&E had developed or enhanced 663 courses since 2012.

2017	162
2016	214
2015	107
2014	78
2013	88
2012	14
Total	663



Figure 50 – Gas Safety Academy, Winters, CA

Table 23 – Gas Operation Training Recommendations 2012 2017	
2012 Recommendation	Progress as of Dec 31, 2017
Develop programs that support employees throughout their career	<ul style="list-style-type: none"> • Courses were developed aligned to business need and results are measurable. • Completed apprentice programs developed to advance employees to journey-level competency • Increased focus on refresher training to maintain skill and competence of existing workforce
Broaden technology solutions and leverage external curriculum	<ul style="list-style-type: none"> • Tablets deployed at new Gas Safety Academy • A Virtual Learning studio was commissioned and placed in service at the Gas Safety Academy in Winters – Six additional topic areas were added to the VL catalogue in 2017 – which reduces non-productive time and travel costs
Implement continuous training improvement processes	<ul style="list-style-type: none"> • The Gas Operations Training Governance Committee has continued to review and approve all of redesign and new curriculum • Training Effectiveness studies in partnership with Quality Management and Operator Qualifications teams to determine how effective key training programs are and how to improve them

4. GAS OPERATOR QUALIFICATIONS

PG&E’s Gas Qualifications Department maintains and implements qualification programs covering welding, plastic pipe joining, and operator qualifications pursuant to federal and state regulations and industry best-practices.

PG&E requires that all employees, contractors and third-party installers of pipelines be appropriately trained, and possess all requisite qualifications to perform tasks on pipeline facilities. A qualified operator has the expertise to complete work correctly and is part of the team that helps PG&E meet its commitment to public and employee safety.



Figure 51 – Employees Taking Written Examinations

Pipeline tasks require specific competencies to be performed safely and reliably. These competencies are reflected in the “Knowledge, Skills, and Abilities” needed for each task; “Knowledge,

Skills, and Abilities” (KSA) are determined by a group of SMEs specific to each topic. An individual’s KSAs are assessed via a combination of written and performance (practical demonstration) evaluations and candidates must score 100 percent on each component of an exam to be “qualified.” Evaluations are primarily geared towards safety and recognizing and addressing Abnormal Operating Conditions. Qualifications must be renewed every six months, one year or three years depending on the task and applicable regulations.

The CPUC’s GO 112-F requirements added new construction activities to the Federal definition of covered tasks, effective in 2017. The effect of this rule change expands PG&E’s list of tasks for which a qualification is required. The expansion is a significant development in the Operator Qualification Program and involves employees, PG&E contractors, and third-party installers working on PG&E pipeline assets.

Personnel in training gain hands-on experience working under the direction and observation of a qualified employee. Working under the direction and observation of a qualified person allows a person in training to practice their skills in real-world conditions and gives the qualified person(s) the opportunity to advise, to correct, and if required for safety, to take over the performance of the task.

By maintaining a qualified workforce, PG&E is in position to quickly and competently recognize and respond to any abnormal operating conditions that may pose a threat to the safety of the public, employees or assets.

PG&E’s Gas Qualifications Department actively participates in benchmarking and process improvement initiatives with other utilities and other industries across the country to continuously find ways to increase the expertise of the workforce. Currently, PG&E is a voting member on an ASME industry best practice standard, called Pipeline Personnel Qualification,³⁵ which aims to further improve on the regulations covering gas industry qualifications.

5. CONTRACTOR SAFETY, TRAINING AND OVERSIGHT

Much like full-time PG&E employees, contractors are an important aspect of PG&E’s highly skilled, competent, and experienced technical workforce. Since contractors often work with PG&E’s assets and infrastructure that directly impact employee and public safety, the Company holds contractors to the same standard of safety as PG&E employees. The CPUC’s Safety OII proceeding (I.15-08-019) included publication of a report that evaluated PG&E’s safety practices, including those in Gas Operations. The report recommended that the Gas organization update the contractor safety procedure to clarify responsibilities and reflect current organizations and processes, including guidelines regarding frequency of field observations. PG&E is complying with this recommendation, and plans to update procedures in



Figure 52 – Four Step Process to Contractor Safety and Oversight

2018. The revised procedure will continue to follow a four step process (Figure 52) for contractor safety, training and oversight.

Prior to starting a job, PG&E *pre-qualifies* contractors and subcontractors, and confirms they are qualified to complete the contracted work. PG&E is continuing to improve its contractor pre-qualification process. Today, PG&E evaluates the contractor’s qualifications and performance results, including a host of personnel injury performance metrics. Contractors on major capital projects are also given in-person and computer-based training on PG&E’s quality and safety expectations, and

typical hazards associated with the work.

Once construction on a major capital project has started, PG&E builds a *plan* for contractor performance and clearly communicates contract terms that hold contractors accountable for safety and quality. Job-site observations start during pre-job walk-throughs to evaluate site specific hazards prior to starting work. PG&E then schedules regular meetings with contractors to *oversee* their work and makes sure expectations are met. In addition to regular oversight, PG&E inspects contractor work and a Quality Assurance (QA) team randomly checks project completion from beginning to end. On a quarterly basis, PG&E’s leadership and contractor leadership meet to understand opportunities to improve the overall Contractor Safety and Oversight Program.

After the job is complete, PG&E evaluates the contractor’s performance utilizing a scorecard that includes metrics on safety performance and contractual obligations. Contractors also have the opportunity to provide feedback to PG&E through a similar scorecard. Contractor performance is tracked throughout the year and compared to Company performance. As shown in Figure 53, metrics track injuries and motor vehicle incidents. In 2017, PG&E Construction Crews and Contractors (See the red bar in Figure 53) outperformed in all performance metrics when compared to Gas Operations and PG&E as a whole all while working over 4 million hours performing higher risk work.



Figure 53 – 2017 Safety Performance

Year-over-year reductions in four of the five categories show the shift in safety and cultural behaviors. As depicted in Figure 54, the data demonstrates that between 2012 and 2016, at-fault dig-ins have significantly reduced as PG&E improves its damage prevention process. Due to the increase in both dig-ins and injuries in 2017, we will increase oversight and engagement. The OSHA recordable rate (ORI Rate) has seen steady improvement between 2012 and 2016, while Lost Work Days, which include PG&E’s construction workforce, has seen significant reductions. As a result of PG&E’s partnership with contractors, environmental compliance performance has also improved.

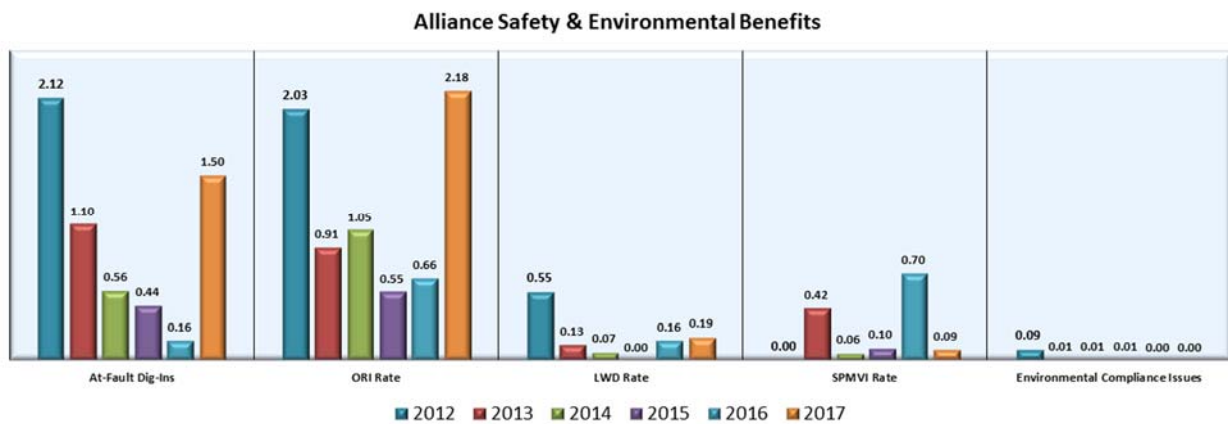


Figure 54 – Alliance Safety and Environmental Benefits

PG&E believes that employees who are engaged at work and who feel authentically recognized are far more likely to work safer, be more productive, make better decisions and produce higher quality work.

As PG&E strives to improve project safety, quality and productivity, the Company takes every opportunity to catch people doing things right and authentically recognize them for their specific efforts, innovations, great contributions, hard work, safe work practices, good decisions, great planning, timely completion or any other specific accomplishment--no matter how small. In 2017, there was an up-tick to 800 quality “Good Catches” turned in to PG&E’s safety and construction management function. Everybody that turned in a “Good Catch” was recognized and the “Good Catches” were shared on a weekly call with all PG&E construction and contractor leadership.

6. PARTNERSHIP WITH LABOR UNIONS

Union-represented employees make up almost 70 percent of PG&E’s workforce, a part of the workforce that is integral to the Company providing safe and reliable gas service. PG&E frequently works with its union partners to identify opportunities for training, process improvement, and other investments in the safety of its union-represented employees and the public. In 2017, PG&E continued

to collaborate with union leadership on projects such as improving emergency response and “make safe” times for blowing gas situations, enhanced lines of progression, the affordability initiatives, Estimating in Training Program, Grass Roots Safety Committee Partnership, and PG&E’s Leak Survey Optimization Program, also known as Super Crew.



Figure 55 – 70% of Gas Operations’ Workforce Is Represented by the IBEW and the ESC

The line of progression effort has updated job duties, training and certification for almost every represented field based position. These changes have driven improved training and certifications for the Company’s workforce (NACE certification³⁶ for corrosion

mechanics, as one example), improving the safe and compliant delivery of service.

An important example of collaboration between PG&E and union leaders is the after-hours shift crews implemented within Distribution Maintenance and Construction, which established a regular shift in four locations that provide emergency response coverage until 10 p.m. Emergency response shift crews increase public safety by allowing PG&E to respond to gas emergencies, reported through PG&E’s emergency dispatch line that cannot be handled by Gas Service Representatives alone.

VI. COMPLIANCE FRAMEWORK

PG&E’s business of providing natural gas to millions of Californians safely and reliably comes with responsibility to do so in compliance with a complex regulatory environment. PG&E’s Gas Operations conducts the transportation and storage of natural gas under the requirements of state and federal safety regulations. In 2016, PG&E adopted the Compliance Maturity Model to standardize and assess its regulatory compliance processes against industry best practices. The Model comprises eight elements: risk assessment, program governance, guidance documents, compliance controls, communications and training, monitoring and auditing, investigation and response, and enforcement and incentives; each element in turn has five performance thresholds. This framework provides Gas Operations a uniform outline from which to assess the performance of PG&E’s compliance processes against their regulatory requirements. In 2016, a baseline performance assessment was conducted, and in 2017 the business began the work of aligning each of its pipeline regulatory requirements and associated processes to the Model, conducting period re-assessments against the framework’s tiered performance thresholds. Programmatic and process controls are undergoing a strengthening to ensure that the business is both compliant with current regulations, as well as prepared to successfully implement new and changing regulations effectively.

The Compliance Maturity Model, at its heart, aims to bring visibility to PG&E’s regulatory requirements, validate that controls are in place to meet those requirements, and to structure the monitoring and testing of those controls for effectiveness while maintaining adequate programmatic oversight to keep compliance at the core of the work that we do. This approach aligns with the “Plan, Do, Check, Act” management method that PG&E employs throughout its operations as part of Gas Safety Excellence.

While the Compliance Maturity Model structures PG&E’s strategic approach to compliance, day-to-day compliance performance continues to be built upon four key enablers:

- Employee expertise
- Providing employees the right information at the right time
- Making available the right resources at the right time
- Implementing supportive controls

1. BUILDING EXPERTISE

PG&E employees require specialized skills to be able to perform their jobs, constructing, operating and maintaining the natural gas T&D systems. As detailed in *Workforce Training (page 58)* and *Gas Operator Qualifications (page 59)*, the Company recognizes that its employees are a critical element in the compliant operation of the pipeline system every day; highly competent and capable employees perform work safely, effectively, and efficiently while using their knowledge and experience to identify and raise opportunities for continuous improvement.

2. THE RIGHT INFORMATION TO DO THE WORK

A highly-skilled workforce is most effective when enabled with timely, accurate information from which to work. Gas pipeline work is highly technical, and if not performed correctly, could result in serious safety concerns. To enable the consistent performance of work across its service territory, written guidance documents, such as procedures and job aids are utilized. These documents are stored electronically in the Technical Information Library (TIL) and are reviewed on a scheduled basis so that they reflect both regulatory requirements and best practices, as well as any lessons learned from Company or industry experiences. While this review and revision practice keeps the Company’s processes at a state-of-the-industry level, it also requires significant efforts to keep all personnel performing work in accordance with these documents, are made aware of any changes and are provided with the requisite training and provided access to subject matter experts to maintain compliance.

In 2017, PG&E moved from a daily to a monthly publication schedule to pace the changes experienced by people performing the work, allowing for more time to receive and digest each change to their work between the publication date and the effective date of any given change. This shift was

accompanied by a new format for email communications that separated changes based on several categories, allowing employees to more efficiently determine relevant changes.

PG&E’s employees had also identified that the user interface for the TIL was less efficient than it could be for convenient field access to information, and so the TIL Viewer, a simplified user interface was developed with field input, allowing personnel to more quickly and efficiently access technical information.

In addition to technical guidance, employees need accurate and timely information about PG&E’s pipeline assets. PG&E has two pipeline GIS mapping systems, one for transmission, and another for distribution assets. These systems contain geospatial information about the pipeline system including, in some cases, detailed information about asset history, materials, manufacturer, and location. These systems help PG&E to effectively conduct integrity management program work, locate mains and services, and plan for construction. PG&E works continuously to improve the quality of the information in both mapping systems. Given the volume of work performed on the pipeline systems every day, it is critical to have processes that update these mapping systems accurately, and in a timely manner. As prescribed in the Compliance Maturity Model, compliance goals need to be accompanied by effective controls and performance monitoring. As further discussed in the CAP section *[See Section Safety Culture: Corrective Action Program page 8]*. PG&E uses CAP to identify, track completion of mapping updates and corrections and has expanded the scope of its timeliness metric, see Table 23 below to include mapping small repair jobs (also known as expense jobs) and introduced additional quality control (QC) steps.

Table 24 – Pipeline Mapping Timeline		
Mapping Metrics	2017 Goal	2017 Results
Time from Construction-Complete to Mapping-Complete	45 Days	24 Days
Average Mapping Corrections Time (through CAP Process)	45 Days	22 Days

Continuous improvement methods are being utilized to reduce the time it takes to map brand new assets following construction completion.

3. THE RIGHT RESOURCES TO DO THE JOB

Once the correct work has been identified, employees need the right resources to be able to complete the work safely and in a timely manner—whether through technology or traditional tools and equipment. PG&E continues to invest in tools to expand our capabilities. Some examples include state-of-the-art patrol aircraft and camera technology. In gas distribution, we’ve introduced, “Keyhole” equipment that allows for smaller pavement disturbances and reduced paving costs, electronic tablets, and digitized data capture to replace paper forms (see Figure 56). Most importantly, the “Keyhole” equipment eliminates the need to dig traditional “bell hole” which must be large enough to fit a person.

The reduced effort to perform the excavation and reduced excavation size may have a positive effect on employee safety through injury reduction and public safety by reducing job-size footprints.



Figure 56 – PG&E Crew Using “Keyhole” equipment to access facilities in a minimally invasive manner.

4. SUPPORTIVE CONTROLS

A compliant company utilizes numerous processes and programs to perform at a high level; some are aimed at monitoring or improving internal processes with corresponding compliance requirements and other are aimed externally, to help PG&E identify opportunities for continuous improvement or pending regulatory changes. Table 24 below details some of these processes and programs.

Table 25 – Compliance Processes and Programs

Quality Management (QM) –The QM group assesses and provides direct feedback on the work quality for PG&E’s important safety programs, including locate and mark, regulator station maintenance, and as-built record development.

[See Section: *Quality Management* ³⁷ page 67].

Internal Audit (IA) – PG&E’s IA team performs arm’s length reviews for all of the company’s lines of business, including Gas Operations, and is responsible for assessing control adequacy.

Non-compliance Self-Reporting – PG&E is committed to self-reporting compliance issues and take prompt mitigative and corrective action to prevent recurrence. PG&E filed 1 Self-Report in 2017 in accordance with the Safety Citation Decision.

Participation in Safety and Enforcement Division (SED) Inspections – In advance of CPUC Safety and Enforcement Division (SED) inspections, PG&E self-evaluates gas divisions, districts and programs, such as Operator Qualification, Emergency Management and Integrity Management, and shares findings with the SED. PG&E’s assessors spent approximately 8,000 hours in 2017 identifying issues and supporting resolution. PG&E strives to resolve identified issues within the same inspection cycle, and respond to any data requests within the duration of the inspection.

Causal Analysis – Similar to the continuous improvement mechanism in PG&E’s Process Safety management framework, Causal Analyses are post-incident investigations that include an assessment for compliance failure. These analyses commonly identify root causes, and lead to recommendations to prevent or mitigate future reoccurrence. PG&E performed 69 causal analysis evaluations in 2017.

Evaluation of National Transportation Safety Board (NTSB) Reports – The NTSB investigates all serious pipeline incidents. PG&E SMEs routinely review NTSB reports to learn from pipeline incidents. As a result, PG&E may adopt new approaches to addressing threats, change work procedures or develop new training.

Evaluation of Pipeline and Hazardous Materials Safety Administration (PHMSA) Bulletins – PHMSA regularly issues safety advisories for pipeline operators. As new safety information comes to light at other gas companies in the US, PHMSA issues bulletins to help operators take preventative action.

VII. CONTINUOUS IMPROVEMENT

Continuous Improvement is the mechanism through which PG&E continues to evolve from being reactive to proactive in the journey to Gas Safety Excellence. By continuously taking a critical eye to existing practices, and identifying the root cause of challenges that arise, PG&E can move to correct problems before they result in compliance violations or in harm to PG&E employees or the public. While continuous improvement is embedded in most PG&E programs, a few programs are highlighted below.

1. GAS STEWARDSHIP

The Gas Stewardship Office, established in 2017, leads our efforts to drive process performance management conversations and continuous improvement activities into our safety and reliability work, to create a more affordable gas operations system without compromising safety or compliance.



Over the last several years, PG&E has made great strides in enhancing safety and reliability. Today, our goal is to continue important safety work while providing a more affordable system for customers. As noted in the Gas Operation’s Guideposts, originally developed as part of Stewardship, “Safety and affordability are not a trade-off; rather, they go hand-in-hand – the lower our per-unit cost, the more work we can do to reduce risk.” Further, the emphasis will always be on “Safety as our absolute core value and non-negotiable top priority” so we must “ensure that actions continue our journey to reduce enterprise risk and promote compliance.”

The entire Gas Operations team has embraced the notion that safety and affordability are not a trade off, but instead can be accomplished at the same time. Of the 800+ initiatives being managed within Gas Stewardship, all of them intend to improve the safety, efficiency and reliability of the Gas transmission and distribution system. One such initiative is the field force effectiveness initiative led by the Distribution Maintenance process. Work began in 2017 aiming to improve field productivity while keeping a strong focus on quality and safety. The team filmed field employees performing tasks in order to identify safety issues and inefficiencies present in day to day work activities. By utilizing lean methods to streamline processes, the team developed specific improvements around utilizing roving workers and job bundling that resulted in maintaining our safe work activities with higher employee utilization and output.

2. QUALITY MANAGEMENT

The Gas QM organization is responsible for centralized QA activities and helping others integrate QC points into processes within Gas Operations. QA activities include conducting quality assessments in the

field and with recordkeeping either as work is being performed or after-the-fact. Both approaches allow for mentoring and coaching opportunities for the people doing the work and to make corrections, when needed. Several new QA programs were implemented in 2017 and include quality assessments on atmospheric corrosion surveys, identification of abnormal operating conditions, Chain of Custody documentation reviews, and post construction asset validation. With the addition of these programs, there are currently 16 active QM programs as of December 2017 and are shown in Table 25 below.

Table 26 – List of Quality Management Programs as of 2017	
Leak Survey	Post-Repair Leak Survey
Locate and Mark	Distribution Construction
Distribution Re-dig	Transmission Construction
Field Service	Regulator Station Maintenance
Valve Maintenance	Rotary Meter Installation and Maintenance
Corrosion Control	Gas Transmission and Distribution As-Builts
Internal Records Review	Atmospheric Corrosion Meter Inspections
Chain of Custody	Post Construction Asset Validation

Continuing on the journey to mature the Gas Operations Quality Management System and build on continuous quality improvement, field quality control programs were further developed in 2017 within the T&D Construction and T&D Operations organizations. The T&D Construction organization was able to start implementing their field QC program in 2017, and T&D Operations is planning to have their field QC program implemented in 2018. This is a major effort to build quality at the source, with a goal to further reduce QA findings and rework.

The fundamental principles in the QMS leverage the “Plan, Do, Check, Act” (PDCA) framework (refer to Figure 57) that is instrumental to PG&E’s implementation of Gas Safety Excellence. PDCA is an iterative four-step management method used in business for the control and continuous improvement of processes and products. Just as a circle has no end, the PDCA cycle should be repeated again and again for continuous improvement.

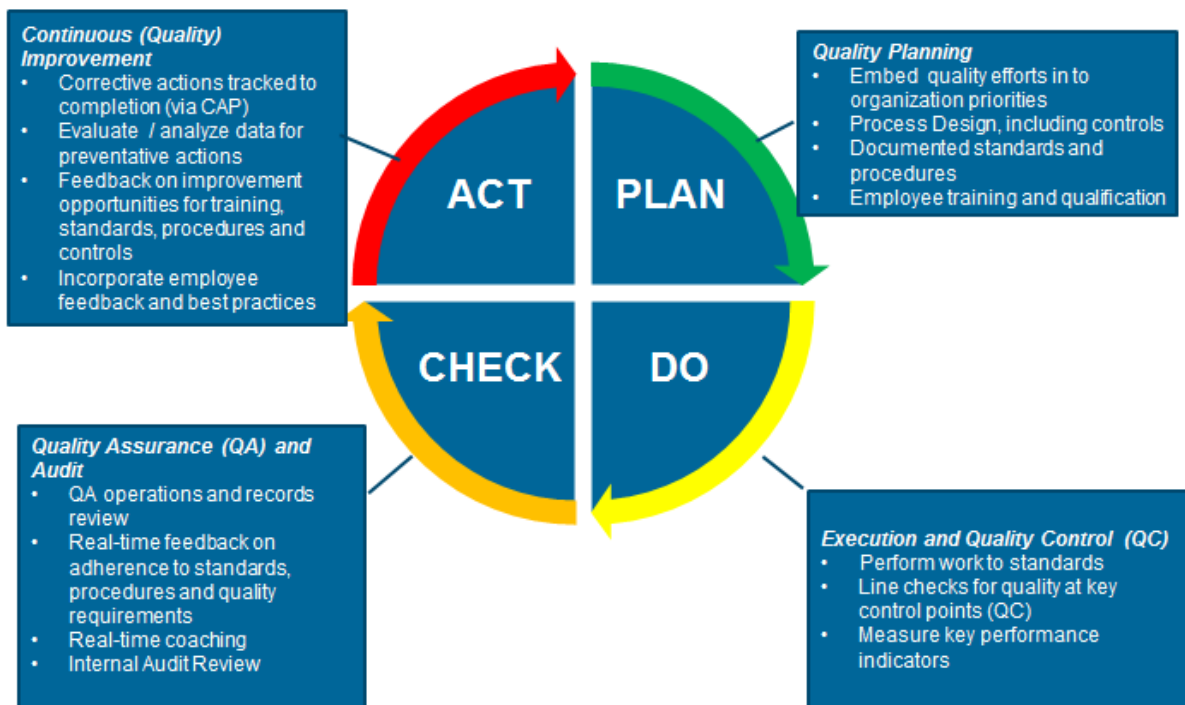


Figure 57 – The Quality Management Process

Accomplishments in 2017 include:

- Performed 5,684 quality assessments in the field and 40,228 in the office;
- Engaged of an expert in Quality Management Systems to assess the health and progress of Gas Operations’ Quality Management System;
- Implemented Atmospheric Corrosion Meter Inspections;
- Developed and implemented Chain of Custody documentation reviews;
- Developed and implemented a Post-Construction Asset Validation program;
- Redesigned the Field Service assessment program; and
- Increased stakeholders’ engagement in quality assessment data through enhanced reporting.

As a result of these accomplishments, the Field Quality Index metric that provides insights on quality for the key processes in Gas Operations improved from 2016 to 2017, with an approximate 30 percent reduction in the critical and high findings. The score of this Field Quality Index ranges from 0 to 2.0, with anything less than 0.5 as does not meet target, 1.0 as meets target and 2.0 as exceeds target. This metric was at 0.9 at the end of 2015, and improved over 2016 to end at 1.62, and continued improving in 2017 ending at 1.68. (Refer to Figure 58 for 2017 performance).

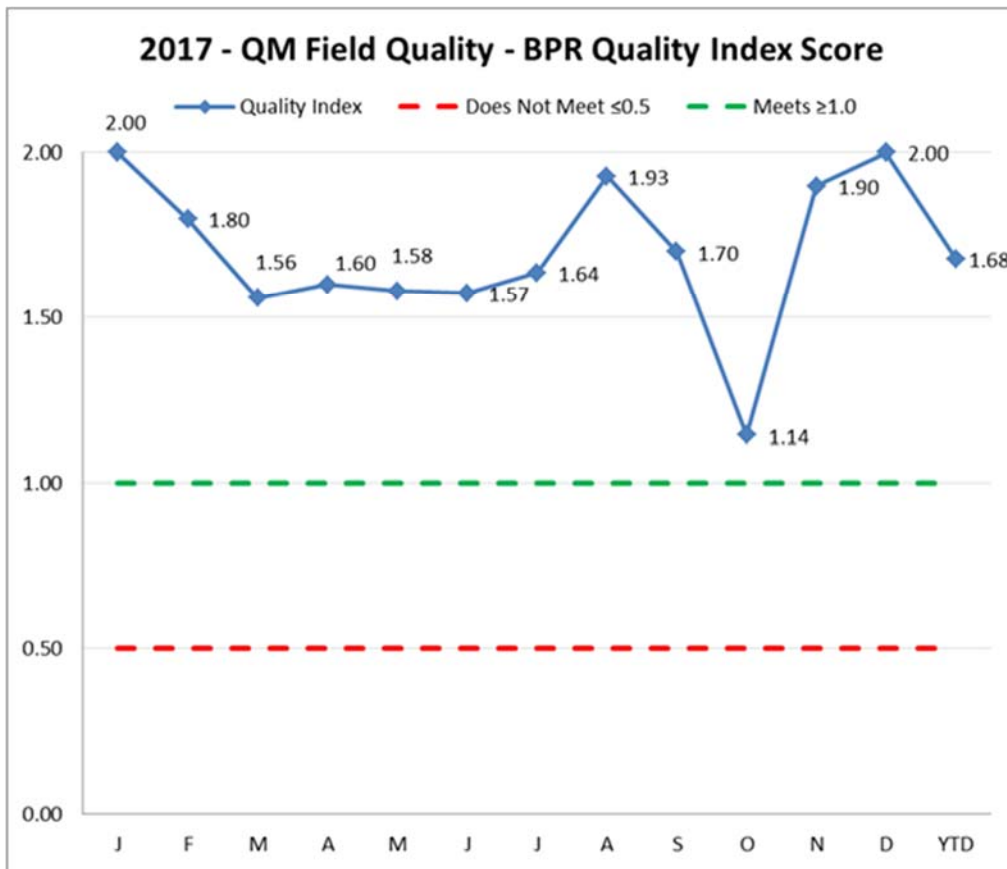


Figure 58 – Quality Index Score

3. RESEARCH AND DEVELOPMENT

The Research and Development and Innovation (R&D and Innovation) Group brings innovative technologies and solutions from industry, government, and academia to the Gas Operations business to improve safety. In 2017, the R&D team partnered with leading U.S. utilities and R&D organizations to manage and implement more than 200 projects.

R&D is embedded in Gas Operations through Gas Safety Excellence and the continuous improvement process. R&D’s work is prioritized based on the results of the Risk Management Process, so projects and innovations align with the most critical needs of the business. [See Section: *Risk Management Process* page 21].

In order to develop robust safety and operations tools in the most effective way, PG&E participates in collaborative efforts with national and international R&D organizations like PRCI, NYSEARCH, and Operations Technology Development (Gas Technology Institute). PG&E also works closely with R&D programs at the California Energy Commission, PHMSA, the California Air Resource Board and the Department of Energy to transfer their results to operations.

Examples of 2017 collaborations include:

- A dig-in prevention device that uses satellite positioning technology to warn heavy duty equipment operators when a pipeline is nearby—introducing an additional layer of safety for contractors.
- Advanced leak detection using laser light differential absorption from a high altitude, allowing PG&E to detect leaks from fixed-wing aircraft.
- Nobel prize-winning technology leveraging multi-frequency laser absorption technology to detect leaks from a longer distance than traditional tools.
- A stationary methane detector allows us to continuously monitor unstaffed facilities such as regulation and metering stations.

R&D and Innovation identified an opportunity to improve safety by sensing potential anomalies in pipe from above ground. In 2017, the R&D team partnered with three companies to test Large Standoff Magnetometry (LSM), which is an above-ground, passive magnetometer inspection technology. LSM detects elevated stress concentrators induced by pipeline anomalies caused by mechanical damages, ground movement, cracks, metal loss, and girth welds, by mapping the signatures in earth magnetic fields around pipelines. This low-cost inspection technology will complement existing In-Line Inspection and Direct Assessment efforts.



Figure 59 – Sample Project: Large Standoff Magnetometry (LSM)

LSM may improve safety in three ways. It allowed employees to remain above ground for detection and mapping, reducing the need for invasive or dangerous work. It has the potential to enhance our ability to understand our underground assets by providing 3-D mapping data including depth of cover and location of anomaly that is accurate to within a meter. Finally, it may improve PG&E’s ability to prioritize future safety work based on stress level, location, and anomaly type. In 2018, R&D will focus on enhancing reliable discrimination between different anomaly types by collaborating with other pipeline operators through PRCI.

4. LEAN CAPABILITY CENTER

SUPER GAS OPERATIONS (SGO)

Super Gas Operations (SGO) began in the summer of 2014 to address feedback from frontline employees about needed improvements in operational processes. Inaccurate information in PG&E’s

work management tool and incomplete job packages resulted in poor work planning and other inefficiencies. SGO set out to solve these problems and support PG&E's commitment to becoming the safest and most reliable gas company in the country by enabling "the Right Work at the Right Time."

From 2014 to 2017, SGO helped the organization standardize, stabilize, and provide visibility to the following processes: Distribution Maintenance, Corrosion, Damage Prevention – Locate & Mark/Standby, Leak Survey, Patrols, Field Services & Dispatch, and Work Requested by Others (WRO).

SGO worked with Gas Ops organization to document their processes, roles and responsibilities, and key tasks associated to helping the work performance of the process. SGO also implemented process huddles in order to have the appropriate discussions with cross-functional teams to understand process issues and address the challenges with the appropriate stakeholders. Key operational and process metrics are included in the huddle to provide visibility regarding the execution of the work plan, confirming that work is prioritized based on compliance and/or customer commitments, and that the job is properly closed in the system and related job documentation.

By performing the above items, SGO helped gas teams better plan the work, improve the flow of work, and increase visibility into a rolling 90-day plan of "ready" work. In 2016, the crew strengthened focus on safety and actual construction activities by increasing visibility to the work plan, improved documentation quality, and increased productivity. In 2017, organization also observed improvements with execution and work performance.

LEAN CAPABILITY CENTER (LCC)

To build upon the success of SGO, Gas Ops organization put in place a Lean Management System approach (A New Way of Working). Lean capabilities have progressed considerably over the past few years in Gas Operations, beginning with the Lean Management foundation to improve operational processes created by SGO. Lean Management (Lean) is PG&E's approach to running Gas Operations now and into the future. It is an integrated system of principles, practices, and techniques for operational excellence based on empowering the front-line and the relentless pursuit of serving customers better. It supports the concept of continuous improvement and provides clarity on our safety, reliability, affordability, and clean goals, while enabling meaningful performance conversations up and down the organization.

In 2017, Lean Capability Center (LCC)³⁸ was created to enable the management system for improving performance by eliminating inefficiencies across Gas Operations, which reduces rework and resource waste. Gas Ops:

- **Staffed the Lean Capability Center with Lean Capability advisors** to drive Lean management principles across Gas Operations. This includes real-time problem-solving, operational excellence assessments, huddle board building and other consultative expertise; and
- **Created more training, documentation and process support provided by the Lean Specialists**, specifically to train functional and departmental Lean Leads, Mega Process Owners, Process Owners and Process Managers. This includes process sustainability reviews, standardized documentation, and maintenance of a centralized repository of core documentation while maintaining the Process Management framework.

LEAN PILLARS AND TOOLS

To keep the Lean system up and running on a daily basis, we use tools that support each of the lean pillars as illustrated in Figure 60 below. The four pillars support the Lean system, which are referred to as “loops” because they must happen in continual cycles. These tools are critical to the success of the system.

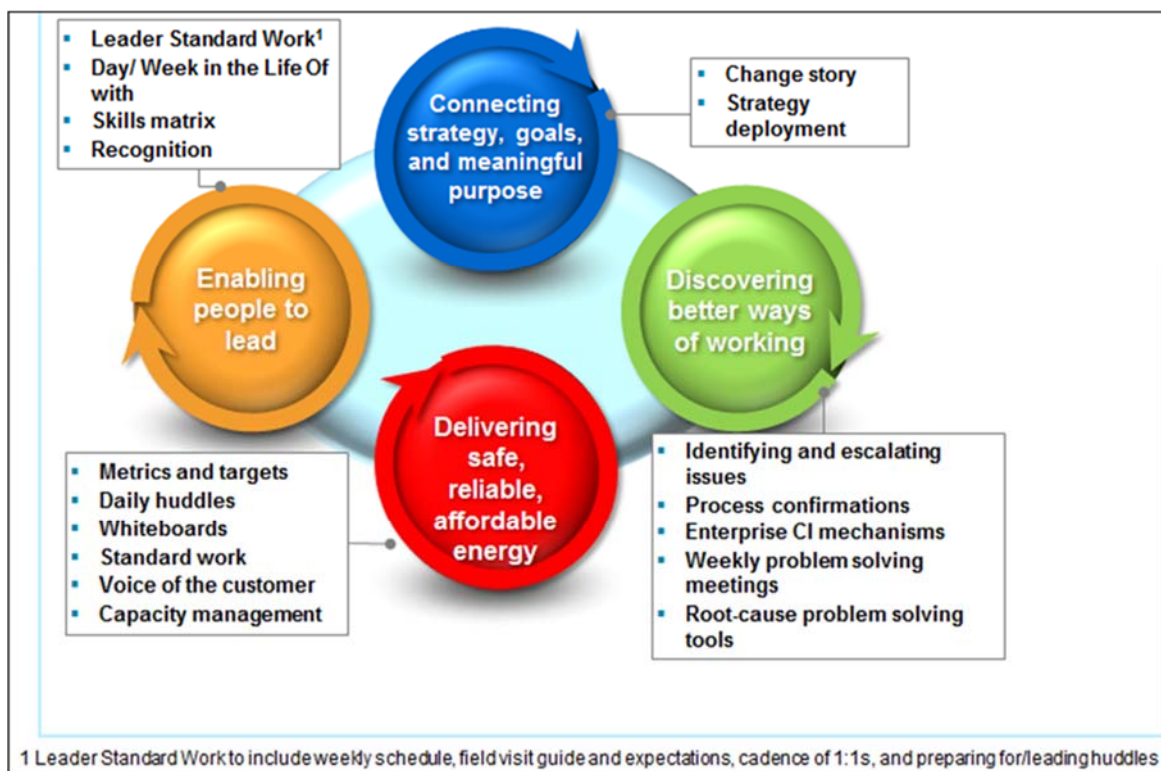


Figure 60 – Lean Pillars

PROCESS MANAGEMENT

Process Management drives efficient and effective work. For example, the Distribution and Maintenance process (formerly known as M&C), Gas Ops T&D Operations developed Close-Out Documentation metrics. In early 2015, T&D Operations measured the number of days to correct

documentation errors prior to completion. By mid-2016, the team also introduced another metric that measured the number of days to prepare the documentation after construction completion to Compliance Desk (CD) review.

When finalizing construction work, it's important for employees to complete the required job package as part of the close out documentation. It captures the work performed on the asset and helps properly record the units in our system of record. Documentation timeliness increases asset record accuracy, which in turn increases safety for employees, customers, and system operations.

- For error corrections (CD to operations), performance improved to an average of 4.9 days in 2017 compared to about 13.1 average days in 2015 and 6.5 average days in 2016. See the green line in Figure 61.
- For documentation preparation (from construction completion to CD), performance improved by almost 50 percent, showing an average of 5.0 days by end of 2016 and an average of 4.5 days in 2017. See the blue line in Figure 61.

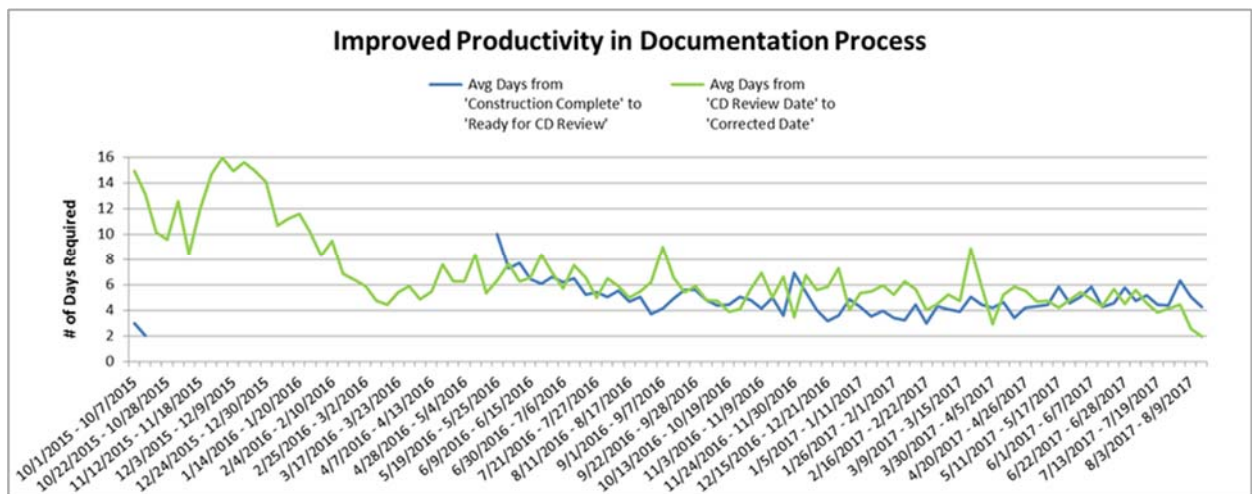


Figure 61 – Improved Productivity in Documentation Process

In addition to the Close Out metrics, T&D Operations' Compliance Desk team measured Documentation Quality. Compliance Desk (CD) uses (2) methods to measure and develop these metrics.

- Method 1 calculates the total number of major errors found in all records in one period vs. total number of potential errors in these records (multiply by 100). See green line in Figure 2.
- Method 2 calculates the ratio of the number of records with at least one major error vs. the number of total records reviewed. See red line in Figure 2.

Since the SGO Program kicked off in 2014, errors in as-built documentation for the Distribution Maintenance process decreased by 90% by end of 2016 and stayed fairly steady in 2017. Distribution Maintenance started realizing many benefits, such as improved documentation productivity and

documentation quality, which increased visibility to the work plan and strengthened the safety on actual construction activities. In 2018, the focus continues on sustaining this improvement on both the documentation productivity and quality.

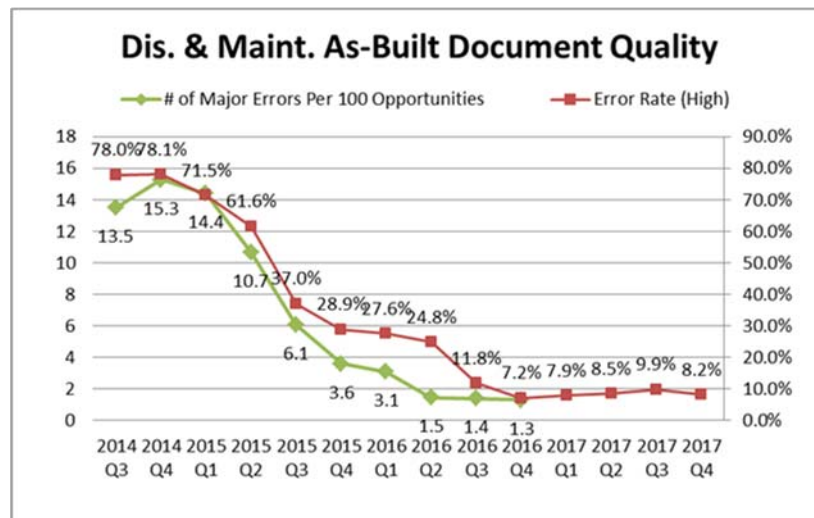


Figure 62 – Improved Quality for Distribution and Distribution Maintenance As-Built Documentation³⁹

Gas Operations began implementing the SGO Program principles with other operational processes in 2016 and 2017, including Corrosion, Damage Prevention – Locate & Mark/Standby, Leak Survey, Patrols, Field Services & Dispatch, and Work Requested by Others (WRO). The team implemented the same documentation quality metrics for the Corrosion and Leak Survey processes.

As we continue to deploy the Lean Management System, Process Owners along with LCC will continue applying the Process Management Framework to improve the maturity of PG&E’s processes.

5. BENCHMARKING AND BEST PRACTICES

Benchmarking is an important step in PG&E’s overall continuous improvement effort, and is used to identify industry best practices. Best practices include, but are not limited to, widely-recognized natural gas practices that directly enhance public and personnel safety over time. Benchmarking is one component of understanding what may constitute an industry best practice, and is accomplished by both formal and informal means. There may also be more than one single industry “best practice” in any given program area. Therefore, PG&E’s best practice identification often begins with identifying a published industry standard that provides guidance and sets overall direction for a program or technical discipline and discussing with other utilities. When standards are not readily identifiable, PG&E may employ various methods, such as reaching out to industry associations, experts, and other utilities, to discuss best program approaches, and then develop detailed procedure manuals to document the practices.

PG&E relies on various outlets for benchmarking best practices such as reviewing standards written by SMEs and public agency publications, and participating in industry associations. How PG&E utilizes each of these outlets is described in the next sections.

a) INDUSTRY STANDARDS WRITTEN BY SUBJECT MATTER EXPERTS

One informal benchmarking practice that PG&E pursues is identification and use of standards written and reviewed by SMEs. Sometimes these standards are referred to as “consensus” standards, meaning that the publisher believes that they represent proven practices in that particular field. In addition to seeking best practice standards that originate in the U.S., PG&E identifies international standards for best practices, including European and ISO. PG&E has adopted for use several European standards. In another example, PG&E pursued the certification of ISO 55000, the recently available international asset management standard, and has both achieved and sustained certification.

PG&E relies on associations such as the ASME (an association of more than 130,000 members in 158 countries) and the API (a national trade association representing the interests of the oil and natural gas industry) to facilitate the development of best practices, prescribe codes and standards for the natural gas industry, to provide forums such as conferences and meetings for like members to learn about relevant best practices, publish best practice literature, industry reports, and relevant industry statistics, and to provide technical continuing education. Some of PG&E’s foundational risk management and gas program activities follow ASME standards and API consensus standards that are referenced in code, such as B31.8S, Managing System Integrity of Pipeline Systems and RP 1162, Public Awareness programs.

b) AGENCY PUBLICATIONS

PG&E reviews relevant agency documents to gain insight into what regulatory and investigation agencies view as best practices. PG&E incorporates input from previous proceedings and reviews, including the CPUC, the NTSB, PHMSA, and reviewers contracted by these entities.

Table 27 – PG&E AGA Committee Participation

BEST PRACTICES

- Program Coordinator
- Steering Committee Member

DISCUSSION GROUPS

- Compression Operations
- Damage Prevention
- GPS/GIS and Work Management Systems
- Management of Company Standards
- Pipeline Expansion
- Pipeline Safety Management System Management
- Pipeline Safety, Compliance, Oversight
- Quality Management Task Group
- TIMP Risk Models

OPERATIONS COMMITTEES

- Building Energy Codes and Standards Committee
- Corrosion Control Committee
- Distribution and Transmission Engineering
- Distribution Construction and Maintenance
- Distribution Measurement Committee
- Gas Control Committee
- Operating Section Managing Committee
- Operations Safety Regulatory Action Committee
- Plastic Materials Committee
- Process Safety Committee
- Safety and Occupational Health Committee
- Supplemental Gas Committee
- Transmission Measurement Committee
- Transmission Pipeline Operations Committee
- Underground Storage Committee
- Utility and Customer Field Services Committee

As an example, PG&E has a procedure to ensure appropriate responses to PHMSA advisories and any proposed or final rulemaking notices from other regulatory agencies. The procedure expedites reviewing, assigning, and tracking of all Gas T&D related advisory bulletins and proposed or final rulemaking notices from any regulatory agency in a timely manner.

c) PEER ASSOCIATIONS

Benchmarking is performed with a variety of utility and non-utility entities to improve PG&E's understanding of how other companies manage various operational programs, including best practices related to safety. For instance, PG&E personnel learn about best practices from interacting with peers and industry experts in organizations such as the INGAA, AGA, NACE International (formerly known as the National Association of Corrosion Engineers), API, ASME, Southern Gas Association (SGA), Public Service Enterprise Group (PSEG) and other organizations.

PG&E employees participate in and present at a variety of industry conferences. These conferences are gatherings of industry representatives with similar backgrounds to discuss best practices, review emerging practices, share operating information, and build networks for future best practice sharing. Some of the peer-to-peer associations PG&E participates in are described below in more detail.

d) AMERICAN GAS ASSOCIATION

As part of PG&E's continuous improvement commitment to safety in Gas Operations, the company is an active member of the AGA. The AGA helps PG&E share, validate and learn about gas safety best practices through targeted Operating Committees and Discussion groups with peer organizations (Table 26 – PG&E AGA Committee Participation). For example, PG&E participated in the AGA SOS Survey Program by both distributing and responding to surveys with topic-specific information requests throughout the year and utilizes the data provided by other U.S. utility gas companies.

e) INTERSTATE NATURAL GAS ASSOCIATION OF AMERICA

INGAA and the INGAA Foundation develop consensus guidelines and position papers based on the input of its members. PG&E considers these materials to constitute evidence of natural gas transmission pipeline companies "best practices" and are widely recognized in the industry as such. INGAA has a membership base that owns approximately 200,000 miles of natural gas pipeline in the U.S. PG&E relies on INGAA to facilitate the identification, development and sharing of best practice materials.

f) NATIONAL ASSOCIATION OF CORROSION ENGINEERS INTERNATIONAL

PG&E also relies on NACE International to identify and develop standards, test methods and material recommendations that are widely regarded as best in the field of corrosion and specifically for Cathodic

Protection and coatings. NACE International creates these materials through the subject matter expertise of its members. NACE International has over 28,000 members in over 100 countries.

g) WESTERN ENERGY INSTITUTE

Western Energy Institute (WEI) is the premier Western association of energy companies that implements strategic, member-driven forums, identifies critical industry issues and facilitates dynamic and timely employee development opportunities. WEI provides forums for exchanging timely information on critical industry issues, information about industry best practices and skills training. PG&E also participates on several committees.

h) PUBLIC SERVICE ENTERPRISE GROUP (PSEG)

The Public Service Enterprise Group is a publicly traded diversified energy company headquartered in Newark, New Jersey and was established in 1985. The company's largest subsidiary is Public Service Electric and Gas Company

The Gas and Electric Utility Peer Panel was established in 1993 and is a collaborative effort between member utility companies that focus on sharing benchmark data on an annual basis.

PSE&G developed the panel of companies for the purpose of exchanging accurate and meaningful data on key performance metrics.

i) ADDITIONAL BENCHMARKING EFFORTS

In addition to the numerous associations, PG&E also uses informal means of benchmarking including using the expertise brought to the Company by new-hires and contractors with industry experience, by attending trade conferences, and by information sharing with other utilities.

PG&E also uses benchmarking to facilitate continuous improvement. When possible, PG&E benchmarks metrics to understand performance against peers. Industry performance also informs target-setting. The following chart lists a few key safety metrics that PG&E benchmarks against other utilities:

Table 28 – Key Benchmarking Metrics Included in Business Performance Review or at the Short Term Incentive Plan Level	
PG&E’s Commitment to Safety	Measurement
Emergency Odor Response	Average response time
Year-End Grade 2 Leak Backlog	Per 1,000 miles of mains and services
Year-End Grade 3 Leak Backlog	Per 1,000 miles of mains and services
Lost Work Day Case Rate*	Lost work days per 200,00 hours worked
Third Party Dig-In Reduction	Number of dig-in incidents per 1,000 tickets

* *This measure is benchmarked at the company level. Comparative data associated with these benchmarks may be protected by confidentiality or non-disclosure agreements.*

VIII. CONCLUSION

The 2018 Gas Safety Plan update demonstrates PG&E’s commitment and progress in implementing processes, programs, and procedures to achieve its vision to becoming the safest and most reliable natural gas utility in the nation. The Gas Safety Excellence framework guides how PG&E operates, conducts, and manages all parts of its business by putting the safety of the public, PG&E’s customers, and PG&E’s employees and contractors at the heart of everything it does; investing in the reliability and integrity of its gas system; and, by continuously improving the effectiveness and affordability of its processes. PG&E has made continued progress, while recognizing that there is more to be done in its journey to achieve Gas Safety Excellence, as measured by both tactical and aspirational longer-term goals. In addition, PG&E continuously invests in its facilities, employees, technology, and operations to enhance the long term safety, reliability and affordability of its system.

VERIFICATION

I, the undersigned, state:

I am an officer of PACIFIC GAS AND ELECTRIC COMPANY, a California corporation, and am authorized to make this verification for and on behalf of said corporation, and I make this verification for that reason. I have read the foregoing 2018 Gas Safety Plan and I am informed and believe the matters therein are true and on that ground I allege that the matters stated therein are true.

I declare under penalty of perjury under the laws of the state of California that the foregoing is true and correct.

Executed at San Ramon, California, on March 8, 2018.



SUMEET SINGH
VICE PRESIDENT, GAS OPERATIONS,
PORTFOLIO MANAGEMENT AND
ENGINEERING
PACIFIC GAS AND ELECTRIC COMPANY

Natural Gas Leak Abatement Program – Best Practice 1 – Compliance Plan Certification

I, the undersigned, state:

I am an officer of PACIFIC GAS AND ELECTRIC COMPANY (PG&E), a California corporation, and am authorized to make this certification of compliance for and on behalf of said corporation, and I make this certification for that reason. I have read the foregoing Natural Gas Leak Abatement Biennial Compliance Plan, covering 2018 and 2019. I am informed and believe the matters detailed therein are true and that the Plan meets the requirements of Best Practice 1 (Compliance Plan), and on this basis I certify PG&E's compliance with Best Practice 1.

Executed at San Ramon, California, on March 8, 2018.



SUMEET SINGH
VICE PRESIDENT, GAS OPERATIONS,
PORTFOLIO MANAGEMENT AND
ENGINEERING
PACIFIC GAS AND ELECTRIC COMPANY

IX. ENDNOTES

- 1 In October 2011, the California legislature signed into law SB 705, which declared “[i]t is the policy of the state that the commission and each gas corporation place safety of the public and gas corporation employees as the top priority.” SB 705 was codified as Public Utilities Code §§ 961 and 963(b)(3).
- 2 Session 1 is the first session of the Integrated Planning process in the year and includes an overview of each Line of Business’ strategy and goals over a 3-5 year timeline to mitigate the risks identified during Session D process. Session 2 is the second session and involves the work execution planning that provides the allocation of budget and resources to execute the required work for the following year to mitigate the risks identified during the Session D process.
- 3 2017 weighted goals are 50% Safety, 25% Customer, and 25% Financial.
- 4 See R.15-01-008 “Order Instituting Rulemaking to Adopt Rules and Procedures Governing Commission-Regulated Natural Gas Pipelines and Facilities to Reduce Natural Gas Leakage consistent with Senate Bill 1371,” issued January 22, 2015. <http://www.cpuc.ca.gov/General.aspx?id=8829>
- 5 To see the Leak Abatement OIR Decision (D.) 17-06-015, follow this link: <http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M190/K740/190740714.PDF>
- 6 American Petroleum Institute’s Recommended Practice Pipeline Safety Management System Requirements (RP 1173) outline specific best practices for safe and effective pipeline operations underpinned by a healthy safety culture. A document summarizing the Recommended Practice was provided with the 2017 Gas Safety Plan. http://www.api.org/~media/files/publications/whats%20new/1173_e1%20pa.pdf
- 7 Due to sampling and the smaller n-size for the group, there is a margin of error of +/-4 to 5 points across the quarters for Gas Operations. The scores do not have the precision we would see for one of our biennial census Premier Surveys, but provide a sense of how Gas Operations is trending.
- 8 Consistent 2018 with CPUC Safety Enforcement Division guidance, PG&E is attaching only the following with this plan: Attachment 1, the Leak Abatement Best Practices, Attachment 2, the change log for PG&E documents attached to the 2017 submittal where the document has been updated since 2017, Attachment 3, a list of PG&E documents previously attached to the Gas Safety Plan in 2017 that have not been updated since last filing, and Attachment 4, TD-3336S Control Room Management Standard.
- 9 This system was designed based on the elements of Process Safety developed by the Center for Chemical Process Safety (CCPS), a branch of the American Institute of Chemical Engineers.
- 10 RC 14001 was developed by the American Chemistry Council, and is based on Responsible Care® Management System and ISO 14001 environmental management systems standard.
- 11 To see PG&E’s 2017-02 Gas Transmission & Storage Pipeline Safety Report, follow link to <https://pgera.azurewebsites.net/Regulation/ValidateDocAccess?docID=439879>.
To see PG&E’s 2016-02 Gas Distribution Pipeline Safety Report, follow link to <http://pgera.azurewebsites.net/Regulation/ValidateDocAccess?docID=406720>.
- 12 The Transmission Pipe asset family includes valves outside of station boundaries and not otherwise included in the Measurement and Control asset family, which are those valves defined in TD-4551S – Station Critical Documentation. An example of valves included in the Transmission Pipe asset family includes manually operated mainline valves.
- 13 As set forth in 49 Code of Federal Regulations Part 192, Subpart O.

- 14** 49 CFR §192.614.
- 15** California Government Code §4216.
- 16** In 2016, PG&E received a total of 898,052 USA Tickets.
- 17** The term cross bore is broadly defined as an intersection of an existing underground utility or underground structure by a second utility resulting in direct contact between the transactions of the utilities. The cross bore can compromise the integrity of either utility or underground structure. Examples include gas, telecom, water, storm, and sewer among others.
- 18** PG&E's 2015-2018 hydrostatic testing goal is based on the CPUC's 2015 Gas Transmission & Storage Rate Case Decision (D. 16-06-056) issued June 23, 2016.
- 19** Identified mileage does not include girth welds or branch connections. Additionally, it does not include the miles of pipe that would be necessary when pipe replacements are rolled into engineered projects.
- 20** This program does not address the threats posed when natural gas pipelines that cross active earthquake faults. Please refer to PG&E's Earthquake Fault Crossing Program in Section IV.5.h, p. 36.
- 21** High risk mileage addressed includes pipeline retirement of 19.9 miles addressed from 2015 – 2018.
- 22** Traditional In-Line Inspection is a term used to refer to in-line Inspection tools that run via propulsion by the pressure and flows of the gas stream. Non-traditional in-line inspection methods are also being employed by PG&E under some circumstances where pressures and flows and/or pipeline lengths are too short to feasibly run traditional in-line Inspection tools.
- 23** Tensile stress is when equal and opposite forces are applied on a body, in this case a pipeline.
- 24** Leak Survey Process (TD 4110P-01) was provided in prior versions of the Gas Safety Plan and is available by request.
- 25** In 2016, DOGGR instituted emergency regulations for all gas storage facilities that required daily inspections. The final DOGGR regulations and additional regulations proposed by the California Air Resources Board (CARB) are pending. In 2017, PG&E surveyed daily and will continue to survey all well-heads in 2018.
- 26** GO 112F was provided with previous versions of the Gas Safety Plan and is available upon request.
- 27** Originated as a gas distribution pilot program in 2014, the Super Crew model an end-to-end process executed by a cross-functional team that travels around the service area to survey and repair leaks, utilizes Picarro Surveyor technology that is mounted on a vehicle and is 1,000 times more sensitive than other leak detection equipment.
- 28** 2017 GRC Exhibit (PG&E-3), Chapter 6C, page 6C-4, Line 9, FN 10 "It will never be possible to survey the entire system with the Picarro Surveyor due to Abnormal Operating Conditions (AOC) and physical conditions that lessen the coverage of the technology, however, PG&E expects to survey one hundred percent of its divisions with the technology in 2018 and believes that in doing so will cover seventy-five percent of the distribution system."
- 29** As of January 1, 2017, PG&E updated its leak grading procedure, TD-4110P-09, to include direction and definition from GO-112F, footage criteria from structures, criteria for leaks in SCADA cabinets, standby requirements, and remove Grade 2+ leak grading.
- 30** In addition to Leak Survey recommendations, R. 15-01-008 includes acceleration of leak repairs.
- 31** 2016 California Gas Report, Prepared by the California Gas and Electric Utilities.

- 32** American Gas Association, 2016: <http://playbook.aga.org/#p=42>.
- 33** Supplier Corrective Action Request.
- 34** The GERP complies with CFR Title 49, Transportation, Part 192—Transportation of Natural and other Gas by Pipeline: Minimum Federal Safety Standards, Section (§) 192.615, “Procedural manual for operations, maintenance, and emergencies” and (§)192.605 “Emergency Plans.”
- 35** ASME B31-Q.
- 36** NACE, formerly known as the National Association of Corrosion Engineers, is an international organization focused on developing industry standards for corrosion management, teaching best practices, and researching corrosion issues. NACE provides multiple certificate programs in a variety of corrosion management areas.
- 37** PG&E’s Gas Operations Quality Management System manual was provided in prior versions of the Gas Safety Plan and is available by request.
- 38** Created as part of Gas Stewardship and was formerly known as Super Gas Operations (SGO) and Process Excellence. The Lean Capability Center includes a select group of leaders from the organization to implement the Lean Management System in Gas Ops organization
- 39** These As-Built metrics are currently part of the Path 2 Zero (P2Z) report. It primarily measures As-Built packages of work performed by distribution maintenance. It typically includes: As built, GSR, A-Form, and other related documentation.

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XII. APPENDIX C – LIST OF ATTACHMENTS

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