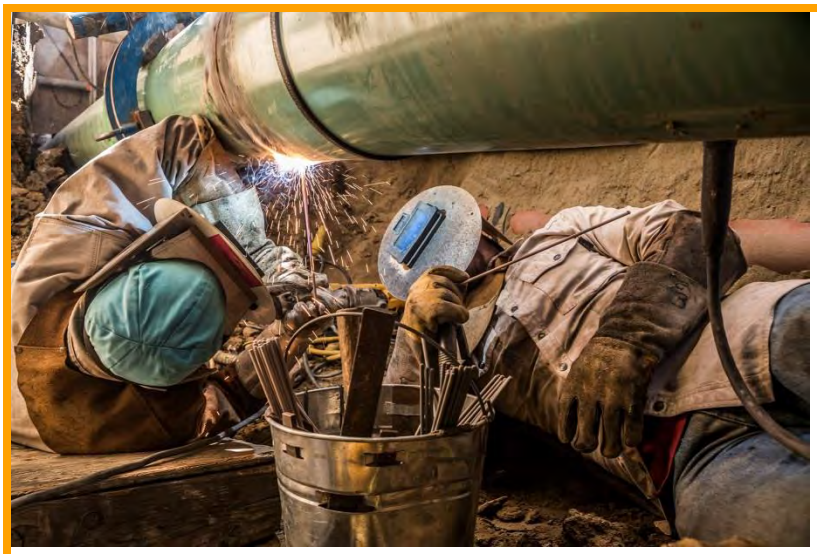
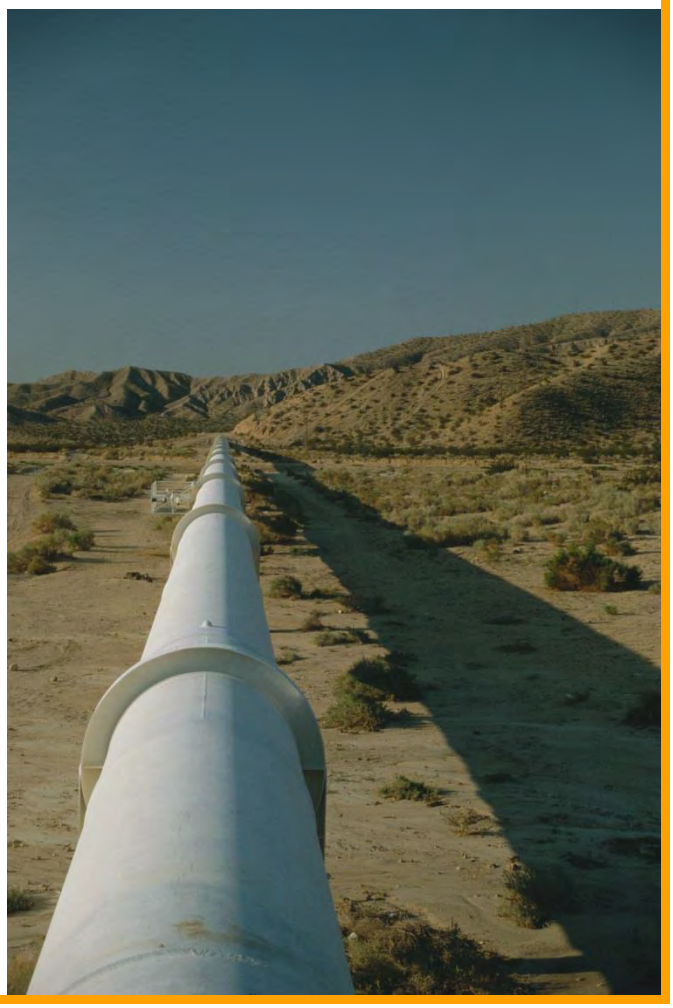


Pacific Gas and Electric Company®

2017 GAS SAFETY PLAN

MARCH 15, 2017



PACIFIC GAS AND ELECTRIC COMPANY
GAS SAFETY PLAN

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PACIFIC GAS AND ELECTRIC COMPANY
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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 42,000 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 2017 Gas Safety Plan (Plan) reports on the progress PG&E has made to become the safest, most reliable gas company in the United States. 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 those risks; making sure employees and contractors have the tools, training, procedures, and records they need to safely and effectively perform construction, operations and maintenance 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, contractors and the gas system 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 six 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 2015 to 2.02 in 2016 and, in 2016, PG&E made an additional approximately 107 miles of its gas transmission pipeline capable of accepting an inline inspection tool.

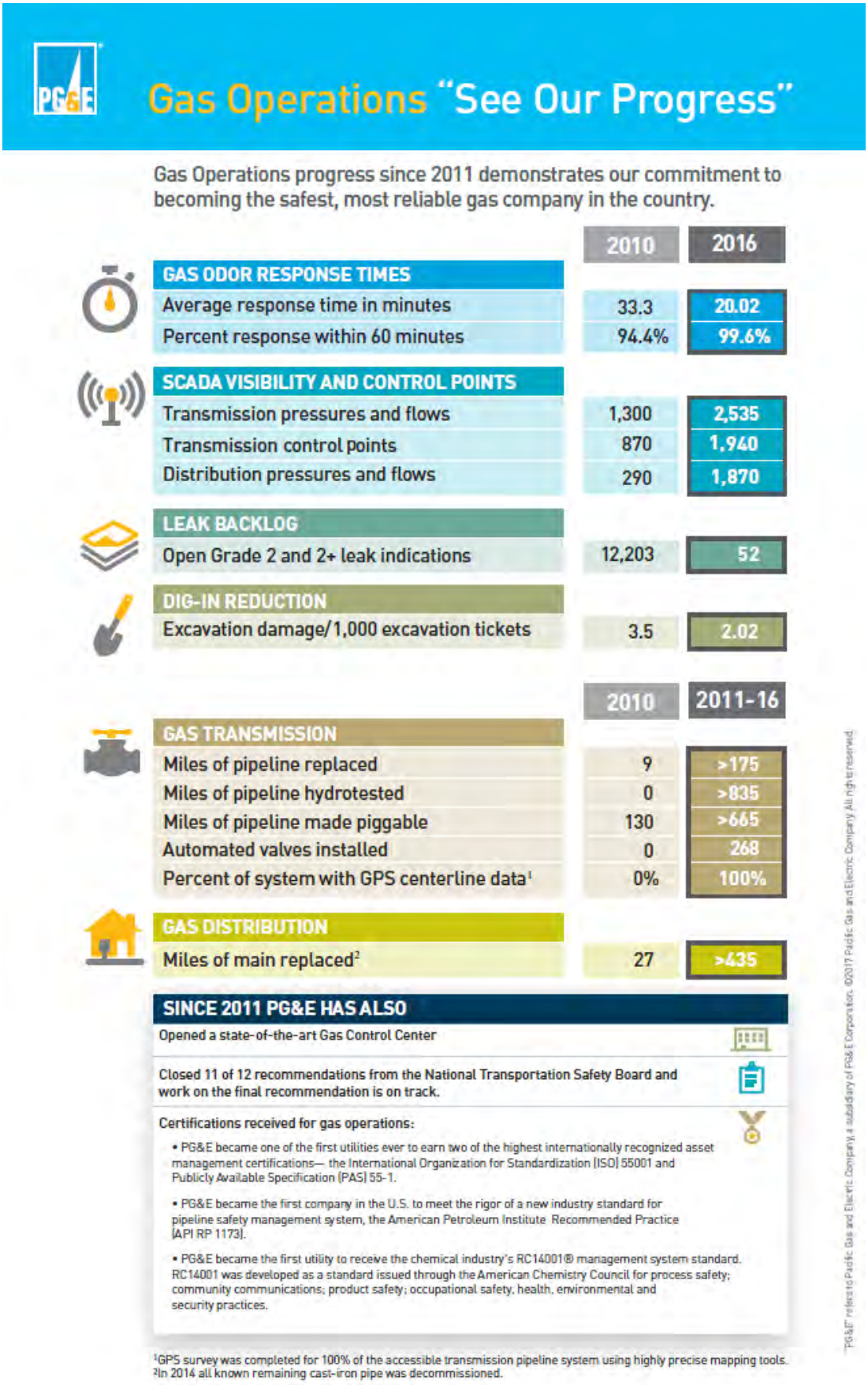


Figure 1 – Key Gas Performance Metrics

This 2017 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 then 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

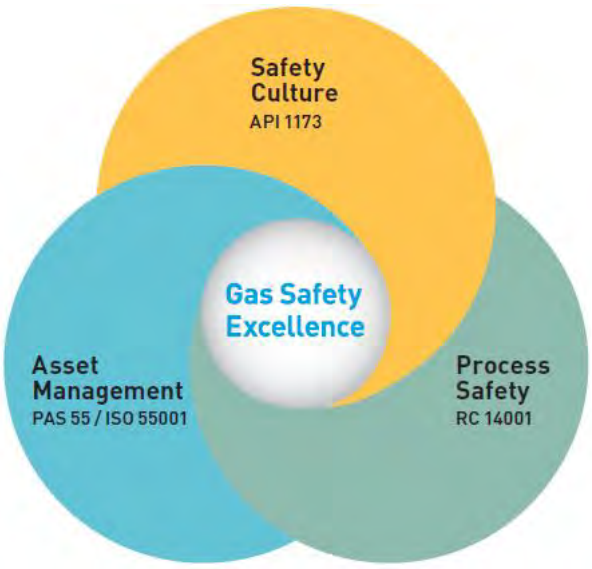


Figure 2 – PG&E Gas Safety Excellence Framework

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 2016, PG&E had mixed success related to its safety related program targets. The three instances below highlight the primary areas in which PG&E measures its performance in safety excellence. For example, In-Line Inspections, Emergency Response Time, and Third Party Dig-Ins are three critical metrics that demonstrate PG&E's commitment to public and employee safety.

- **In-Line Inspection:** In 2016, PG&E fell slightly short of its outlined goal, however increased piggability to roughly 25% of the approximately 6,600 miles of the Gas Transmission system and used in-line inspection tools to inspect just over 259 miles of transmission main. Approximately two-thirds of PG&E's transmission system (about 4,500 miles) has been or will be upgraded to accept in-line inspection tools by 2026.
- **Emergency Response Time:** PG&E exceeded its target and achieved first quartile performance with a 20.33 minute average response time to gas odor calls despite implementing more stringent emergency evaluation criteria that resulted in PG&E responding to and over 25% increase in call volume. In addition to responding to gas odor calls, Figure 3 shows a picture of PG&E's response to the Butte's fire, one of many types of incidents to which PG&E responds.

- **Third Party Dig-In:** PG&E exceeded its target by achieving 2.02 dig-ins per 1,000 Underground Service Alert tickets received which equated to the top of the second quartile. This was an improvement over 2015 performance.

Figure 3 – PG&E responded to a variety of emergencies including gas and electric incidents, dig-ins, fires and other incidents.

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 2016, Gas Employees were involved in 38 Lost Time Injuries (a 3.7% increase over the prior year) and eight Serious Preventable Motor Vehicle Incidents (a 51% improvement over the previous year). In 2016, the Occupational Safety and Health Administration (OSHA) recordable rate decreased by 4.6%. This signifies the programs are having a positive effect on workforce injuries, and through consistent application of the preventative efforts, that the serious lost time injuries will 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 seeing the early positive effects of the initiatives in the safety action plan in both a reduction in OSHA recordable injuries and motor vehicle incidents. [See Section: *Safety Projects page 55*].

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 now 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] This adjustment reflects PG&E's continued emphasis on the importance of public and employee safety.

II. SAFETY CULTURE

Safety culture is the first pillar of PG&E's Gas Safety Excellence structure. PG&E is driven to achieve an effective and robust safety culture, the goal of which is to ensure the safety of the public, and employee and contractor workforce. As the California Public Utilities Commission (CPUC or Commission) noted in its Safety Culture and Governance OII (I.15-08-019),[4] this is a prerequisite for any utility's positive safety performance. PG&E's philosophy is that safety is each employee's concern, priority, and job. PG&E's safety culture lives in its people and the way they approach their work every day. The safety culture at PG&E is formed as a result of the work, actions and decisions made every day that demonstrate that safety is PG&E's core value. PG&E understands that a workforce that is convinced they have full support of their leaders on safety matters will do the right thing, in the right way, at the right time, even when no one is looking. PG&E's focus is to nurture a culture based on trust where employees feel comfortable speaking up, stopping jobs, sharing incidents or near hits, and learning from one another.

PG&E recognizes that maintaining a positive safety culture requires continual diligence throughout the organization to address issues including complacency, fear of reprisal, overconfidence, and normalization of deviance. Employees are encouraged to report and act on safety concerns, including through PG&E's CAP, which further fosters an environment of accountability and ownership where significant and essential behavioral changes can occur at all levels.

To demonstrate its continued progress in achieving Gas Safety Excellence, and in particular, its commitment to nurturing a robust safety culture through adopting a safety management system, PG&E adopted and implemented the American Petroleum Institute's (API) Recommended Practice (RP) 1173, Pipeline Safety Management System Requirements.[5] 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.

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. For example, PG&E developed the gas carrier pipe checklist that crews now use to verify the potential existence of plastic inserts in the field prior to conducting work. PG&E is in the process of building a new gas training facility with extensive employee engagement around design, layout, training areas, and equipment. Additionally, course content and technology development are being led by cross-functional employee teams. The Company is continuing work to close the feedback loop by expanding the acceptance and use of the CAP. In 2016, PG&E set a goal of use by 31% of the gas team. By year-end, more than 40% of the gas team had used the CAP. Finally, PG&E performs a biennial employee survey. In 2016, 85% of the Gas Operations organization participated. 93% of PG&E employees responded affirmatively to a survey question introduced in 2016 asking employees if they feel free to stop work if conditions are unsafe. 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

In October 2013, PG&E implemented the Corrective Action Program (CAP) to offer employees a simple method to identify and report issues related to gas assets and processes. The types of issues seen in the CAP entries include employee concerns or suggestions, operational events, audit findings, or issues with facilities, or tools, records, training, and safety. The Gas CAP ensures that issues are categorized, assessed for risk, and assigned to an owner to implement corrective actions to prevent recurrence.

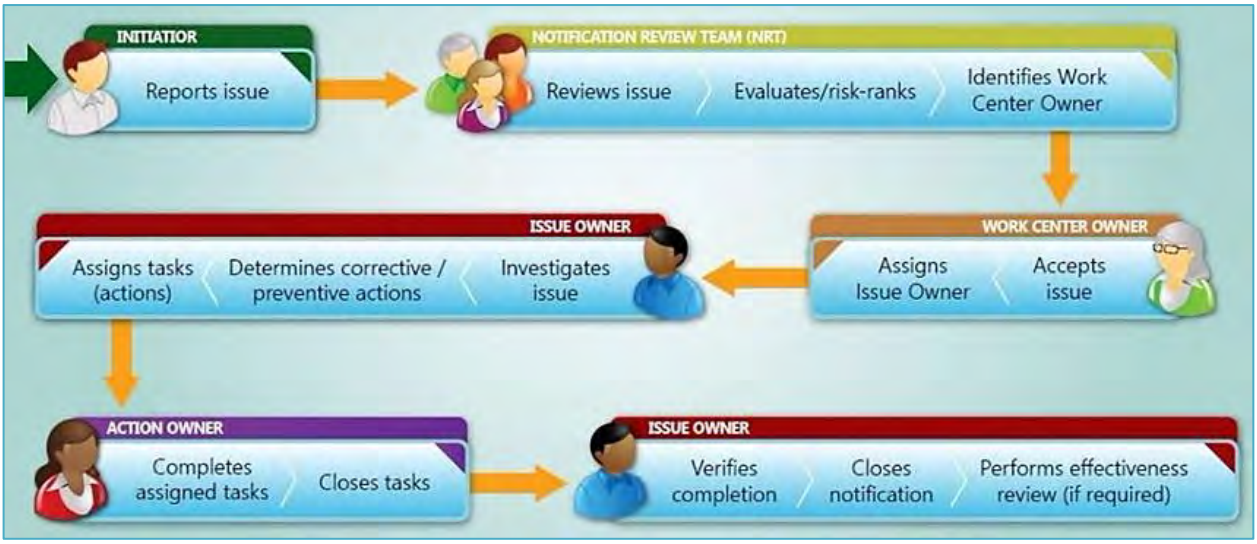


Figure 4 – Corrective Action Program Process

The CAP employs a standardized approach (Figure 4), including a Notification Review Team that meets daily to review the previous day's CAP submittals, to investigate and identify the causes underlying the issue, and to address them appropriately. Initiators receive an email when the item they submitted is assigned and again when it is closed. The CAP provides real-time data, transparency, trending capabilities and feedback to promote continuous learning focused on improving the safety and reliability of PG&E's operations.

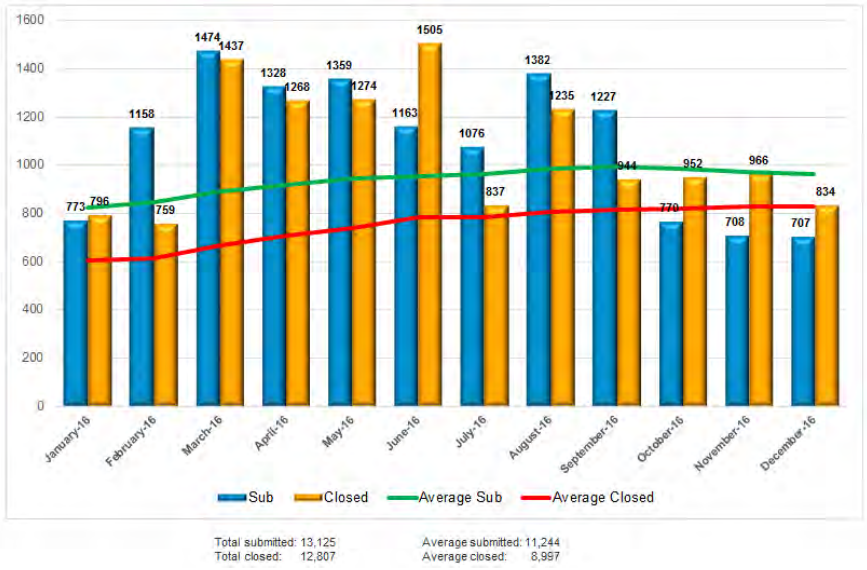


Figure 5 – Corrective Action Program is used widely to identify continuous improvement opportunities and to engage PG&E employees in supporting Gas Safety Excellence.

At the beginning of 2016, the third full year of the program, CAP set a goal to have 31% of Gas employees participate in the program. By the end of the year CAP participation reached 40%, exceeding its goal. The Gas CAP received approximately 13,130 issues, and resolved approximately

12,800 issues (Figure 5). In 2016, the CAP team conducted monthly quality closure reviews on all high and medium risk notifications, as well as a sampling the low risk-ranked notifications.

PG&E's CAP team was actively engaged in a number of continuous improvement activities in 2016. First, a CAP survey was conducted to better understand the needs of initiators and users. Leadership observations were conducted on the notification review process.

In 2017, the CAP program will be deployed across PG&E's other lines of business.

b) Compliance and Ethics Helpline

PG&E's Compliance and Ethics Helpline is a toll-free telephone number available to employees, contractors, consultants, suppliers, and customers 24 hours a day, 7 days a week. The Helpline, managed by Navex Global, can be used for both guidance on conduct matters and legal and regulatory requirements or to report situations that may require investigation. Callers have the option of remaining anonymous with any call. In addition to the Helpline channel, the following methods are available to raise concerns and ask for guidance on a range of company policy topics:

- Submitting concerns through the Navex Global web-based submittal service;
- Calling, emailing or sending a letter or fax to the Compliance and Ethics Department directly; and
- Meeting with a Compliance and Ethics staff member.

Concerns and questions raised with Compliance and Ethics, and those raised through the Helpline, are addressed and tracked.

In 2016, the Compliance and Ethics Department launched Speak Up training. The training was designed to build awareness of how to enhance an open communication environment and help leaders appropriately handle misconduct reports. The training demonstrated what to expect when employees speak up to raise a concern or a new idea and how leaders should respond when a concern is raised. All employees were required to complete the live training facilitated by their direct supervisor or leader in their organization.

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: Material problems identified as material arrives at PG&E's facilities (Incoming MPRs) or field sources identifying material problems after

material receipt by PG&E (Field MPRs). In 2016 the management of MPRs was reorganized. The Supplier Quality group now manages Incoming MPRs and the Gas Engineering/Operations team now manages Field MPRs in an effort to align the issue resolution with the kind of technical expertise needed.

PG&E measures the number of days to address MPRs to evaluate timeliness in resolving identified problems by monitoring the average age of the MPR closure. The 2016 target for MPR closure was 35 days. The average age of a MPR in 2016 was 76 days. The increased length in resolving MPRs was mainly due to the reorganization of field MPRs. In 2017, the department that took over the management of the field MPRs will establish metrics that target the timeframe needed for initial engineering assessment completion, as well as tracking MPRs to closure, given the dynamic factors that affect field MPR initial assessment and ultimately closure, such as offsite engineering analysis and coordination between multiple functions.

2. PG&E Corporate Safety Committees

PG&E's safety governance structure drives a consistent safety culture and ensures PG&E is aligned on 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 Nuclear, Operations, and Safety 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
Chairman's Safety Council	Provides overall governance of safety guides the enterprise safety strategy and philosophy. Assures continuous improvement of public, employee, and contractor safety performance
Gas Operations Safety Council	Sponsors initiatives to improve Line of Business safety. Monitors Line of Business safety performance and initiatives. Ensures 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

Attachments 1 and 2 are the charters for the Board of Directors Nuclear, Operations, and Safety Committee, and the Chairman's Safety Council.

III. Process Safety

The second pillar in Gas Safety Excellence is a plan to develop and implement Process Safety Management.[6] Process Safety Management focuses on preventing low frequency, high consequence incidents and mitigating their consequences. The Process Safety Management system is used for engineering of facilities, maintenance of equipment, facility changes, and ensuring safe operation.

The Process Safety Management System contains four foundational blocks (Figure 6): Commit to Process Safety, Understand Hazards and Risk, Manage Risk, and Learn from Experience. The four blocks are further divided into 20 elements. PG&E is improving Process Safety performance by strengthening performance in each of these areas.

Figure 6 – The PG&E Process Safety Method

A survey of each element is periodically conducted to assess performance. When performance gaps are identified, plans are developed and implemented to strengthen process safety. 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.

Process Safety Highlights from 2016 include:

Commit to Process Safety: PG&E's commitment in implementing process safety led to certification to chemical industry standard RC14001® (Responsible Care® and International Standards Organization (ISO) 14001)[7] in 2016. PG&E is the first utility in the world to attain this certification. A significant amount of work within the foundational blocks including Stakeholder Outreach and Workforce Involvement occurred to prepare PG&E's workforce to successfully achieve this certification. By achieving RC14001 certification, PG&E Gas Operations has committed to comply with the elements of Responsible Care® which incorporate process safety and the ISO 14001 environmental management system standard.

Understand Hazards and Risk: Process Safety management is a key contributor in PG&E's efforts to reduce large overpressure events.

In 2016, in support of PG&E's goal to reduce large overpressure events to zero, process safety principles were applied to better understand overpressure events that are caused by human error. The team identified next steps to reduce incidents due to human error, which account for about half of the large excursion overpressure events, associated with field operations and the clearance process. These next steps are currently being implemented with the goal of reducing events in 2017-2018.

Manage Risk: Process Safety efforts support risk mitigation. Process Hazard Assessments serve two functions. The first is to engage during the design process to understand and mitigate operation risk inherent in modification of new facilities and the second is to drive risk reduction associated with ongoing operations. PG&E believes that process hazard assessments provide a significant contribution to risk identification and result in performance of risk mitigation activities at PG&E's gas facilities. In 2016, the number of open action items following process hazard assessments was reduced by about 50%. This effort ensures that risk reduction opportunities identified in the risk assessment are put in place in the field.

Learn from Experience: PG&E strives to continuously improve in Process Safety. Root Cause Evaluation (RCE) studies are conducted in the occurrence of a Process Safety incident or near hit. The Process Safety team assists to identify the root cause and implement corrective actions so that PG&E can avoid a similar incident from occurring in the future. One such incident is the Discovery Bay Outage, where wet gas entered the gas system, resulting in hydrates (solids) in PG&E's regulator equipment pilots. The result was erratic pressure control at PG&E's Discovery Bay regulator station. To address the issue, PG&E made the decision to shut-in about 5,900 customers in the Discovery Bay and Byron communities. Corrective actions resulting from PG&E's causal analysis are currently being implemented to further safeguard against a future incident.

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

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) (**Attachment 3**) 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 (**Attachment 4**). 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 (**Attachments 5**).

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 7:

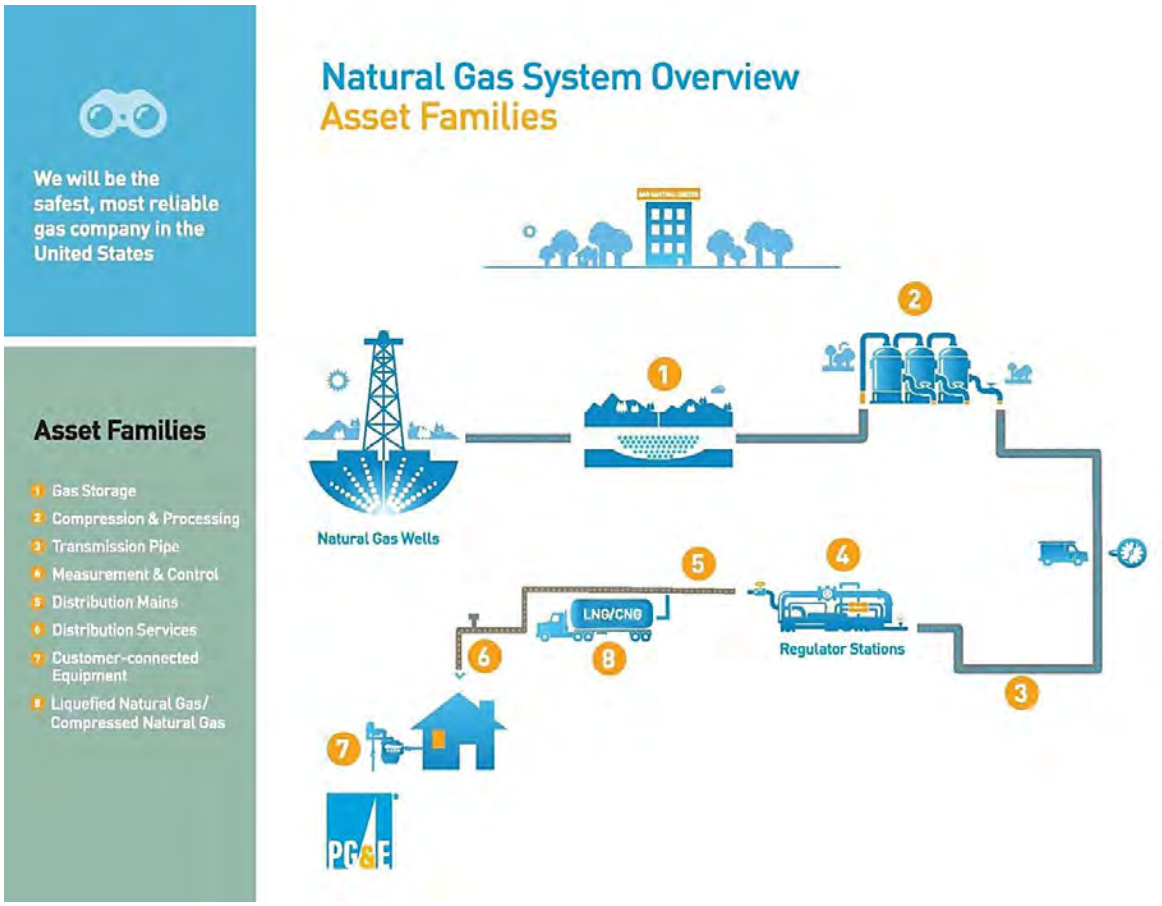


Figure 7 – Natural Gas System Overview – Asset Families

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. 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 Compression and Processing Asset Family, these assets perform a key role in system reliability. The primary assets within this family include 117 storage wells, 14 miles of transmission pipe, 89 downhole safety valves, 217 uphole safety valves, 191 well meters, and 3,404 acres of storage reservoirs with over 102 billion cubic feet of working gas capacity.

Figure 8 – Well Rework: Rig on Well

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 the following Table 2:

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 117 wells by 2025	Number of baseline assessments performed: 2013 – 2015: 18 wells 2016 – 10 wells
Evaluate and incorporate Well Integrity Management Plan (WELL) enhancements	2015 – Drafted WELL documentation 2016 – Submitted final WELL documentation to the Division of Oil, Gas and Geothermal Resources for approval and identified improvements to WELL to incorporate in scheduled revisions of the publication
Assess work on transmission pipeline through Transmission Integrity Management Program	2014 – Began internal corrosion site specific plan baseline assessments 2015 – Completed internal corrosion site specific plan baseline assessments 2016 – Completed written monitoring and assessment plans; Began development of 10-Year Storage Pipe Plan to assess pipe integrity
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

The Gas Storage Asset Management Plan describes these objectives in detail in **Attachment 6**. See **Attachment 7** for PG&E's Gas Storage Safety Report, filed on August 22, 2016, that provides information on the Los Medanos, Pleasant Creek, and McDonald Island storage facilities.

b) Compression and Processing

The Compression and Processing Asset Family includes 38 company-owned compressor units, associated equipment installed at compressor stations, and compressor units and gas processing facilities installed at three underground storage facilities for a total of nine compressor stations. Additionally, this asset family includes 105 gas odorizers and associated equipment installed system wide. These stations support the system's reliability and the odor added to gas at these points helps keep PG&E customers safe when gas arrives at their service point.

Figure 9 – PG&E's Delevan Compressor Station

The Compression and Processing Asset Management Plan describes the roadmap for achieving the asset management strategy and how PG&E delivers the management objectives. Some key strategic objectives are listed in Table 3.

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 2019 Gas Transmission & Storage Rate Case	First iteration of plan developed
Reduce total number of compressor unscheduled shutdowns by 10% per year	Number of unscheduled shutdowns per year: 2013 – 649 2014 – 711 2015 – 330 (54% reduction from 2014) 2016 – 162 (51% reduction from 2015)[8]
Evaluate 100% of Transmission Total Station Features by end of 2019	Completed Evaluations: 2016 – 10,662 (81,799 estimated total station features)
Implement site-specific corrosion monitoring programs to enhance existing programs by end of 2018	Atmospheric corrosion program in place Internal corrosion program for large facilities under development Pilot program for Pressure Vessel Inspection Program to be initiated in 2017
Apply Facility Integrity Management Principles (FIMP) to all stations by 2025	Maturity model was completed in 2015: FIMP at 24% complete in 2015 FIMP at 32% complete in 2016
Complete Physical Security Upgrades at Critical Facilities by 2021	37 of 105 milestone tasks complete end of 2016
Complete all critical documents as defined and required by TD-4551S for all facilities by the end of 2019	Program activities began in 2016

The Compression and Processing Asset Management Plan is found in **Attachment 8**.

c) Transmission Pipe

The Transmission Pipe asset family consists of approximately 6,600 miles of line pipe and major components, such as valves, used in transporting natural gas.[9] PG&E's Transmission Integrity Management Program (TIMP) is one of the programs that govern how PG&E assesses integrity performance and identifies risks that need mitigation 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 is based on the federal TIMP regulations.[10] 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 10 – Transmission Pipeline Span

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	Developed methodologies to aggregate occupancy count across all ASME B31.8S threats.
Evaluate the scope of and assessing for Stress Corrosion Cracking (SCC) and Internal Corrosion risks based on data by 2019	Improved assessment methodology to identify SCC. 2016 – SCC conditions were identified and repaired on three pipelines.
Improve system data to enhance threat and risk analysis by executing on Data Quality Improvement roadmap by 2020	Incorporated all Risk Management procedures into the Codes and Standards format.
Proactively manage assets by planning integrity assessments three years in advance by 2017	The TIMP 2016 Working Assessment plan identifies which threats are required for assessment on each HCA pipeline with 5-year associated compliance deadlines. Advance detailed project scoping is the next step. For ILI, scope has been developed for 30 pipelines to define how to modify each pipeline for in line inspection technology. PG&E will be performing the same level of detail for the remaining assessment types (direct assessment and strength test).
Improve system capacity, reliability, and improve employee safety by meeting 100% of design day conditions, eliminating high risk, and reducing medium risk manual operation in abnormal peak day (APD) conditions by 2019	2016 – Eliminated four high risk manual operations. Added one high risk manual operation for a total year-end inventory of 26. Completed Line 407 western phase, 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	2016 – System visibility is 98% for backbone transmission and 67% for local transmission, improving recognition and response to significant incidents. See Section 7.a for additional information on progress. The Gas transmission SCADA software was replaced.
Industry leading damage prevention program	See page 26 for more information on PG&E's Damage Prevention Program and progress. See page 39 for more information on line marker progress.

The Transmission Pipe Asset Management Plan describes these objectives in more detail and is included as **Attachment 9**.

d) Measurement and Control

PG&E's measurement and control assets measure large customer gas usage, regulate the flow of gas and control gas pressure. The assets in this family perform a critical role in system safety by preventing overpressure events. 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, 428 gas transmission pressure regulating and meter stations, 2,397 distribution pressure regulating stations, 2,433 services tapped off of high pressure regulators, 26 large customer meter sets, and 48 gas quality analyzers. PG&E's Measurement and Control (M&C)

Figure 11 – A Simple Station – Vaulted

equipment is located both above and below ground and located in vaults and includes: Terminals, Complex Regulation Stations, and Simple Regulation Stations (as in Figure 11).

The M&C Asset Management Plan describes the roadmap for achieving the asset management strategy and how PG&E delivers the management objectives. Some key strategic objectives 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 completed in 2015 FIMP at 24% complete in 2015 FIMP at 32% complete in 2016
Eliminate large overpressure events by 2020	Large overpressure events per year: 2013 – 9 2014 – 7 2015 – 7 2016 – 10[11]
Complete physical security upgrades at critical facilities by 2021	37 of 105 milestone tasks complete end of 2016
Implement corrosion monitoring programs to enhance existing programs by 2018	Atmospheric corrosion program in place Internal corrosion program for large facilities under development
Accomplish Obsolescence Management by maintaining the turnover of the fleet to 60 years	Average age of transmission and distribution station fleet: 2015 – 58 years

The M&C Asset Management Plan is provided in **Attachment 10**.[12]

e) Distribution Mains and Services

Figure 12 – Distribution Main Replacement Project

Distribution Mains and Services asset families have been combined for asset management planning purposes into a single plan. This combined asset family includes over 42,400 miles of pipeline that connects to the gas measurement and control 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 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, in a continuous effort to maintain a safe system. Some key strategic objectives include the following:

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 2016 target of 2.03 dig-ins per 1,000 tickets. In 2016, PG&E experienced 2.02 dig-ins per 1,000 tickets and met its target for 2016.
Reduce large overpressure events to 0 by 2020	2013: 5 2014: 4 2015: 5 2016: 6[13]
Identify all potential cross-bores and remediate by 2023	Inspections planned through 2016: 120,600 Inspections completed as of December 31, 2016: 101,900

The Distribution Mains and Services Asset Management Plan provides additional information on these objectives and is included in **Attachment 11**.[14]

f) Customer Connected Equipment

The Customer Connected Equipment 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 Customer Connected Equipment Asset Management Plan provides an assessment of condition and risk of the Customer Connected Equipment asset family and includes the identifications of risks, mitigations, strategic objectives and asset maintenance, for the life cycle of the assets. The plan's key objectives are included in Table 7:

Table 7 – Customer Connected Equipment Asset Management Plan Strategic Objectives and Progress To-Date	
PG&E's Commitment to Safety	**Progress Towards Goal**
Meet Meter Protection Program regulatory commitments by Dec 2016	2015: 408,500 units – 99.8% complete[15]
Implement a policy that minimizes the number of new indoor meter sets installed during new reconstruction projects by 2017	The CPUC issued General Order 112F effective in 2017, which includes requirements for location of service lines and indoor meter locations. PG&E's policies for meter locations are consistent with the new general order.
Reach a steady state backlog of 60,000-70,000 meter set leaks for repair annually	2016 Beginning Year Inventory: 66,531 • Influx of work: 64,718 • Completed: 68,113 2016 End of Year Inventory: 63,113
Identify and remove problematic regulators by 2018	Over 1,488 completed in 2016 – 119% of plan

The Customer Connected Equipment Asset Management Plan is included as **Attachment 12**.[16]

g) Liquefied Natural Gas and Compressed Natural Gas

The Liquefied Natural Gas/Compressed Natural Gas asset family portable assets 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 2016, there were no loss of containment incidents for portable assets. The portable Liquefied Natural Gas/Compressed Natural Gas Asset Management Plan describes its objectives in detail and is included in **Attachment 13**.

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 2016, 98% of PG&E's natural gas fueling customers submitted their 3-year vehicle certificates of inspection. In 2016, there was one significant loss of containment incident for CNG 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	2016: A minor incident occurred involving a break in a 1/4" tubing on the discharge side of a natural gas fueling station compressor. 2016 Activities: Maintenance of Liquefied Natural Gas/Compressed Natural Gas equipment and assets. Liquefied Natural Gas/Compressed Natural Gas equipment training development and operating training
Implementing an industry-leading inspection program to improve safety inspection certifications from less than 20% to 99% of Compressed Natural Gas fuel customer vehicles	2016: 98% 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	2016: Completed major inspection and upgrades of all Liquefied Natural Gas/Compressed Natural Gas portable over-the-road assets to establish baseline standard

The Liquefied Natural Gas and Compressed Natural Gas Station Asset Management Plan describes its objectives in detail and is included as **Attachment 14**.

3. Risk Management Process

Transporting natural gas involves moving a flammable product under pressure to where PG&E's customers live, cook, heat their homes, and warm their offices—and as such, 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. Like slices of Swiss cheese, any one process may fail in a way that presents hazards, but multiple layers of protection are placed on top of one another, to 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 13 – 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 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 2016 risk assessment process.

Figure 14 – Two PG&E Welders

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 timeframe 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 2016 Session D, Gas Operations identified 20 risk drivers, which resulted in 35 risks. Of the 35 Gas Operations risks, seven were enterprise risks. Table 9 reflects the seven Enterprise Risks:

Table 9 – 2016 Gas Enterprise Risks	
Risk	**Description of Risk and Risk Drivers**
Transmission Pipeline Failure – Rupture with Ignition	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. 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.
Natural Gas Storage Failure – Loss of Containment with Ignition at Storage Facility	The risk of failure at gas storage facility (such as reservoir, well, 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. The drivers of this risk include: Internal Corrosion and/or Erosion, External Corrosion, Manufacturing Related Defects, Third-Party Damage, Seismic, Welding/Fabrication Related Defects.
Failure to Maintain Capacity for System Demands	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.
Measurement and Control Failure – Release of Gas with Ignition Downstream	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. The drivers of this risk include Incorrect Operations and Equipment Related Defects.
Measurement and Control Failure – Release of Gas with Ignition at M&C Facility	The risk of failure at gas M&C transmission or distribution facility may result in loss of containment with ignition. The drivers of this risk include: Seismic, Equipment Failure, Incorrect Operations, Welding/ Fabrication Related Defects.
Construction Defect with Release of Gas with Ignition on Distribution Facilities	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. The driver of this risk is Incorrect Operations.
Compression and Processing Failure – Release of Gas with Ignition at Staffed Processing Facility	The risk of catastrophic loss of containment incident at a manned gas storage processing facility may result in catastrophic safety impacts. The drivers of this risk include: Physical Security, Seismic, Manufacturing Related Defects, Welding/Fabrication Related, Defects, Incorrect Operations External Corrosion, Internal Corrosion and/or Erosion Stress Cracking Corrosion.

Some risks impact more than one Line of Business, also 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**
Employee Qualifications	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.
Records Management	Not implementing fully an effective records and information management 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.
Employee Safety	The inability to fully identify, evaluate, and mitigate workplace exposures may result in serious injury and/or fatalities.
Contractor Safety	Failure to comply with contractor pre-qualification and field oversight processes may result in serious injury and/or fatalities.
Cybersecurity	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.
Changing Green House Gas Regulations	Incompatible and/or stringent state and federal Green House Gas regulations may result in unaffordable cost increases to customers.
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.

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 (SMAP) and the Risk Assessment Mitigation Phase (RAMP). SMAP'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.

4. Records and Information Management

PG&E's Gas Operations records management team, as part of the Enterprise Records and Information Management Program, focuses on the deployment of consistent, integrated processes that support records development associated with operational safety, regulatory compliance, and knowledge management. Gas Records and Information Management 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 Records and Information Management initiatives completed in 2016 include:

- Updating the Gas records retention schedule to include the updated requirements of CPUC General Order 112F.
- Updating the gas records inventory and establishing an annual update process requiring leader approval of records inventories.
- Revising the Gas Operations Records and Information Standard that defines the requirements for the lifecycle of records, and integrating the Vital Records standard into the corporate policy and standards for records management.
- Transferring more than 1,700 boxes of paper records from field locations to centralized off-site storage.
- 98.3% of gas operations personnel (comprised of employees and contractors with systems access) completed mandatory annual records training.

These ongoing recordkeeping initiatives continue to support PG&E's actions to maintain PAS 55-1/ISO 55001, API 1173, and RC14001 certifications.

A critical component of the Gas Records and Information Management (RIM) Program is the part-time RIM Coordinator Network, which was established in 2014 and was comprised of over 125 coordinators in 2016. In 2016, a full-time Enterprise RIM Coordinator network supporting all lines of businesses at PG&E was rolled out across the PG&E service territory. The existing part-time Gas RIM Coordinator network transitioned to the Gas RIM Ambassador network to continue to provide local support to gas employees.

In 2016, the RIM Coordinators and Ambassadors covered 140 gas field offices and facilitated communications between the Gas RIM team and the field office 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.

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

Table 11 – Gas Operations Records and Information Management Roadmap Highlights

Key Roadmap Initiatives	Roadmap Drivers
Ongoing inventory management, including an integrated plan for re-indexing offsite records	• 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 I.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
Establishing vital records plans	
Training and educating employees on records management responsibilities	
Executing a digital strategy for the lifecycle management of electronic records	

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

In 2016, PG&E was presented with the seventh annual Common Ground Alliance President's Corporate Excellence Award (CGA). The annual President's Award is presented to organizations showing leadership and innovation in support of damage prevention during the previous year. PG&E was recognized by CGA for its overall leadership in damage prevention.

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.

Figure 15 – Excavation Safety Demonstration for Construction Management Class

PG&E conducted 128 "811 Call Before You Dig" contractor workshops, reaching over 3,900 attendees, representing over 500 excavation companies or municipalities.

PG&E communicates gas safety information multiple times each year, and in 2016, reached approximately 4.5 million paper bill customers and sent nearly 2 million e-mails to those customers who receive paperless billing. In addition to the bill inserts and e-mail campaigns, PG&E also sent targeted direct mail pieces to over 585,000 of those living or working within 1,000 feet of a PG&E gas transmission pipeline. These targeted audiences include 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 right-of-way, un-odorized pipelines or storage and compressor facilities.

Table 12 – Public Awareness Highlights
Executed three social media campaigns targeting homeowners, promoting the importance of calling 811 before digging. These campaigns reached over 212,000 customers and led to over 17,000 additional visits to PG&E's gas safety website.
Developed safe-digging advertising that targeted the agricultural community. The advertising ran in three different publications with total readership of over 110,000.
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 12,000 field visits, at which about 25% did not have a valid Underground Service Alert (USA) ticket.[17]
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.
The Gold Shovel Standard is a program involving a set of safety criteria that PG&E's 2nd-party contractors are required to meet in order to be eligible to do work on behalf of the company. The Gold Shovel Standard became an internationally recognized program, with companies in Canada adopting and implementing its certification requirements. In recognition of the program's ability to reduce excavation damage outside of PG&E's service territory, PG&E enlisted a company named OroPala to make the program available to utilities across North America. PG&E's 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 this area 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 2.11 in 2015 to 2.02 in 2016.

Figure 16 – 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 (Dig-In Reduction Team)	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 training 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.
Senate Bill 661 - Dig Safe Act of 2016	Supported by PG&E and passed into state law in 2016, SB 661 provides to PG&E important clarifications on existing excavation law and creates the Safe Excavation Board.

* 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. To become Gold Shovel Standard certified, contractors must perform no more than two dig-ins within a rolling 12-month period and develop and adhere to a Dig-In Prevention Policy.

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 regulations[18] and California state law[19] 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. 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 Underground Service Alert (USA). In 2016, PG&E received over 576,000 USA tickets, and PG&E Locators made on average, 48,067 positive contacts each month, and responded to over 99.9% of locate requests within 48 hours.

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.

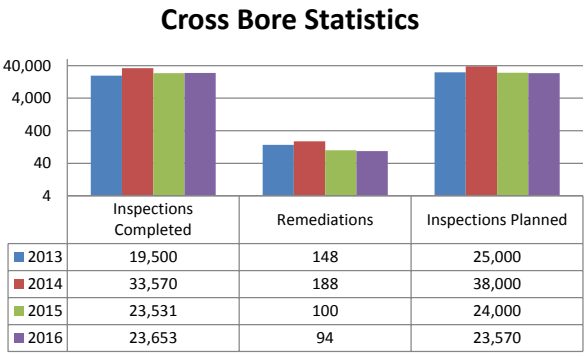
PG&E has three pipeline replacement programs to improve distribution safety: Gas Pipeline Replacement Program, Plastic Pipe Replacement Program, and Main Replacement Reliability Program. PG&E's objective is to maintain an asset age limited to less than 100 years.

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 2016 the GPRP Program replaced 30 miles of pipe.	Since PG&E began its Plastic Pipe Replacement Program in 2012, PG&E has replaced about 224 miles. In 2016, approximately 80 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 2016, PG&E replaced 16 miles of distribution pipe through this program.

c) Cross-Bore Mitigation

A cross-bore is a gas main or service that has been installed unintentionally, using trenchless technology, through a waste-water, or storm-drain system. Cross-bores pose a gas system risk in that they can cause gas leaks into the sewer system if damaged during mechanical sewer cleaning operations and thereby providing a possible gas migration path. PG&E has an inspection program to identify and remediate cross-bores, and a public outreach program that provides safety information to PG&E customers, sewer districts, public works agencies, licensed plumbers, and the plumbers union. In addition, PG&E has implemented a 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.



	Inspections Completed	Remediations	Inspections Planned
2013	19,500	148	25,000
2014	33,570	188	38,000
2015	23,531	100	24,000
2016	23,653	94	23,570

Figure 17 – 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 23,653 inspections in 2016 (100,254 inspections since 2013). PG&E finds about 5.3 cross-bores per 1,000 inspections—consistent with the reported industry benchmark of about two per mile.

d) Strength Testing

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 maximum allowable operating pressure. This process allows 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 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 navigation of the cleaning tools (pigs), allowing PG&E to run inspection tools at later dates [See Section: *In-Line Inspection page 32].* 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 within 12-15 years of year-end 2011. Once completed, PG&E will have a test record for its entire gas transmission pipeline. In 2016, PG&E completed approximately 89 miles of hydrotesting (Table 15). This work brings PG&E to a total of approximately 842 miles hydrotested since 2011. The pipeline miles proposed for strength testing in 2017 are prioritized based on a risk informed mix of integrity management threats and testing untested pipe or pipe lacking a record of a test.

Figure 18 – Main Line Valve Removal Before a Strength Test

Table 15 – Hydrostatic Strength Testing Program					
Strength Test (miles)	**2011-2013**	**2014**	**2015**	**2016**	**Total**
PSEP	539	135	N/A	N/A	674
Subsequent Testing	0	0	79	89	168
Total	**539**	**135**	**79**	**89**	**842**

PG&E's 4-year goal between 2015-2018 for hydrotesting is 680 miles.[20] 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.

e) Vintage Pipe Replacement

A significant portion of PG&E's natural gas transmission pipeline system—approximately 47 %—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.

Examples of "Vintage Pipe"

Figure 19 – Wrinkle Bends

Figure 20 – Miter Bends

Figure 21 – Orange Peel Reducers

PG&E has identified approximately 524 miles of transmission pipe,[21] with some of the characteristics that make it more susceptible to certain construction threats. Of those 524 miles identified, PG&E further identified approximately 100 miles of high risk pipe targeting replacement where vintage fabrication and construction threats interact with high likelihood of land movement in populated areas.[22] Additionally, PG&E is monitoring an additional approximately 950 miles of pipeline with girth welds through in-line inspections or the Geohazard program. In 2016, approximately 6 miles of pipe was replaced.

Table 16 – Vintage Pipe Replacement Program

	Miles Complete/Target	% High Risk Mileage Addressed
Pre-2015	16 miles	16%
2015	10 miles	26%
2016	6 miles	32%
Program Target:	100 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" as well as pipeline features that would obstruct the passage of the tool to make the pipeline piggable. After the pipeline is upgraded 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 Examination and Repair process where the anomaly is exposed, examined and repaired as necessary. The information from Direct Examination

Figure 22 – A Magnetic Flux Leakage Tool or "Smart Pig" Being Loaded Into the Pipeline Launcher.

and Repair is used to generate mitigation activities to improve the long-term safety and reliability of the pipeline.

The Traditional[23] In-Line Inspection Program is ramping-up to complete more projects in the next ten years than ever before to reach the goal of 66 percent total system mileage piggable. As of 2016, approximately 25% of the system is piggable. Much of PG&E's pipeline was installed decades before in-line inspection was invented. Making pipelines capable of accepting traditional in-line inspection often involves replacement of ancillary assets like valves and fittings that may block the passage of the in-line inspection tool and installing launchers and receivers that allow tools to be inserted. Today, about 35% of the PG&E system is not capable of supporting the running of traditional In-Line Inspection 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 23 details PG&E's progress to-date to upgrade pipelines to make them capable of accepting traditional In-Line Inspection tools.

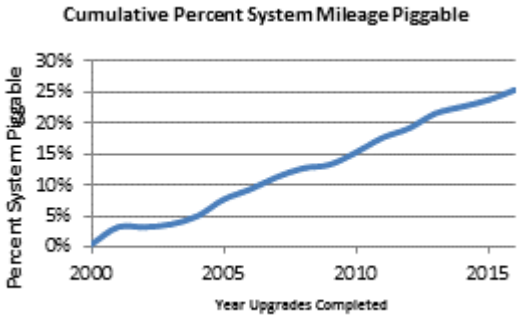


Figure 23 – Cumulative % Transmission System Mileage Piggable

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.

g) Corrosion

All of PG&E's metallic assets are susceptible to corrosion—a natural, time dependent process where 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. Stress corrosion cracking is degradation of the pipe due to cracks induced from the combined influence of tensile stress[24] 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 Stress Corrosion Cracking 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-infomed 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.

Figure 24 – Example of Corroded Pipe

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. In 2016, PG&E addressed 45 transmission pipeline spans and inspected over 1.8 million customer meters.
Casings	Identifies and remediates electrically shorted cased crossings. PG&E remediated more than 30 shorted casings in 2016.
Cathodic Protection	Designs, installs, and maintains cathodic protection systems to prevent corrosion. In 2016, PG&E monitored and maintained cathodic protection on approximately 26,000 miles of steel pipeline.
Close Interval Survey	Collects survey data pertinent to Cathodic Protection levels, coating condition, and other issues at intervals between test points. PG&E surveyed more than 100 miles of transmission pipeline between 2015 and 2016.
Corrosion Investigations	Investigates the cause of insufficient cathodic protection levels or other issues and recommends mitigating solutions.
Cathodic Protection Resurvey	Evaluates field current measurements and updates documentation to ensure that Cathodic Protection systems are operating properly. In 2016, PG&E resurveyed over 270 miles of distribution pipe.
Electrical Interference – AC	Mitigates the threat of alternating current interference with investigative modeling and installation of grounding and/or shielding equipment. PG&E modeled more than 500 locations in 2016 and installed multiple grounding systems, AC coupon test stations, and other mitigating measures.
Electrical Interference – DC	Addresses the risk of direct current interference with investigation and installation of Cathodic Protection, bonding, or other equipment. In 2016, PG&E installed five capital systems and conducted 41 investigations of potential interference.
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.
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 progressed toward its goal of having approximately one test station per mile of pipe by installing more than 180 in 2016.

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 and supports efforts to incorporate the results of such research into corrosion control regulations and standards through its participation in NACE International, the Interstate Natural Gas Association of America, and the American Gas Association.

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 systemwide 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*
2016	55	5**

* 2015 – 14 crossings are FFS per current design

** 2016 – 2 crossings are FFS per current design as of January 23rd, 2017. Final results expected mid-March 2017.

Figure 25 – Pipeline 21A As-found Condition After the 2014 Napa Earthquake

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.

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 depend on the type of facility, operating pressure, and class location of the pipe.

Figure 26 – PG&E Employee Performs a Leak Survey

PG&E outlines current requirements, standards, and guidelines for the Leak Survey and Detection Program in its procedures.[25] In 2016, PG&E surveyed over 896,000 services, over 15,000 gas transmission pipeline miles for compliance, and began performing daily leak surveys on 117 wells in compliance with the California Division of Oil, Gas and Geothermal Resources (DOGGR) emergency gas storage regulations.[26] In 2017, PG&E will leak survey more assets for reasons including that the implementation of General Order (GO-112F) will change the survey

frequency for some gas transmission pipelines.[27] Summaries of PG&E's 2017 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		5 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

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.[28] PG&E's Super Crew model is an end-to-end leak management process that begins with performing what would traditionally be multiple weeks of gas distribution leak survey in one week, using the Picarro Surveyor. 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 and performs all of the leak repairs in a month or two rather than over a multi-month period. PG&E continued this process in 2016 and met 60% of its 5-year distribution system compliance survey requirements using its Super Crew approach. All other repairs were completed by local division resources.

As PG&E transitions its 5-year gas distribution compliance survey to a 4-year survey cycle, it will continue its expanded use of its Super Crew model in all of its divisions, completing at least 75%[29] 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 greenhouse gas emissions.

To further enhance its distribution Leak Survey process, initiatives are in progress to support PG&E's transition to a 4-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 to maintain and assure the safety of the system and the public. In 2016, PG&E's trained and

operator-qualified personnel classified leaks into four grades (Grade 1, 2, 2+, and 3)[30] 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 Gas Piping Technology Committee Guide for Gas Transmission and Distribution Piping systems in monitoring Grade 3 leaks at least every 15 months.[31] 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 General Order 112F.

Also similar to Leak Survey, PG&E utilizes its Super Crew to support gas distribution leak repair. During survey, Super Crew has the ability to find more leaks utilizing advanced technology faster, which in turn provides a number of leaks requiring some form of repair in a short amount of time. 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 2016, PG&E repaired nearly 27,000 gradable leaks on the gas distribution system. Those repairs aided PG&E in its lowest open leak inventory of Grade 2+ and Grade 2 leaks at the end of any year, at 52 leaks. PG&E will continue to utilize and improve the Super Crew model in 2017.

Figure 27 – PG&E's Super Crew at Work

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.

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, 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

In 2016, Aerial Patrol patrolled an average of 4.5x times the mileage required by the Code of Federal Regulations, for a grand total of over 123,000 miles.

structural encroachments.

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.

	Q1	Q2	Q3	Q4
Special Patrol	1,371	1,560	1,510	108
HCA Patrol	8,734	10,614	9,846	9,078
GT Patrol	19,892	20,113	20,153	20,170
CFR Required	6,728	6,728	6,728	6,732

Figure 28 – 2016 Aerial Patrol Mileage by Quarter

In 2016, Aerial Patrol patrolled four and a half times the mileage required by the Code of Federal Regulations, for a total of over 123,000 miles. Program goals for 2017 include:

- Expanding the centralized team of dedicated ground patrollers equipped with mobile solutions to increase coverage of the gas transmission system and improve response times to aerial observations.
- Acquiring and implementing foliage-penetrating LiDAR (Light Detection and Ranging) technology to improve aerial monitoring in areas covered by vegetation.

l) 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.

Figure 29 – Installing a Pipeline Marker and Physical Protection

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 2015, PG&E repaired, replaced, or installed 18,309 markers, representing a 600 percent increase over 2014 installations; and in 2016, PG&E addressed another 11,226 markers to make its gas transmission pipeline more visible from above ground. Going-forward, PG&E will focus on maintaining its existing marker inventory and adding new markers as needed.

m) Community Pipeline Safety Initiative

The Community Pipeline Safety Initiative is a five-year (2013-2017), shareholder-funded program that is focused on enhancing safety and reducing risk to PG&E's gas transmission pipelines. The program involves working collaboratively with more than 10,000 customers in more than 380 communities to check the area above PG&E's 6,600 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.

This safety program was informed by 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 358 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. 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 325 structure miles and 1,211 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.

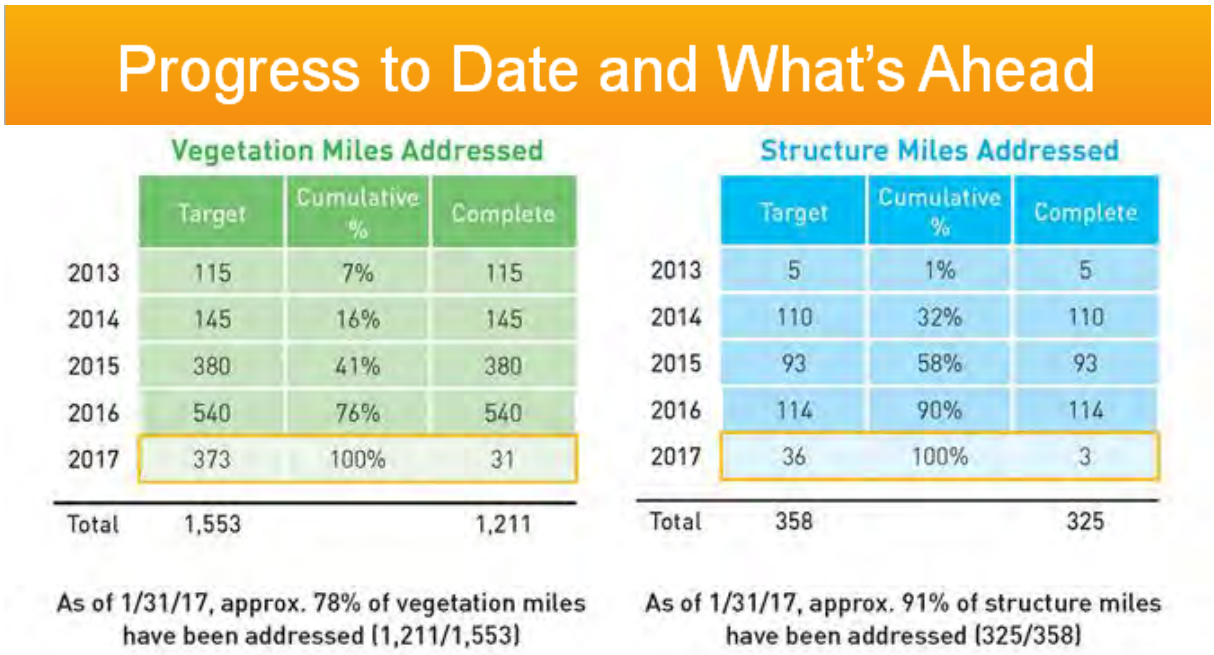


Figure 31 – Overall Community Pipeline Safety Initiative Program Metrics (2013-2017)

6. Mitigating Loss of Supply

In 2016, PG&E transported and delivered about 1,000 billion cubic feet of gas.[32] 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.[33] 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 47*]. Additionally, PG&E measures and works to reduce over-pressure incidents. PG&E's pipeline capacity is sized to provide all core customers, PG&E's residential and small commercial customers, with uninterrupted service on a one-day-in-90-year cold temperature event (referred to as an Abnormal Peak Day), and to provide all customers, including non-core, (large commercial, industrial or institutional customers) with uninterrupted service on a one-day-in-two-year event (referred to as a Cold Winter Day). PG&E's gas system was successfully tested in real-time in December of 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.

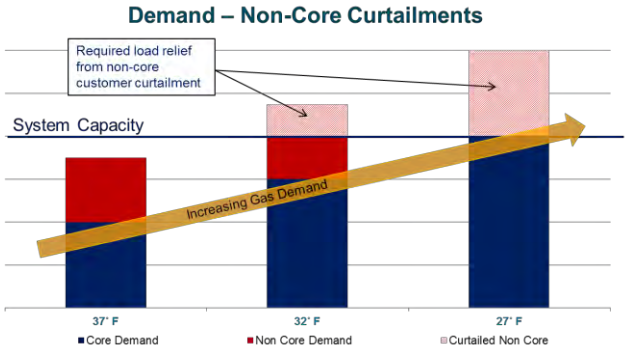


Figure 32 – How Demand for Gas Affects Capacity

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

Gas System Planning	Network Investment Plan	2016
Obtains information from a variety of sources to determine possible load growth and other potential changes that may affect system capacity requirements. In addition, systems are studied as needed to ensure that planned pipeline operations are managed for minimum impact on capacity.	A multi-year program that analyzes PG&E's gas systems to optimize system design. The objective is to efficiently incorporate various safety-related pipeline efforts into design work driven by other factors. This effort is intended to identify and correct design inefficiencies.	**Between 2014 and 2016, PG&E completed 28 investment plans.** • 6 Local Transmission • 19 Distribution • 3 Combined Local Transmission and Distribution systems

b) Overpressure Elimination Initiative

A pipeline that operates at higher than the Maximum Allowable Operating Pressure (MAOP) presents an operational risk to the safety of the public, employees and contractors working on the facilities (See **Attachment 15** for PG&E's MAOP standard) and in addition to loss of supply can lead to a loss of containment. When a pipeline operates above its MAOP, it is known as an abnormal operating condition (AOC) and is described as an overpressure event. Human error and equipment failure are currently the two most common causes of an overpressure event. Overpressure events have the potential to overstress pipelines and may lead to loss of containment. Large overpressure events (such as those graphed in Figure 34) are those that could pose significant safety and operational impacts to

PG&E's gas system. In 2012, PG&E began an initiative to eliminate system overpressure events. In 2016, PG&E continued to implement priority actions to eliminate overpressure events by evaluating and implementing station design and construction best practices, implementing a lock-out/tag-out process and other clearance improvements, and delivering awareness of associated risk factors through training and communication initiatives.

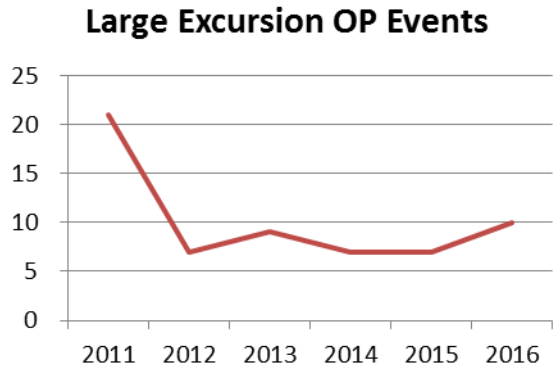


Figure 34 – Large Excursion OP Events

PG&E will continue to apply mitigation strategies from previous years, and in 2017, focus on corrective actions directed at human performance and equipment failures. Additional human performance tools and training will roll out to PG&E's workforce, with additional communications sharing overpressure event elimination strategies. PG&E plans to install additional supervisory control and data acquisition (SCADA) points annually to increase system real-time visibility in the Gas Control Center. PG&E recently implemented new, complex SCADA alarm capabilities to aid in the ability to proactively prevent and minimize overpressure events.

Additionally, PG&E is incorporating predictive analytics to identify equipment (i.e., gas regulation) with compromised operational performance. Predictive analytics enable a proactive response prior to potential equipment failure. PG&E further continues to modify operations and upgrade gas system regulation equipment to provide greater separation between normal operating pressures and the maximum allowable operating pressure. Each activity contributes to the goal of reducing overpressure 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.

The separate gas clearance processes for transmission and distribution were reviewed in 2015. As a result, the clearance procedures for transmission and distribution were aligned to a single process in 2016. This alignment was performed to eliminate gaps between the two processes and improve consistency and execution.

In 2016, a new procedure, called Lock-Out/Tag-Out, was incorporated into the clearance process. The procedure uses process safety principles to implement an additional layer of safety to the clearance process. "Lock Out Tag Out" is a specific set of practices and procedures to safeguard employees from the unexpected energization or startup of machinery and equipment, or the release of hazardous energy during service or maintenance activities.[34] To develop the procedure in compliance with Federal and CAL-OSHA Lock Out Tag Out requirements, PG&E benchmarked how other companies implemented and use the practice.

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 75% over a 3-year period to approximately 1,146 in 2016. PG&E's 2017 goal for DPPM is 950, and continues to take a step by step approach towards becoming Six Sigma equivalent DPPM, which is 100.5.

Figure 35 – How PG&E Manages Suppliers

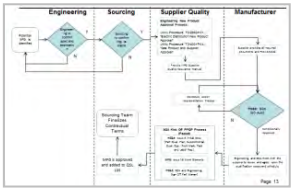
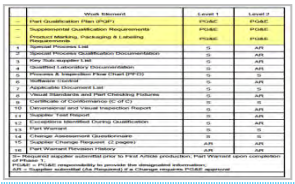
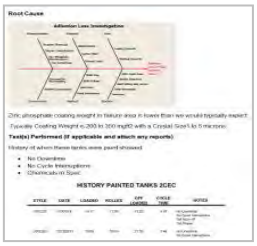
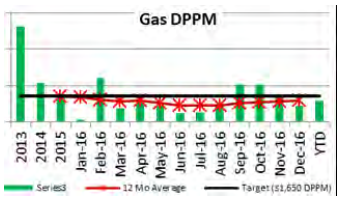
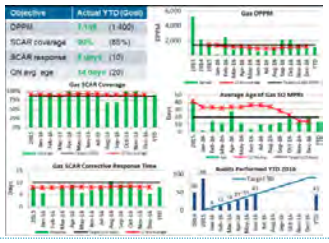
1. Qualification	2. Material Inspection	3. Material Problem Reports
Supplier (QSL) Dashboard  Product (PPQP) Dashboard 	Receiving (DC)  Source (Supplier) 	Material Problem Reports (MPR)  *[See Section: *Material Problem Reporting page 9]* for more detail on the Material Problem Reporting process.

Figure 35 – How PG&E Manages Suppliers (cont'd)		
4. Corrective Actions	**5. Supplier Management**	**6. Business Allocation Strategy**
SCAR[35] / Failure Analysis	Defective Parts Per Million	Supplier Scorecard
		

Two continuous improvement efforts illustrate PG&E's commitment to mitigating supplier risk. First, in February 2016, PG&E achieved certification with the International Standards Organization ISO-9001, the international standard for Quality Management Systems.[36] 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% of its critical and high-risk suppliers, an increase of over 80% 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 personnel to limit damage from accidents, explosions, fires and dangerous conditions. It is PG&E's policy to:

Objective	Description
Establish Command	Determine the Incident Commander, set up an Incident Command Post, 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

- 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 Transmission and Distribution Gas Control Center monitors and controls the flow of gas across PG&E's system 24 hours a day, 365 days per year, to ensure that it 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.

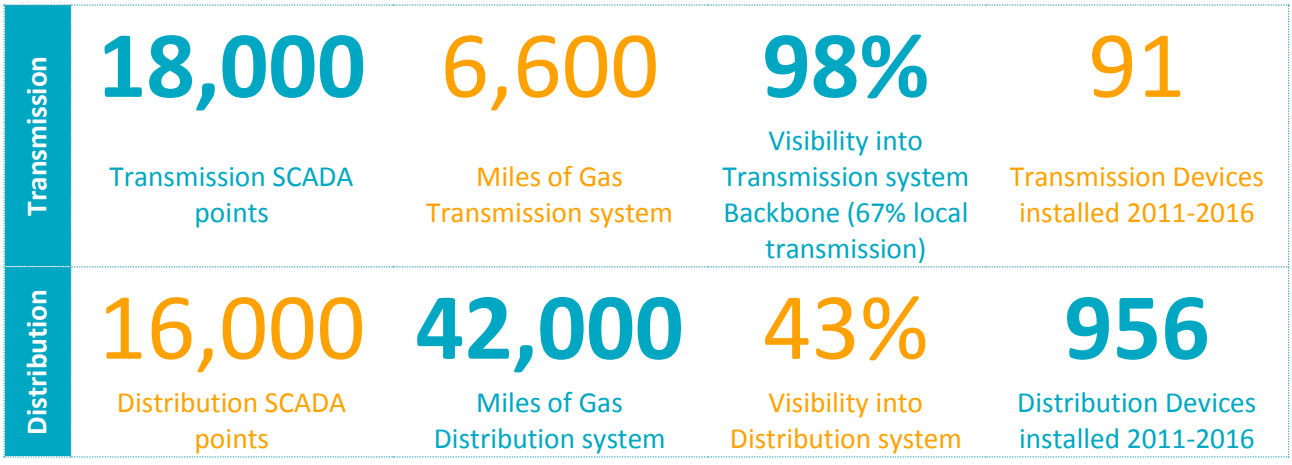


Figure 37 – PG&E's Progress in Enhancing System Visibility Through SCADA

G&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 vision for long-term gas safety excellence.

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 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.

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

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
- 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).

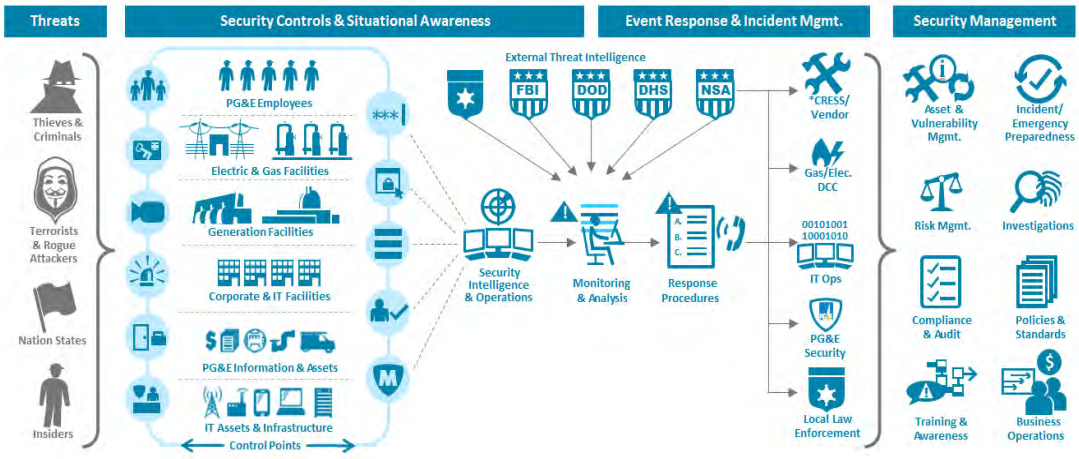


Figure 40 – PG&E's vision is to develop an industry leading unified cyber/physical security program that effectively manages risk and proactively adapts to evolving threats and changing business needs.

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 2016 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 2016, an additional 18 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.

Figure 41 – Valve Automation at Edgewood Park

Table 20 – Valve Automation (Pipeline Safety Enhancement Plan)					
Valve Automation (units)	**2011-2013**	**2014**	**2015**	**2016**	**Total**
PSEP	134	74	9	N/A	**217**
2015 – 2018 GT&S Rate Case	0	0	18	33	**51**
Total	134	74	27	33	**268**

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 47*].

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. See **Attachment 16** for PG&E's Gas System Operations Control Room Management Manual and **Attachment 17** for the Gas Emergency Response Plan.

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 Supervisory Control and Data Acquisition (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

For gas incidents that require additional coordination and exceed normal (Level 1) day-to-day or "routine" incident response, the Gas Emergency Response Plan (GERP) provides an outline of Gas Operations' organizational structure and activities undertaken in response to emergency incidents that exceed a "routine" incident response. The GERP presents 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 primarily through the use

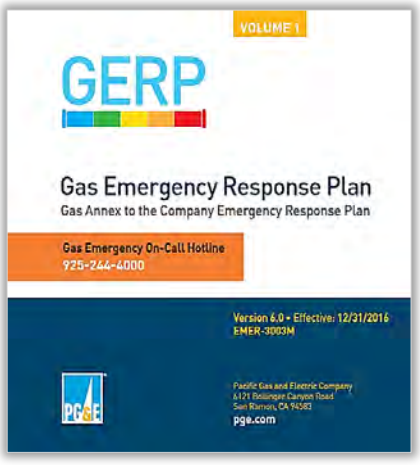


Figure 42 – The Gas Emergency Response Plan as of Dec. 31, 2016

of the Incident Command System.[37]

Company Emergency Response Plan

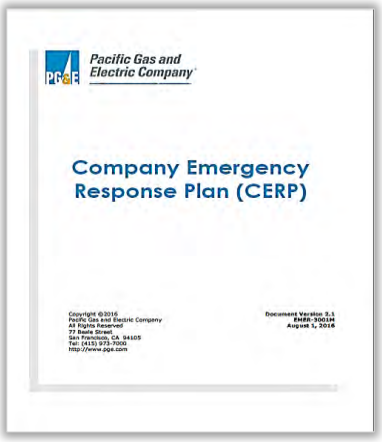


Figure 43 – The Company Emergency Response Plan as of Aug. 1, 2016

The purpose of the Company Emergency Response Plan (CERP) is to assist the gas and electric businesses with a safe, efficient, and coordinated response to an emergency. For a copy of PG&E's 2016 Company Emergency Response Plan, please see **Attachment 18**.

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 23 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 and Response

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 2016, the Gas Emergency Preparedness group:

- Conducted 42 instructor led trainings
- Facilitated 16 Operations Emergency Center exercises
- Facilitated 4 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 2016, Public Safety Emergency Preparedness completed the following efforts in partnership and close coordination with first responders and local governments:

Figure 44 – Delivered 583 First Responder Workshops to more than 9,000 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.

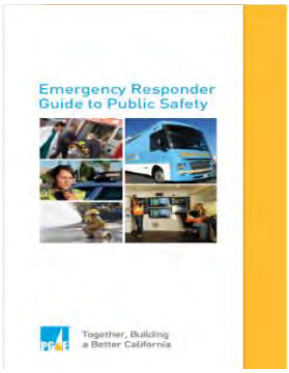


Figure 45 – Met with the 361 fire departments responding to gas incidents. These meetings focused on contingency plans in the event of an emergency.

Figure 46 – Hosted eight 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 57 Safety Fairs and Conferences reaching over 52,000 people, including first responders and the general public.

Figure 48 – Supported several events leading up to Super Bowl 50 in the South Bay and San Francisco areas. Working as a single, integrated gas and electric team, PG&E was prepared to respond to any unusual gas or electric incident for Media Night at the SAP Center and the opening and operation of Super Bowl City.

Figure 49 – Responded to 90 dig-in incidents. Public Safety Emergency Preparedness acted as an Agency Representative between PG&E and the first responder community.

Figure 50 – Throughout 2016, Public Safety Emergency Preparedness supported PG&E's vegetation and right-of-way management activities by presenting information to first responders, attending community presentations and generally providing ongoing support to community engagement activities across the PG&E service territory.

Figure 51 – Public Safety Specialists worked in collaboration with the Damage Prevention team to improve safety within PG&E's communities and reduce the incidents of third party dig-ins.

PG&E's work requires well-trained personnel to correctly perform work activities. Therefore, the Company invests in recruiting and retaining, providing ongoing development and training, and maintaining supportive controls for employee and contractor work. Fully engaging PG&E's employees 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.

V. Workforce Safety

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 make progress towards a flat organizational structure and identifying ways to execute work in a safe, efficient, and effective manner. PG&E continues to seek ways to consolidate, streamline, and work more efficiently while continuing PG&E's commitment to safety. 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 2016 PG&E deployed a number of projects designed to improve employee safety. Table 21 summarizes four workforce safety projects.

Table 21 – Examples of PG&E's 2016 Workforce Safety Projects			
Serious Incidents and Fatalities (SIF)	**Safety Leadership Development**	**Personal Protective Equipment Matrix**	**Phone Free Driving**
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 receive a deeper evaluation and increased management oversight to prevent repeat occurrences.	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.	Collaborative development of a tool, available for use by all employees, to evaluate the correct personal protective equipment for the task being performed. The project developed a matrix based on the tasks performed by each department with a goal of reducing injuries due to incorrect Personal Protective Equipment by 25% during year two after full implementation and engagement sessions.	Industry leading, proactive policy to prevent use of cellular communication while operating motor vehicles. Any distraction while driving increases the risk of accidents and injuries. By preventing the use of cellular devices with the exception of emergency situations PG&E may reduce motor vehicle incidents and improve both public and employee safety. PG&E's MVI rate for Serious Preventable incidents was reduced by 50% and overall preventable MVI rate showed 30% improvement due to PG&E's Motor Vehicle Safety Program enhancements.

3. Workforce Training

The cornerstone of safe and reliable gas facility design, construction, maintenance, operations and retirement is maintaining a workforce of highly-skilled, competent and experienced technical employees. Training program improvement priorities are determined and driven by regulatory changes, new tools and instruments, standards and policy changes and strengthened Operation Qualification requirements. In 2016, PG&E Gas Operations employees rated their technical training experience a 4.45 on a scale of 1-5.

In 2016 PG&E continued construction activities on the new, state-of-the-art gas training facility in Winters, California (Figure 52), and expects to be delivering curriculum at that facility in the second half of 2017. The facility's master plan was established with input from a cross-section of PG&E's technical workforce and is based on that team's experience and benchmarking of industry training facilities. The facility will include a utility village to provide realistic scenarios for leak survey, leak pinpointing, and emergency response. Other features include an industry-leading measurement and control flow lab to provide hands-on training for instrumentation and regulation equipment found in the field, and a construction training area that will include hands-on excavation, shoring, and other construction-related activities. In early 2012, PG&E finished a comprehensive benchmark study that compared PG&E's gas training to other utilities. Three recommendations were made in support of employee training and PG&E's Gas Operations training program identified approximately 400 courses

to develop or enhance between 2012 and 2016. As of December 31, 2016 PG&E had developed or enhanced 501 courses.

- 2016: 214 Courses
- 2015: 107 Courses
- 2014: 78 Courses
- 2013: 88 Courses
- 2012: 14 Courses

Figure 52 – Construction in Progress at PG&E's Winters Training Center

In 2016, course publications included:

- 28 courses upgraded to improve the training quality, and
- 214 courses either developed or redesigned.

Beginning in 2016, training redesign and new curriculum priorities were established through the training governance committee. Additionally, a curriculum review committee is now engaged to determine the best solution for approved projects.

Table 22 – Gas Operation Training Recommendations 2012-2016

2012 Recommendation	Progress as of Dec 31, 2016
Develop programs that support employees throughout their career	• Courses were developed or realigned to support new lines of progression • Seven apprentice programs in Gas Operations that have been developed or are currently being developed to move employees to journey-level competency • Increased focus on refresher training to maintain skill and competence of existing employees
Broaden technology solutions and leverage external curriculum	• 22% of curriculum built in 2016 was web-based or on other technology based medium • The use of iPads was piloted in the two largest volume courses • Virtual Learning was leveraged to reduce non-productive time and reduce travel cost • Contract vendors used for training to that resulted in employees obtaining industry-recognized certifications
Implement continuous training improvement processes	In 2016, Gas Operations Training implemented: • The Gas Operations Training Governance Committee reviewed and had approval authority on 100% of redesign and newly created curriculum • The Curriculum Review committee was established to review new and maintenance training curriculum projects to determine the correct solution and to review curriculum as it is developed • 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 applicant installer contractors participate in mandatory training, and possess all appropriate qualifications to perform covered 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.

Pipeline tasks require specific competencies in order to be performed safely and reliably. These competencies are reflected in the "Knowledge, Skills, and Abilities" needed for each task; "Knowledge, Skills, and Abilities" (KSAs) are determined by a group of subject matter experts 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% 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. Initial qualifications follow training.

Figure 53 – Employees Taking Written Examinations

The CPUC's General Order 112-F requirements add 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 covered tasks. The expansion is a significant development in the Operator Qualification Program and involves employees, PG&E contractors, and Applicant Installer contractors working on PG&E pipeline facility assets.

For new personnel, experience is gained through working under the direction and observation of a qualified employee and formal training. 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 efficiently and appropriately 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 in order 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,[38] 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. In order to adhere to this high standard, PG&E follows a four step process (Figure 54) for contractor safety, training and oversight.

Figure 54 – Four Step Process to Contractor Safety 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 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 55, metrics track injuries and motor vehicle incidents. In 2016, PG&E Construction Crews and Contractors (See the red bar in Figure 55) out performed in all performance metrics when compared to Gas Operations and PG&E as a whole all while working close to six million hours performing higher risk work.

Figure 55 – 2016 Safety Performance

Year over year reductions in four of the five categories show the shift in safety and cultural behaviors. As depicted in Figure 56, the data demonstrates that between 2012 and October 2016, at-fault dig-ins have significantly reduced as PG&E improves its damage prevention process. The OSHA recordable rate (ORI Rate) has seen steady improvement, 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.

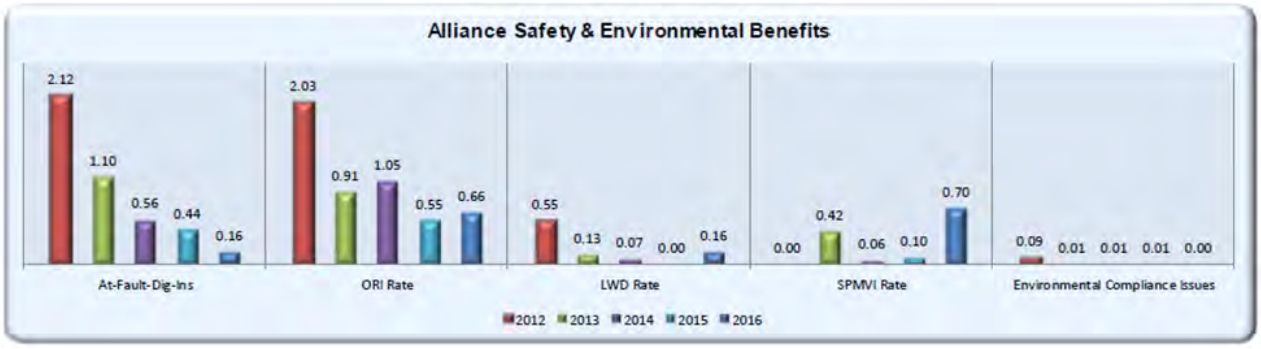


Figure 56 – Alliance Safety and Environmental Benefits

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 2016, there were over 600 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 2016, 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 Mapping Advancement Program,[39] and PG&E's Leak Survey Optimization Program, also known as Super Crew.

Figure 57 – 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 certification[40] 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 Leak Optimization Program, commonly referred to as "Super Crew," which incorporates advanced leak detection technology, and includes a streamlined and bundled approach to finding and fixing leaks. The benefits of this program include a significant increase in leaks found, improved work performance, enhanced system reliability, and increased public safety. Currently, PG&E is partnering with the International Brotherhood of Electrical Workers on additional safety-related improvements [See Section: *Leak Survey, Leak Repair pages 36, 37*].

VI. Compliance Framework

PG&E's business of providing natural gas to millions of Californians comes with responsibility for public, workforce and environmental safety in compliance with state and federal requirements. PG&E believes a compliant organization does the right thing, even when no one is looking. PG&E's enterprise-wide compliance approach is grounded in a model consisting of eight program areas:

- Risk Assessment
- Program Governance and Resources
- Guidance Documents
- Compliance Controls
- Communication and Training
- Monitoring and Auditing
- Investigation and Response
- Enforcement, Discipline and Incentive

Each Line of Business, including Gas Operations, uses milestones within each program area to assess challenges and opportunities for compliance performance improvement.

In 2016, PG&E's Chief Ethics and Compliance Officer (CECO) instituted programmatic improvements across both the enterprise, and at the Line of Business level focused not only on the structural components of compliance, such as understanding regulations, designing processes to ensure compliance and implementing testing controls to ensure compliance, but also focusing on the cultural elements of compliance such as a speak-up culture and safety-first approach.

Within Gas Operations, compliance requirements such as Operator Qualifications and record-keeping are being mapped to operational risks such as overpressure events and third-party damage to pipelines. PG&E's effort is to facilitate a richer integrated planning process with the goal of allocating resources to the right work at the right time.

Gas Operations has identified specific drivers of compliance risk, and implemented process improvements and projects to further the Company's progress towards being the safest, most reliable gas company. Those drivers are building expertise, having the right information and resources available to perform work, and supportive controls, discussed further below.

1. Building Expertise

PG&E employees require specialized skills to be able to perform their jobs, constructing, operating and maintaining the natural gas transmission and distribution systems. The Company invests in training employees to perform work and to fix problems safely, quickly and effectively. In its 2016 Session D review of operational risks and foundational compliance requirements, PG&E identified Operator

Qualifications as a top compliance risk and developed mitigations that include digitizing records to provide easier access to qualification information, expanding program elements for new Operator Qualifications, and strengthening procedures. As discussed in the previous section, PG&E has also strengthened the rigor of qualification exams. [See Section: *Workforce Training page 56*] and [See Section: *Gas Operator Qualification page 58*] for more information.

2. THE RIGHT INFORMATION TO DO THE WORK

PG&E can't fix what it doesn't know about. Doing the right work depends on having the right information available, when employees need it. The right information starts with knowing what assets need to be worked on, the type of work to be completed, where the asset is located, and the procedures necessary to perform the work. PG&E uses an SAP Work Management module to maintain its asset registry and to identify the right work [See Section: *The Right Resources to Do the Job page 64*], pipeline mapping systems to ascertain where the asset is located, and the operations and maintenance manual, located on PG&E's digital Technical and Information Library, to dictate the correct procedures to perform the work.

The SAP Work Management Module identifies assets that must be maintained and the schedule for doing so. PG&E uses the work management module to plan who will do the work, when it will be done, where it will be done, and what will be done. This system organizes PG&E's efforts to accurately identify the work to be completed, schedule the work for timely completion, and cost-effectively schedule resources. In 2016 a variety of updates were made to the system including adding to the work management system regulator and valve maintenance activities. PG&E's focus in 2016 was on improving data for analytics and providing an enhanced user experience to drive efficient, reliable processes for the end user.

PG&E has two pipeline GIS mapping systems, one for natural gas 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. For example, PG&E has been using its CAP to identify, track and complete mapping corrections. Additionally, PG&E is focused on mapping timeliness, using continuous improvement methods to reduce time to map assets following construction completion. In 2016, mapping volume of work more than doubled, but mapping cycle time decreased slightly from 47 days (in 2015) to 45 days (in 2016). Mapping staffing increased in 2016 and the team made improvements to training, procedural guidance, and streamlining the as-built record development process.

Table 23 – Pipeline Mapping Timeline		
Mapping Metrics	**2016 Goal**	**2016 Results**
Time from Construction-Complete to Mapping-Complete	35 Days	45 Days
Average Mapping Corrections Time (through CAP Process)	45 Days	43 Days

The Gas Distribution As-Built Records Collection (GD ARC) project is collecting, scanning, and indexing over seven million pages of as-built records from 24 local offices and making them accessible to authorized personnel in an electronic document management system at any time, at any networked location. The result will be speedier access to records and information needed to make decisions that could affect the safety and reliability of PG&E's gas system.

Finally, PG&E proactively updates and maintains tools like its O&M manual so that employees have ready access to the most up-to-date and compliant specifications, standards and procedures. The company has identified an opportunity to make these manuals easier to use, thereby making it easier for employees and contractors to be compliant. And, in 2016, PG&E initiated a review process to consolidate the Transmission and Distribution manuals into a single volume.

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 in a timely and safe way—whether through technology or traditional tools and equipment. For instance, PG&E has introduced mobile technology for several key processes, including aerial patrols, access to and management of locate and mark tickets and leak repair forms (see Figure 58).

Figure 58 – Screenshot of iPad GIS Application Used by Aerial Patrol in Monitoring Potential Excavation Observations

4. Supportive Controls

As PG&E works to achieve its compliance culture vision, several programmatic controls are in place to help the organization meet its regulatory compliance obligations. Table 24 summarizes some of the programmatic controls that PG&E uses as a building block to create an effective compliance culture:

Table 24 – Compliance Controls

Building 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, regulatory station maintenance, and as-built record development. [See Section: *Quality Management page 66*], and for a detailed program description, see **Attachment 19**.

Conducting Internal Audits (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.

Submitting Self-Reports (ALJ 274) – PG&E is committed to self-report compliance issues and to take prompt mitigative action. In total, PG&E filed 11 ALJ 274 reports in 2016.

Participating in Safety and Enforcement Division (SED) Inspections – In advance of SED inspections, PG&E self-evaluates gas divisions and districts and additional programs, such as Operator Qualification, Emergency Management and Integrity Management, and provides results to SED. PG&E's assessors spent approximately 8,500 hours in 2016 identifying and supporting issue resolution. PG&E strives to resolve issues raised by self-evaluations within the same inspection cycle.

Performing Causal Analysis – Similar to the continuous improvement mechanism in PG&E's Process Safety method, 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 33 causal analysis evaluations in 2016.

Evaluating National Transportation Safety Board (NTSB) Reports – The NTSB investigates all serious pipeline incidents. PG&E subject matter experts 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.

Evaluating 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. PG&E received, reviewed and acted on five bulletins in 2016.[41]

As outlined in this Plan's Risk Management Process section, the Gas Operations Risk and Compliance Committee lead the organization's identification, prioritization and communication of the top operational risks and foundational compliance requirements to the gas business. The Committee's oversight role of the Gas Operations risk mitigation work is a critical contribution to PG&E's system of controls. The Committee is composed of senior leaders in the gas business up to and including the President of Gas Operations, and the Senior Vice President of Gas Operations at PG&E. The Committee prioritizes Gas Operations' risk and compliance activities and commitments. Additionally, the Committee reviews Internal Audit findings, regulatory compliance and audit results, and approves action plans to address compliance issues. Governance at this level is instrumental in reviewing trends and identifying best practices, and expanding implementation of successful and safe practices to the rest of the business, one of PG&E's many efforts to continually improve its gas business.

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. QUALITY MANAGEMENT

The Gas Quality Management (QM) organization is responsible for centralized quality assurance (QA) activities and helping others integrate quality control 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. There are currently 14 active QM programs as of 2016 and are shown in Table 25 below. In 2017, QM plans to perform quality assessments on atmospheric corrosion surveys, identification of abnormal operating conditions and the ability to locate assets after construction.

Table 25 – List of Quality Management Programs as of 2016

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	**Transmission and Distributions As-Builts**
Internal Records Review	**Field Service Records Review**[42]

In 2016, Gas Operations began reaping the benefits from the Quality Management System (QMS) manual it follows and implemented in 2015, resulting in lower QA findings and less rework. Since the implementation, multiple construction, maintenance and operations departments started incorporating quality control (QC) into their own work processes, allowing Quality Management to provide quality assurance functions as prescribed in the QMS.

The fundamental principles in the QMS leverage the "Plan, Do, Check, Act" (PDCA) framework (refer to Figure 59) 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.

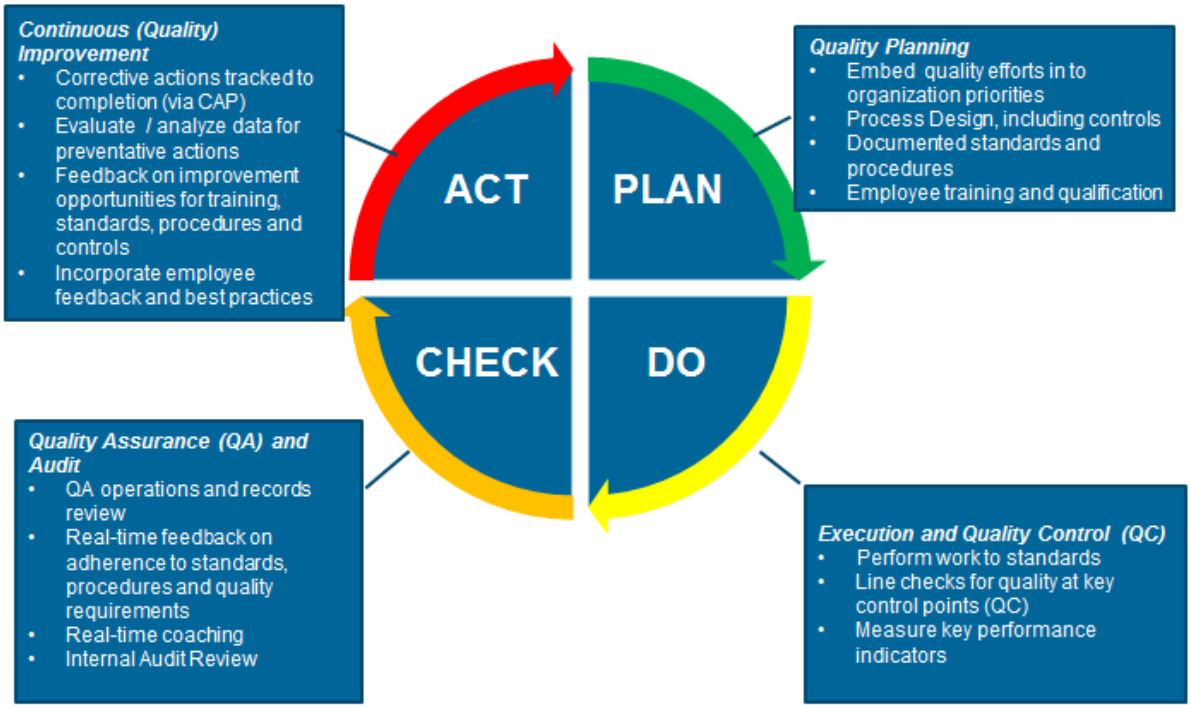


Figure 59 – The Quality Management Process

In addition to the benefits realized from implementing the QMS manual, QM also achieved many accomplishments in 2016. Some of these accomplishments include:

- Incorporated industry acknowledged Risk-Based Process Safety principles into PG&E's quality assurance programs.
- Multiple employees received training and became certified ISO 9001 auditors.
- Performed 26,707 quality assessments in the field and office.
- Created multiple trainings and bulletins to address identified gaps in work procedures and top findings from quality assessments.
- Developed draft of quality assurance protocol to strengthen data quality in the gas distribution GIS.
- 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 dramatically improved in 2016. 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 (refer to Figure 60).

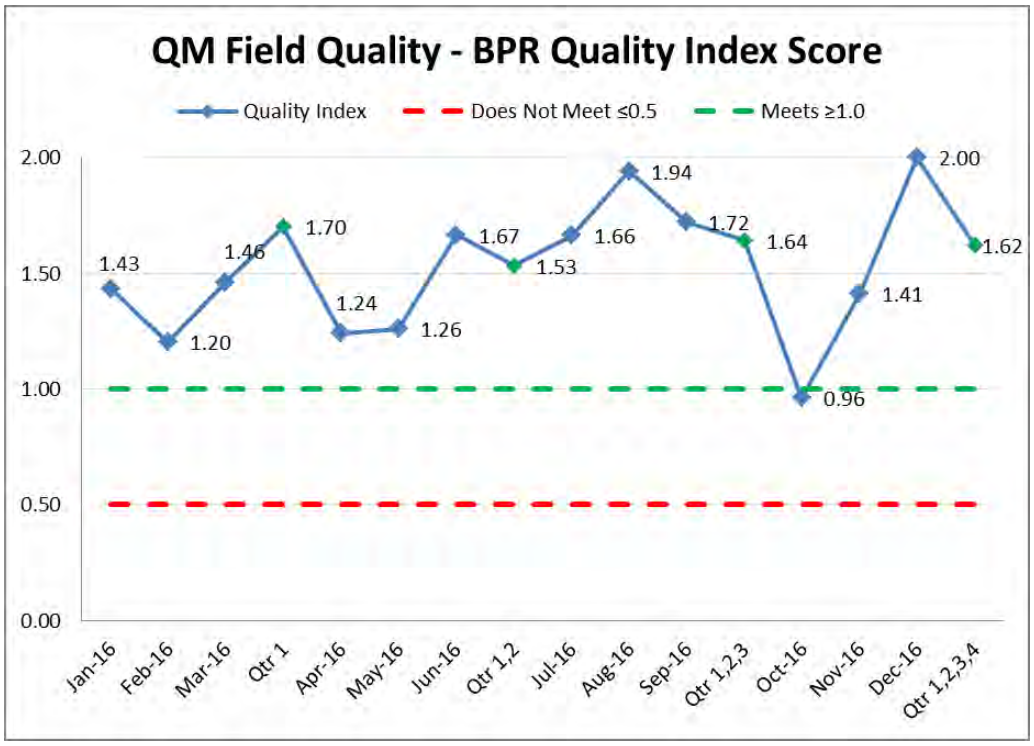


Figure 60 – Quality Index Score

2. RESEARCH AND DEVELOPMENT

Research and Development and Innovation identifies, adapts, qualifies and implements innovative solutions in the Gas Operations business to improve its performance measured in public and work safety, customer satisfaction, environmental impact, regulatory compliance, communication, and cost effectiveness.

The Research and Development and Innovation Program is embedded in Gas Operations through the continuous improvement process of Gas Safety Excellence and its work is prioritized based on the results of the Risk Management Process, assuring that projects and innovations align with the most critical needs of the business. In this framework, each Research and Development project is assessed using multiple criteria that not only weighs its strengths and weaknesses to justify decisions but also defines the actions that must be engaged early in the life cycle to prepare its successful deployment. As a result, the Research and Development and Innovation Program includes more than 200 projects that balance one-year and three-to-five-year objectives.

In order to optimize resources, PG&E participates in numerous collaborative efforts through national and international Research and Development organizations such as the Pipeline Research Council International (PRCI), NYSEARCH, and Operations Technology Development (Gas Technology Institute). In addition, PG&E monitors and tests emerging technologies developed through PHMSA's collaborative Research and Development Program as well as the California Energy Commission, which

assigns a specific budget to Gas Pipeline Integrity improvement within its Public Interest Energy Research Program. This effort is illustrated below by two examples addressing leak detection and damage prevention.

Unstaffed Aerial Vehicle (UAV) Mounted Leak Detection System

In collaboration with NASA-JPL, PRCI and the University of California Merced, PG&E has developed and successfully tested a drone mounted methane detector. The sensor is able to measure concentrations of 10 parts per billion above ambient methane concentration. Tests have demonstrated that the sensor placed in front of the propellers can correctly detect even subtle increases in methane concentration without being affected by the drone's propeller wash. Small simulated leaks were detected reliably on a series of flights demonstrating the capabilities of the new leak survey tool. The system has been designed as an independent module that can be easily mounted on different unstaffed aerial vehicle) platforms. Next steps include developing a mount for fixed wing drones that offer longer flight times and better coverage for linear asset surveys. In addition, first applications will be explored at facilities such as compressor stations and in areas that are hard to reach by foot.

GPS Based Damage Prevention System

Dig-ins are the most frequently occurring threat to pipelines. PG&E is exploring a new GPS-based technology to alert excavation equipment operators about their proximity to underground pipelines. Developed in collaboration with the Gas Technology Institute through the Operations Technology Development Program, the solution uses a GPS device installed in the machine that communicates in real-time its position and other parameters to a central server for analysis. Field tests performed in 2015 and 2016 have shown that the data collected can successfully inform excavation equipment operators and owners about the activity of the equipment when it is digging or ripping the ground. Its GPS location is also used to determine the distance to assets. Different awareness and alert messages are sent to the operator and other stakeholders such as the utility and the business owner to prevent an incident. A collaborative pilot with the California Energy Commission is planned for 2017 before full deployment. Such a system may provide an additional layer of safety to excavation operators.

Figure 61 – UAV mounted methane detector flying at UC Merced

3. 'SUPER GAS OPERATIONS'

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 to 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."

SGO helps gas teams to better plan the work, improve the flow of work, and increase visibility into a rolling 90-day plan of "shovel-ready" work. In 2016, the crew strengthened focus on safety and actual construction activities by increasing visibility to the work plan. As a result, Gas Operations met 95.9% of customer commitments on time in 2016. The gas maintenance and construction teams realized many other benefits after implementing the SGO program, such as improved documentation quality and productivity as seen in Figures 62 and 63. Since the SGO Program kicked off in 2014, errors in as-built documentation for the M&C organization decreased by 90% through year-end 2016 (See Figure 62).

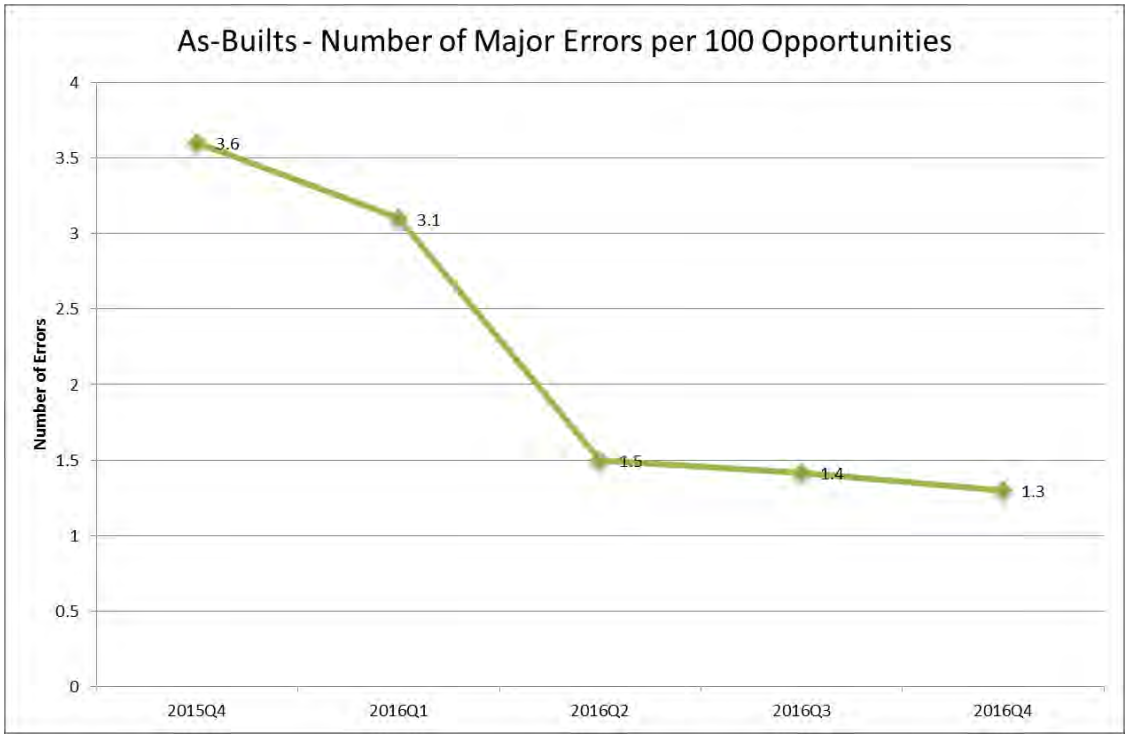


Figure 62 – As-built document improved by 90% after implementation of SGO for Maintenance and Construction, measured by # of major errors per 100 opportunities.

The time required to correct documentation errors from the time construction was complete to the time the documentation was ready for its compliance review (compliance desk (CD) review) improved significantly, requiring 16 days on average at the beginning of 2016, to only requiring 2.3 days

on average by the end of 2016 (See the green line in Figure 63). In mid-2016, the team added a metric to measure the length of time it took to complete the documentation process after construction. Initially, the documentation process was an average of nine days. By the end of 2016, performance improved by almost 50% showing an average of five days (See the blue line in Figure 63). Documentation timeliness increases record accuracy, which in turn supports increased safety for employees, customers and system operations working with or around assets.

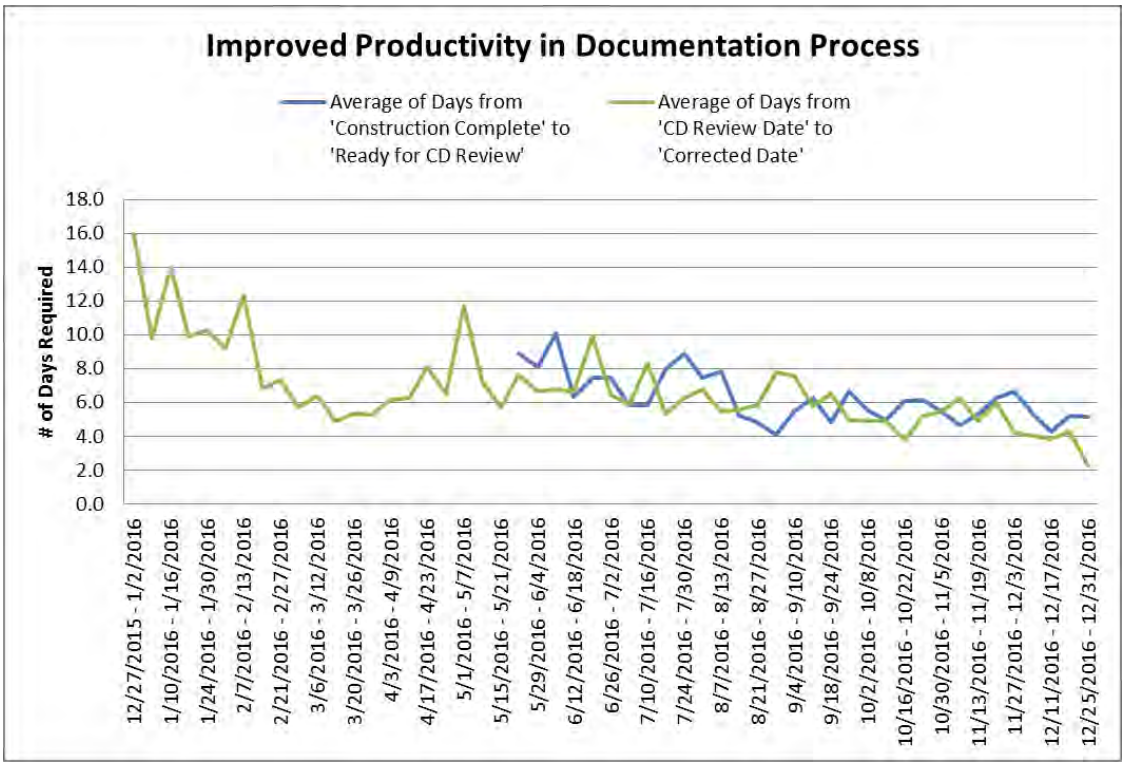


Figure 63 – Productivity improved significantly in 2016, requiring fewer days to complete or correct documentation.

Because of these realized benefits, Gas Operations began implementing the SGO Program principles with other operational processes in 2016, including corrosion, leak management, damage prevention, patrols, and field services and dispatch. SGO process improvements implemented for corrosion work in mid-2016 realized positive results quickly, reducing past-due work tickets by 56% in 90 days. In 2017, Super Gas Operations plans to continue implementing the SGO Program principles for additional operational processes such as stations, work requested by others , and strength testing.

4. 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 Subject Matter Experts 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 International Standards Organization. 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.

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 Transmission and Distribution 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 Interstate Natural Gas Association of America (INGAA), American Gas Association (AGA), NACE International (formerly known as the National Association of Corrosion Engineers), API, ASME, Southern Gas Association (SGA) 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.

Table 26 – 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

d) American Gas Association (AGA)

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 US utility gas companies.

e) Interstate Natural Gas Association of America (INGAA)

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 (NACE) 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 (WEI)

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) 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 27 – 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 2016 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.

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 2015 weighted goals are 50% Safety, 25% Customer, and 25% Financial. In 2014, the weighted totals were: 40% Safety, 35% Customer, and 25% Financial.

4 The Safety and Enforcement Division (SED) has retained NorthStar Consulting to review and analyze PG&E's safety culture. PG&E welcomes and looks forward to SED's and NorthStar's input and recommendations resulting from this report as a means to further PG&E's stated goal of becoming the leading gas utility.

5 American Petroleum Institute Recommended Practice Pipeline Safety Management System Requirements (API RP 1173) outline specific best practices for safe and effective pipeline operations underpinned by a healthy safety culture. For more information, please see Attachment 20 – API RP 1173 Fact Sheet.

6 This system was designed based the elements of Process Safety developed by the Center for Chemical Process Safety, a branch of the American Institute of Chemical Engineers.

7 RC 14001 was developed by the American Chemistry Council, and is based on Responsible Care® Management System and ISO 14001 environmental management systems standard.

8 The reduction in the number of unplanned outages is partially due to decreased demand on the Baja Path and less usage of rental units at McDonald Island.

9 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.

10 As set forth in 49 Code of Federal Regulations Part 192, Subpart O.

11 Of the ten large overpressure events in 2016, six were on the distribution system and four occurred on the transmission system. PG&E's overpressure elimination initiative addresses both transmission and distribution overpressure events.

12 Additionally, a more in-depth discussion of distribution Measurement and Control-related projects for which PG&E is requesting funding is provided in Exhibit (PG&E-3), Chapter 5 of the 2017 General Rate Case.

13 See page 43 for more information on overpressure incidents.

14 A more in-depth discussion of specific programs such as ongoing pipeline replacement programs, cross-bores and other distribution-related reliability programs are covered in Exhibit (PG&E-3), Chapter 4 of PG&E's 2017 General Rate Case.

15 2016 data was not readily available at the time of this filing. Please contact PG&E for updated information.

16 A more in depth discussion of specific programs such as regulator replacement, leak repair and atmospheric corrosion remediation can be found in Exhibit (PG&E-3), Chapter 6A of PG&E's 2017 General Rate Case.

17 A USA ticket is the authorization to excavate issued by the 811 services PG&E and other utilities use. The ticket validates that all underground utilities have been appropriately marked at the excavation site. The ticket further provides special instructions to excavators, such as, "hand dig" or "stand-by required" when excavators dig around certain natural gas pipeline.

18 49 CFR §192.614.

19 California Government Code §4216.

20 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.

21 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.

22 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.

23 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.

24 Tensile stress is when equal and opposite forces are applied on a body, in this case a pipeline.

25 See Attachment 21 for the Leak Survey Process (TD 4110P-01).

26 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 will continue to survey daily until the pending regulations are finalized. Once finalized, PG&E will update its standards to reflect the frequency of the survey required on the facilities identified by DOGGR and CARB.

27 General Order 112F (See Attachment 23).

28 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.

29 2017 GRC Exhibit (PG&E-3), Chapter 6C, page 6C-4, Line9, 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 2017 and believes that in doing so will cover seventy five percent of the distribution system.

30 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.

31 In addition to Leak Survey recommendations, R. 15-01-008 includes acceleration of leak repairs. See Attachment 22.

32 2016 California Gas Report, Prepared by the California Gas and Electric Utilities.

33 American Gas Association, 2016: http://playbook.aga.org/#p=42.

34 "Lockout/tagout" refers to specific practices and procedures to safeguard employees from the unexpected energization or startup of machinery and equipment, or the release of hazardous energy during service or maintenance activities. This requires, in part, that a designated individual turns off and disconnects the machinery or equipment from its energy source(s) before performing service or maintenance and that the authorized employee(s) either lock or tag the energy-isolating device(s) to prevent the release of hazardous energy and take steps to verify that the energy has been isolated effectively. If the potential exists for the release of hazardous stored energy or for the reaccumulation of stored energy to a hazardous level, the employer must ensure that the employee(s) take steps to prevent injury that may result from the release of the stored energy.

35 Supplier Corrective Action Request.

36 This certification will be discussed in more detail in the 2017 Gas Safety Plan.

37 Volume 1 of the Gas Emergency Response Plan contains the Introduction, Emergency Organization and Responsibilities, Concept of Operations, Coordination and Communication, Performance Indicators, Training and Exercises, After Action Reports and Appendices A through E. Volume 2 contains Internal Gas Operations Resource Directory including PG&E personnel contact lists, communications information, logistics, materials, tools, and equipment for use during emergencies. Volume 1 of the 2016 version is provided as Attachment 17. The 2016 Gas Emergency Response Plan was published on December 31, 2016.

38 ASME B31-Q.

39 Mapping Advancement Program is a two-year training program comprised of 17 Workstation Based Training modules to be completed in conjunction with on-the-job training that enables mappers to move from a Mapping Technician to a Senior Mapper.

40 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.

41 In total, PG&E received seven bulletins in 2016. However, two were received in December and were responded to in January, 2017.

42 At the end of 2016, the Field Services organization adopted the Field Services Records Review program to align with QM's operating model.

X. APPENDIX A – LIST OF FIGURES

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XII. APPENDIX C – LIST OF ATTACHMENTS

Attachment 1 – Board of Directors Nuclear, Operations and Safety Committee Charter

Attachment 2 – Chairman's Safety Council Charter

Attachment 3 – PG&E's Gas Asset Management Policy (TD-01)

Attachment 4 – PG&E's Strategic Asset Management Plan

Attachment 5 – PG&E's 2016-01 Gas Distribution Pipeline Safety Report and 2016-02 Gas Transmission and Storage Safety Report

Attachment 6 – 2016 Gas Storage Asset Management Plan

Attachment 7 – PG&E's 2016 Gas Storage Safety Report

Attachment 8 – 2016 Compression and Processing Asset Management Plan

Attachment 9 – 2016 Transmission Pipe Asset Management Plan

Attachment 10 – 2015 Measurement and Control Asset Management Plan

Attachment 11 – 2016 Distribution Mains and Services Asset Management Plan

Attachment 12 – 2016 Customer Connected Equipment Asset Management Plan

Attachment 13 – 2016 Liquefied Natural Gas and Compressed Natural Gas Asset Management Plan

Attachment 14 – 2016 Liquefied Natural Gas and Compressed Natural Gas Station Asset Management Plan

Attachment 15 – 2016 MAOP Establishment Standard

Attachment 16 – PG&E's 2015 Control Room Management Standard (TD-4436S)

Attachment 17 – 2016 Gas Emergency Response Plan

Attachment 18 – PG&E's 2016 Company Emergency Response Plan

Attachment 19 – Gas Operations Quality Management System

Attachment 20 – API RP 1173 Fact Sheet

Attachment 21 – Leak Survey Process (TD 4110P-01)

Attachment 22 – Order Instituting Rulemaking (R.15-01-008) – Leak Abatement and Acceleration of Leak Repairs Recommendations

Attachment 23 – General Order 112F